

2021
PERMANENT
MODULAR
CONSTRUCTION

REPORT



About the Modular Building Institute – The Voice of Commercial Modular Construction

The Modular Building Institute (MBI) is the international nonprofit trade association serving the commercial modular construction industry for over 35 years.

As the Voice of Commercial Modular Construction™ MBI promotes the advantages of modular construction while advocating for the removal of barriers that limit growth opportunities.

Through its long-standing relationships with member companies, policy makers, developers, architects, and contractors, MBI has become the industry's best resource for information for the commercial modular construction industry.

Acknowledgements and Special Thanks to:

Members of the Modular Building Institute for providing corporate and project data for this report.

Modular Administrative Programs – The industry's regulatory partners tasked with ensuring public safety and building compliance.



Cover:

Trethewey Avenue Supportive Housing Complex (exterior).
Built by Nomadic Modular Structures Inc. & Grandeur Housing.
Honorable Mention, Permanent Modular Multifamily
Over 10,000 sq. ft.

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The definitive source for information about permanent modular construction in North America



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Region 1 – Maine, Vermont, New Hampshire, Massachusetts, Connecticut, Rhode Island, New York

Region 2 – Virginia, West Virginia, Pennsylvania, Maryland, District of Columbia, Delaware, New Jersey

Region 3 – Florida, Georgia, Alabama, Mississippi, North Carolina, South Carolina, Tennessee

Region 4 - Louisiana, Texas, Arkansas, New Mexico, Oklahoma

Region 5 – Ohio, Kentucky, Indiana, Michigan, Illinois, Wisconsin, Minnesota, Iowa, Missouri

Region 6 – California, Arizona, Nevada, Utah

Region 7 – Oregon, Washington, Idaho, Alaska, Hawaii

Region 8 – Colorado, Kansas, Nebraska, South Dakota, North Dakota, Wyoming, Montana

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OVERVIEW

SECTION 1

of Modular Construction Industry

The modular construction industry is primarily regulated at the state and local levels by building code administrators and authorities having jurisdictions. As with site-built structures, a building constructed using the modular process must meet the local codes where the building will be placed. Unlike federal manufactured housing products, built in accordance with the Housing and Urban Development (HUD) standard, there is no specific “modular building code” or exceptions for a building constructed utilizing the modular construction process. It is simply a more efficient process to construct building components at an offsite facility, and then transport and assemble components of a building at the final building site.

Good Samaritan Pediatric ED Addition (exterior).
Built by Axis Construction Corp. & Modlogiq Inc.
First Place, Permanent Modular Healthcare.



Modular construction can be utilized for a variety of uses including residential, commercial, or industrial applications. MBI represents the commercial sector of the industry.

Commercial Modular Buildings are nonresidential factory-built building components and structures designed to meet all applicable building codes. Commonly, these buildings are constructed in accordance with the International Building Code (IBC) in the United States, the National Building Code (NBC) in Canada, or a local version modeled after these codes. In this context prefabricated, mechanical, electrical, or plumbing (MEP) systems are not included for industry revenue and production figures.

The commercial modular building industry is comprised of two distinct divisions, both represented by MBI.



Relocatable Buildings (RB) – Relocatable buildings, as defined in the International Building Code, are partially or completely assembled buildings constructed and designed to be reused multiple times and transported to different building sites. This segment of the industry maintains fleets of relocatable buildings offered for sale or lease to customers.

Permanent Modular Construction (PMC) – PMC is an innovative, sustainable

**Good Samaritan Pediatric ED Addition (interior).
Built by Axis Construction Corp. & Modlogiq Inc.
First Place, Permanent Modular Healthcare.**



construction delivery method utilizing off-site, lean manufacturing techniques to prefabricate single or multi-story whole building solutions in deliverable volumetric module sections. PMC buildings are manufactured in a safe, controlled setting and can be constructed of wood, steel, or concrete. PMC modules can be integrated into site-built projects or stand alone as a turnkey solution, and can be delivered with MEP, fixtures, and interior finishes in less time, with less waste, and higher quality control compared to projects utilizing only traditional site construction.

PMC buildings are subject to the same building codes and requirements as site-built structures, depreciate in much the same manner, and are classified as real

property. This segment of the industry provides construction-related services for the successful design, manufacturing, delivery, installation and finish-out of commercial and multi-family buildings.

This report focuses on permanent modular construction division (PMC).

Unlike other “prefabrication” reports, which rely almost exclusively on publicly available data and often include a mix of construction methodologies under the off-site construction umbrella, MBI obtains industry information for this report from multiple sources including:

MBI member surveys

Each year, MBI asks all members for data regarding their annual revenues, sources of revenue, markets served, production, capacity, and total employees.

MBI’s project database

Through the annual Awards

of Distinction contest, MBI gathers specific project data to calculate average square footage of buildings by market type, average days to complete by market type, modular project cost, and total project costs.

Construct Connect Insight (formerly Reed Construction Data)

MBI uses this database to determine the baseline for new construction starts in key markets and to measure overall industry market share.

Publicly available data

such as news stories, public filings (U.S and Canada), and corporate websites.

Every effort has been made to ensure the accuracy and reliability of this data. In some cases, MBI’s best estimates and member experience are used. Given that no one, single source for this information exists regarding production, revenue, and market

share for the entire commercial modular industry in North America, MBI is confident that this report represents the most comprehensive and accurate information available on the commercial modular construction industry in North America.

About Permanent Modular Construction

Many industries regularly use permanent modular construction, including schools, banks, restaurants, hospitals, hotels, medical clinics, and housing developers. The industries that utilize our services are numerous (as measured by the North American Industry Classification System, or NAICS), but the most common categories include:

236116 New Multi-family Housing Construction

236220 Commercial and Institutional Building Construction

Modular construction helps owners and contractors address:

Quicker occupancy

Streamlined construction process, in many cases 30-50 percent faster than with conventional construction.

Labor shortages

More efficient use of skilled labor with a safer work environment

Predictability

Due to the shortened construction schedule, up-front materials purchases and reliable labor, modular projects provide a hedge against construction market uncertainty.

Reduction of waste

Utilizing modular construction methods can reduce the amount of waste that ends up in landfills by more than 50 percent compared to a comparable site-built project.

The term “modular” describes a construction method or process where individual modules stand alone or are assembled to make up larger structures. Unlike relocatable buildings, these structures are intended to remain in one location for the duration of their useful life; thus, they are permanent. Permanent modular buildings may be wood-frame, steel, or concrete and can have as many stories as building codes allow.

Industry Standards

The North American modular industry is currently made up of over 250 regional manufacturers building everything from construction site offices to single-family homes and hotels. The industry is regulated primarily at the state level through administrative agencies that implement and enforce the rules for building in that state.

However, only 35 states (and one Canadian province) have

such a program. This means the remaining jurisdictions rely on local code officials to determine compliance and safety. Additionally, the programs lack a degree of uniformity in requirements and even terminology. For example, the program in Massachusetts is referred to as the “manufactured buildings program,” while in other states the industry is referred to as “industrialized buildings,” or “factory-built housing.”

MBI is currently working with the International Code Council to develop two new industry standards for various aspects of modular and offsite construction, including standard definitions. Once developed, these ANSI standards will address how modular buildings get approved, among other aspects of construction. Currently, the various state program requirements make it extremely challenging and costly for regional manufacturers shipping into

multiple states. Helping to develop and implement more consistent administrative rules will improve efficiency and lower costs.

MBI is also working with the Canada Standards Agency for the development of a new standard for multi-story modular buildings including transportation, installation, and module-to-module connections. Preceding this work, MBI helped CSA with standards research which led to the development of a June 2020 publication titled: *High-Rise Modular Construction: A Review of the Regulatory Landscape and Considerations for Growth*.

Stages of Modular Construction

Primarily, four stages make up a modular construction project:

UNION FLATS IN SAN FRANCISCO CA | FROM DAVID BAKER ARCHITECTS | GUERDON MODULAR BUILDINGS | DCI ENGINEERS

01.



Design approval by the end-user and any regulating authorities

02.



Assembly of module components in a controlled environment

03.



Transportation of modules to a final destination

04.



Erection of modular units to form a finished building

Approval Process

Thirty-five states in the U.S. and one Canadian province (Alberta) have an administrative agency that oversees and regulates the modular construction industry. While the terminology sometimes differs (see next section on industry standards), the general procedures for building inspection and approval are similar. In the states where no agency exists, the local Authority Having Jurisdiction (or AHJ) is responsible for the inspection and approval process.

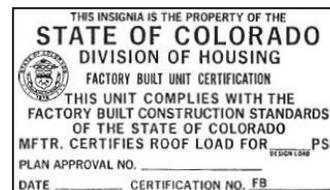
The administrative rules of each agency provide for safety standards and inspection procedures for industrialized building construction, design, and manufacture. Buildings and building components are either inspected and approved directly by the agency staff or by a third-party inspection agency (TPIA) or engineering firm acting on behalf of the agency.



City of Cottonwood Shores Police Department Headquarters (exterior). Built by Ramtech Building Systems, Inc. First Place, Permanent Modular Correctional

Buildings constructed using the modular process must comply with all applicable building code requirements including wind, snow, and seismic conditions. Because most elements of the building – including electrical and plumbing – are completed and “closed” off-site at the modular manufacturing facility, the inspection protocols must be clear and concise. Local code officials must be assured that the building has been inspected and will meet all requirements so that destructive inspections do not need to occur once the building is on site.

Once inspected and approved, modular/industrialized building components are deemed to have met all the applicable code requirements and a modular program label or insignia will be affixed to the module (see image below of sample state insignia).



Example of state modular code label.

Once the modules are delivered to the final site, other requirements are subject to approval at the local level. These requirements may include land use and zoning, local fire zones, site development, building setback, side and rear yard requirements. Other requirements could be property line requirements, subdivision regulations, subdivision control, review and regulation of architectural and aesthetic requirements, foundation design, utility, and module connections.

SECTION 2

DESIGN

Considerations

Construction of New Camp Antamina Phase II (exterior). Built by Tecno Fast S.A. First Place, Permanent Modular Workforce Housing



Lindisfarne Hall (exterior). Built by Vesta Modular & Diamond Builders, Inc. Honorable Mention, Permanent Modular Assembly



Design for Modular Manufacturing

In 2019, MBI worked with the American Institute of Architects to help develop a new guideline called “Modular and Off-Site Construction Guide.” This Guide serves as a primer on the modular approach for architects and includes:

Value and opportunities of modular design

Pitfalls designers should be wary of

Case studies that exemplify successes and obstacles



The document can be downloaded for free at:
<https://www.aia.org/resources/6119840-modular-and-off-site-construction-guide>

Architect's Role

In general, the architect's role in a construction project is critical to its overall success. The decision to utilize modular

construction should be made prior to design and should factor in the following considerations:

- Three-dimensional modules have widths that are typically nominal eight, 10, 12, 14, and 16 feet, with 12 and 14 feet

being the most common. Framing dimensions are typically two inches less than nominal size.



Dialysis Treatment Center (exterior).
Built by Black Diamond Group. Honorable
Mention, Permanent Modular Healthcare.

- Module lengths are up to 70 feet, usually in two foot increments.
- Module heights vary from approximately 11 feet, six inches to 13 feet, not including the height of the unit’s transport trailer or frame.
- Wood-frame construction is the most common type of construction; however, manufacturers also build with steel and concrete and can meet the requirements for Type-I, -II, and -III construction.
- Multi-story modular buildings can be built up to the maximum stories allowed by code. While most modular buildings are one- to four-stories, a growing number of projects have exceeded 10-stories in recent years, including a 32-story project in New York.
- Restroom areas should be designed so that a module “marriage line” does not split the space.
- Multiple roof-framing styles are available. Some can be completed in the factory, and some may require the installation of trusses on-site.
- Modular buildings can be configured using modules of various lengths and widths.
- Design elements need to be decided earlier in the process (paint color, for example) as the off-site construction process begins and is completed more quickly.

Best Practices for Design of Modular Project

(Excerpts taken from MBI’s Modular Advantage magazine: May/June 2021)

Anthony Gude emphasizes the familiar advice to bring all the key players on a project together early in the design process. “Everyone says this — because it’s true!” Gude says. “Nobody has all the necessary information at the start, especially on innovative or large-scale projects. A conference call with 20 or 30 people giving input at the pre-design stage is not uncommon.”

There will be numerous design iterations while the team explores project feasibility and it’s important to remain flexible during this process. “Re-designs — such as designing a whole building in steel and then re-designing in wood, or vice versa — often happen because someone was pulling in a particular direction too soon,” Gude says. “So have that group discussion first and get all the information and constraints on the table from the beginning.”

**Anthony Gude, Operations Director,
R & S Tavares Associates**

Once the scope of the project is understood, Eric Parnell says it’s important to understand any and all codes and/or ordinances that need to be followed.

“Local codes and ordinances are another area to research and pre-plan to comply or work with local authorities to ensure a smooth project. Local codes and ordinances can vary wildly by different jurisdictions and can include setback restrictions, location of occupancy restrictions, exterior finish requirements, and even an outright ban on modular construction (as discussed earlier). To avoid endless delays



College of Idaho Dorms (exterior). Built by Lochsa Engineering & indieDwell. Honorable Mention, Permanent Modular Dormitory

and issues, a meeting with local authorities to discuss the plans and to show that a custom modular does not resemble a ‘traditional portable building’ can ensure the process can move forward before being offered to a client.”

Eric Parnell, architect and founder, ArchBoutant LLC

Once it’s time for to begin construction, Nick Gomez underscores the need for a finalized design.

“It is essential to establish a design freeze using a modular construction approach because of the factory production schedule and process. Design changes late in the process can be costly and require permit drawings modification and impact factory shop drawings. Unlike traditional construction processes, up-front decision-making and design freezes are critical for the modular construction processes, leaving little time in the schedule for alterations.”

Nick Gomez, Studio Director, Multi-Family Housing, Lowney Architecture

During the construction phase, Kendra Halliwell recommends spending time at the factory to ensure compliance and to see the process firsthand.

“The Architect/Engineers of Record and contractor/installers on site are ultimately responsible for closeout and affidavits. Our General Contractor maintained oversight of the boxes in the factory during construction, with observation from the representative of the state review board. The mechanical contractors also visited the factory so they were aware of exactly what was coming to the site. Additionally, visiting the factory allowed the team to see the benefits of modular construction firsthand: construction jobs are created in a safe, controlled work environment, with less waste and no exposure to weather.”

Kendra Halliwell, AIA, LEED-H AP, Associate Principal, Practice + Design Team Leader, ICON Architecture

Industry DRIVERS

Labor Shortages

According to a recent report by the Associated General Contractors (AGC), “A severe labor shortage will continue to plague the construction industry, driving up construction costs further.” The report shows that 79 percent of construction companies wanted to hire more employees in 2019, but the industry

is only estimated to grow its workforce by half a percent annually for the next ten years. That is hardly enough to make up for the 600,000 jobs lost since the last recession. The Covid pandemic appears to have made the problem even worse.

According to the U.S. Bureau of Labor Statistics, the median

age of construction workers in 2018 was 42.5 years. Two-million-four-hundred thousand of those workers are age 55 or older, while only one million are age 16-24. Simply put, the number exiting the industry is exceeding the number entering by a 2:1 margin.

Of course, the modular industry is experiencing the

same labor challenges and labor is still needed to staff factories. But the modular industry is well positioned to tap non-traditional sources that the construction industry has not or cannot tap. Imagine a new automated facility in your town, employing men, women, minorities, and the disabled. Swinging hammers would be a thing of the past, replaced with programmers



Aqsarniit Hotel and Conference Centre
(exterior). Built by Stack Modular.
First Place, Permanent Modular Hotel

monitoring the automated equipment utilization for wall assemblies. Imagine a whole new generation learning about 3D modeling and animation on computer screens to simulate actual projects to prevent costly on-site errors.

To be fair, the industry is not there yet – at least not at scale. While some modular manufacturers incorporate automation and robotics that rival any factory, most are still considered “off-site construction” operations. Even so, the assembly line process requires fewer labor hours to complete a project compared to a typical site-built project.

One area where the modular industry can help with labor shortages is when the manufacturer acts in the capacity of a subcontractor, or “super-sub.” In the same manner that a computer scientist is not required to build computers and an auto mechanic is not required on the Toyota

assembly line, semi-skilled workers are utilized on the factory floor at various stations of the building assembly with strict control measures to ensure code compliance and quality. A general contractor can “sub out” a significant portion of a building to one company, rather than tracking down multiple trades.

High Housing Demands

The National Low Income Housing Coalition (NLIHC) reports a shortage of seven million available and affordable rental homes for America’s extremely low-income (ELI) renters in its annual report, “The Gap: A Shortage of Affordable Homes 2019.” This shortage leaves only 37 available and affordable homes for every 100 ELI renter households. The Coalition found that no state or major metropolitan area has an adequate supply of rental housing for its poorest renters.

Households are considered housing cost-burdened when they spend more than 30 percent of their incomes on rent and utilities. They are considered severely cost-burdened when they spend more than half of their incomes on their housing. More than nine million extremely low-income renters, five million very low-income renters, and four million low-income renters are cost burdened.

The severe shortage of affordable homes for extremely low-income renters is systemic, affecting every state and metropolitan area. Absent public subsidy, the private market is unable to produce new rental housing affordable to these households because the rents that the lowest-income households can afford to pay typically do not cover the development costs and operating expenses of such housing.

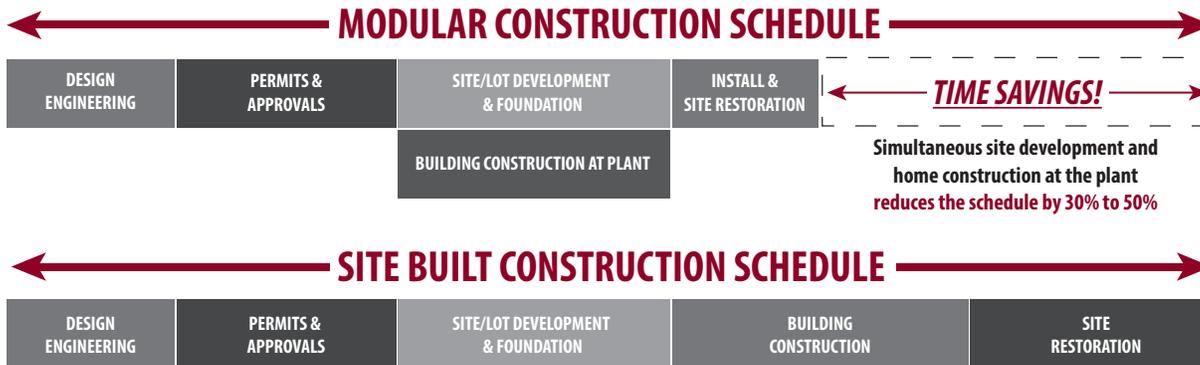
Housing authorities can no longer ignore construction

processes that help address the chronic housing shortages. Several agencies are starting to reexamine housing policies to include “innovation credits” for completing projects more quickly, an area where modular construction excels.

Jurisdictions such as Salt Lake City and the City of Chicago have recently recognized modular construction as a viable tool to help address housing needs. The Canadian Mortgage Housing Corporation (CMHC) went a step further and allocated \$1 billion towards their “rapid housing initiative” requiring all projects to utilize modular construction. The agency was surprised when over \$4 billion in qualified applications were received and is now evaluating whether to allocate additional funding.

If you have ever tried to build a custom building in the dead of winter or during hurricane season, you understand that

Shorter Schedules / Quicker Return-on-Investment



the weather has a huge effect on how long it takes your building to be constructed. Inclement weather can cause site-constructed buildings to take months longer than anticipated.

The ability to construct building modules in a factory while simultaneously preparing the building site work leads to a shortened construction schedule, quicker occupancy, and therefore, quicker return on investment.

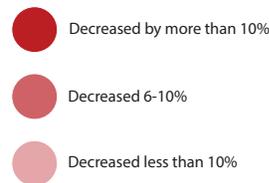
Time is money, especially where construction is concerned. If you are creating a business, delays in construc-

tion equal delays in revenue. Hotel rooms cannot be rented, hospital equipment cannot be installed and inventory cannot be stocked until your building is complete.

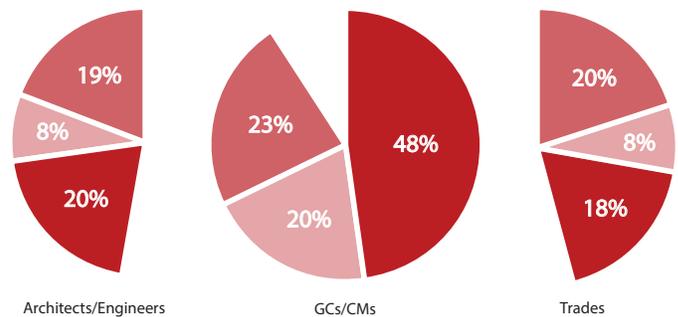
Modular buildings are significantly faster to build than traditionally crafted buildings. In fact, numerous case studies demonstrate that modular buildings take 25-50 percent less time to build than traditional buildings.

Cost Savings

Dodge Data & Analytics' Prefabrication and Modular Construction 2020 Smart Market Report captured cost



Cost Savings



Impact of Modular Construction on Project Budget Performance
(Percentages Reporting Each of Three Levels of Improvement)
Dodge Data & Analytics, 2020

savings data from general contractors and construction managers. Ninety-one percent of all general contractors/construction managers responding (48 in total) reported a favorable impact on project budget performance, with many citing “cost certainty” as a key benefit.

Over the years, MBI has found some contractors and companies that benefit from the advantages of modular construction may have in fact experienced a cost increase on their first modular project but gained efficiency and savings on future projects due to a greater understanding of the process.

Environmental Impact

According to the Environmental Protection Agency, construction waste and debris is one of the largest contributors to landfills annually. While construction demolition of existing structures represents

about 90 percent of this landfill waste, new construction activity accounts for nearly 57 million tons of landfill waste.

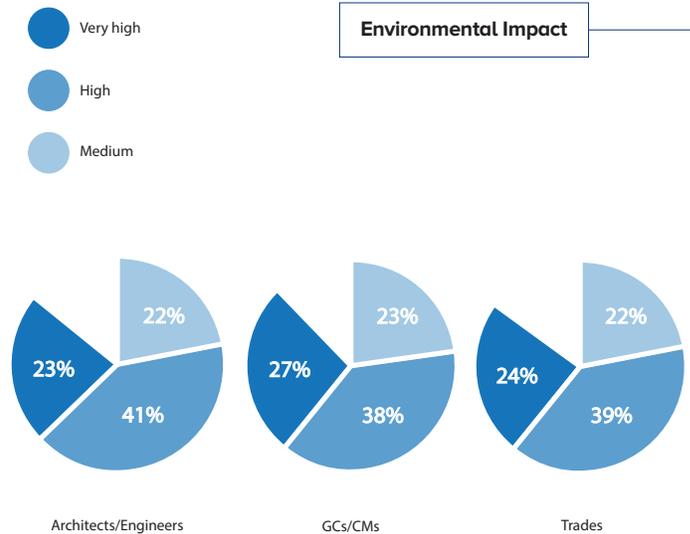
Of the 203 architect, engineer, and contractor respondents to the Dodge Smart Market Report, only one percent indicated that modular construction had no impact on reducing waste, while five percent were unsure. Sixty-five percent said that it had a high or very high impact on reducing waste generated by construction activities. Among the 59 contractor respondents, 97 percent report that modular construction does have a positive impact on reducing construction waste, while three percent were unsure.

On two occasions, MBI commissioned university-based research to determine the environmental impact of modular construction compared to traditional site-built construction.

The University of Virginia conducted a study (Quale, et.al.) using life cycle assessment to quantify the environmental impacts of constructing a typical residential home using two methods, based on data from several modular construction companies and conventional homebuilders. The study, peer-reviewed and published in the *Journal of Industrial*

Ecology, included impacts from material production and transport, off-site and on-site energy use, worker transport, and waste management.

In terms of materials usage and waste, homes constructed using a modular process were found to use about 17 percent less material overall. This included greater material use



Impact of Modular Construction on Construction Waste Reduction
 (Percentages Reporting Medium, High, or Very High Contribution)
 Dodge Data & Analytics, 2020

for modular mate lines and transportation but significantly less material waste for modular. In fact, the modular homes sent about 75 percent less wood and drywall waste to the land fill per project (1,380 lbs. for modular vs 5,500 lbs. for conventional). Worker transport to the jobsite daily had a negative impact for conventional construction while energy use in the factory added to the environmental impact for modular construction projects.

The analysis revealed that environmental impacts from modular construction are, on average, lower than those from on-site construction with total greenhouse gas emissions about 30 percent less by using modular construction.

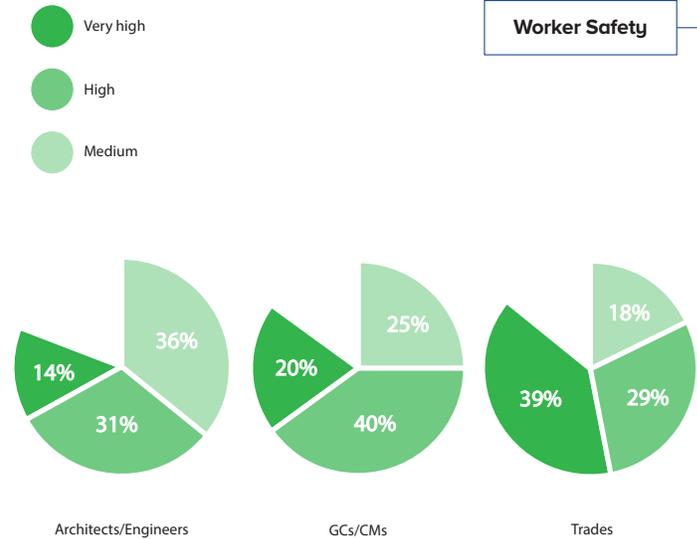
A study conducted by the University of Alberta (North Ridge CO2 Analysis Report – Al-Hussein, et.al.) comparing modular and on-site construction noted even greater

advantages for modular construction. The research found that by using modular construction, the overall schedule was shortened by four months on an 11-month project and CO2 emissions were reduced by 43 percent.

Worker Safety

Modular construction has demonstrated the ability to provide a safer environment for the construction workforce. By shifting as much as 80 percent of the building construction to an off-site, factory-controlled setting, workers have a much more predictable and consistent work atmosphere. Additionally, the ability to construct multi-story buildings in modules while remaining on the ground floor of a factory virtually eliminates hazards associated with falls, one of the most common accidents in the construction industry.

The 2020 Dodge Smart Market Report addressed the issue



Impact of Modular Construction on Improved Safety Performance
(Percentages Reporting Medium, High, or Very High Contribution)
Dodge Data & Analytics, 2020

of workplace safety and their research findings support MBI’s position. Of the 203 responses received regarding safety, only five percent of architects, engineers, and contractors indicated that the use of modular construction had no demonstrated safety benefits, while 89 percent indicated it did (six percent unsure).

Of the 48 general contractors responding, only eight percent said that modular construction had no impact on improving

safety, while 69 percent said it had a high or very high impact. The results are even more dramatic among large contractors with revenues over \$100 million annually. Among the 18 contractors in that subset, half said that modular construction had a “very high” impact on safety. A full 100 percent of these respondents said that modular construction had a medium (11 percent) high (39 percent), or very high (50 percent) impact on worker safety.

SECTION 4

Key North American MARKETS



Permanent modular buildings are considered real property, built to the same building codes and requirements as site-built structures, and can be financed, sold, and depreciated in a similar manner. As such, the markets for permanent modular construction are like the markets for site-built contractors, with few exceptions. MBI has identified the following key markets for PMC in North America:

Office and Administrative

Permanent modular buildings serve as corporate headquarters, satellite offices, institutional and administrative buildings, and offices for all business types. Modern single- and multi-story buildings can be configured in several ways to include independent offices, conference rooms, elegant lobbies, kitchens, restrooms, and large open spaces for cubicles or other partition systems.

MBI members have architectural and engineering designs for workspace planning, storm water management, landscaping, parking, and zoned heating and air conditioning. If it is time to capitalize on company growth, modular construction offers a fast, economical approach.

The business and office market historically represents one the largest building sectors for the industry. In 2020,

manufacturers reported that 25.8 percent of all production was in the office and administrative market, the highest among all markets reported.

MBI analyzed 28 office and administrative buildings constructed from 2015-2018. The average size of the buildings was 17,348 sq. ft., with the modular portion making up 15,313 sq. ft. or 88 percent of the overall footprint. The average total cost for the six of the buildings MBI obtained data on was \$2,804,099. The modular portion of the building made up 47 percent of the total cost.

MBI also obtained data and analyzed information on an additional thirteen projects completed in 2019 and 2020. The average size of these projects was smaller than the prior averages, at 9,882 sq. ft., consisting of an average of 16 modules each. These projects took on aver-

age 202 days to complete from approval to occupancy.

Based on financial data obtained on ten of these projects, the average cost of these most recent modular office projects was \$869,604 with the modular portion of the cost making up \$600,419 or about 69 percent of the total project cost. For these ten projects, the average cost was \$297 per square foot.

This trend towards smaller projects and a higher percentage of modular costs indicates that this market is less impacted by the “hybrid” construction process with industry companies providing more of a turn-key approach to these projects.

Multi-Family Housing

Federal, state, and local governments around the world are struggling with policies to help address the growing housing crisis. Modular construction offers the ability

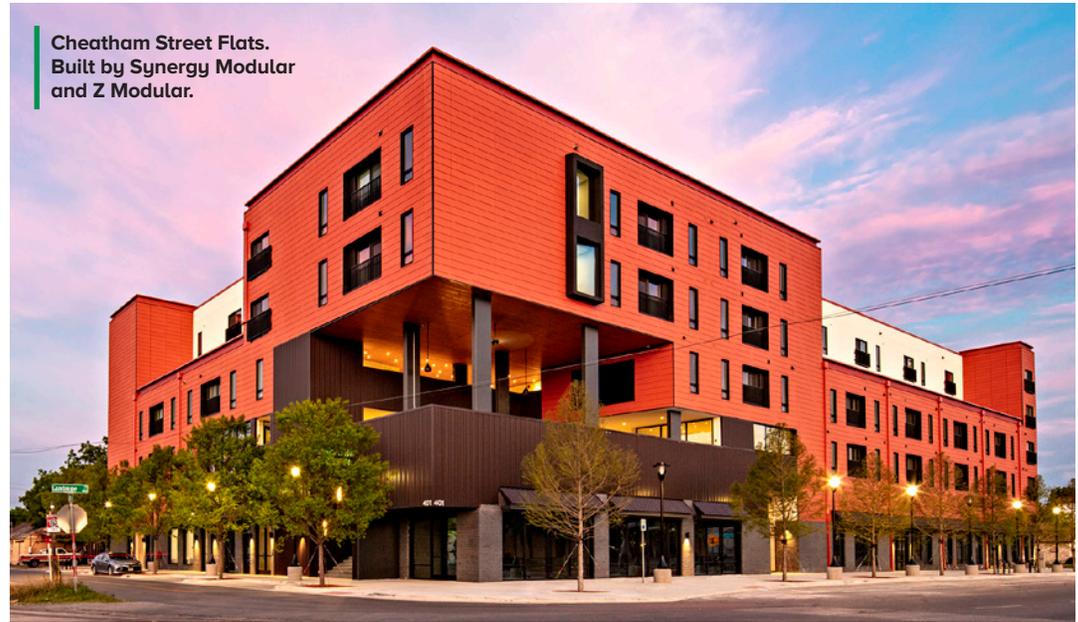
to provide condominiums, apartments, and student dorms in about half the time as traditional, site-built construction methods.

In fact, the multifamily market is now the largest and fastest growing segment of the industry, from seven percent of industry production in 2019 to nearly 21 percent in 2020. Thirty companies reported building for the multifamily market in 2020, up from 23 in 2019. For the factories building multifamily projects, many focus almost exclusively on this market. Of the seventy-six factories submitting data to MBI, twelve reported that the multifamily market constituted 80 percent or more of total factory output, while the output of the remaining 18 companies, on average was 25 percent in this market.

While the cost and value of modular multi-family projects is comparable to on-site construction methods, the

shorter schedule and earlier occupancy has a significant impact on cash flow. For example, consider the following project at an initial construction cost of \$10,000,000 and assuming the modular project is completed and ready to rent in eight months while the traditional project is ready in fourteen months. A complex with 35 units rented at \$2,000/month with an occupancy rate of 90 percent would generate \$63,000 in monthly rental income. All other expenses—including taxes, insurance, and maintenance—remaining equal, the modular project would generate an additional \$378,000 in revenue for the owner due to earlier occupancy.

This earlier cash flow influx on the front end of a project often makes the difference for developers considering modular construction. Given the increasing number of successful modular multi-family projects, modular construction



now has a proven track record of success. The added benefits of cost certainty, quality and worker safety make this an obvious growth market for the modular industry.

MBI analyzed 26 multifamily projects completed over the past two years in the U.S. and Canada. Twenty of these projects were wood framed while six were steel, including one container-based project.

Most of these projects were three to five stories, with

projects consisting of multiple buildings and an average of 95 total living units per project. On average, each project was 67,112 total sq. ft. and consisted of 99 modules. The projects took an average of 385 days to complete from approval to occupancy.

MBI obtained cost information on 18 of these projects, including six Canadian projects. These Canadian projects were converted to U.S. dollars for cost analysis. The average project size in terms of total

cost was \$13,959,398, with the modular portion of the cost averaging \$5,197.638, or about 37 percent of the total cost. The average cost per square foot for these projects was \$208, ranging from a low of \$86/sq. ft. to a high of \$536/sq. ft.

Many factors determine the total cost per square foot including location, labor availability and cost, design considerations and finishes, and the construction teams' experience working together.

Education

From single classrooms to complete campuses, modular construction offers public, private, and charter schools what other construction methods cannot: accelerated project timelines, more economical pricing, and less site disruption. Permanent modular schools are indistinguishable from other schools and can be constructed to any architectural and customer specifications. MBI members design and build schools of all types and sizes using traditional building materials such as wood, steel, and concrete.

Virtually any size permanent school can be built, installed, and ready for occupancy in as little as 90 days. Perhaps most importantly, using off-site technology, open construction sites are eliminated while school is in session. Students are safer, and teachers do not have to compete with noises and construction-related disruptions.

MBI analyzed data on 46 educational projects from 2015-2018. The total average size of these projects was 23,274 sq. ft., with the modular portion of the project making up about 13,404 sq. ft. or 57 percent of the total project. Each project consisted of an average of 22 modules. The average completion for these projects was 155 days from approval to occupancy.

MBI also reviewed a total of 14 permanent educational projects completed in 2019 and 2020 for comparison. The average size of these projects was 14,197 sq. ft., significantly smaller than the average project completed in prior years. Interestingly, the average number of modules for these projects increased to 25 per project, meaning the average module size for educational projects was smaller. The average completion time for these projects was 159 days, slightly higher than projects completed in prior years. It should

be noted that this latter subset of projects included facilities constructed in 2020 with schedules adversely impacted by the pandemic.

MBI also reviewed cost data on 12 projects completed in 2019 and 2020. The average portion of the modular cost of the project to the total cost was approximately 40 percent. On average, these projects cost about \$236 per square foot with costs varying significantly depending on location, percent of modular portion of the project, and other factors.

Institutional & Assembly

This market includes police and fire stations, prisons, security, facilities for industrial complexes, workforce housing, as well as facilities used for assembly such as churches. Combined, this market accounts for 8.1 percent of all reported manufacturing production in 2020. This analysis

does not include relocatable workforce housing projects, common in more remote areas with natural resources extraction. (See MBI's Relocatable Buildings Report).

MBI obtained data from 12 projects completed in 2019 and 2020, at an average project size of 8,001 sq. ft. consisting of fifteen modules. On average these projects took 156 days to complete with an average cost per project of \$2,294,702. The modular portion of cost made up 71 percent of total cost. Many of these projects were smaller and highly customized, resulting in a higher cost per square foot of \$383 on average.

Healthcare

Many hospitals and healthcare facility contractors are turning to modular, primarily for building components such as bathroom pods and headwalls. However, entire hospitals have been constructed utilizing

modular construction techniques. Modular construction offers quiet, safe, and clean applications for medical, surgical, clinical, and dental use. The insight MBI contractors have from designing and building medical facilities has resulted in satisfied healthcare professionals worldwide. If an organization or community needs a new rehabilitation clinic, emergency room, operating room, hospital extension, laboratory, diagnostic center, or other medical facility, modular construction can be used for custom-built facilities with the tightest budgets while maintaining strict medical and aesthetic specifications. Modular construction also results in much less on-site disturbance during the construction phase.

MBI analyzed data on 24 healthcare projects from 2015-2018 with an average size of just over 18,000 sq. ft. The modular portion of these

buildings was approximately 17,500 sq. ft. indicating that most of the building footprint was made up of modular components. Most of these projects were labs, clinics, as well as health and wellness centers as evidenced by the relatively small building size. MBI obtained cost data for ten of these projects showing an average total cost of approximately \$5 million. The modular portion makes up 96 percent of total square footage of the footprint but only 47 percent of the cost of the project.

MBI also reviewed six additional healthcare projects completed in 2019 and 2020. The average size of these projects was 6,545 sq. ft., smaller than the healthcare projects from prior years. On average these projects took 355 days to complete from approval to occupancy, again factoring in the impact of COVID-19 on schedules. MBI obtained cost data on

five of these projects, with an average cost of \$7,631,896 and an average modular cost of \$2,972,425. That is about 40 percent of total cost. With such limited data, an accurate average cost per square foot in this market is not available.

Historically, the healthcare market makes up between five to eight percent of total industry output. For 2020, manufacturers reported that 6.5 percent of their factory output was in the healthcare sector, exclusive of temporary relocatable healthcare facilities (see MBI's Relocatable Buildings Report).

Commercial & Retail

Simply put, quicker occupancy equals quicker return on investment. Modular construction is accelerated construction. Why is this important to banks, restaurants, convenience stores, childcare centers, and other retail establishments? Because earlier occupancy means a customer generates

revenue faster. In fact, it is not uncommon for many modular buildings to be up and running within a week—an important consideration for retailers of all types.

Typical retail applications include restaurants and diners, banks, golf pro shops, convenience stores, gas stations, car washes, and concession stands to name a few. MBI contractors provide a full array of services including site, mechanical, and electrical work. Customers can accommodate their emerging business with modular buildings customized to their financial needs, space requirements, and deadlines.

Modular projects in this market made up just about one percent of all production again in 2019, with between 150-250 modules produced annually.

MBI was able to obtain and analyze data on 18 retail

projects constructed from 2015-2018. Not surprisingly, the average size of these buildings was smaller than in other markets at around 4,000 sq. ft. The modular components made up over 90 percent of the footprint of the typical retail facility.

MBI obtained data for five additional retail projects completed in 2019 and 2020 with an average size of 2,141, comprised of four modules per project. The average total cost of these projects was \$772,340 with the modular portion making up about 38 percent of total cost. These projects were completed on average in 179 days. Given the small sample size and cost variables (location, labor, level of customization) a cost per square foot average is not a reliable benchmark for this market.

Other Markets

Other markets reported by manufacturers in 2020 in-

cluded hotels/hospitality, data centers, equipment shelters, and bathroom pods. Collectively, these other markets accounted for 15.6 percent of factory production in 2020.

Hospitality/Hotels

A shorter construction schedule means quicker occupancy for owners, and that means guests checking in months earlier than with conventional construction methods. It should come as no surprise that companies like Marriott Corporation, Citizen M, and Hilton have made modular construction part of their strategic plan. This market, perhaps more than others, suffered during the pandemic as new projects were delayed or put on hold.

Nonetheless MBI obtained data from nine hotel/hospitality projects completed in North America during the past two years. On average, these projects were 48,062 sq. ft. and consisted of 58 modules

each. These projects took an average of 420 days from approval to occupancy. MBI obtained cost data for seven of these projects, converted to U.S. when the project was in Canada. On average, the total project cost was \$22,578,251 with the modular portion consisting of 30 percent of the total cost. The average cost on these projects was \$326 per square foot.

As with the multifamily market, a big incentive for utilizing modular construction in this market is the shorter construction schedule which leads to quicker occupancy and quicker return on investment. Across the board, owners are indicating that the modular process results in their hotels opening four to eight months earlier than if site built.

Data Centers, Bathroom Pods, Equipment Shelters

MBI obtained data on six projects completed in

2019 and 2020 classified as “other” markets. These projects included bathroom pods, small washrooms, and equipment enclosures. In past years, data centers would fall into this category. However, no information was obtained specific to data centers.

For the six projects, the average size was 2,545 sq. ft., consisting of seven modules. These smaller projects took on average 160 days to complete from approval to occupancy. Again, the small footprint and high degree of customization with some of these projects, coupled with the pandemic, likely caused projects to take longer to complete. Costs for these projects ranged from a low of \$59,000 to a high of nearly seven million in U.S. dollars. With such a high variance among a small sample, an average cost per square foot for this market is not a reliable benchmark.

SECTION 5

FINANCIAL

Data

VIP Village Pre-School (exterior).
Built by Silver Creek Industries.
First Place, Permanent Modular
Education Over 10,000 Sq. Ft.



Overview

MBI obtained 2020 data from 76 of its North American manufacturer members. Not all manufacturers provided all the data we requested. Nonetheless, this information represents the most comprehensive data available and the best source of information on the North American modular construction industry.

Factory Output

Based on data obtained from 70 manufacturers, the average company produced 202,496 sq. ft. of “product” in 2020. The output was reported in the following markets:

- Office & Administrative = 25.8%
- Multifamily = 20.7%
- Education = 15.9%
- Other = 15.6% (hospitality, datacenters, equipment shelters, bathroom pods)
- Institutional & Assembly = 8.1%
- Retail = 7.4%
- Healthcare = 6.5%

Revenue & Market Share

This report provides estimates of PMC market share from 2015 to 2020 for markets that frequently utilize PMC techniques.

Process

In estimating the overall North American market share for commercial modular construction, it is necessary to make a series of calculations and adjustments to compare to a baseline figure more accurately.

MBI uses data from Construct Connect Insights as its baseline measurement for new construction starts in the key markets previously mentioned.

MBI obtains revenue and production data from its manufacturer base to determine the average (mean) revenue per manufacturer.

That number is then multiplied

by the total number of North American manufacturers engaged (or partially engaged) in PMC projects.

The industry’s revenue survey generated 76 total responses from manufacturers, with the overall modular building industry estimated to encompass 252 firms. For the average building project using PMC technologies, the modular construction team supplies approximately 55 percent of the total value of the project put in place. This was determined in 2017 by reviewing nearly 200 projects in our database over the past four years. Consequently, to obtain the value of projects using PMC, these revenues have been multiplied by the ratio 1/0.55.

For 2020, MBI collected data from seventy-six manufacturers engaged in PMC in North America, totaling \$1,356,175,209. The overall average revenue of these manufacturers was \$17,844,411

down from 2019’s reported average of \$19,941,888.

When scaled by 1/0.55, and multiplied by the total number of industry participants, the total value of modular building construction projects for 2020 can be estimated at \$8,175,984,514 down from 2019. However, overall construction starts were also down in 2020, due in large part to the global pandemic. As a result, the modular industry fared better than traditional construction and increased its market share to 4.39 percent of new starts.

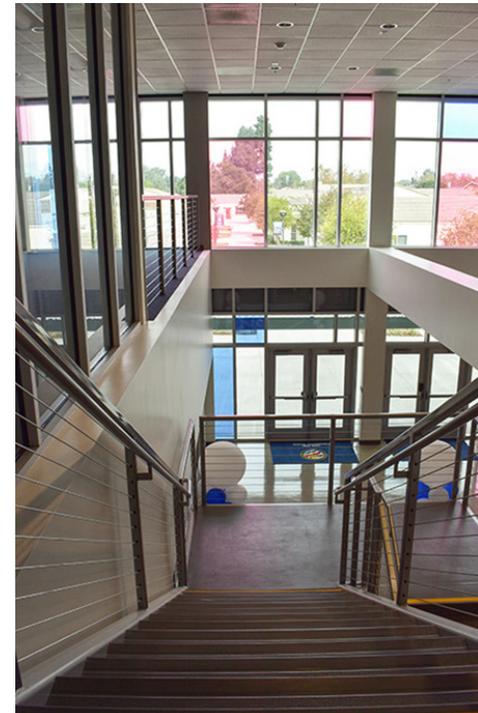
It should be noted that in recent years and in certain markets, the percentage of the modular portion of the project to the total value has been demonstrated to be lower than 55 percent. For example, the multifamily projects analyzed over the past two years show that 37 percent of the project value was comprised of modular elements, while the

FINANCIAL DATA



John Muir Fundamental Elementary School (interior). Built by Silver Creek Industries. Honorable Mention, Permanent Modular Education Over 10,000 Sq. Ft.

educational market percentage was 40 percent. For year-over-year consistency, MBI will continue to use the 55 percent calculation in this report, acknowledging that the overall value of modular projects put in place is a conservative estimate.



PMC Market Shares, 2015-2020

Year	PMC Firm Revenue	Value of PMC Projects (divide by .55)	Construction Start Value	Annual PMC Market Share
2015	\$2,040,500,000	\$3,710,000,000	\$173,729,905,578	2.14%
2016	\$3,301,664,172	\$6,003,025,767	\$244,509,444,333	2.46%
2017	\$3,979,680,268	\$7,235,782,305	\$246,089,662,933	2.94%
2018	\$4,943,067,948	\$8,987,396,269	\$243,316,997,946	3.69%
2019	\$5,025,355,734	\$9,137,010,425	\$255,013,842,707	3.58%
2020	\$4,496,791,482	\$8,175,984,513	\$186,315,485,840	4.39%

Source: Modular Building Institute, Construct Connect

A detailed look at modular value by market in 2020 shows that the weighted overall value of the modular portion of a project was 47.8 percent based on analysis of 70 projects across key markets. A more accurate market share for 2020 based on this data (not used in prior reports) yields a total North American market share of 5.05 percent.

Caveats

In preparing this report, there are numerous variables, adjustments, and calculations

that are necessary to arrive at the final numbers.

Not all the 252 firms engaged in commercial permanent modular construction in North America are exclusively serving the commercial sector. Several also manufacture single-family residential modules or relocatable (temporary) products.

Another challenge is that some manufacturers are engaged in three-dimensional volumetric modular construction while others are primarily

two-dimensional panelized factories, making comparisons and calculations difficult.

MBI is also aware of multiple PMC projects that were fabricated by companies outside North America and incorporated into projects here. While the value of these projects is most likely captured in the overall new construction starts (baseline measurement), MBI did not attempt to include this production and revenue data for purposes of this report. MBI included only revenue and

production data from North American manufacturers. Using the averages provided by the MBI survey and manufacturers input of data, it is possible to estimate certain information about the industry as a whole. The calculated information is reliable only to the extent the data provided by the industry participants is accurate.

SECTION 6

REGIONAL Analysis

Edward J. Hopkins Elementary
School Modular Classroom
Addition (exterior). Built by
Triumph Modular & Modlogiq Inc.
Honorable Mention, Permanent
Education Under 10,000 Sq. Ft.



U.S. Market Overview

According to Construct Connect Insights: “Total US construction starts fell 22.3 percent in the fourth quarter of 2020, taking the 2020 full-year decline to 18.3 percent. Non-residential building experienced the steepest decline. The pandemic has weighed heavily on sectors such as hospital-ity, entertainment, retail, and office, working with limited investment in new facilities in related sectors.

GDP growth is expected to slow in the first quarter of 2021. Overall, we expect GDP to rise 4.2 percent in 2021 after a 3.5 percent contraction in 2020. US construction activity is forecast to post a “modest” rebound (relative to last year’s decline) in 2021 of 8.8 percent. However, the pandemic will leave severe scarring on the sector, with new construction not



Edward J. Hopkins Elementary School Modular Classroom Addition (interior). Built by Triumph Modular & Modlogiq Inc. Honorable Mention, Permanent Education Under 10,000 Sq. Ft.

expected to reach its 2019 level until 2023.”

MBI obtained data directly from 60 U.S. based modular manufacturers for this report. The manufacturers in this data set were collectively involved in \$1.5 billion in new construction projects in 2020.

When separating U.S. from Canadian manufacturer data, the multifamily market leapfrogs office and administrative as the top market, accounting for 23.7 percent of all U.S. factory output in 2020 (compared to

just 8.3 percent for Canadian only data). Office projects accounted for 18.9 percent while educational facilities were 16.5 percent of U.S. output. Other key markets were retail (8.8 percent of production), and healthcare (5.2 percent).

In general, a modular manufacturer can ship modules within a 500-mile radius of their factory in a cost-effective manner. There are, of course, exceptions to this rule including modules imported from other countries for specific projects.

Region 1 – Maine, Vermont, New Hampshire, Massachusetts, Connecticut, Rhode Island, New York.

Not surprisingly, there are very few modular manufacturers located in this region. Higher than average land and labor costs tend to discourage factory expansion into this region. Of the factories located in this region, multifamily projects are the dominant market. Other key markets include educational and office facilities.

According to Construct Connect Insights, this region

saw a significant decrease in overall construction activity, dropping from \$40 billion in key modular markets in 2019 to \$26 billion in 2020. This is not surprising given the pandemic shutdown that hit this region early and hard. The multi-family market saw the biggest drop from \$13 billion to \$8 billion. But this market is forecasted to rebound to \$9.8 billion in 2021, with gains in Massachusetts from \$14 billion to \$2.9 billion. After dropping to \$5.4 billion in 2020, the multi-family market in New York is expected to begin recovering, growing to \$5.6 billion in 2021.

Educational facilities account for \$4.5 billion in this region while office projects dropped to \$4.2 billion in 2020 and forecasted to continue to drop to \$2.4 billion in 2021.

While housing and educational facilities needs are significant, MBI often must address anti-industry and anti-growth



LexHAB FarmView Lowell Street Modular (exterior). Built by Triumph Modular & KBS Building Systems. First Place, Permanent Modular Multifamily Under 10,000 sq. ft.

policies such as project labor agreements and local hiring mandates in this region.

Region 2 – Virginia, West Virginia, Pennsylvania, Maryland, District of Columbia, Delaware, New Jersey.

MBI obtained data from five manufacturers in this region. It should be noted that this region, and Pennsylvania in particular, is home to several modular manufacturers primarily engaged in single family modular production (not included in this report). The multi-family market, followed by education and office

projects were the key markets for this region in 2020. The healthcare market showed a healthy increase in this region increasing to nine percent of output.

This region, like all regions, saw a decline in overall construction activity in key modular markets, falling from about \$35 billion in 2019 to \$26 billion in 2020. The region is expected to bounce back in 2021 forecasted at \$29 billion in activity.

With many populous cities in this region (Baltimore, D.C.

Philadelphia), the multi-family sector continues to be the biggest opportunity despite dropping from \$10 billion in 2019 to \$6.5 billion in 2020. Multi-family is forecasted to increase to \$8.1 billion in 2021. Construction of educational facilities in this region held steady at about \$4.2 billion but forecasted to decrease slightly in 2021.

Region 3 – Florida, Georgia, Alabama, Mississippi, North Carolina, South Carolina, Tennessee.

MBI obtained information from 12 manufacturers in

this region. Many of the manufacturers in this region are “wholesale” manufacturers, often building products and projects for contractors and fleet owners. These companies are generally less engaged in multi-family markets and more in educational and office projects. The manufacturers in this region produced a diverse mix of wood, steel, and concrete modules in 2020.

Overall construction starts in key modular markets declined to \$40 billion in 2020 from \$55.5 billion in 2019. Multi-family projects accounted for nearly half of overall projects in 2020 with a reported \$17 billion in activity. As population shifts towards sunbelt states, the need for housing is expected to continue to grow. This market represents a big growth opportunity for the industry.

The hospitality sector, while down significantly from 2019,

still represents a multi-billion-dollar opportunity annually in this region. Education, office, retail, and healthcare are all strong markets for this region, presenting a strong opportunity for gains in the modular industry market share.

Generally speaking, construction labor rates are lower in this region, making a shift towards modular manufacturing less appealing than in higher labor rate markets such as New York and San Francisco.

Region 4 – Louisiana, Texas, Arkansas, New Mexico, Oklahoma.

MBI obtained data from nine manufacturers in this region, primarily from Texas. The modular project profiles for this region tend to vary significantly from the Northeast region in part due to land availability. Some of the largest modular projects ever built were for this region, by many were only two or three stories, unlike taller modular projects more recently in the

news in places like New York and Philadelphia.

The education and office markets are more common here with only one manufacturer reporting activity in the multifamily sector in 2020. In fact, the education market accounted for over \$6 billion in overall construction activity for this region in 2020, or nearly one-third of the total \$21 billion for the year. This sector is expected to jump to \$8.7 billion in 2021.

This is one of the few regions where opportunities for construction of educational facilities equals or exceeds multifamily projects with the latter forecasted at \$6.3 billion in 2021. Office, retail, and healthcare are other strong market opportunities for this region in 2021.

Region 5 – Ohio, Kentucky, Indiana, Michigan, Illinois, Wisconsin, Minnesota, Iowa, Missouri.

MBI obtained data from eight

manufacturers in this region, with Indiana as the hub of activity for the industry in this region. The manufacturer mix in this region includes several wholesale companies (not unlike Region 3) as well as smaller market niche manufacturers. Projects generated from this region include a diverse mix of education, office, healthcare, retail and multifamily.

Like other regions, overall construction activity in key modular markets declined in 2020. Unlike other regions, the decline was not as severe, dropping to \$29.7 billion in 2020 from \$36.2 billion in 2019.

The multi-family market represents the largest opportunity for growth with \$10.6 billion in activity in 2020. While forecasted to drop to \$6.2 billion for 2021, this market is still larger than all others. Opportunities are dispersed among the states

in this region with Wisconsin reporting the highest construction starts for multifamily at \$2.4 billion in 2020.

Construction starts in education totaled about \$4.8 billion in 2020, down from \$5.4 billion in 2019. The healthcare market is stronger here than most other regions, with a 2021 forecast of \$4.4 billion. Office and retail markets make up the other \$1 billion-plus opportunities in 2021.

As an example of how housing needs shape policy changes, the State of Illinois recently passed a bill to create a level playing field for modular construction. The bill, backed by the City of Chicago, simply states that the requirements imposed by the state regulations for modular projects cannot exceed those imposed for site-built projects. The City felt this law was necessary to help address pressing affordable housing needs.

Region 6 – California, Arizona, Nevada, Utah MBI obtained data from 16 manufacturers from this region, more than any other region covered in this report. A vast majority of those companies are California-based and not surprisingly, active in the education and multifamily markets. This region is also stronger in the retail sector than others, with eight manufacturers reporting production in this market in 2020.

Much like Chicago, social and affordable housing needs in this region are driving greater interest in modular construction, while changing perceptions and policies in a more favorable manner for the industry.

As a result, the multifamily market, while 22 percent lower than the reported \$15 billion in 2019, still represented 44 percent of construction activity in this region in

2020. The historically strong education market accounted for \$4.5 billion in activity in 2020, down from \$5.9 billion in 2019.

Region 7 – Oregon, Washington, Idaho, Alaska, Hawaii MBI obtained data from six manufacturers in this region, which is growing in influence and impact. Like other regions, education and office projects are strong in this area. But the multi-family sector is the big driver for companies in this region. The location of these factories makes serving the Pacific Northwest, Northern California, and portions of the Midwest quite practical.

Total construction activity in key modular markets dipped below \$10 billion for this region in 2020, down from \$14.4 billion in 2019. The multi-family market is dominant in this region, accounting for 48 percent and 49 percent of total activity in 2019 and

2020, respectively. The trend is expected to continue in 2021. Housing opportunities in Washington constitute most of this activity.

The educational market represented nearly \$2 billion in overall activity in 2020, down from \$3.2 billion in 2019. Construction activity for offices actually increased in 2020 compared to 2019 and is forecasted to grow to nearly \$1 billion in 2021.

Region 8 – Colorado, Kansas, Nebraska, South Dakota, North Dakota, Wyoming, Montana This region is historically the “doughnut-hole” for modular manufacturers, with few located in this region. That has changed in recent years with newer companies emerging in Colorado and the Dakotas. MBI obtained data on two manufacturers in this region, both of which are diverse in markets served.



**Home2Suites (exterior). Built by Fulcrum & Guerdon.
Honorable Mention, Permanent Modular Hotel**

This region, while one of the smaller in terms of construction activity, experienced the least severe decline, dropping to \$9.2 billion in 2020 from \$10.6 billion in 2019. The multi-family market remained fairly constant in 2020 and is expected to grow to \$3.7 billion in 2021, an increase of 19 percent compared to 2019. Other key markets in this region include educational facilities forecasted at \$1.8 billion in 2021, down from \$2.4 billion in 2020.

Canadian Market

The biggest news for the modular industry in Canada last

year was the announcement by the Canadian Mortgage Housing Corporation (CMHC) regarding their “Rapid Housing Initiative.” CMHC committed to \$1 billion in funding for housing utilizing modular methods of construction, primarily due to the reduced construction schedules. The agency received over \$4 billion in qualifying projects for this initiative and is now accessing future funding options.

MBI is also working with the Canada Standards Agency for the development of a new standard for multi-story modular buildings including

transportation, installation, and module-to-module connections. Preceding this work, MBI helped CSA with standards research which led to the development of a June 2020 publication titled:

High-Rise Modular Construction A Review of the Regulatory Landscape and Considerations for Growth.

According to Construct Connect Insights, total construction starts in Canada in the fourth quarter of 2020 declined 43.4 percent year over year, and 22.3 percent in 2020 as a whole. Canadian construction

starts are expected to climb 11.5 percent in 2021, not rising above their pre-pandemic high (in 2018) until 2024.

Overall non-residential construction put in place for key modular markets increased to \$27 billion CAD in 2019, up from approximately \$25 billion in 2018. This figure remained relatively flat in 2020 and forecast to continue to be approximately \$26 billion for 2021.

The multi-family sector represents about \$9 billion of the forecasted \$26 billion for 2021, up about 2.2 percent from 2020. Educational facilities at \$4.7 billion and healthcare at \$3.6 billion are the next largest markets overall.

MBI represents 60 companies (manufacturers, fleet owners, suppliers) based in Canada, including 26 manufacturers of modular structures. In all, MBI estimates that there are about

45 total modular manufacturers in Canada fabricating for a variety of markets including residential, multi-family, commercial, educational, and industrial sectors. MBI directly obtained revenue data from 16 Canadian manufacturers.

On average, manufacturers in Canada generated approximately \$27,877,778 CAD in revenue in 2020. Top markets for manufacturers in 2020 were:

- Workforce Housing = 16.1%
- Education = 15.6%
- Office & Administrative = 14.5%
- Construction Site= 10.9%
- Healthcare = 10%
- Multifamily = 8.3%
- Retail = 2.2%
- Other/Not indicated = 22.4%

Historically, one of the key markets for the modular industry in Canada has been the industrial workforce housing sector. The modular industry provided temporary

workforce housing solutions in remote regions where the energy sector was active. With the decline in oil prices in recent years, the industry has diversified into some of the above-mentioned markets more aggressively. However, workforce housing still accounted for 16.1 percent of industry revenue generated in 2020.

**Western Canada
(British Columbia, Alberta, Saskatchewan)**

Overall construction starts in this region fell significantly to just over \$5 billion, with a huge drop off in multi-family construction in 2020 as the leading cause for the decline. This region is expected to rebound to \$7.4 billion in 2021, according to Construct Connect Insights. That rebound will be driven by the multifamily sector, expected to grow 58 percent from 2020, but still hovering around half of the 2019 value.

The multi-family and educational markets in British Columbia are the largest markets in this region, accounting for 41 percent of all projects in the entire region. The multi-family market was also the largest sector in Alberta in 2020 and forecasted to be the largest in 2021 at \$528 million, less than half its 2019 value of \$1.3 billion. The education and office markets show the most promise for growth in Saskatchewan for 2021.

**Eastern Canada
(Atlantic Provinces, Ontario, Quebec, Manitoba)**

Not surprisingly, overall construction activity in the eastern provinces dropped significantly in 2020 to \$16.1 billion, down from \$26.4 billion in 2019 in key modular markets. The multifamily market dropped from \$12 billion in 2019 to \$7 billion in 2020, accounting for half the total decline. This market is forecasted to drop again in 2021 before rebounding in 2022.

The retail and shopping sector also took a big hit in 2020, dropping from \$2 billion in activity in 2019 down to under \$200 million in 2020.

Construction activity is expected to remain steady in 2021, hovering around \$16 billion in new construction starts in key markets. The educational sector still appears strong in this region, with nearly \$2.9 billion in activity in 2020, down 16 percent from 2019. However, the education market is expected to make a strong comeback for 2021, forecasted at \$3.8 billion, ahead of the 2019 figure. Healthcare, hospitals, and clinics are also expected to remain strong markets, with 2021 forecasted activity just under \$3 billion.

European Market

MBI represents 25 European companies and obtained revenue data from eleven manufacturers. Based on this data, the average



Casa inHAUS in Masnou (exterior).
Built by Casas inHAUS. Honorable
Mention, Permanent Modular
Multifamily Under 10,000 sq. ft.

manufacturer revenue in 2020 was \$9,355,909, virtually even with 2019.

As reported, revenue was generated from the following markets:

- Multifamily = 48.6%
- Institutional & Assembly (workforce housing, construction, correctional) = 16.8%

- Bathroom pods = 10.5%
- Office and Administrative = 6.9%
- Retail = 5%
- Education = 4.5%
- Healthcare = 2.7%
- Other/Not classified = 4.9%

Seven manufacturers provided factory production data with an

average of 29,303 square meters (or 96,138 sq. ft.) produced in 2020. These factories had an average of 112 workers.

MBI obtained data on 13 projects across a variety of markets and European countries completed over the past three years. The projects were 1,204 square meters

on average and comprised of 16 modules. The projects took an average of 148 days to complete from approval to occupancy. The modular cost made up an average of 42 percent of the total cost per project.

Compared to U.S. market data, the European projects are

smaller on average and more heavily concentrated in fewer markets. For example, bathroom pod production is much more prevalent in Europe than in the United States.

The average module size is also smaller in Europe, approximately 75 square meters (or 246 sq. ft.) for the projects reviewed compared to 677 sq. ft. per module for the multifamily market in the U.S.

South American Market

MBI obtained data on 22 projects completed in South America over the past three years, including projects in Argentina, Brazil, Chile and Peru. On average, the project size was 8,146 meters, with a significant variance in project sizes. Four projects were over 20,000 square meters while the remaining eighteen were under 8,000 square meters, with nine of those under 500 square meters.



Coburn Crossing Apartments (exterior). Built by Nashua Builders & ProSet, Inc. First Place, Permanent Modular Multifamily Over 10,000 sq. ft

Several of the projects consisted of one to four modules, while the larger workforce housing projects had over 1,000 modules per project. The average completion time from approval to occupancy was 187 days across all market.

The average total cost of these projects was \$8,644,017 in U.S. dollars with the modular portion of the costs

constituting 42 percent of the total cost.

While workforce housing is still the dominant market in South America, modular projects were built for the following markets as well: Education, Healthcare, Office, Hospitality, Retail, and Residential.

Trends & Forecast

As reported in Dodge Data and Analytics' Prefabrication

and Modular Construction 2020 Smart Market Report, 203 architects, engineers, and general contractors were asked how often they planned to use volumetric modular construction over the next three years. The results were segregated by company type, revenue, and region.

General contractors

Fifty-nine general contractors answered the question

“how likely are you to use volumetric (three-dimensional) modular construction over the next three years?” Only 14 percent answered that they were not likely to use it while 63 percent said they intend to use it for more than 10 percent of their total projects. Additionally, 24 percent of all respondents indicated that they planned on using modular construction for more than half of all their projects.

For the 31 larger general contractors answering (over \$100 million in annual revenue), only six percent indicated that they had no plans to use modular construction over the next three years. In the prior three years, these general contractors had used modular construction for healthcare facilities (42 percent of respondents), multi-family projects (32 percent), hospitality (28 percent) and college dorms and buildings (22 percent).

Architects

Sixty-three architects answered the same question, with only 17 percent indicating that they did not plan to use modular construction or were not sure. One-third of all architects indicated they plan to use modular on 25 percent or more of their projects in the next three years.

Engineers

Only 20 engineers answered the question but did so with less optimism about modular construction. Thirty-five percent said they did not plan to use it or were not sure. However, ten percent said they planned to use it on 75 percent or more of their projects (compared to five percent of architects answering the same), indicating that perhaps more engineers will specialize in this field compared to architects.

Regional

Of the 203 total respondents, eight percent of companies in the West will use modular construction almost exclusively, compared to four percent in the East, South, and Midwest. Thirty-two percent of all companies in the East will use modular construction on at least 25 percent of their projects, compared to 29 percent of companies in the West, 28 percent in the Midwest, and 25 percent in the South.

Perhaps the most telling signal of the modular industry’s growth potential is that nearly half of all contractors responding to the Dodge report indicated they plan to add a prefabrication operation to their business model over the next three years.

Key Takeaways

In 2020, the industry drove over eight billion dollars in construction activity, growing at a faster clip than site-built construction.

Estimated market share for PMC in key North American markets is approximately 4.39 percent up from 3.58 percent in 2019.

Overall average revenue per manufacturer dropped to \$17,844,411 from \$19,941,888 in 2019.

Modular construction projects demonstrated measurable improved results on cost, quality, safety, and environmental impacts.

To what code are modular buildings constructed?

It is helpful to think of “modular” as a construction process rather than a building type. A modularly constructed building simply means that the materials were delivered to an off-site location (the modular manufacturing facility), assembled into components or three-dimensional building modules, then transported to the final site for assembly. As such a building constructed in this manner must still meet all the same building codes and requirements as if it were built on-site. This is most commonly a version of the International Building Code (IBC) in the U.S. or the National Building Code (NBC) in Canada.

Do the buildings last as long as site-built? Same quality?

A building constructed using modular methods will last as long, if not longer than, a traditional site-built structure. Again, the building is constructed to the same building codes and must meet the same wind, snow, and seismic conditions. While there is limited

research to prove this point, one such study does exist. Following Hurricane Andrew in 1992, FEMA commissioned a study called “Building Performance: Hurricane Andrew in Florida” comparing site-built, modular, and manufactured housing. In that report, FEMA found “Overall, relatively minimal structural damage was noted in wood-framed modular housing developments. The module-to-module combination of the units appears to have provided an inherently rigid system that performed much better than conventional residential framing.”

Is modular construction cheaper/less expensive?

Generally speaking, yes. There are a lot of variables with a modular project, just as there are with a conventional construction project. The availability and cost of on-site labor is a key factor. In larger urban areas where labor is scarce and/or more expensive, shifting construction to an off-site (often rural) location can yield significant cost savings.

Additionally, the overall efficiency of the process can lead to cost savings. Fewer labor hours are needed to complete a comparable project and waste is significantly reduced. The shortened construction schedule can reduce the time needed for a construction loan and can dramatically advance the occupancy date, critical considerations for revenue-generating businesses such as hotels and fast-food restaurants.

McGraw-Hill published a Smart Market Report titled “Prefabrication and Modularization: Increasing Productivity in the Construction Industry.” Through an internet survey of hundreds of AEC professionals, the report found: “Sixty-five percent report that project budgets were decreased—forty-one percent by six percent or more.”

Perhaps as significant as the cost reduction is the cost certainty with modular projects. Early communication and integration of the entire construction team leads to fewer change orders and a more predictable budget.

Isn't this a new, untested method for construction?

Far from it! A report from 1670 indicates a prefabricated building was shipped by boat from England to the United States. In the 1800s, demand for modular housing increased as the country expanded westward. During the Gold Rush of 1849, more than 500 preassembled homes were shipped from factories in New York to destinations in California.

In the 1920s, Sam Kullman began manufacturing the popular “Kullman Diners” along the northeast coast.

In 1933, the first of Franklin Roosevelt’s New Deal communities, Arthurdale, West Virginia, was established. All types of modular structures were shipped there: post offices, stores, homes, and schools. After World War II, modular construction offered fast and low-cost homes to returning servicemen.

In the 1940s, the industry began to expand into commercial projects with the founding of



University of Delaware (exterior). Built by Modlogiq Inc. First Place, Permanent Education Under 10,000 sq. ft.

industry giants Williams Scotsman (now WillScot), and ATCO in Alberta.

In 1969, Zachry Construction utilized modular construction techniques to complete a 21-story modular hotel on the Riverwalk in San Antonio. The hotel, still in operation, was the

tallest modular building in North America until the recent completion of the 32-story Pacific Park building in Brooklyn, New York.

Disney Corporation followed with completion of its Contemporary and Polynesian Resorts in 1972, constructed by U.S. Steel. There is a long

history of innovative companies successfully utilizing modular construction techniques.

I have heard about “pop-up” or project specific manufacturing plants. Is that the same as a modular factory?

The modular factories detailed in this report are not project



Citadel VTR (exterior). Built by Vesta Modular & Southeast Modular Mfg. First Place, Permanent Modular Dormitory

specific plants. Rather the companies build for several clients within a given geographic region (typically about a 500-mile radius from the factory). MBI has seen some examples of general contractors renting vacant warehouses near larger project sites and using

these “pop-up” factories for some preassembly work and for materials staging and coordination. These are not automated plants and often do not incorporate assembly-line processes or lean manufacturing techniques. Rather these locations are often just an extension of the existing job site.

Do prevailing wages apply for work done in a modular factory?

No. Davis-Bacon rates and state prevailing wages laws typically are limited to the work performed “at the site.” By definition, work done in a modular factory is “off-site.”

That said, there are many considerations and nuances to understand about the applicability of prevailing wages. Often state laws vary on this subject, so when in doubt, seek a legal opinion. Also, if a factory is established for a specific project and intended to only serve that

project (see the pop-up example above), it will be considered an extension of the jobsite and prevailing wages will likely apply.

So, why hasn't it caught on before now? Why the sudden interest?

Until recently, developers and contractors seemed content with the status quo, regardless of the inherent and understood inefficiencies. Planning and preparing for those inefficiencies seemed easier than learning a different way of building for many.

Today, developers and owners are facing the “perfect storm” in the construction sector, including:

- A widely recognized skilled labor shortage that will not get better anytime soon.
- High housing costs and low housing availability in urban areas, a condition that is worsening.
- A widely documented lack of productivity in construction; and, as previously mentioned.

- The increasing need for shorter construction schedules.

Adding to those factors, the construction industry has more fully embraced innovations and technologies that are leading towards more of an “industrialized construction process.”

More environmentally conscious customers are demanding greater accountability regarding wasted resources and the massive amount of construction debris that ends up in landfills annually. Modular construction is a proven solution to reduce construction waste.

Where is the industry headed? What other trends do you anticipate? Will this interest lead to greater adoption of modular construction?

If history is any indication, we will see a significant shift towards modular and off-site construction techniques over the next five years as greater numbers of the skilled labor force retire. The construction industry will (and must) evolve

into a more industrialized and automated process – it is just inevitable. Every major industry has undergone this same transformation. The construction industry is the last holdout while clinging to a lost cause. The companies that build modular now and build it into their strategic plans will be more successful sooner.

In North America, the movement has begun. We are seeing some large general contractors and developers establish their own modular divisions, while others partner with existing modular manufacturers.

How many square feet does the typical manufacturer produce in a year?

This is where the averages can be misleading. The number of modules a particular manufacturer produces each year depends on a few factors such as the type of project the company is building, the level of customization involved in the project, and the scope of the manufacturer’s contract (i.e., whether the customer wanted

certain work to be completed on-site). Based on overall data obtained from 76 manufacturers in the U.S. and Canada, the average square footage produced in 2020 was 202,496

Where can I learn more about modular construction?

The Modular Building Institute’s website, www.modular.org is loaded with case studies, research, articles, and links to companies in your area.

MBI adopted the definitions contained in the ICC/ANSI standard 1200 and 1205 for consistency. Sources for other terms not used in the standard include state administrative programs as well as the National Institute for Building Sciences.

Accessory Dwelling Unit (ADU). A smaller, independent residential dwelling unit located on the same lot as a stand-alone (i.e., detached) single-family home. (source: American Planning Association).

Authority Having Jurisdiction (AHJ). Organization, political subdivision, office, or individual charged with the responsibility of administering and enforcing the provisions of the applicable building code. The authority having jurisdiction shall include a state agency or local building department.

Building Envelope. The physical separator between the interior and the exterior environments of a building. It serves as the outer shell to help maintain the indoor environment (together with the mechanical conditioning systems) and facilitate its climate control. Building envelope design is a specialized area of architectural and engineering practice that draws from all areas of building science and indoor climate control.

Building Site. A lot, the entire tract, subdivision, or parcel of land on which industrialized housing or buildings are sited.

Building System. The design and/or method of assembly of modules or modular components represented in the plans, specifications, and other documentation which may include structural, electrical, mechanical, plumbing, fire protection, and other systems affecting health and safety.

Certification Label. A decal, insignia, or alteration decal.

Closed Construction. A building, component, assembly, subassembly, or system manufactured in such a manner that all portions cannot be readily inspected at the installation site without disassembly or destruction thereof.

Commercial Structure. An industrialized building classified by the building codes for occupancy and use groups other than residential for one or more families.

Compliance (or Quality) Control Program. The manufacturer's system, documentation, and methods of assuring that industrialized housing, buildings, and modular components, including their manufacture, storage, handling, and transportation conform with this chapter.

Compliance Assurance Program. Procedures that state the guiding principles and define the framework for ensuring that construction documents approved by a design review agency, or that modular buildings inspected by a third-party inspection agency, comply with the applicable building codes.

Component. A subassembly, subsystem, or combination of elements for use as a part of a building system or part of a modular component that is not structurally independent, but may be part of structural, plumbing, mechanical, electrical, fire protection, or other systems affecting life safety.

Data Plate. A plate attached by the manufacturer or installer, to a modular building, or modular component that contains identifying information allowing code officials or end users to determine if the structure is suitable for installation in their jurisdiction, location, or project.

Decal. The approved form of certification issued by the authority having jurisdiction, to be permanently attached to the modular building, modular component or panelized system indicating that it has been constructed to meet or exceed the applicable building code requirements.

Deconstruction. The process of taking a building or structure, or portion thereof, apart with the intent of repurposing, reusing, recycling, or salvaging as many of the materials, products, components, assemblies, or modules as possible.

Design Package. The aggregate of all plans, designs, specifications, and documentation required by these sections to be submitted by the manufacturer to the design review agency or required by the design review agency for compliance review, including the compliance control manual and the on-site construction documentation. Unique or site-specific foundation drawings and special on-site construction details prepared for specific projects are not a part of the design package.

Erection/Installation/Set. The process of blocking, leveling, and anchoring a modular building unit on the building site upon delivery.

Industrialized Building. A commercial structure that is constructed in one or more modules, or constructed using one or more modular components, built at a location other than the commercial site and is designed to be used as a commercial building when the module or modular component is transported to the commercial site and erected or installed.

Industrialized Housing. A residential structure that is designed for the occupancy of one or more families, is constructed in one or more modules, or constructed using one or more modular components, built at a location other than the permanent site and is designed to be used as a permanent residential structure when the module or modular component is transported to the permanent site and erected or installed on a permanent foundation system.

Insignia. The approved form of certification issued by the authority having jurisdiction to the manufacturer to be attached to the modular building, modular component or panelized system indicating that it has been constructed to meet or exceed the applicable building code requirements.

Manufacturer. The entity responsible for the manufacturing of assemblies, panelized systems, modular buildings, or modular components.

Manufacturing Plant. The location other than the building site, at which modular buildings, modular components, modules, panels, or tiny houses are assembled or manufactured prior to transport to the final construction site.

Marriage Wall/Cross Over Connections. The joint between the modules in a complex, commonly called a mate-line or mod-line.

Modular Component. A sub-assembly, subsystem, or combination of elements, including panelized systems, building shells or bathroom pods, for use as a part of a modular building that is not structurally independent, but is a part of structural, plumbing, mechanical, electrical, fire protection, or other systems affecting life safety.

Off-Site Construction. The planning, design, fabrication, and assembly of building elements at a location other than their final installed location to support the rapid and efficient construction of a permanent structure. Such building elements may be prefabricated at a different location and transported to the site or prefabricated on the construction site and then transported to their final location. Off-site construction is characterized by an integrated planning and supply chain optimization strategy (source: National Institute of Building Science).

Off-Site Construction. A modular building, modular component, panelized system, or tiny house which is designed and constructed in compliance with this standard and is wholly or in substantial part fabricated or assembled in manufacturing plants for installation – or assembly and installation – on a separate building site and has been manufactured in such a manner that all parts or processes cannot be inspected at the installation site without disassembly, damage to, or destruction thereof.

Open Construction. A modular building, modular component, panelized system, or tiny house manufactured in such a manner that all portions can be readily inspected at the building site without disassembly, damage, or destruction thereof.

DEFINITIONS

Permanent Modular Construction (PMC). An innovative, sustainable construction delivery method utilizing off-site, lean manufacturing techniques to prefabricate single or multi-story whole building solutions in deliverable module sections. PMC buildings are manufactured in a safe, controlled setting and can be constructed of wood, steel, or concrete. PMC modules can be integrated into site-built projects or stand alone as a turnkey solution, and can be delivered with MEP, fixtures, and interior finishes in less time, with less waste and higher quality control compared to projects utilizing only traditional site construction.

Prefabricated. The manufacture or fabrication of sections of a building at an off-site location which are delivered to and assembled at the building site.

Quality Control. Controls and inspections implemented by the manufacturer, as applicable, to ensure the material provided and work performed meet the requirements of the approved construction documents and referenced standards applicable building codes.

City of Hope Big Building Project (exterior).
Built by Pacific Mobile Structures, Inc. &
Phoenix Modular. First Place, Permanent
Office Over 10,000 sq. ft.



Registered Design Professional. An individual who is registered or licensed to practice their design profession as defined by the statutory requirements of the professional registration laws of the state or jurisdiction in which the project is to be constructed.

Relocatable/Industrialized building. A partially or completely assembled building that complies with applicable codes and state regulations and is constructed in a building manufacturing facility using a modular construction process. Relocatable modular buildings are designed to be reused or repurposed multiple times and transported to different sites.

Site or Building Site. A lot, the entire tract, subdivision, or parcel of land on which industrialized housing or buildings are sited.

Third-Party Inspector. An approved person determined by applicable statutory requirements to be qualified by reason of experience, demonstrated reliability, and independence of judgment to inspect modular buildings, and portions thereof, for compliance with the construction documents, compliance control program, and applicable building code. A third-party inspector works under the direction of a third-party inspection agency.

Tiny Houses. A dwelling that is designed and constructed in accordance with the IRC with additional requirements as specified in IRC Appendix Q.

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