

2019
PERMANENT
MODULAR
CONSTRUCTION

REPORT



About the Modular Building Institute

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 trusted source of 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.

Hallahan & Associates, Baltimore, Maryland – Hallahan Associates provides expert business planning and marketing consulting services to the modular housing industry.
www.hallahanassociates.com

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

Cover:

citizenM Hotel in New York City from Stephen B. Jacobs Group PC and Polcom Modular

Thank you to our 2019 MBI Corporate Sponsors

PLATINUM



GOLD



SILVER





CONTENTS

- 4 Overview of the Modular Construction Industry**
 - Commercial Modular Buildings
 - Relocatable Buildings*
 - Permanent Modular Construction*
- 7 About Permanent Modular Construction**
- 9 Stages of Modular Construction**
- 10 Design for Modular Manufacturing**
- 12 Architect's Role**
- 13 Approval Process**
- 15 Key North American Markets**
- 22 Regional Analysis:**
 - Canadian Market Overview***
 - Western Canada*
 - Eastern Canada*
 - U.S. Market Overview***
 - Region 1 – Maine, Vermont, New Hampshire, Massachusetts, Connecticut, Rhode Island, New York*
 - Region 2 – Virginia, West Virginia, Pennsylvania, Maryland, District of Columbia, Delaware, and New Jersey*
 - Region 3 – Florida, Georgia, Alabama, Mississippi, North Carolina, South Carolina, and Tennessee*
 - Region 4 – Louisiana, Texas, Arkansas, New Mexico, Oklahoma*
 - Region 5 – Ohio, Kentucky, Indiana, Michigan, Illinois, Wisconsin, Minnesota, Iowa, and Missouri*
 - Region 6 – California, Arizona, Nevada, and Utah*
 - Region 7 – Oregon, Washington, Idaho, Alaska, and Hawaii*
 - Region 8 – Colorado, Kansas, Nebraska, South Dakota, North Dakota, Wyoming, and Montana*
 - International***
- 34 Revenue and Market Share**
- 37 Key Take-Aways**
- 37 Additional Resources Available**
- 38 Frequently Asked Questions**
- 42 Definitions**

OVERVIEW

of Modular Construction Industry

Unlike the federally-regulated HUD-Code manufactured housing industry, the modular construction industry is regulated primarily at the state and local levels by building code and agency administrators. As with site-built structures, a modularly constructed facility must meet the local codes where the building is going to be located.

There is no specific “modular building code” or exceptions for a building constructed utilizing the modular construction





process. It is simply a different and more efficient process to assemble the materials and components of a building. Modular construction can be utilized for 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 systems (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 a partially or completely assembled building constructed and designed to be reused multiple times and transported to different building sites. This segment of the industry maintains a fleet of relocatable buildings offered for sale or lease to customers.

- **Permanent Modular Construction (PMC)** – 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.

- PMC is an innovative, sustainable 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



Dorm in Langley, Canada from ATCO Structures

with MEP, fixtures and interior finishes in less time, with less waste and higher quality control compared to projects utilizing only traditional site construction.

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

Data for this report was gathered from multiple sources including:

- **MBI member survey** – Each year, MBI asks

all members for data regarding their annual revenues, sources of revenue, markets served, production, 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.

- **Hallahan & Associates** – MBI contracts with Hallahan & Associates for additional production data by market and region. This data was obtained by direct conversations with state administrative agencies regarding labelling programs and production as well as analyzing data from the U.S. Census Bureau on new construction starts.

- **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, and corporate websites.

Every effort has been made to ensure the accuracy and reliability of this data. However, in some cases, MBI’s best estimates and experience were 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 feels that this report represents the most comprehensive and accurate information available.

ABOUT

**Permanent
Modular
Construction**



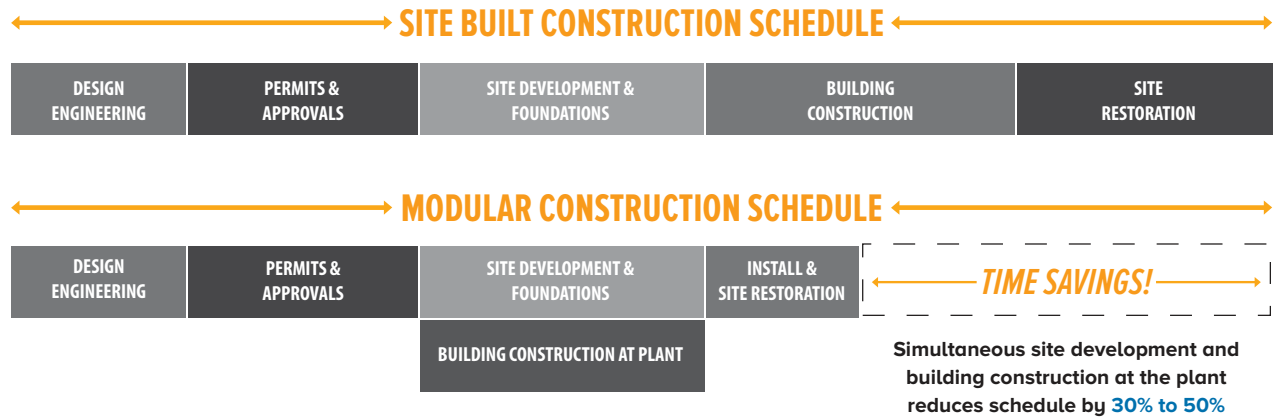
Hotel in Louisville, KY from Champion Commercial Structures.

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 to 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.



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

DESIGN **of Modular Manufacturing**



Modular extension to a hotel
in Sochocin, Poland from
DMD modular

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>



Home in Scoth Creek, BC
 from Horizon Logistics

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.

- Module lengths are up to 70 feet, usually in two feet increments.
- Module heights vary from approximately 11 feet, six inches to 13 feet, not includ-

ing 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.



Photo from
PCL Agile

APPROVAL Process

School in California
from Meehleis Modular
Buildings Inc.



Thirty-five states in the U.S. and one Canadian Province (Alberta) have some form of administrative agency that oversees and regulates the modular construction industry. While the terminology sometimes differs, 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.



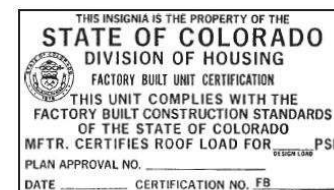
The administrative rules of each agency provide for safety standards and inspection procedures for industrialized building construction, design, and manufacture. Buildings and building components are either inspected and approved directly by the agency staff or by a third-party inspection agency (TPIA)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

Buildings constructed using modular methods 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 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.

Once inspected and approved, modular/industrial-

ized 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).

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, property line requirements, subdivision regulations, subdivision control, review and regulation of architectural and aesthetic requirements, foundation design, utility, and module connections.



Colorado State Modular Code Label

Key North American MARKETS

citizenM
Hotel in New
York City
from Stephen
B. Jacobs
Group PC
and Polcom
Modular



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 similar to the markets for site-built contractors, with few exceptions. MBI has identified the following key markets for PMC in North America:

Multi-Family Housing

Modular construction offers the ability to provide condominiums, apartments, and student dorms in about half the time as traditional, site-built construction methods. Federal, state, and local governments around the world are struggling with policies to help address the growing housing crisis. So how big is this problem?

According to a recent report called “The State of the Nation’s Housing 2018” issued by the Joint Center for Housing Studies of Harvard University (JCHS):

Homeownership rates among young adults are even lower than in 1988, and the share of cost-burdened renters is significantly higher, with almost half of all renters paying more than 30 percent of their income for housing. Soaring housing costs are largely to blame. The national median rent rose 20 percent faster than overall inflation

between 1990 and 2016 and the median home price rose 41 percent faster. While better housing quality accounts for some of the increased costs, higher costs for building materials and labor, limited productivity gains, increased land costs, new regulatory barriers, and growing income inequality all played major roles as well.

In California alone, about 180,000 housing units are needed annually to keep pace with population needs, yet only about 80,000 housing units come online. Each year, California falls another 100,000 housing units behind.

In a recent *New York Times* article, it was reported that the federal government now classifies a family of four earning up to \$117,400 as low-income around San Francisco’s Bay Area.

The Housing Crisis Solution Coalition (HCSC) believes the nation has reached a crisis point. HCSC

focuses on policies and legislation aimed at bringing a new perspective to the housing policy debate. “For the two decades between 1960 and 1980, 10 million apartments were built in the United States. Volume supply met demand at rental rates affordable to most American renters. By contrast, between 2000 and 2020 less than five million multi-family units will be built; with only 20 percent (or one million units) considered affordable. At the same time, renter household formation exceeded seven million new renters creating a shortfall of six million affordable housing units.”

Perhaps it should come as no surprise that the multi-family sector was the fastest growing for the modular industry in 2018. Total production of multi-family modules more than doubled from 1,136 units in 2017 to 2,314 units in 2018. California, Massachusetts, Florida,

New York, Washington, New Jersey, and Colorado were the top seven states (in order) with the most modular multi-family units, based on state labeling data. These states also represented 87 percent of all multi-family modular units manufactured in 2018.

Based on state label information, the multi-family market accounted for about 8.9 percent of all industry production in 2018, up from five percent in 2017. This production still represents less than one percent of all new multi-family developments in 2018, indicating a huge market opportunity for an industry that can deliver on speed to occupancy.

MBI analyzed project data from 17 modular multi-family projects constructed over the past four years. On average, the projects were 33,182 total square feet, with the modular portion constituting 27,261 square feet or 82 percent of the total project. On average,

Modular hotel in Oklahoma City, OK from Guerdon Modular Buildings and installed by ProSet, Inc.

the projects consisted of approximately 50 modules each.

Accelerated project timelines are driving greater interest in multi-family. These projects were completed in just 241 days from approval to occupancy.

MBI obtained cost data on four projects in this market. The average value of these projects was \$22,816,754 with the modular portion making up 33 percent of total value.

While the cost and value of the projects was comparable to traditional construction methods, the earlier occupancy had 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 in ready in 14 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 cash flow difference alone is enough to encourage many developers to consider modular construction. The added benefits of cost certainty, quality, and worker safety make this an obvious growth market for the modular industry.

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 have made modular construction part of their strategic plan. This sector was previously categorized under “multi-family housing” for MBI’s reporting purposes. However, given the explosive interest and tremendous growth opportunities for the hotel and hospitality sector, this arca

has been identified as a key market for the industry.

Based on production data obtained, the hospitality sector showed an increase of 16.8 percent in total modules manufactured in 2018 and a 141 percent increase since 2016. However, this market still only represents 5.7 percent of all modules produced in 2018 (1,487 hospitality modules / 26,269 total modules). Projects in California and New York accounted for most of this production in 2018.

This market is expected to show strong gains in the coming years due to initia-

tives by major hotel brands to encourage modular construction.

MBI analyzed 25 hospitality/lodge projects over the past three years to determine an average size of 45,568 square feet with the modular portion making up an average of 35,579 square feet or 78 percent of the total project.

On average, these projects took 249 days to complete, from approval to occupancy.

MBI obtained cost data on a smaller subset of five hospitality projects, showing an average total value of \$45,606,000. The modular portion of these projects constituted 56 percent of the total value of the project on average.

Education

From single classrooms to complete campuses, modular construction offers public, private, and charter schools what other construction methods cannot: acceler-



Murray Middle School
in Ridgecrest, CA from
Meehleis Modular
Buildings Inc.

ated 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.

Based on production figures, the education market accounted for 23.4 percent of all modules produced in 2018. The industry manufactured about 10 percent more educational units in 2018, from 5,575 in 2017 to 6,127

modules in 2018.

Texas, New York, and California were the top states in terms of utilizing modular construction in 2018, accounting for 25 percent of total production of educational units.

MBI analyzed data on 46 educational projects over the last three years. The total average size of these projects was 23,274 square feet, with the modular portion of the project making up about 13,404 square feet 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 obtained project value data on 12 of these facilities, with an average total cost of \$3,351,695 each. The modular portion of the building makes up 57 percent of total square

footage and 61 percent of total value.

Healthcare

Many hospitals and health-care 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 should be considered 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 22 healthcare projects over the past four years with an average size of 18,190 square feet. The modular portion of these buildings was approximately 17,482 indicating that most of the building footprint was made up of modular components. Most of these projects were labs, clinics, and health and wellness centers as evidenced by the relatively small building size.

MBI obtained cost data for eight of these projects show-



Gotham Health – Vanderbilt Family Health Clinic in Staten Island, NY from Axis Construction Corp. and NRB, Inc.

Hawaii Film Studio from WillScot

ing an average \$4,889,583. The modular portion makes up 96 percent of total square footage of the footprint but only 47 percent of the value of the project.

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 represents the largest building sector for the industry. Nearly half of all modular production in 2018 is attributed to this market.

MBI analyzed 28 office and administrative buildings constructed over the past four years. The average size of the buildings was 17,348 square feet, with the modular portion making up 15,313 square feet 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.

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's 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 but are not limited to restaurants and diners, banks, golf pro shops, convenience stores, gas stations, car washes, and concession stand. 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 in 2018, or 229 modules, based on state labeling information. About 35 percent of these units went to Texas, New York, and California.

MBI was able to obtain and analyze data on 15 retail projects constructed over the past four years. Not surprisingly, the average size of these buildings was smaller than in other markets at 3,857 square feet. The modular components made up 91 percent of the footprint of the typical retail facility.

MBI obtained cost data for five retail projects, with an average total value of \$734,951. The modular

Market	Avg Size	Avg modular portion of size	Avg Total Value Put in Place*	Avg modular portion of value
Multi-family	33,182	82%	\$22,816,754	33%
Hospitality	45,568	78%	\$45,606,000	56%
Education	23,274	57%	\$3,351,695	61%
Healthcare	18,190	96%	\$4,889,583	47%
Office/Admin	17,348	88%	\$2,804,099	47%
Commercial/Retail	3,857	91%	\$734,591	59%
Inst/Assembly	60,015	66%	\$1,034,372	66%
Total All Markets	27,615	76%	\$9,237,580	54%

MARKET SUMMARY

*Cost per square foot calculations are not available due to data not being available on all buildings used in the calculation of average square footage and value.

portion of these projects averaged 59 percent of the total value.

Institutional & Assembly

This market includes police and fire stations, prisons, and facilities used for assembly such as churches. While not a large market overall, some modular companies specialize in these markets. PMC institutional buildings more than doubled in 2018 to 897 total modules, primarily due

to new prison construction in the southeastern United States. South Carolina, Indiana, and Tennessee accounted for 53 percent of total units in this market.

Overall, the institutional and assembly market represents about 3.5 percent of all industry production in 2018.

MBI obtained data on 20 projects in the market built in the last four years. The average size of these buildings was 60,015 square feet, with the modular portion

constituting about 39,278 square feet or 65.5 percent of the footprint.

MBI also obtained cost data for four projects in this market, showing an average value of \$1,034,372 with the modular portion making up 66 percent of that amount.

REGIONAL Analysis

CANADIAN MARKET OVERVIEW

MBI represents 60 companies 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 eight Canadian manufacturers.

Yale First Nation
Community Housing
6-Plex in Yale, BC from
Metric Modular



SEDAR (www.sedar.com) is the official site that provides access to most public securities documents and information filed by issuers with the 13 provincial and territorial securities regulatory authorities (“Canadian Securities Administrators” or “CSA”) in the SEDAR filing system. MBI also obtained relevant information from annual filings on the following companies:

ATCO Ltd. was incorporated under the laws of the province of Alberta and is listed on the Toronto Stock Exchange.

Horizon North Logistics Inc. is a corporation registered and domiciled in Canada and is a publicly-traded corporation, listed on the Toronto Stock Exchange under the symbol HNL.

On average, manufacturers in Canada generated approximately \$11,012,676

in revenues and drove approximately \$901 million in construction projects.

Overall non-residential construction put in place for key modular markets declined 16 percent for year end 2018 to approximately \$25 billion CAD, compared to year-end 2017. This excludes single-family residential and engineering (bridges, highways, infrastructure).

Across Canada, construction starts in the education market declined 8.6 percent to approximately \$3.76 billion. Other drivers of the decline include healthcare (43 percent decline year-over-year) and the multi-family sector (15.8 percent decline).

The administrative and office sector showed five percent growth to approximately three billion dollars. Healthcare and education markets are forecast to rebound in 2019 while the multi-family sector (Canada’s largest market opportunity)

stabilizes around \$12 billion annually.

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.

Construction industry activity in key modular markets is forecast to hover between \$25-\$26 billion for the next few years according to Construct Connect Insights.

Western Canada (British Columbia, Alberta, Saskatchewan)

Overall construction starts in this region dropped from approximately nine billion dollars in key markets in

2017 to \$6.6 billion in 2018. It should be noted that hospital construction account for \$1.3 billion of this decline, often indicative of a large project ending in the prior year. Overall construction is expected to bounce back and exceed 2017 figures, topping \$10 billion annually by 2020.

Like other regions, the multi-family market is the biggest opportunity for the industry, despite a decline from \$4.1 billion in 2017 to \$3.2 billion in 2018. This market is forecast to rebound and approach five billion dollars in new construction by 2020.

The education sector declined slightly but remains consistent at \$1.2 billion and is expected to reach \$1.3 billion by 2020. The office and administrative market were just below one billion dollars annually, but is forecast to double to nearly two billion dollars by 2020.

Alberta showed strong growth in construction for



Hotel in Oliver, BC from Horizon North Logistics Inc.

educational facilities in 2018, while British Columbia led the way in multi-family construction at \$2.6 billion. The multi-family market also shows the most promise for growth in Saskatchewan from \$50 million in 2017 to \$255 million by 2020.

This region, more so than Eastern Canada, was negatively impacted by the downturn in the workforce housing market. In the past, it was not uncommon for companies in the industry

to generate more than 80 percent of their revenues from the workforce housing sector. In 2018, no Canadian manufacturer providing data to MBI reported greater than 20 percent of their revenue from this sector.

Energy Sector Not Dead Yet

Even though many modular manufacturers have scaled back on workforce housing for the oilfields in northern Alberta, there are still signs

of life building for this sector. Alberta-based ATCO Structures and Logistics began construction on the LNG Canada workforce accommodation contract in the first quarter of 2019 and will continue work until early 2021. The 4,500-person facility is being built to house workers involved in the construction of LNG Canada’s natural gas liquefaction and export facility in Kitimat, British Columbia.

Modular Construction Used to Address Social Issues in B.C.

One company in the region that made the shift away from workforce housing was Horizon North. Until four years ago, constructing housing for workers in Alberta’s oil patch had been a hefty part of Horizon North’s business. Then, the price of oil crashed and so did the demand for thousands of quickly built apartments at remote locations in the province.

“Instead of laying off 300

people in Kamloops, British Columbia, the company decided to pivot,” said Rod Graham, Chief Executive of the Calgary-based company.

In 2017, the provincial government of British Columbia pledged nearly \$300 million to build 2,000 modular housing units to address homelessness. Under its “Rapid Response to Homelessness, the province is more than half way to that goal, having delivered over 1,200 units. The program has been such a success, that in the 2019 budget, the province announced another \$76 million to build an additional 200 modular units.

Metric Modular in Penticton also helped supply the first round of 2,000 homes. The initiative to build apartments for the homeless is now the inspiration for a broader move to provide affordable housing for income earners priced out of the traditional home market due to the higher cost.

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

Overall, construction activity in the Eastern Provinces declined 11.4 percent from \$20.6 billion to \$18.3 billion in 2018. The biggest market decline was in the hospital/healthcare sector. This decline could indicate a larger project was completed in the prior year. Ontario led this region with 64 percent of all construction activity reported.

The multi-family sector accounted for nearly half of all regional construction activity in key markets at \$9.1 billion. However, this sector is forecasted to drop significantly over the next two years, with reductions in multi-family housing projects in Ontario as the main driver.

Construction of fire and police stations more than doubled in 2018, while the office and administrative sector showed slight growth year-over-year. The education



market dropped 11.2 percent in 2018 but remains one of the largest market opportunities at just over \$2.5 billion in activity.

This region is forecasted to drop again in activity in 2019, before rebounding in 2020.

One key point to consider when evaluating modular activity in Eastern

Canada is the impact of modular exports to affordable housing-starved areas of the northeastern United States. One such regional factory makes about 600 apartments and hotel rooms a year, many of which have constructed for housing developments in Massachusetts.

Temporary sales center in Ontario by NRB, Inc.

U.S. MARKET OVERVIEW



Inspira Oncology Center in Woodbury, NJ from Sustainable Modular Management Group and Southeast Modular Manufacturing

Based on data obtained from state modular administrative agencies, production of PMC modules grew to 26,269 units in 2018, up from 23,286 units in 2017 (increase of 12.8 percent), and up from 22,809 units in 2016. This figure represents the number

of labeled units only, as not all states have a labelling program.

Region 1 – Maine, Vermont, New Hampshire, Massachusetts, Connecticut, Rhode Island, New York. Production in this region

increased by 4.2 percent in 2018 to 2,834 modules fabricated, due primarily to an increase of multi-family projects in New York and Massachusetts. Top markets in this region included education, offices, hospitality, and multi-family. While the

multi-family sector accounted for 18.5 percent of all modular production in this region, and nearly doubled in terms of number of modules manufactured, it only accounted for 1.4 percent of all multi-family housing units constructed in 2018. Multi-family market in

this region is forecasted at \$11 billion in 2019, growing to over \$14 billion in 2020 and 2021.

This region currently accounts for over 22 percent of U.S. modular hotels, apartments and dormitories and is forecasted to generate approximately \$35 billion in new construction activity in 2019, growing to over \$40 billion in 2020 and 2021.

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

Total production in this region is up 7.1 percent to 2,996 units in 2018, primarily due to a 231 unit increase in hospitality units and apartments. The strongest markets in this region in 2018 were office, education, and multi-family

housing. Over 17 percent of all modular units for hospitality and multi-family in the U.S. were in this region.

The multi-family sector will remain strong in this region accounting for about 25 percent of construction activity. This region is forecast to generate approximately \$32 billion in construction activity in key modular markets in 2019,

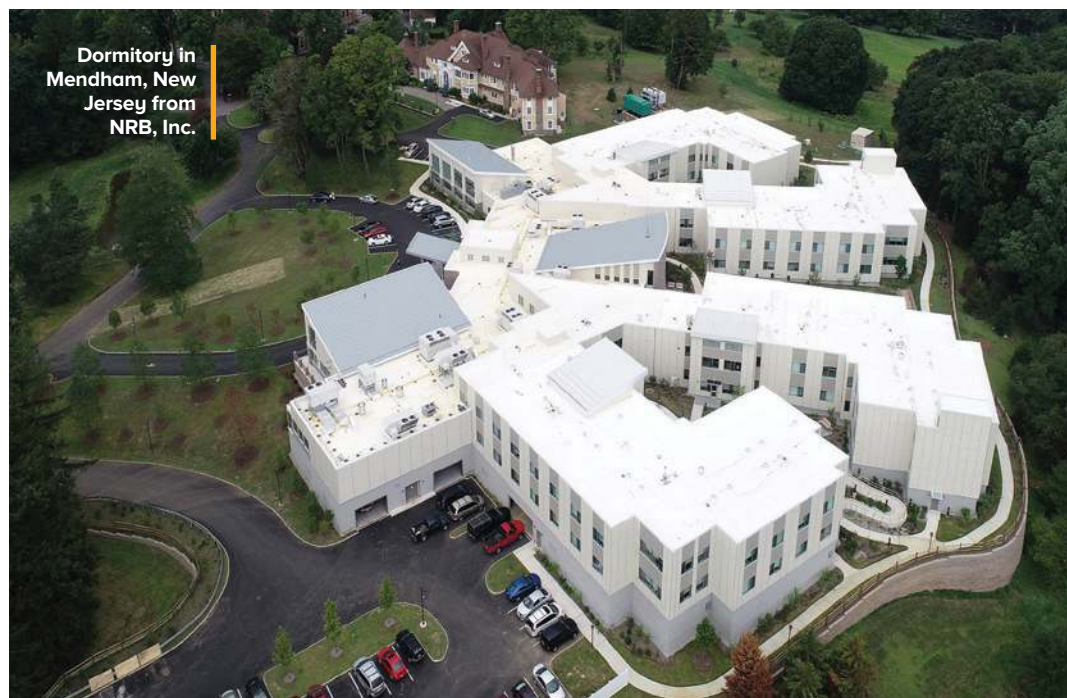
growing to \$34.8 billion in 2020 and \$35.6 billion in 2021.

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

Total region is up 32.3 percent to 6,263 units in 2018 due to increases in offices, education, prisons, and multi-family units. The multi-family market, non-existent in 2017, jumped to 316 units in 2018. That sector is expected to remain strong for the near future, forecasted at \$16 billion in new activity in 2019, and growing to over \$17 billion in 2020 and 2021.

This is a strong region overall with about \$58 billion in forecasted activity in 2019. Educational facilities for this region accounting for 27 percent of all units produced in the U.S. Nearly one-fourth of all U.S. production was for projects in the region in 2018.

Modular multi-family complex in Tennessee from Core Development. Photograph by Aerial Innovations.





Modular multi-family complex in Tennessee from Core Development. Photograph by Aerial Innovations.

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

Total region is up 4.1 percent to 3,461 units in 2018 due to increases in offices and project specific increases in hospital-ity, multi-family, and jails.

Nearly 700 classroom modules were labeled in this region, or about 12 percent of total production in the U.S. The education market is

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

Total region is up 14.8 percent to 3,828 units in 2018 with increases in office and education units, each accounting for 17 percent of all U.S. production of these type units.

There was very little multi-family activity in this region in 2018 for the industry. However, that is expected to change in 2019 as at least one new factory is opening in the region and targeting this

market. Additionally, MBI successfully lobbied to eliminate the maximum four-story height limit for modular buildings in Texas, which paves the way for taller structures.

The education market is the largest potential opportunity in this region over the next few years, with a strong multi-family market as well. This region is forecasted to generate over \$40 billion in key markets in 2019, growing by more than 10 percent to \$45 billion by 2021.



Fairfield Inn & Suites in Pleasant Prairie, WI from Champion Commercial Structures and Hayes Modular.



**Hotel in Hawthorne, CA
from Guerdon Modular
Buildings**

projected to account for eight billion dollars in new construction, remaining a strong opportunity in 2019.

Additionally, the multi-family market adds another eight billion dollars in forecasted opportunities annually for the next several years. Office and healthcare markets are solid opportunities with nearly six billion dollars combined in forecasted activity.

Region 6 – California, Arizona, Nevada, and Utah

Total region is up 25.0 percent to 4,200 units in 2018, with prolific increases in hospitality units and apartments primarily in California.

California currently accounts for 55 percent of national hospitality units and 31 percent of national multi-family units.

This is also a strong market for the educational sector, with 841 units labeled for states in this region. This region is forecasted to generate about \$10 billion in construction activity in the education sector over the next few years, largely driven by activity in California.

Like many other regions, the multi-family sector offers the greatest opportunity with over \$14 billion in activity forecasted in 2019, growing to over \$15 billion in 2020 and 2021.

This region is forecasted to generate about \$43 billion

in construction activity for key modular markets in 2019, and remain relatively consistent in 2020 and 2021.

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

Total regional labelled units were essentially flat at 1,095 units in 2018, although apartment units in Washington increased from 12 in 2017 to 173 in 2018. The office and education sectors were the strongest markets for this region accounting for



**Multi-family complex
in California from
Silver Creek Industries.**

Modular multi-family project in Seattle, Washington from JacksonMain Architecture, DCI Engineers, and Guerdon Modular Buildings and owner- developer NexGen Housing Partners.



78 percent of all labeled units in this area.

Within this region, there are potential opportunities for growth in the hospitality and multi-family sectors. Large urban areas such as Seattle and Portland are considering modular solutions to address

urgent housing needs. Additionally, at least one modular hotel was under construction in Washington as of this writing.

This region is expected to account for about \$15 billion in total construction activity in 2019, growing to \$16.4 billion by 2021. Of that amount, one-third

is in the multi-family sector, and about one-fourth is in the educational markets.

Modular multi-family project in Seattle, Washington from JacksonMain Architecture,

Region 8 – Colorado, Kansas, Nebraska, South Dakota,

North Dakota, Wyoming, and Montana

Total region is up 27.8 percent to 1,567 units in 2018 due to increases in office units, education, and multi-family units in Colorado. The multi-family market grew at the highest rate in this region,

from a relatively low 32 units in 2017, to 160 units in 2018. Despite the growth, this figure still represents less than one percent of all new multi-family units built in the region.

Like other regions in the U.S., the office and education sectors are the largest markets accounting for nearly 75 percent of all labeled units. Construction of K-12 facilities is expected to hover around \$2.5 billion in the region for

the next few years, while the office market is expected to be just under one billion dollars annually.

The total forecasted construction activity for this region is about \$14 billion and expected to grow slightly to \$14.5 billion by 2021. Again, the biggest market opportunity in this region is the multi-family sector at a forecasted \$3.6 billion, growing to \$4.4 billion by 2020.

INTERNATIONAL

In 2017, MBI retained Professors Ryan Smith from Washington State University and Ivan Rupnik from Northeastern University to embark on a global research project. The aim of the research was to assess market conditions and adoption rates for modular and off-site construction in various countries, to determine the drivers and barriers to adoption, and to analyze those findings to improve the adoption rate in North America.

Growth in **Sweden's** modular industry appeared relatively recently, as compared to the United States and Japan. Lindbacks is currently the industry leader, having produced more than 10,000 housing units since 1994. Lindbacks, along with its two-other volumetric modular competitors, grew out of the large Swedish single-family home industry, but now focus almost entirely on affordable and market rate multi-unit housing. Like the US, Sweden's volumetric modular construction is governed by a conventional building code.

Common to all three-

major volumetric modular companies in Sweden is the marketing strategy of closely aligning modular construction with sustainable or green building. This strategy is showing immediate benefits in terms of consumer response but is also seen as a long-term strategy that anticipates stricter green building regulations.

Japan's volumetric modular industry is nearly as old as America's. Sekisui Heim, the top player, started production in the early 1970s. Currently dominated by Sekisui Heim, the largest volumetric modular company in the world, with 10,000+ housing units pro-



Townhouses in Vail, CO from Prefab Logic and DCI Engineers



Module from RI SpA

duced, the Japanese industry has achieved an impressive level of market penetration (approximately 15 percent of new construction starts).

Japan is a renew culture stemming from the Shinto tradition of rebuilding temples as a religious act. Therefore, modular meets this demand for new, fast delivery of housing. Like Sweden, the predominant off-site system is panelized construction. Both volumetric modular and panelized companies utilize light-gauge steel components although some

light-wood frame construction is also used.

Like many off-site construction systems, including volumetric modular, Japanese companies initially touted their systems speed and affordability. Since the late 1970s, the focus shifted to the superior quality of the product (on average, volumetric modular is eight percent more expensive than conventional construction in Japan).

Poland is a relative newcomer to the global volumetric

modular industry, the three key players all benefit from that countries steel industry as well as its furniture industry. All three companies are currently focused on Western European and North American markets.

Polish volumetric modular companies have developed the logistics necessary for a commercially viable export business. Polcom Modular has shipped complete hotel modules to Holland, the UK and, most recently, to New York City. DMD has shipped

modules to southern Germany and to the U.S.

United Kingdom – It is estimated that off-site construction constitutes seven percent of the total construction output equating to £1.5 billion per annum. It is unclear how much of that is modular construction; however, modular construction has a long history in Britain stemming from colonial migration. Modular construction in the UK leverages techniques from Sweden and Germany/Austria that have a longer modern history with the technologies. The UK has also adopted techniques from Japan in its hot-rolled steel modular program.

The UK tends to be geographically specific, with light-wood frame Swedish techniques and automated equipment being used in Scotland and Northern England and light-gauge steel and hot-rolled steel more common in the Midlands and London. Like North America, the modular industry is regulated by the same codes



Primary School in Australia from Fleetwood

as conventional construction. Off-site and modular construction is being used for primarily for low-rise

The UK government has put forward numerous reports to industry from 1994 forward calling out the inefficiencies and lack of innovation (productivity). These reports set targets for the construction industry including lower initial and lifecycle costs, faster delivery, lower emissions, and the symptoms of such, dysfunction in training, and workforce recruitment. During this time, the reports have pointed to off-site manufacture as one solution to overcome such challenges.

Australia – Prefabrication in Australia began when the

Manning Cottage was delivered from the UK during the colonial period. Despite early research from the Australian government on the potentials of off-site construction, Australian modular construction has only emerged in the last decade. Currently there are an estimated 74 modular manufacturers in Australia of 169 total off-site manufactures (2013). It is difficult to determine the overall contribution of modular to the construction industry in Australia, but in housing, off-site is estimated at five percent with modular being the dominant method.

Following population distributions, most modular manufacturers in Australia are located on the East Coast of Australia with the largest

stronghold in the metropolitan region of Melbourne, Victoria.

Although there are two scales of volumetric modular occurring: steel and concrete modular for mid-to high-rise in centers and light-wood frame and light-gauge steel modules for urban and suburban housing development, the modular companies are more diversified, offering many different off-site solutions and material modular solutions for a myriad of building types –

there is less concentration and specialization.

MBI obtained revenue data on 11 manufactures located outside North America. These companies we located in various parts of the world including Chile, Argentina, Italy, Poland, China, and Australia.

The average revenue from these manufacturers was \$20.4 million in 2018, in line with average revenue of companies within North America.

Multi-family housing in Seoul, South Korea from POSCO A&C



REVENUE

and Market Share

Emergency Department
and Mental Health
Facility from
Rad Medical Systems



This report provides estimates of PMC market share from 2015 to 2018 for sub-segments 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 more accurately compare to a baseline figure.

MBI uses data from Construct Connect Insights (formerly Reed Construction Data) as its baseline measurement for new construction starts in the key markets previously mentioned. As new construction starts can be volatile year-over-year, MBI uses a three-year average for new construction starts.

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



University Classrooms
by Tecno Fast S. A.

number of North American manufacturers engaged (or partially engaged) in permanent modular construction projects (PMC).

The industry's revenue survey generated 53 total responses, with the overall modular building industry presumed 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 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 2018, MBI collected data from 53 manufacturers engaged in PMC in North America. The overall average revenue of these manufacturers was \$19,615,349, up from \$15,897,021 in 2017.

When scaled by 1/0.55,

the total value of modular building construction projects for 2018 can be estimated at \$8,987,396,269 up from approximately \$7.2 billion in 2017.

Rendering these statistical adjustments results in an estimate that PMC technologies drove about \$8.9 billion in construction activity in 2018. Because the value of construction starts can be incredibly volatile from year-to-year, MBI uses a three year moving average of industry activity to

Year	PMC Firm Revenues	Value of PMC Projects	Construction Starts Value	3-Year Moving Average of Construction Starts Value	PMC Market Share
2015	\$2,040,500,000	\$3,710,000,000	\$173,729,905,578	\$152,848,424,717	2.43%
2016	\$3,301,664,172	\$6,003,025,767	\$244,509,444,333	\$188,939,551,127	3.18%
2017	\$3,979,680,268	\$7,235,782,305	\$246,089,662,933	\$221,443,004,281	3.27%
2018	\$4,943,067,948	\$8,987,396,269	\$243,316,997,946	\$244,638,701,737	3.67%

PMC Market Shares, 2015-2018

Source: MBI & Construct Connect

estimate PMC market share.

Based on a combination of industry survey data and data characterizing construction starts, projects using PMC technologies accounted for 3.67 percent of the value of commercial construction starts in the key North American segments that serve as the focus of this report.

Separating the market share by country we have determined that for Canada, the average revenue by manufacturer was approximately \$11,012,676. Using the same market share calculations, this equates to approximately 3.6

percent of all new construction starts.

Removing Canadian companies from the calculation increases the average U.S. manufacturer revenue to \$21,144,713 and the overall market share to 4.05 percent of new construction starts in the U.S.

Disclaimers:

In preparing this report, there are numerous variables, adjustments, and calculations that are necessary to arrive at the final numbers.

Not all of 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.

Key Take-Aways:

The industry drove approximately nine billion dollars in construction activity in 2018.

Estimated market share for PMC in key North American markets is approximately 3.67 percent up from 3.27 percent in 2017.

Estimated market share for U.S. is approximately 4.05 percent of new construction starts based on 207 manufacturers.

Estimated market share for Canada is 3.60 percent based on 45 manufacturers.

Overall permanent modular construction production grew by 12.8 percent in 2018 based on state labeling information.

Overall average revenue per manufacturer grew from \$18,325,759 in 2017 to \$19,615,349 in 2018.

Companies modifying shipping containers for use as permanent building components were included in the 252 North American firms in his report.

Additional Resources Available

AIA Design Guide for Modular

ICC Guideline for Modified Shipping Containers

MBI Whitepaper: Saving Time with Modular Bathroom Pods

National Institute of Building Construction Off Site Construction Council



Vanderbilt Family Health Clinic installation from Axis Construction Corp. and NRB, Inc.

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 in 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

Union Flats in Union City, CA from David Baker Architects, Guerdon Modular Buildings, and DCI Engineers.

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 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.

Lastly, 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.

MBI partnered with other organizations to fund research conducted by Professor Ryan Smith at the University of Utah to analyze several modular projects compared to similar site built “peer” projects. In all but one of the comparisons, the modular project was found to be more cost effective.

McGraw-Hill published their 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:

“65 percent report that project budgets were decreased—41 percent by six percent or more.”

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 commer-

cial projects with the founding of industry giants Williams (now WillScot) in Baltimore, Maryland and ATCO in Alberta (now a multibillion-dollar global corporation).

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



Harrison Street Oasis in Oakland, CA from UrbanBloc Inc. & R & S Tavares Associates

successfully utilizing modular construction techniques.

I've 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 specific plants. Rather the companies build for a number of 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 incorpo-

rate 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 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 won't 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."

Lastly, consumers (especially younger, more environmentally-conscious ones) 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?

Over the past five years, MBI has seen a shift towards more steel frame modular construction. Five years ago, about 80 percent of the North American industry was utilizing wood-frame modules. Today, it's about 70 percent wood-frame. We are also seeing a trend

towards taller modular buildings here, also contributing to the increased use of steel.

North America actually lags behind several countries in terms of construction innovation and advancement. In places like the U.K., Singapore, Australia, Japan, Sweden, and China, industrialized construction processes are more widely accepted. Many of these countries faced the same challenges we have in North America today. Not surprisingly, we have seen several examples where the building modules were fabricated outside North America and imported and incorporated into projects here. The concept will catch on. It's really a question of whether the North American construction industry is concerned enough to get on board.

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's 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 modular now and build it into their strategic plans will be more successful soon.

In North America, the movement has begun. We are seeing some large general contractors 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 in a given year depends on a few variables 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. did the customer want certain work to be completed on-site). Based on overall data obtained from 37 manufacturers in the

U.S. and Canada, the average square footage produced in 2017 was 122,000. At roughly 800 square feet per module, that equates to about 152 modules annually. However, this figure should not be used as a measurement of a company's efficiency or success.

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.



Sumas First nation Administration Building in Abbotsford, BC from Metric Modular

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.

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 (source: Louisiana Industrialized Buildings program).

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 Agency (aka third-party inspection agency) – An architect or professional engineer, or an organization, specially qualified by reason of facilities, personnel, experience, and demonstrated reliability, to investigate, test and evaluate modular buildings; to list such buildings complying with standards; to provide adequate follow-up services at the point of manufacture to ensure that

production units are in full compliance; and to provide a label as evidence of compliance on each manufactured section or module. (source: Virginia Industrialized Buildings Program).

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.

Decal (insignia or label) – The approved form of certification issued by the state administrative office to the manufacturer or builder to be permanently affixed to the module indicating that it has been constructed to meet or exceed the 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.

Installation – On-site construction of industrialized housing or buildings (see definition of on-site construction)

Local building official – The agency or department of a municipality or other local political subdivision with authority to make inspections and to enforce the laws, ordinances, and regulations applicable to the construction, alteration, or repair of residential and commercial structures.

Manufacturer – A person who constructs or assembles modules or modular components at a manufacturing facility which are offered for sale or lease, sold or leased, or otherwise used.

Manufacturing facility – The place other than the building site, at which machinery, equipment, and other capital goods are assembled and operated for the making, fabricating, constructing, forming, or assembly of industrialized housing, buildings, modules, or modular components.

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

Module – A three-dimensional section of industrialized housing or buildings, designed and approved to be transported as a single section independent of other sections, to a site for on-site construction with or without other modules or modular components.

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 OSCC).

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.

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.

Repurpose – To divert a material, product, component, module, or building from the waste stream for use for an application that is different than its original use or occupancy.

Reuse – To divert a material, product, component, module, or building from the waste stream in order to use it again for a purpose that is consistent with its original use or occupancy.

State Administrative Office (SAO) – The designated representative for the enforcement of this chapter and shall act as the building official for registered industrialized buildings.

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

Third-party inspection agency (TPIA) – An approved person or entity determined by the state or program to be qualified by reason of facilities, personnel, experience, demonstrated reliability, and independence of judgment to inspect industrialized housing, building, and portions thereof for compliance with the approved plans, documentation, compliance control program, and applicable codes. Also known as “Approved Testing Facility or ATF,” or “Compliance Assurance Agency.”

MODULAR BUILDING INSTITUTE

944 Glenwood Station Ln., Suite 204 | Charlottesville, VA 22901 US

888.811.3288 | Fax: 434.296.3361 | info@modular.org | modular.org

COPYRIGHT 2019