

# How Prefabricated Modular Manufacturing Can Give You More Advantages Over Prefabricated Offsite Construction



Debates about the benefits of modular prefabricated construction over traditional on-site construction have gone on for decades, but modular performance has improved and is more credible now than it ever has been. With the changing economic times and challenges of cost, schedules and labor in the construction industry, we have seen a large resurgence of prefabrication and modular solutions. There has been substantial growth in the number of new “modular” companies as well as existing long-standing companies moving into the prefabrication and modular manufacturing method of delivery. While this is great for the construction industry, this flood of new offerings into the market has created some confusion among those seeking to understand the benefits and potentially implement this method of design and construction.

## We hope to provide you two things in this article:

A quick comparison between two methods of prefabricated solutions: prefabricated modular manufacturing (PMM) and prefabricated offsite construction (POC)

Why Prefabricated Modular Manufacturing offers the best solution in key areas before, during and after the construction process

Personally, I am an advocate of all prefabricated construction solutions, and while highly debatable, it is my belief that both methods presented should provide benefits over traditional on-site construction. Additionally, it is important to note that neither approach presented will eliminate the need for traditional on-site construction and coordination by construction professionals.

### **What are the differences between Prefabricated Modular Manufacturing (PMM) and Prefabricated Offsite Construction (POC)?**

Prefabricated Offsite Construction and Prefabricated Modular Manufacturing have been intertwined over the past several years and often used in some context as being the same thing. In fact, there are significant distinctions between the two. While there are numerous prefabricated products provided in the industry, for the purpose of this comparison, we will only focus on the Volumetric Modular Units, both Load Bearing and Non-Load Bearing. A volumetric unit can be simply defined as a six-sided, fully finished out room, as an either load bearing or non-load bearing structure. Non-Load bearing structures require a superstructure, typically steel or concrete, in which to be inserted in to. Load Bearing structures are attached or stacked to become the superstructure of the building.

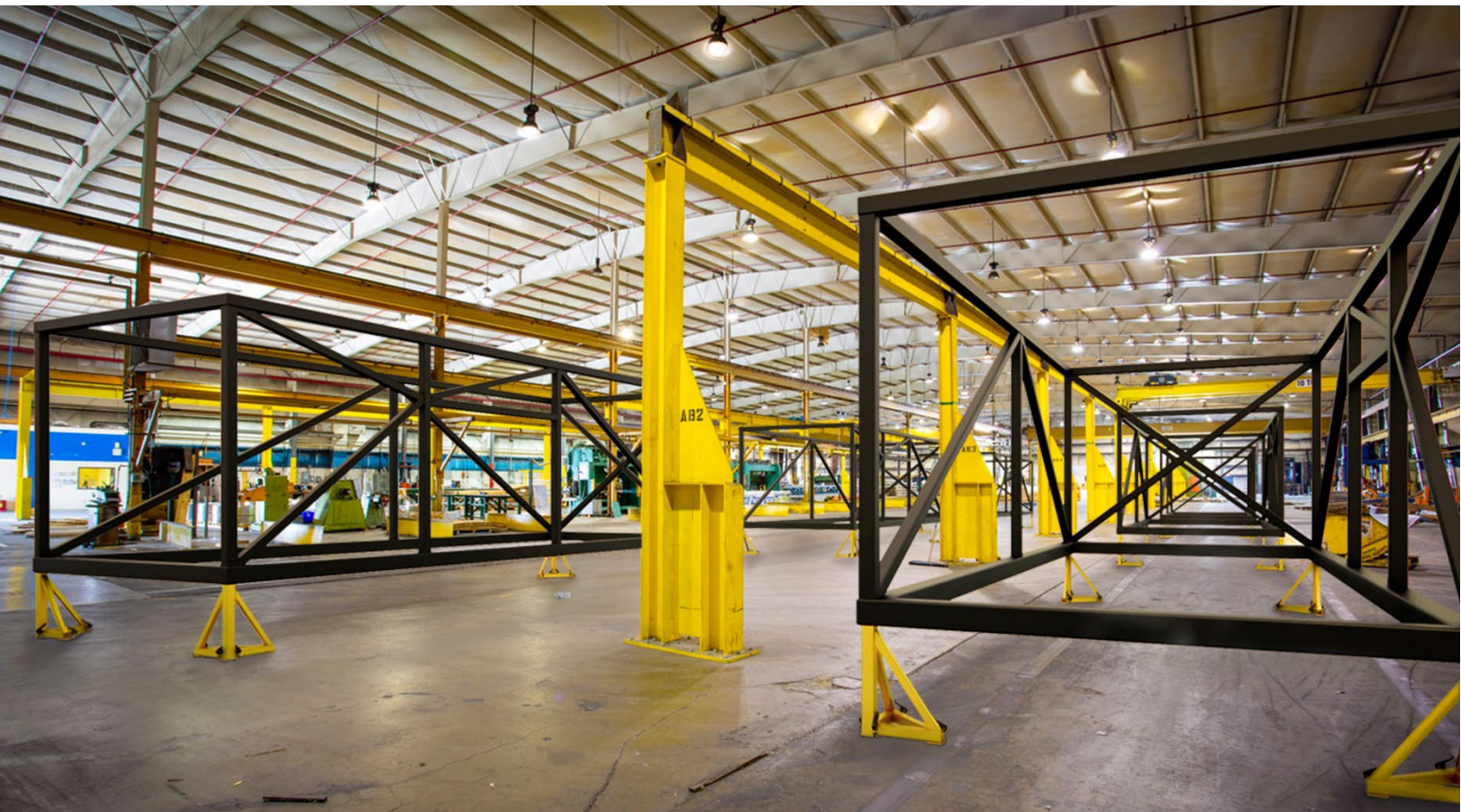
### **What are the definitions of and Prefabricated Modular Manufacturing (PMM) and Prefabricated Offsite Construction (POC)?**

#### **Prefabricated Modular Manufacturing (PMM)**

The method in which a manufacturing company has built a manufacturing plant or factory, with company-employed and trained construction workers, and has received a license and certification by the state for the purpose of fabricating or manufacturing portions or modules of any facility type in a factory line or assembly line method to then be transported to and installed or erected at the construction site in hopes of achieving a faster construction rate than would traditionally allow if done in a on-site sequential order.

#### **Prefabricated Offsite Construction (POC)**

The construction method in which a contracted construction group, typically a General Contractor, Construction Manager and/or a Sub-Contractor is contracted for an individual project and uses a temporary facility, warehouse, factory or other large open space, to construct portions or modules of a building away from the chosen construction site of the particular permanent facility in an effort to overlap portions of the construction process, allowing multiple portions to be built simultaneously, then transported to and installed or erected at the site in hopes of achieving a faster construction rate than would traditionally allow if done in an on-site sequential order.

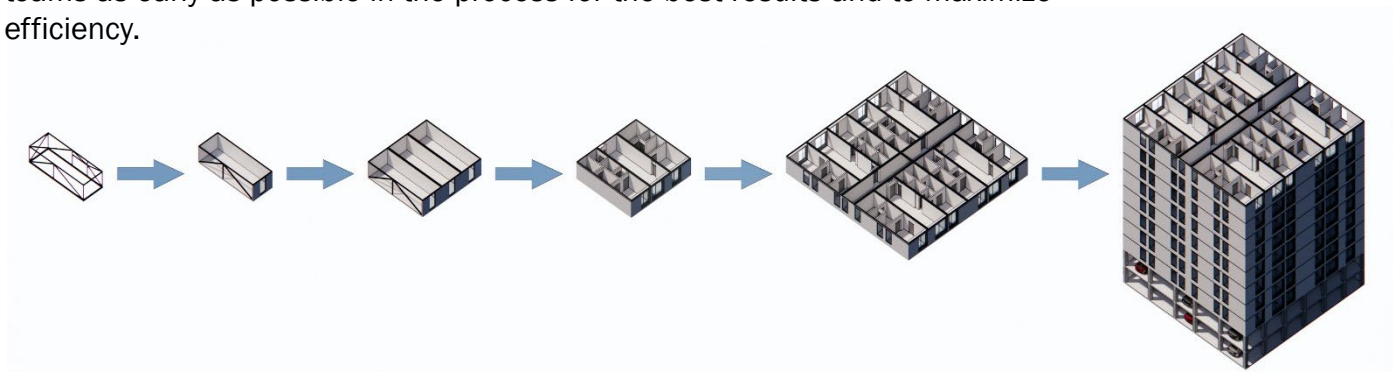


## What are the pros and cons of each method?

It's important to identify the pros and cons of each method through the lens of the full construction process and potential outcomes. I've laid out a few key milestones below and give thoughts on how each method can differ.

### Design

The design is the first critical stage of both implementation methods. It is the stage in which the architecture and engineering (A/E) team must be fully on board with the chosen prefabricated solution. It is also recommended to engage the POC and PMM teams as early as possible in the process for the best results and to maximize efficiency.



### PMM

When utilizing the PMM process, the earlier the PMM company is engaged in the design process the better. Providing design assistance to the A/E team, the PMM team can help to guide the design process for best practices in manufacturing. While this does not completely dictate the design, there are often a few parameters to follow in order to provide the most efficiency. We call this process DfMA (Design for Manufacturing and Assembly), and one step further, unique to MD+, to include DfMI (Design for Manufacturing and Installation). These processes help the A/E to better understand the logistics of the assembly process, the shipping restrictions for best logistical rates and ultimately the installation or erection of the units on site. With a clear understanding of these elements early in the design phase, the team is less likely to encounter late changes or fabrication/construction coordination issues.

### POC

When using the POC process, the recommendation to engage the CM/GC early in the design process is the same. The largest difference in the POC process is, while the chosen GC or CM may have some experience in prefabrication, they are likely using the same traditional on-site sub-contractors that do not. This leaves a potential gap in best practices for prefabrication, as they are likely to provide what they know, which is traditional on-site construction means and methods, only fabricated in a rented warehouse or other facility offsite. In addition, the integrated process breaks down, as in traditional on-site construction, they are likely to produce separate and individual shop drawings from each trade that are not integrated in to one single set. This leaves potential for issues with clash detection that may not be identified until fabrication, leading to further delays and cost. The POC process does not provide for many of the benefits of PMM, such as integrated coordination and design knowledge that a true manufacturing process would provide through a proper design assist process. The POC process does allow for easier competitive bidding later in the construction process and will not likely allow for any proprietary prefabricated systems to be applied due to copyright protected design and fabrication elements.



## Certification/Inspection

The Certification and inspection process in the POC and PMM methods are one of the key differences in the two methods.

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### PMM

The PMM company is a state certified manufacturer of product. This is an extensive process in which the manufacturer has had to receive certification from the state through a series of test, inspections and regulations to hold a license to manufacturer an industrialized modular product. Once they have received this license in their home state, they have to simply apply for approval in the other 50 states, through third party inspections process, in order to be able to deliver their product to those states and have them installed. After the plant is inspected and certified by the state, a third-party inspector at the plant inspects the product during fabrication and upon completion of the assembly line, no other inspection of the unit is required on site. This is how a modular unit can be completely finished out in the plant, sealed, and not required to be opened until the building nears completion on site. Of course, there are a series of inspections and tests all through the assembly line process, but they are all part of the established quality assurance/quality control (QA/QC) process and do not slow down the fabrication line.

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### POC

The POC process is almost the same process as on-site construction inspections, except it is done offsite in a rented warehouse or other facility. The GC/CM is likely not an approved manufacturer, therefore must rely on the local Authority Having Jurisdiction (AHJ) to provide the inspection all through the process, same as they would on-site. This means they are dependent on the AHJ's schedule and availability to provide the inspection before continuing with the fabrication of all units. This can often slow down the prefabrication process leading to schedule delays and/or coordination issues. In addition, if either the AHJ or GC are not experienced in prefabricated modular installation, this could lead to further complications and delays in the on-site installation process and inspections.



### Schedule Compression

Schedule compression is one of the greatest benefits and likely top reasons for deciding to utilize a prefabricated solution in any construction project. As I said in the beginning, both POC and PMM methods will both provide schedule compression, however, PMM is much more predictable over the POC for all the criteria provided in this paper.

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#### PMM

The PMM method will provide the most predictable schedule compression hands down if properly implemented from the beginning. Why? Because it is simple! The key is in the design and coordination from the start of the project and proper implementation of DfMA and DfMI. If the design is properly completed for full volumetric units and is closely coordinated with the manufacturer, studies have shown as much as 50% schedule compression (McKinsey & Company, June 2019 “Modular Construction: From Project to Products). While most of this compression is in fabrication and construction, the process can also be beneficial in the design stages. Often overlooked, the design schedule can also be significantly reduced by utilizing DfMA for the larger and more repetitious portions of the building, allowing designers to focus more on the primary or more critical features of the buildings design. The fabrication will often begin even before groundbreaking, allowing fully finished structural units to be delivered on site as soon as the foundation or superstructure is suitable for installation. The units (fully finished load bearing units) can allow for as much as 80-85% of the facility to be completed off site, thus providing the ability for a large, multi-storied building to be completed in weeks, not months or years, with only minimal on site work required. All this equates to significant cost savings and early revenue generation.

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#### POC

The POC method can provide substantial benefits in schedule compression as well, which would provide many of the same benefits as the PMM method for time savings. The most significant difference between PMM and POC regarding schedule compression is the POC method can prove to be very challenging to fabricate a fully finished load-bearing volumetric unit, therefore this method is typically limited to only the non-load bearing units.

This limitation leaves the project schedule and any anticipated compression dependent on the on-site traditional erection of a super-structure, limiting time savings only to the interior finish out. This reduces the amount of the overall building that can be prefabricated off site to around 30-40% of the total building. In addition, the GC/CM will be tasked with coordination of several sub-trades in a traditional construction process, often leaving gaps in scope and assembly that have to be resolved, leading to costly delays, further reducing the schedule compression benefit.



## Labor

Commonly overlooked in the pursuit of a construction project is the current deprivation of skilled labor in the construction sector. Studies have shown a 2/1 margin of skilled labor leaving the market v. those that are coming into the market among the younger generations (Modular Building Institute: The U.S. Construction Industry: A National Crisis Looming, 2020). In addition, the average age of the skilled labor today is around 42.5, with around a 3/1 ratio of those workers over the age of 55 to those aged between 16-24. We will likely see well over 50% of our skilled labor sector retire over the next ten years with no one to replace them. This will result in substantial cost increases or lower quality construction if something does not change.

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## PMM

When a project is built utilizing the PMM method, it requires approximately a 1/10 ratio of skilled labor when compared to traditional on-site construction. This significantly offsets the deprivation figures while providing a higher quality product. The reason for this offset is the assembly line process. One worker can be trained in a multitude of fundamental tasks, performed at a higher level, therefore they do not require high level certifications typical of on-site skilled labor. In addition, a highly skilled and certified supervisor can oversee more tasks in a smaller area of a few thousand square feet, as opposed to running around a large jobsite of several hundred thousand square feet, attempting to supervise several crews. This provides an environment that results in fewer certified skilled supervisors, while providing a higher quality of supervision and fabrication, faster and at lower cost.

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## POC

A project that utilizes the POC method will also benefit from the smaller work area footprint and greater supervision but will require a larger number of certified supervisors to cover a greater area than compared to PMM. The primary reason for this is the warehouse, most likely temporary, will not be set up in an assembly line fashion. Therefore, the supervisor from each sub-trade will be required to cover the entire floor area of in order to oversee their specific application in each unit. In addition, the sub-contractor will not have a separate crew from the one usually provided for traditional on-site work. They will be building out each unit piece by piece as they would in traditional on-site construction, rather than a set of prefab components coming together in an assembly line fashion. This provides room for more inconsistency of installation and coordination gaps. In addition, change orders can occur more frequently since trades are still working on top of other trades, rather than sequential order, creating punch lists items that can be costly and slow the final inspection process.

## Cost/Savings

The cost and savings are one of the areas most misunderstood in the world of prefabricated solutions. This is because there is no magic wand that makes materials cheaper simply because they are purchased and put together offsite. Unless the manufacturer is using a proprietary system, the modular units will be built with the same or similar materials as would be used in on-site construction as specified by the A/E team. When evaluating prefabricated solutions, it is best to not compare the price, but to compare the cost. To clarify, the evaluation should compare the overall cost savings through the proforma (overall financial results) of the entire construction process, not just the initial bid or estimate of modular units. While the price of materials is relatively the same in both delivery methods, the schedule compression, labor, early revenue generation and other factors are where the overall cost are going to provide savings. The more streamlined the process, the greater the savings. This savings is not a monetary value that can often be shown in the modular or prefabrication companies estimate but should be clearly understood by the GC and ultimately conveyed to the client.



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## PMM

Using the PMM method, the cost and savings of the fabrication alone are extremely predictable. It is like determining the cost of a car model from year to year. While the design may change some, the materials and cost of labor through the assembly line process maximizes savings and provides a very predictable outcome for the owner. In addition, unlike traditional on-site construction, the assembly line is typically in an indoor climate-controlled environment, so there are little to no design or weather contingencies for delays or other mitigating circumstances. This relates to minimal or no changes in the schedule or design, which in turn means minimal to no costly change orders after the design has been completed. In a similar fashion as to how Ford or Chevrolet can tell you the price of a car they may not manufacturer until next year, the streamlined process provides a predictable outcome and savings that can be factored in to the project budget very early in the process.

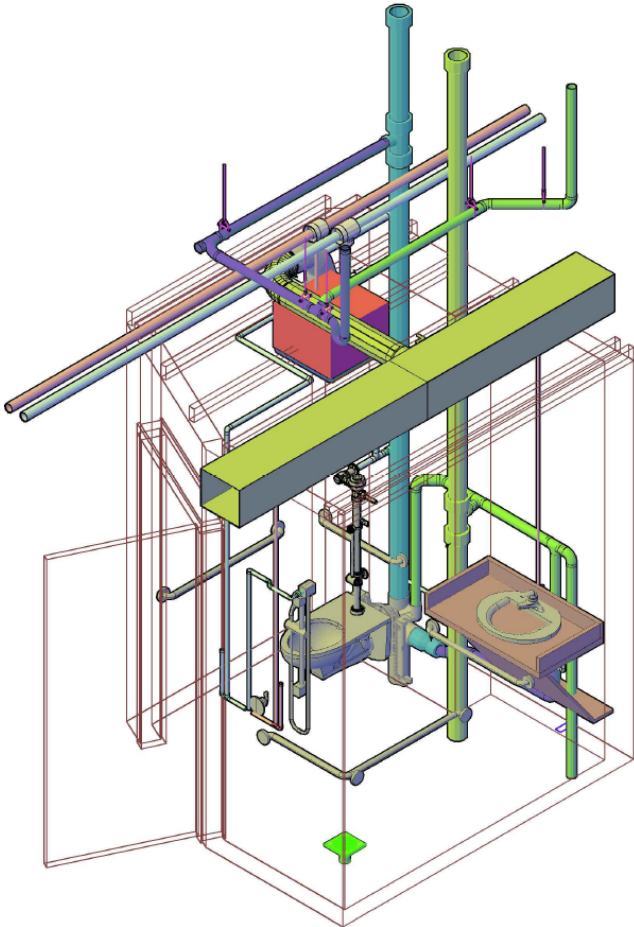
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## POC

Unlike PMM, utilizing the POC method will be similar to the traditional on-site procurement, only done in a warehouse or other facility offsite. The GC or CM will solicit sub-trades in a similar fashion as an on-site project and have them provide bids for the allocated work based on their particular trade. This can often lead to more cost as the sub-trades may or may not be experienced with this type of delivery, therefore will add contingency to their bids. If they are familiar with this method, they are still likely to add contingency and mark-ups to the bid to cover the nonconventional delivery. This process is avoided in the PMM method of assembly line manufacturing for each trade as each trade is an employee of the company and trained in multiple facets of the assembly line process. In addition to the separate sub-contracts, the separate sub-trades have to be managed. The GC/CM will add their mark up for this service on each sub-trade and will need to provide redundant GC management to manage each trade offsite, leading to additional oversight cost. In summary, the POC delivery process is basically the same as the traditional on-site method, only utilizing an offsite location, which provides the added cost of shipping to the site after completion of the units. The only real savings in POC will be that these units are built at the same time as other on-site work is being completed (providing some schedule compression if there are no coordination issues and fabrication runs smoothly) and the ability to competitively bid the units much later in the construction process, if required, but further reduces the benefits of schedule compression.

## Quality Assurance/Quality Control (QA/QC)

QA/QC is where the rubber meets the road when it comes to the most substantial difference between PMM and POC methods of delivery.



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## PMM

The entire PMM process begins with Quality Control (QC) certification of the manufacturing plant. There is an extensive process, regulated in each state, then certification individually for each state outside of where the factory is located, in order to manufacture a licensed product. This ensures that products being manufactured meet strict manufacturing guidelines that are applicable nationally, whether it be a toilet or full load bearing volumetric units that will come together to form an entire building. The regulations from safety to quality of fabrication to final inspection and testing must be met for the factory, the personnel running the factory and the third-party inspectors providing the final manufacturer certification of the product. These requirements are only the beginning of the strict QC process. It should be understood, a product manufactured in a quality-controlled, regulated environment through an assembly line process with many checks and balances throughout, simply means a better built product. This is provided through close oversight, constant testing and verification, and repeatable assembly line processes that only improve with each application, eliminating congestion, coordination and sequencing issues traditionally inherit with on-site construction.

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## POC

The POC process is much more in line with traditional on-site construction. As discussed in the Cost/Savings section, the GC/CM will provide much of the same process with the only difference being that it is done in a rented warehouse or other facility offsite. The contracting of traditional sub-trades will make up the bulk of the prefabrication process. The sub-trades will need to be coordinated across many units across a warehouse floor, determined by the size of the floor space, with little to no inline assembly process. The sub-trades will need to be timed and sequenced to maximize efficiency, a task that is difficult to manage on-site, now applied in a warehouse offsite that only removes weather delays and other mitigating factors. The labor force will be much larger than that of the PMM process, as several units will need to be produced simultaneously in order to keep the flow moving for timely delivery and on-site erection. All these issues, if not properly planned, can cause difficulty and delay, many times coordination and installation issues that can lead to, you guessed it, costly change orders.





## Environmental Impact

Our environment is one of the main concerns of our time not only in construction, but society as a whole. The construction industry is seriously looking at this factor and modular construction can help make sense of the cost considerations when evaluating environmental impact.

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### PMM

Utilizing the PMM method, waste can be reduced to as low as 2-3% through manufactured streamlined processes, compared to average on-site construction around 15%+. This starts with the design, working through the DfMA process discussed earlier in the Design section. By designing for manufacturing and assembly, then implementing the design through a true manufacturing process, almost every inch of every piece of material is accounted for. In traditional on-site construction, 15-20% waste is built into the cost estimate because field installation does not provide as precise of a calculation, resulting in many cuts and adjustments in the field from raw material leading to an excess in discarded cut pieces. In manufacturing, the cuts, and even the cut pieces, are carefully calculated through the DfMA process and used on other areas of the product to significantly reduce, and many times, eliminate waste. This is also assisted, when working with true manufacturers through design assist process, by utilizing generative design software to maximize efficiency and use of materials. With specific lengths and quantities, a licensed manufacturer is also able to order directly from the materials manufacturer, not a materials supply house as sub-trades would be required, providing additional cost savings and further reducing waste and fabrication time in the shop.

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### POC

Utilizing the POC process, again often uses similar methodology as on-site construction, only in a warehouse offsite. The sub-trades will have likely accounted for typically 10-15% waste in the bid and will attempt to stay under that value during fabrication of their specific trade. Now imagine, a project that has 15-25 different sub-trades or more on larger developments, and each of them has accounted for 10-15% waste in each of their specific trades. The waste multiplies quickly. This can add cost to the project very fast as a 20-yard dumpster can cost from \$400-\$700 per load. A typical large commercial job site could have 5-6 of these that are dumped almost daily. This is not only a significant cost to the project imagine how much room this takes up in a landfill. Construction waste adds up very quickly and should be a significant concern not only for how much it cost a project, but the overall impact it has on our environment.



## Safety

Safety, I have saved for last as, in my opinion, it is most critical yet most often overlooked as a key benefit in deciding which method of delivery for a particular project is used. Both POC and PMM will provide a safer environment compared to that of on-site construction, simply because both methods are done in a more easily controlled environment, typically on a ground level.

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### PMM

The PMM method, as stated in the QA/QC section, by far provides a safer working environment because it is built from a QC process that is closely regulated. This process is regulated by both the state and third-party inspection groups in order to receive the initial manufacturer license. These regulations have higher restrictions and certifications requirements for OSHA certified safety managers and management staff in general. The manufacturing factory and assembly line process will be built from the start with safety as a top priority, from strategically located safety equipment and medical stations to cooling rooms and painted warnings and protective zones. In addition, because it is an assembly line process, the safety protocols of each station and the person managing it is inherent in the training process and that specific zone of the plant. Much like entering into the same building you work in day in and day out, you know the layout, where things are located such as fire exits, stairs, extinguishers and fire alarm pulls.

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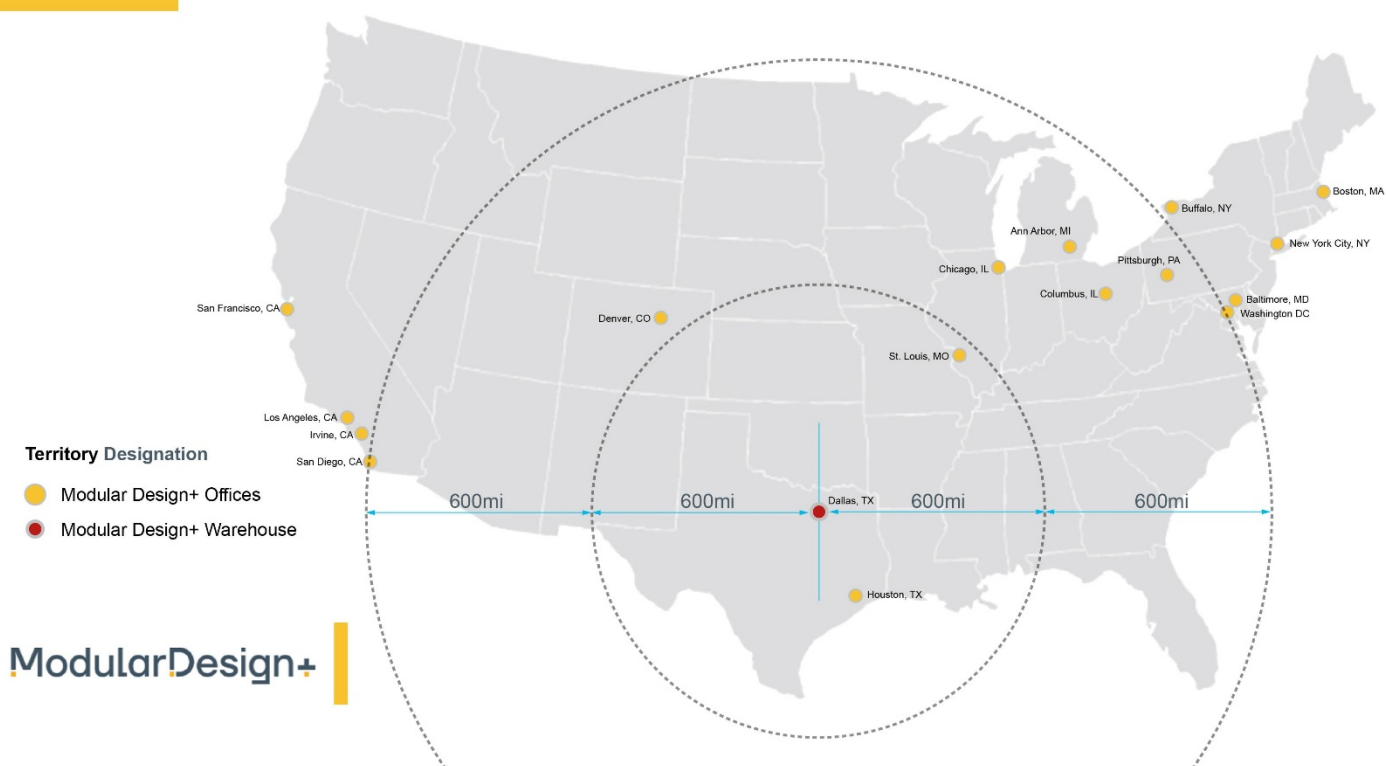
### POC

The POC method of delivery is typically completed inside a make-shift warehouse or other facility rented specifically for a one-off project. The space is adapted in the most cost-effective way to keep within budget, therefore many items applied, such as safety equipment and supplies, are temporary, much like on-site construction. The safety measures and protocols must still meet OSHA safety requirements, and the sub-trades will have some training, however, they come into the space and operate much like they would with on-site construction. They communicate as needed with the other trades but are only intermittently tied to them. This is very different of what would be in a manufacturing plant where all are employed by the same company and likely following all the same policies, rules and regulations. This make-shift or temporary type of environment can create disorientation, as the sub trade worker will likely be working in a different area day in or day out and would have to familiarize themselves with the orientation of safety equipment and/or safety exits and medical stations on a daily basis.

In conclusion, both methods will offer benefits over traditional on-site construction that should be carefully considered when deciding how to approach your next project. This paper was not a comprehensive dive in to all the differences, and I will admit, some of the information is skewed based on my 24 years of personal experience.

The results will vary from project to project and different facility types, manufacturing companies, GC's, A/E teams and all involved in the development of any given project, but the overall high-level evaluation should hopefully clear the air and provide a little more definition to what is Prefabricated Modular Manufacturing vs. Prefabricated Offsite Construction.

## Distribution Reach



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Sean currently serves as President of ModularDesign+, a Prefabrication Modular Manufacturing company based in the Dallas/Fort Worth area. With a focus on the study and design of large residential developments across the country, Sean's 23+ year career includes working with a multitude of clients across municipalities, universities and private developers. His portfolio features the design, management and production of several complex, multi-million dollar residential facilities with major developers and prime institutional clients.

Through his extensive experience over the past 23+ years, Sean has seen a change in the market, a demand for higher quality housing, delivered sooner at a more affordable rate through an integrated delivery model. This is the primary reason Sean is leading the charge in innovative solutions through modular design and construction with ModularDesign+.

He is a member of the American Institute of Architects, Texas Society of Architects, National Council of Architectural Registration Boards and Modular Building Institute.