

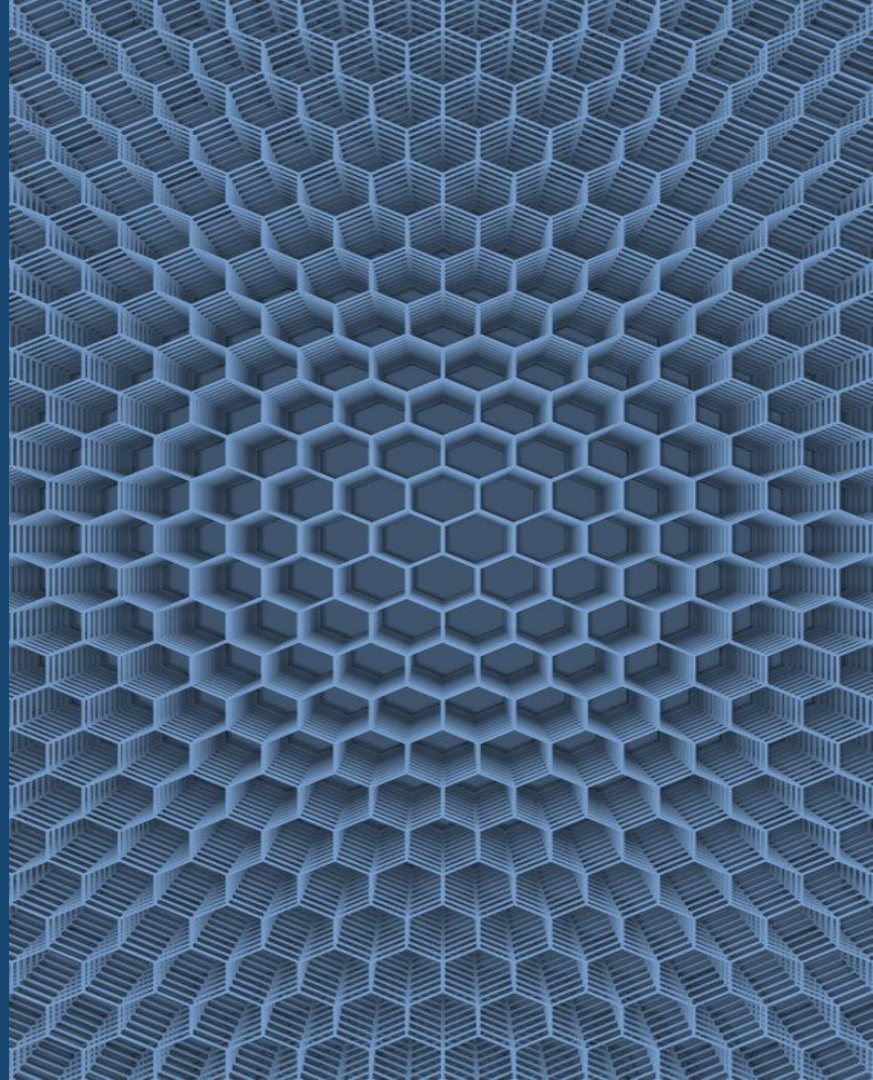


5 - 8 DECEMBER 2022
DUBAI WORLD TRADE CENTRE

Modular Construction, Opportunities for Whole Life-Cycle Carbon Reduction

DAFIR MANN

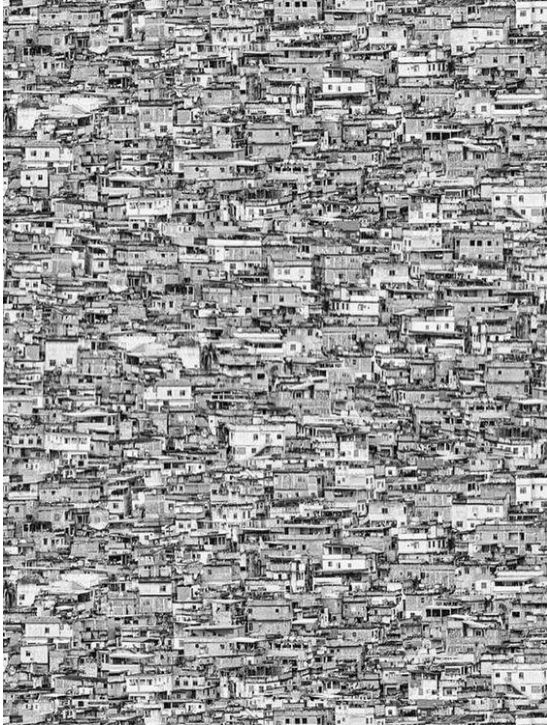
Offsite & Modular / 05 Dec. 2022



Urban Centres Population Increase

Built Environment Areas to be doubled by 2060
50 % currently, 60 % in 2030, 66.4 % in 2050

**Adding
a new city
to the world
the size of New York,
Monthly for 40 years.**



1

There are now more than 10,000 cities on planet earth.

2

How many can we name?

3

At a stretch, we could probably name 200, Leaving 9,800 that we have never heard about.

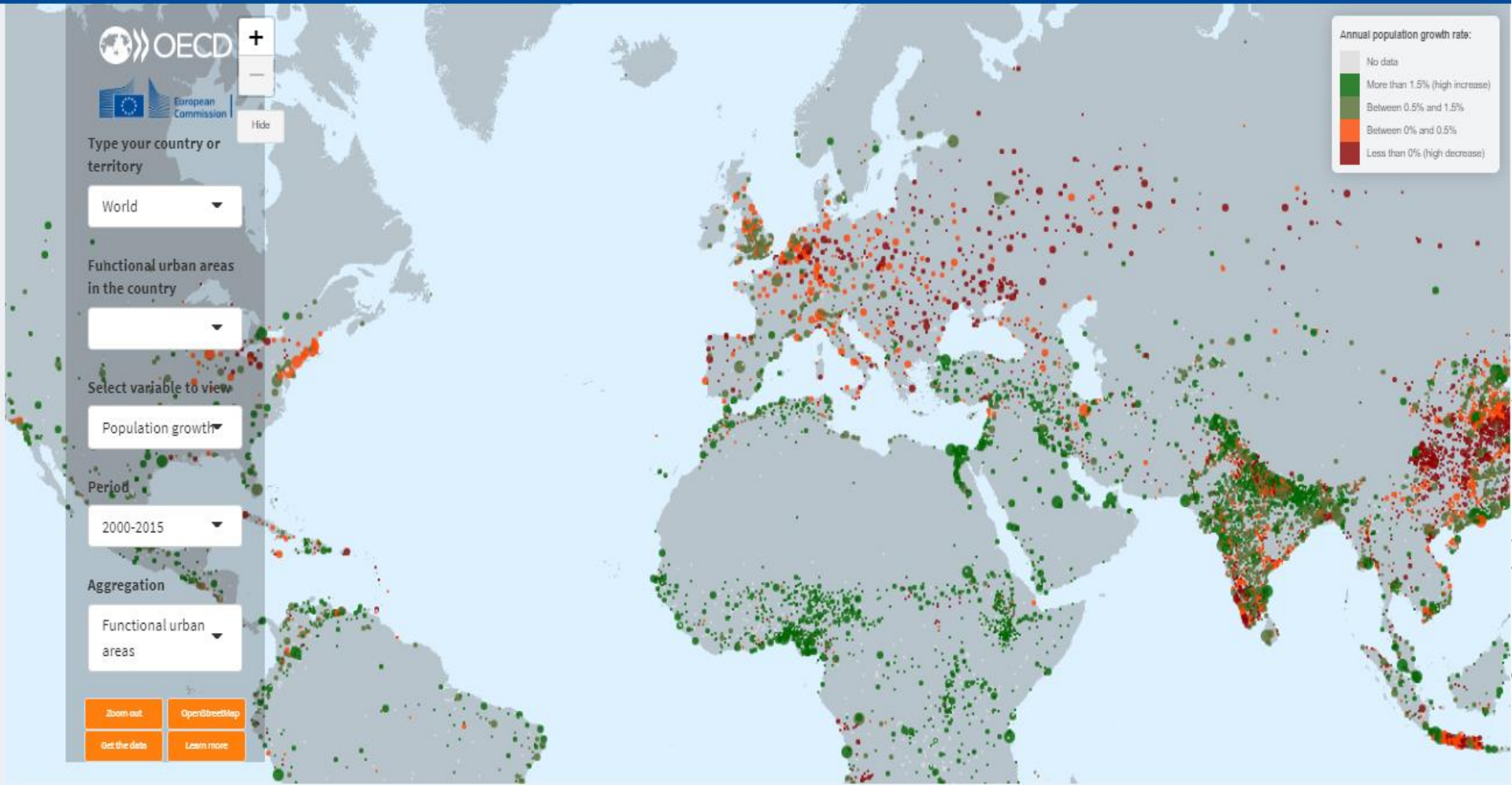
www.worldcitiestool.org

Organized by

dmg events

#THEBIG5EXHIBITION
www.thebig5.ae

Cities in the world



Urban Centres Consumption and Waste

Consumes nearly 50%
of the world's raw materials



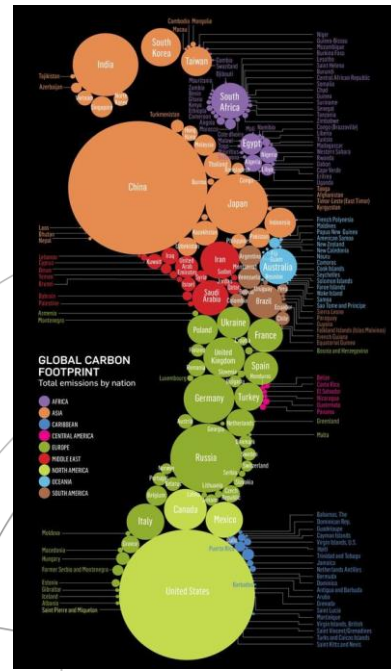
Causes about Third of the total
amount of Waste



Urban Design
& Landscape



Responsible for about
40% Global Carbon
Emissions



Climate Change Conference COP27 - Egypt



WORLD
ECONOMIC
FORUM

WORLD
ECONOMIC
FORUM

Global emissions must fall
by 1.4 GtCO₂ every year
until 2030...

If we are to keep warming
to within 1.5° C

Climate Change Conference COP27 - Egypt



Urban Design
& Landscape



Organized by

dmg events

#THEBIG5EXHIBITION
www.thebig5.ae

Reducing the negative environmental impact

How can we contribute to the reduction of the negative environmental impact and carbon footprint of the construction sector?

Most major industries have evolved to rely on Industrial and Automated Processes, It's inevitable that the Building Industry will do the same



INDOORS
SPEED SCHEDULE
TECHNOLOGY
GREATER CONTROL

STRONGER
EFFICIENT
FLEXIBILITY

RB
PROTECTED
LESS TRAFFIC
FLEXIBILITY

RELOCATABLE
PMIC

HIGHER QUALITY
NO WEATHER DELAYS
PREFABRICATED

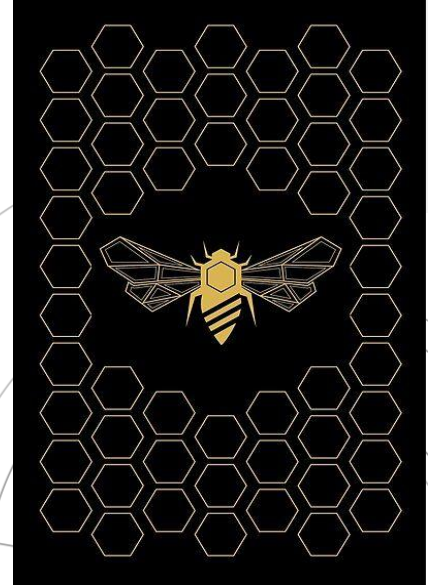
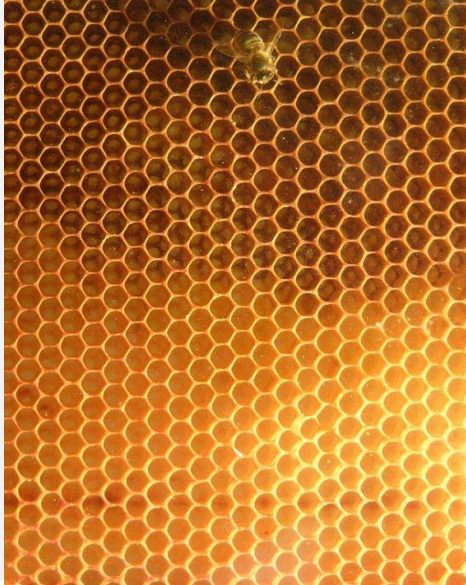
MODULAR CONSTRUCTION

IMPROVED SAFETY
LESS SAFETY HAZARDS
BETTER INDOOR AIR QUALITY

BIM
PERMANENT

LOWER CARBON FOOTPRINT
LESS MATERIAL WASTE
LEAN CONSTRUCTION
ACCURATE DESIGNS

History



History

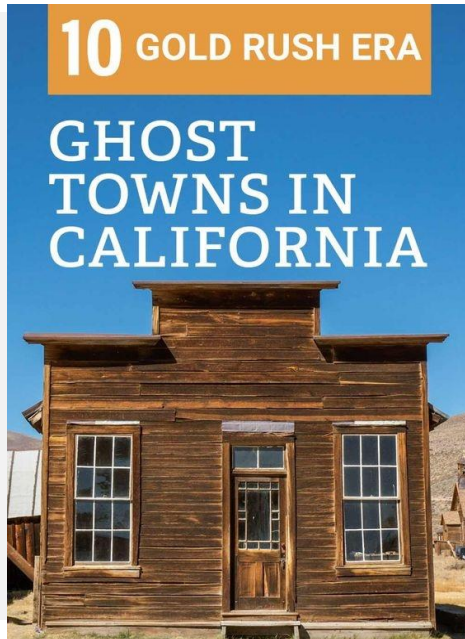
1849 California Gold Rush,
Prefabricated houses were
transported from New York
to California.

Following World War II,
Schools and healthcare facilities

'60s and '70s
Modular Construction being used
to build large-scale hotel projects.



Urban Design
& Landscape



Modular Construction

Modular Building Process
Modular Building Components
Prefabricated off-site
In a controlled setting



Organized by **dmg** events



Then Shipped to the project site
And Assembled



Benefits of Modular Construction

Conducting the bulk of the construction process off-site in a controlled setting, with reduced risk.

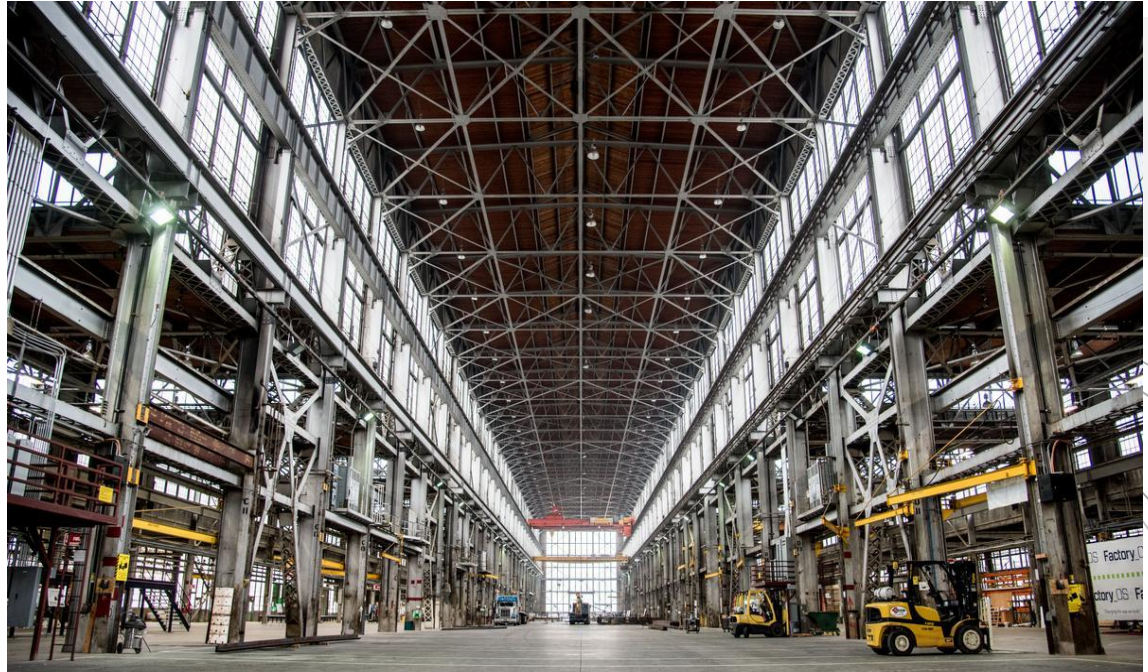
Less waste

Improved quality,
Increased control of cost



Reduced exposure to weather.

The production and storage of building components in an enclosed facility also results in reduced exposure to the weather.

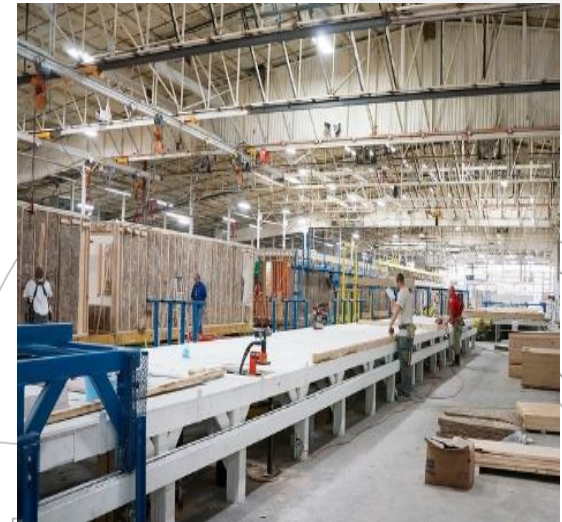
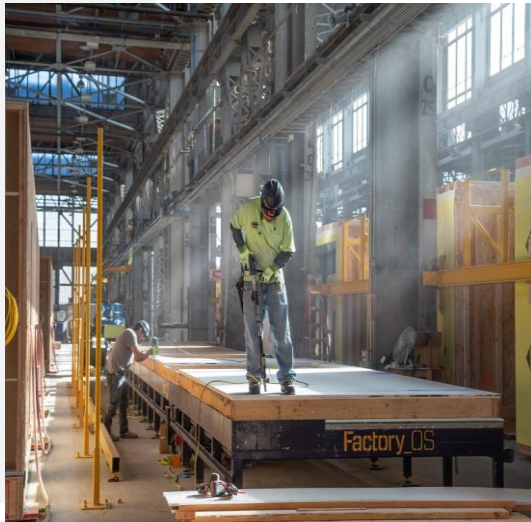


Safety & Productivity

Labour Safety & Productivity increase when using an off-site approach, with precise tools and machinery, providing ideal conditions for manufacture.

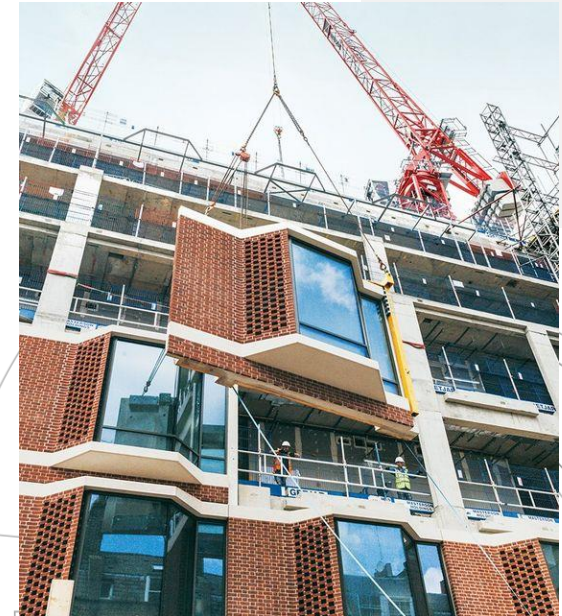


Off-site construction also means;
More consistent crew
More controlled workflow
Less disruption.



Quality

Especially beneficial when it comes to the installation of sensitive high-tech components such as fire and security systems or sensor-based environmental controls.

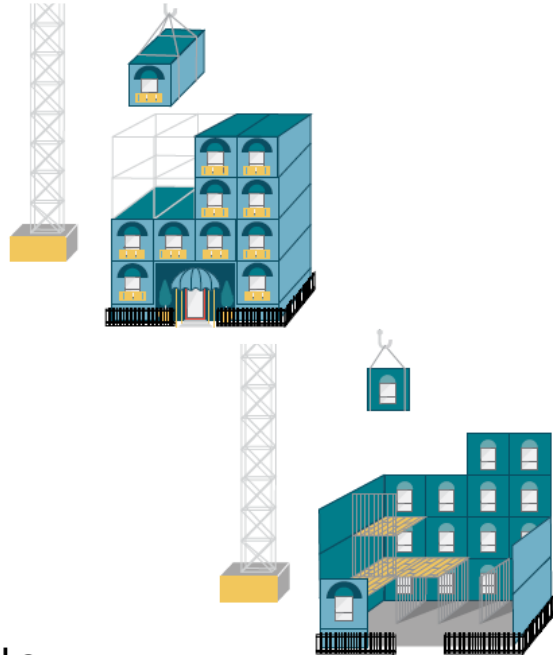


Increased precision in fabrication of exterior wall components results a much tighter building envelope with fewer air leaks.

Volumetric units. Non-volumetric components

Volumetric elements;

Guest / Patient rooms, Bathroom pods, Elevator sections and Stair cores.



Volumetric units. Structural / Non-structural

Volumetric modular components may be manufactured as structural or non-structural components. As a set of structural units that together form the structure of the building once assembled on-site, or As non-structural units such as bathroom pods—that will be set within a superstructure.



Non-volumetric building elements

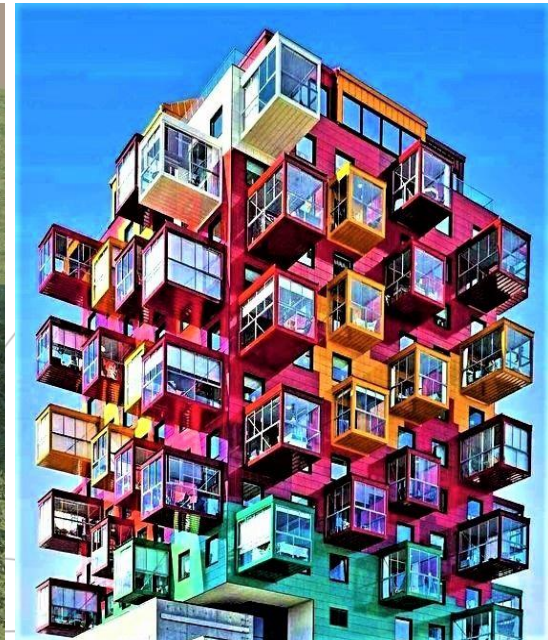
Structural elements such as frames, beams and columns, Sections of building façade and cladding
Wall panels and interior partitions, Floor cassettes and planks, Roof trusses

Non-volumetric elements require additional assembly and sealing work on-site, the cost of which may offset any transport savings gained.



Projects Size

Majority are four stories or less,
In recent years an increasing number have exceeded 10 stories,
Modular construction can be used to build structures up to any height now,
unless otherwise restricted by the local codes.

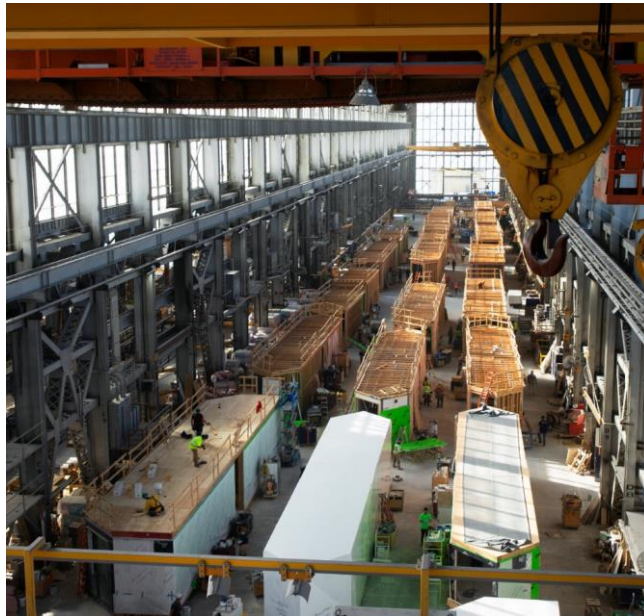


Integrated Design, Processes and Technologies



Integrating the processes and technologies of design, manufacturing, and construction, without having to compromise on aesthetic intent.

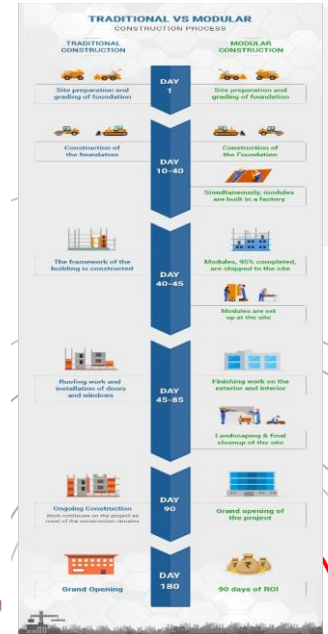
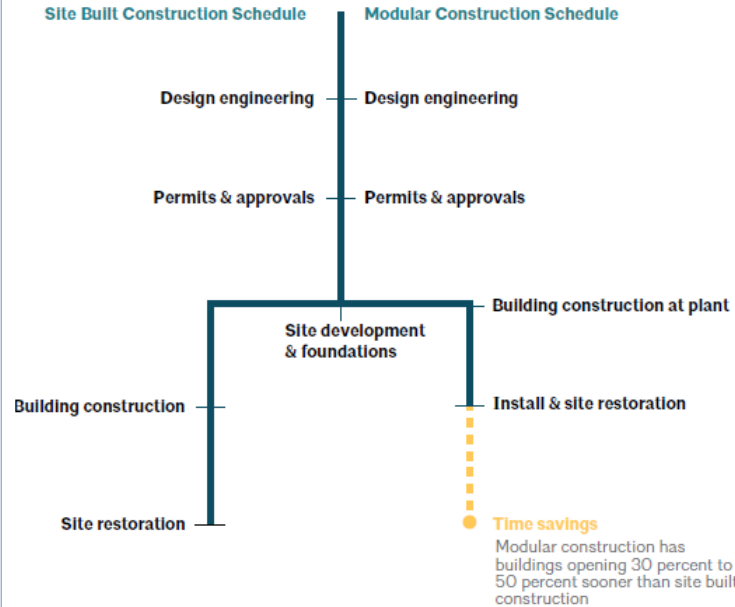
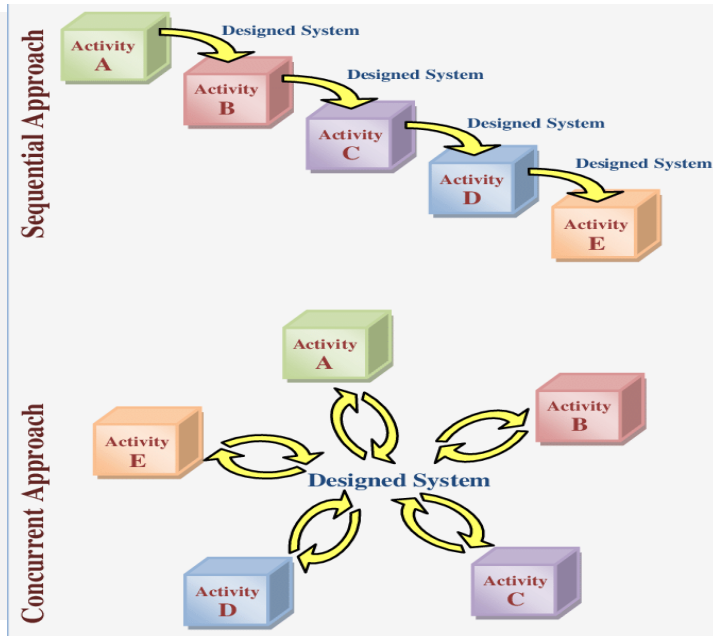
Many decisions have to be made earlier in the process, with higher level of coordination between the various parties — as construction tolerances and scheduling— becomes critical.



Linear versus Concurrent Process

Compared to the linear process that characterizes traditional construction, with trades working sequentially, Off-site construction allows trades to work concurrently.

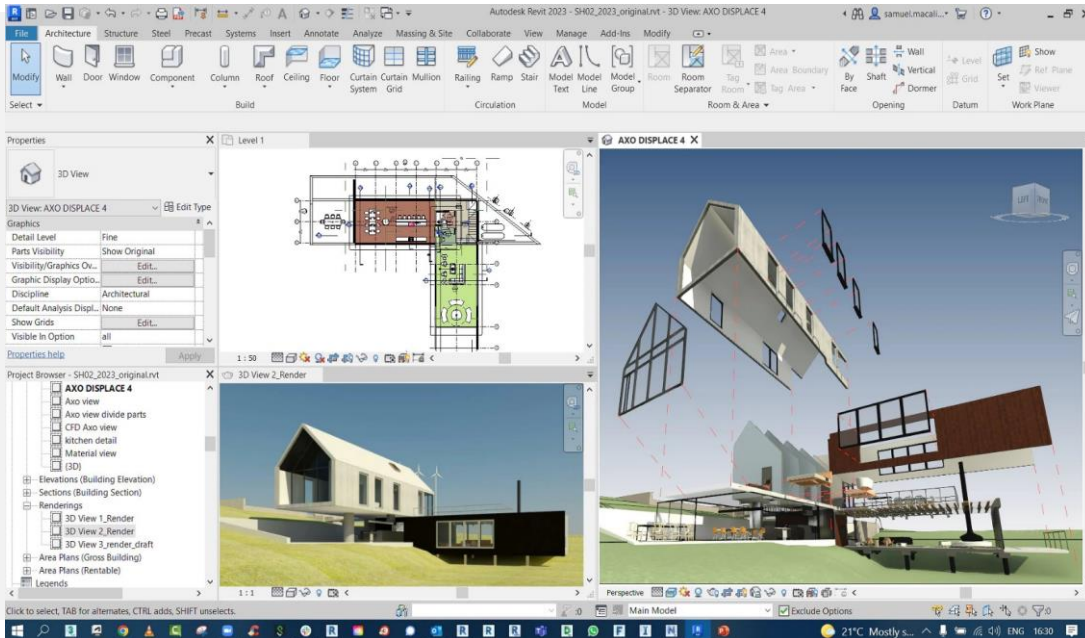
Construction Schedule can be shortened by 30 to 50%



Design for Manufacture and Assembly (DfMA)



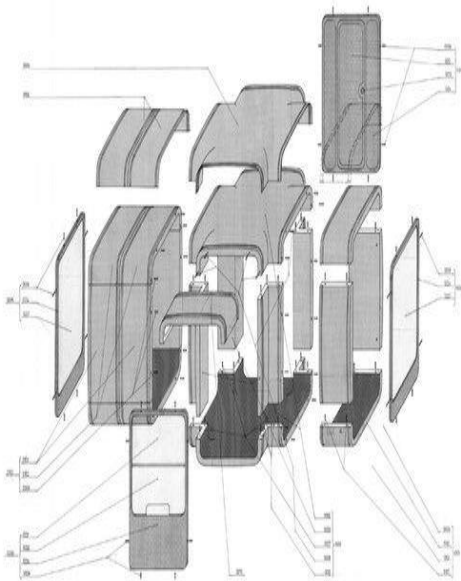
Project teams not only design the building's various elements, they also plan the process of how those elements will be manufactured, moved to the site, and assembled.



Design to Disassemble



The concept of Prefabricated buildings can be dismantled and re-installed elsewhere, Reducing demolition and material use and waste. (Expo Pavilions)



Design for disassembly



To maximize Sustainability or requirements for future Re-locatability or Repurposing.



Sustainability



Reduced material input and waste, and can be recycled back

Modular construction requires less space around the building site for workers, truck traffic, and material storage, resulting in a smaller construction footprint and reduced site disturbance. Shorter construction process, involving fewer workers, less traffic, processing of materials.

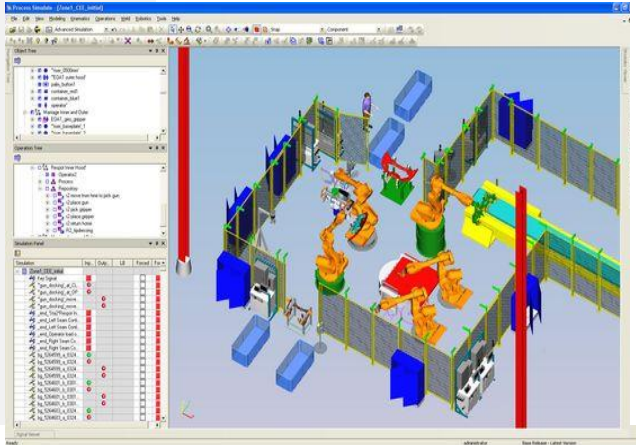


Design and Manufacturing Tools



Designers should understand the central role of digital technologies in the fabrication of modular components, including; BIM, CAD, CAM, and computer numerical controlled (CNC) machinery.

And how these tools can support mass customization, to produce designs at a cost-effective industrial scale using standardized components.



Autodesk Product Design & Manufacturing Collection

- | Desktop | Cloud |
|-----------------------------------|--------------------------------|
| AutoCAD | AutoCAD Mobile App |
| AutoCAD Architecture | Fusion 360 |
| AutoCAD Electrical | Recap 360 Pro |
| AutoCAD Mechanical | Rendering in A360 |
| AutoCAD Map 3D | Process Analysis 360 |
| AutoCAD MEP | Autodesk Drive (Cloud Storage) |
| AutoCAD Plant 3D (including P&ID) | |
| Factory Design Utilities | |
| Inventor Professional | |
| • Sheet Metal | |
| • Linear Stress Analysis | |
| • Tubing & Piping | |
| • Mold Design | |
| • Electro-Mechanical Design | |
| Nastran In-CAD | |
| HSM | |
| • 2.5- to 5-axis Milling | |
| • Turning | |
| • Mill-Turn | |
| • Laser/Plasma/Waterjet | |
| Inventor Nesting | |
| Navisworks Manage | |
| Vault Basic | |
| 3ds Max | |
| 3ds Max Interactive | |

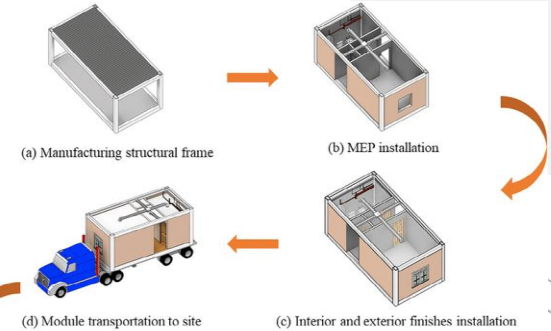
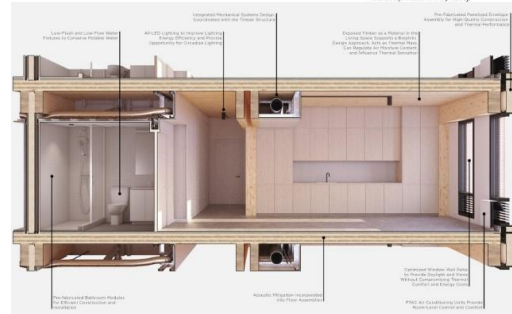
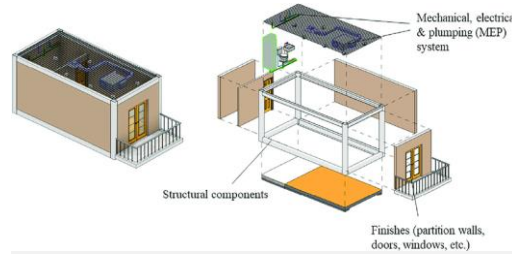
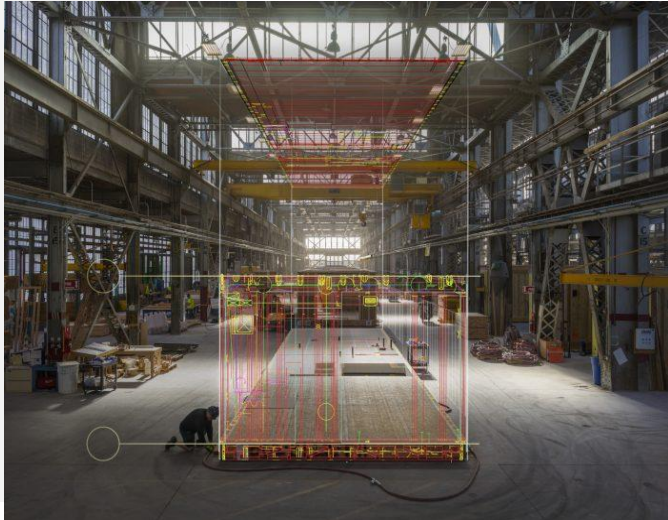


Building Information Management (BIM)



BIM tools like Revit can contribute significantly to a well-coordinated design, manufacture, and assembly process. BIM can be used to plan sequencing to ensure that construction tolerances are maintained, and the clash detection features of BIM tools can help avoid conflicts at mate lines.

Installing the modules requires placing them into notches sunk into the floors. High precision is necessary. The use of BIM to coordinate off-site and on-site operations is critical to achieving this precision.



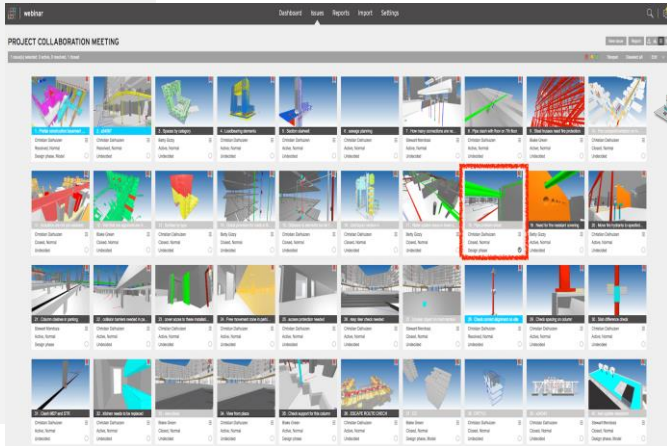
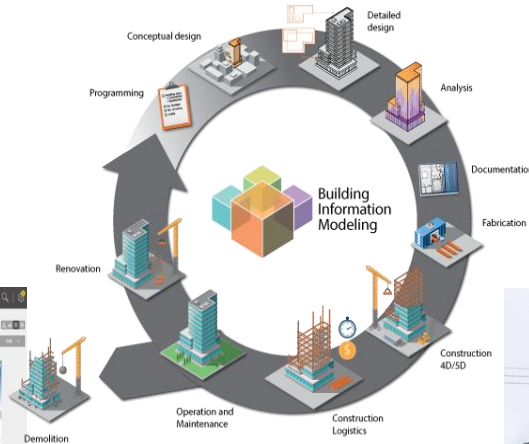
(e) Module lifting and installation at site

Integrated process



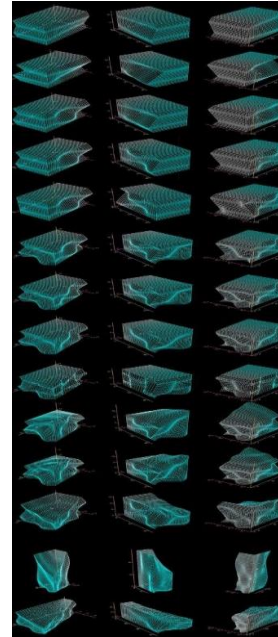
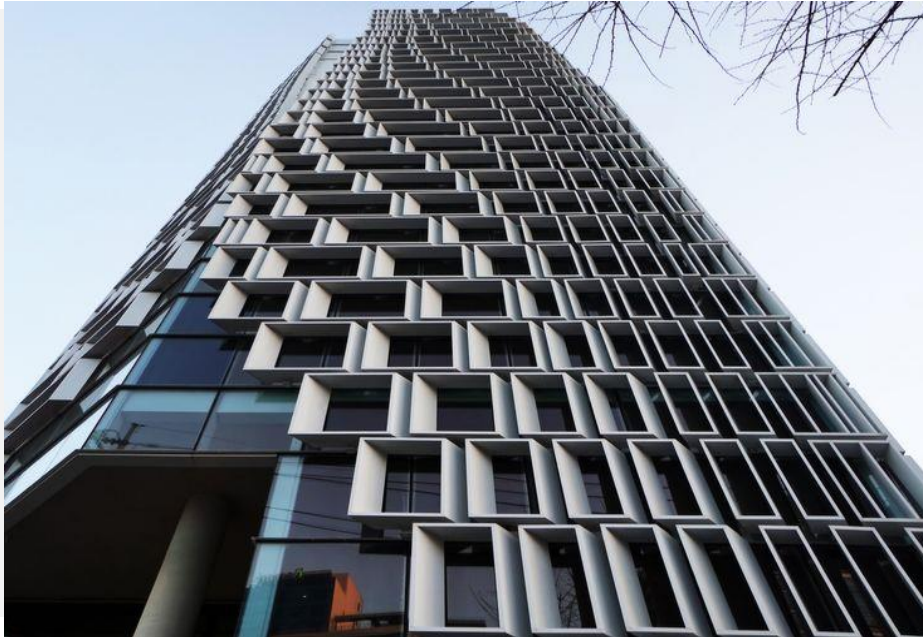
Architects should be intentional about the process by which the buildings are fabricated, transported, and connected.

Design team should shift their perspective to thinking of the building as a system of connected processes and components.



Parametric design considerations

Parametric design tools can provide a wider range of options in modular construction. Experimenting with these tools, creates variations of standard modules to be used on a project while remaining within the parameters defined by what the manufacturing process can cost-effectively achieve.

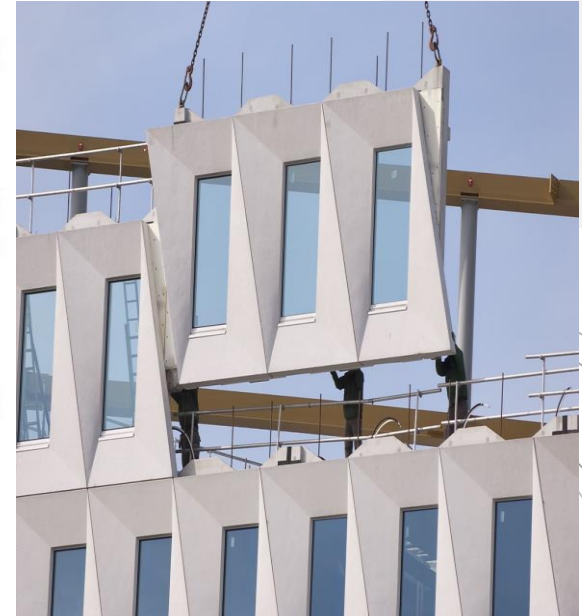
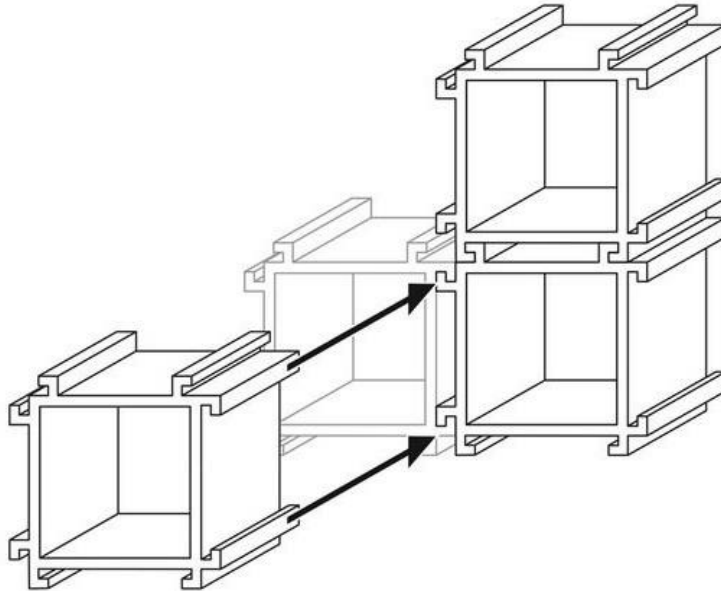


Connections

Interface details for module-to-module connections and module-to-foundation connections.

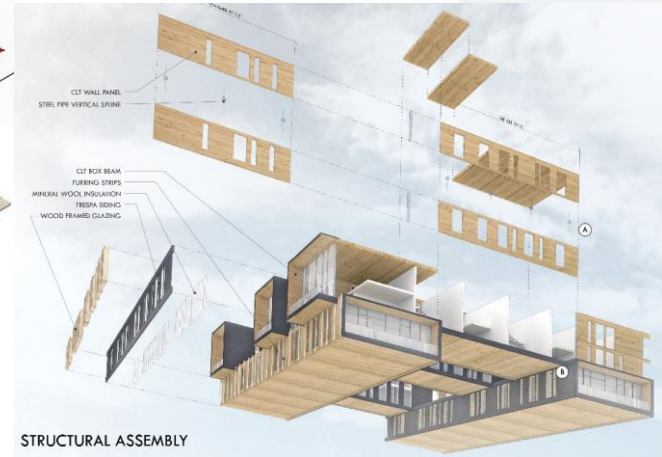
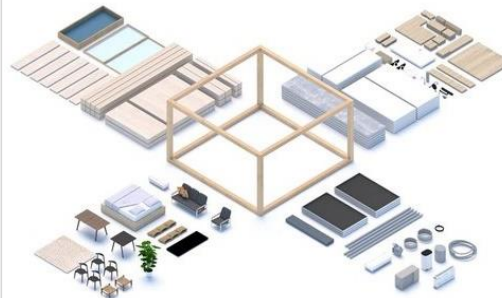
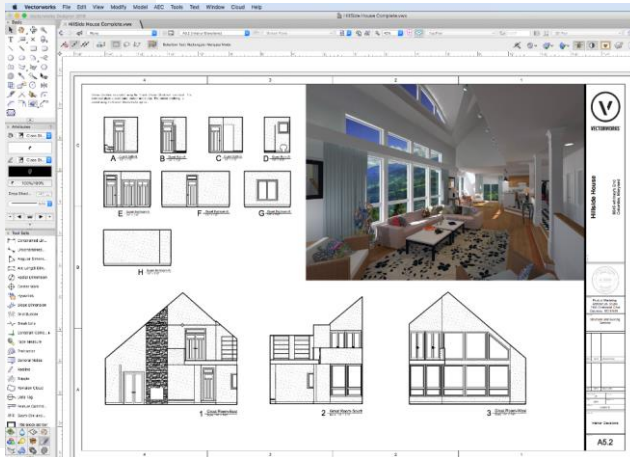
Thermal performance and the potential for water penetration, both between modules and between the modules and the façade system.

From an aesthetic standpoint, designers should address how mate lines on the interior and exterior will be treated to either express the modular construction methodology or conceal it.



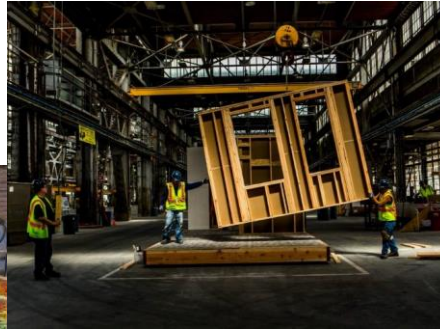
Design freeze

Design changes late in the process can be costly.



Engage a Modular Manufacturer

Once a modular project is ready to proceed beyond schematic design, Modular manufacturer should be brought on to provide consultation and, potentially, design-assist services. Structural system is the most critical element. The Manufacturer should take on full liability for that system. The early involvement of major subcontractors is also highly beneficial. Bids should be sent out earlier than standard (when construction drawings at 50%) to allow subs to share feedback.



Manufacturing, Commit Early

Using modular approach after the design development phase may not yield the desired advantages.

The Modular Fabricator may take ownership of the structural design.



Organized by **dmg** events



Increased use of Cranes for assembly on-site.



Modular manufacturer's scope, 3 common construction approaches

1. The Modular Manufacturer acts as a Subcontractor and hands off the completed modules to the General Contractor responsible for completing the project on-site.



2. The Modular Manufacturer also performs the installation of the completed modules, but not responsible for anything else.



3. The Modular Manufacturer acts as the General Contractor, responsible for all aspects of the projects, off-site and on-site.



Process – Installation, Transport, Staging, Assembly

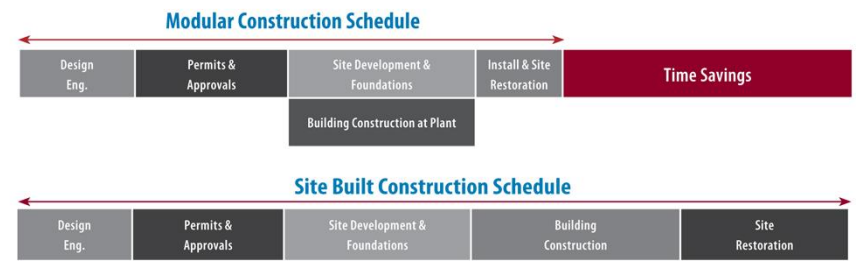
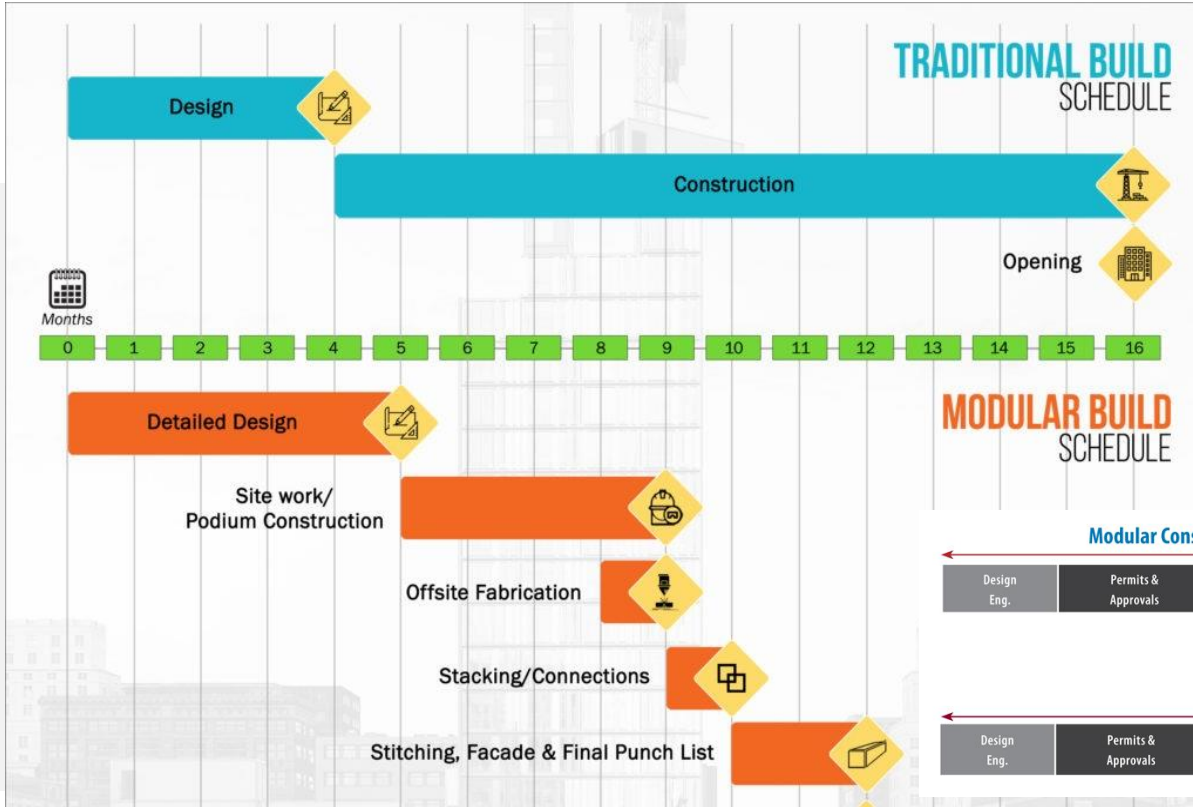


A just-in-time (JIT) delivery schedule.

The production, transport, and assembly of modules to be balanced, so that there's neither time wasted waiting for modules from the manufacturing facility nor a backup of modules on-site waiting to be installed.



Schedule



Cost & Funding Differences compared to traditional construction

The shorter construction period, the fewer developer's carrying costs and the sooner the project will return a profit.

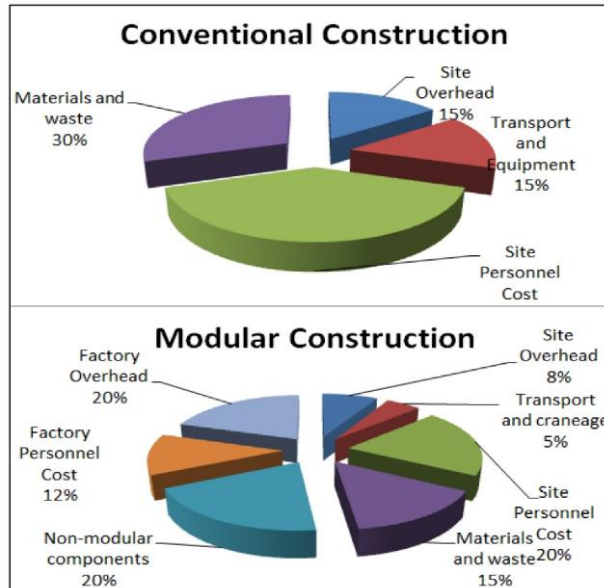
Modular projects can require higher upfront costs for technical approval compared to traditional construction projects.

The labour cost typically makes up about 60% of the total project cost,

This will reduce the need for traditional trade labour, and influence specific insurance policies.



Urban Design
& Landscape



Target Cases



- Projects where schedule reduction or time to market is a primary motivator for the owner
- Projects with repetitive elements such as identical classroom units, dormitory units, office spaces, or labs
- Projects with relatively dense framing and no excessive spans
- Projects located on remote or less accessible sites, where on-site construction would be difficult, as in;
 - ❑ dense urban areas,
 - ❑ locations with constricted build seasons, or
 - ❑ where materials, labour, and/or land is expensive
- Projects located in areas where labour is not readily available

Organized by

dmg :: events



Companies with Ideal Practical Approach

- Production capacity relative to project scale and schedule
 - Extent of established network of resources
 - Level of experience with specific project type and level of design complexity
 - Proximity of plant location(s) to project site
- (Most manufacturers will ship to locations within about a 350- to 500-mile radius.)

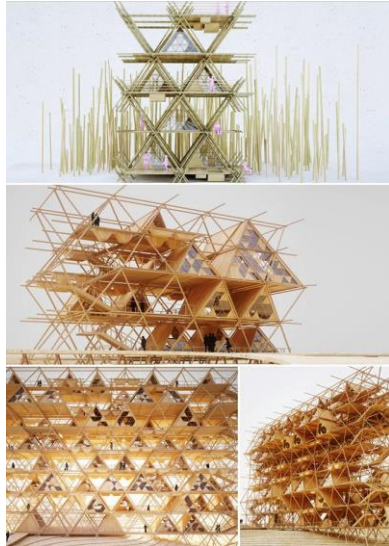
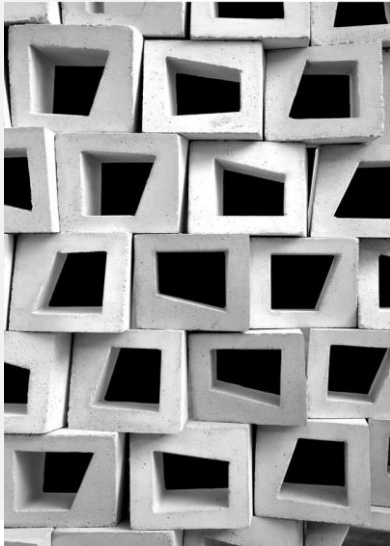


Organized by **dmg** events



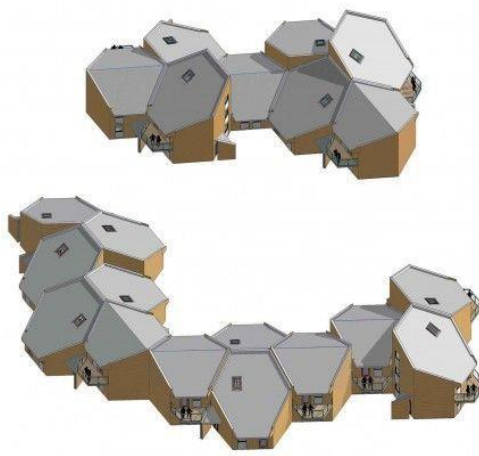
BARRIERS, and Mis-perceptions

- **Limited supply chain**, Only 33 % of projects currently use modularization.
- **Lack of experience**, the industry needs to gain familiarity with the approach, or Creating a hybrid approach
- Some architects believes that modular construction limits their design options or restricts their control
- Mass customization approaches increase the ability to tailor the design of manufactured components. By integrating parametric design, with advanced BIM modelling and the precision of computer-aided fabrication



Other factors to consider

- Manufacturers may not be able to cost-effectively produce highly complex forms.
- Local jurisdiction is less familiar with off-site fabrication approval methods.
- Generally, Modular Construction can result in a bulkier structure, with deeper independent floors and thicker walls compared to traditional construction. This might negatively impact interior living spaces in taller structures—by reducing the usable area and volume of interior space—if not properly considered during design, despite its benefit in terms of acoustics, energy efficiency, and thermal comfort.
- Expansive clear spans and considerably high open ceilings, is not conducive to modular construction.



Future Applications

- Projects located on remote or less accessible sites, where on-site construction would be difficult;
 - Space
 - Submarine
 - Arctic
 - ??



THANK YOU

Talks

Concrete

Talks

Facilities
Management

Talks

Geotechnical
& Engineering

Talks

HVAC R

Talks

Offsite
& Modular

Talks

Project
Management

Talks

Solar

Talks

Stone Design

Talks

Technology

Talks

Urban Design
& Landscape