Changing the Way We Think of Prefabrication: New Solutions for Your Building Envelope

Integrated sheathing is a key component

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Learning Objectives

Upon completion of this course, you should be able to:

- 1. **Discover how prefabrication offers productivity and management** advantages for the building envelope.
- 2. **Discuss how prefabrication can address common project management issues** at the job site, including weather delays, crew safety, quality control, labor shortages, and scheduling.
- 3. **Explore** how traditionally applied **WRB-AB** and integrated WRB-AB sheathing solutions are impacting lean manufacturing productivity goals.
- 4. **Compare WRB-AB integrated sheathing solutions** transportability from prefabrication factory to the job site.

Part 1
Prefabrication in Construction

Definition

Evolution of prefabrication over the past seven decades

Prefabrication Definition

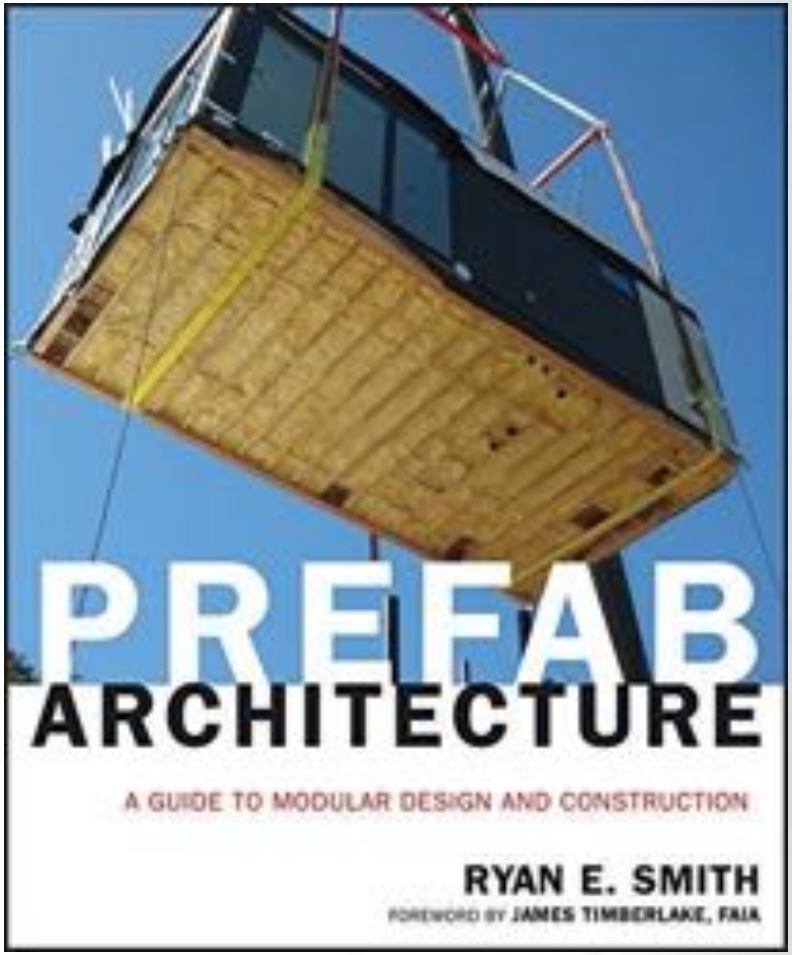
Prefabrication ("Prefab")

- Prefabrication is the construction of some parts of a building **off-site** and then transporting them to the job site for final installation.
- This can include:
  - Single components
  - Structures: walls, floors, etc.
  - Spaces or rooms
  - Entire buildings in panelized or modular components
- Focus here is framed wall panels

Prefabrication Evolution

Historical Look

- Book: *Prefab Architecture: A Guide to Modular Design and Construction* (John Wiley & Sons, 2010)
  - Author Ryan E. Smith chronicles the history of industrialized building and architecture in the context of environment, organization, and technology.
  - He identifies 20th century examples of work and trends that have contributed to current notions of manufactured construction.



Prefabrication Evolution

Levittown: Post World War II Housing

- Prefabricated construction began to emerge following World War II.
- Levittown is an example of housing produced on factory-style "assembly lines."
- This made it possible to build a house in as little as one day.
- It sold quickly and was built in seven large suburban areas in United States and Puerto Rico.

Prefabrication Evolution

Hilton Palacio del Rio Hotel, San Antonio

- Constructed in 1968 at same time as the Texas World's Exposition
- Built in only 202 total working days by the H. B. Zachry Company
- Set in place about 10 modular rooms a day and installed a total of 496 rooms by crane in just 46 days
- Still in active use today

Prefabrication Overview

Modern Example: Katerra

- "A technology company at heart, we're applying tested systems approaches from other industries to design and construction."
  - On a mission to change by optimizing every aspect of building design, materials supply, and construction

Prefabrication Evolution

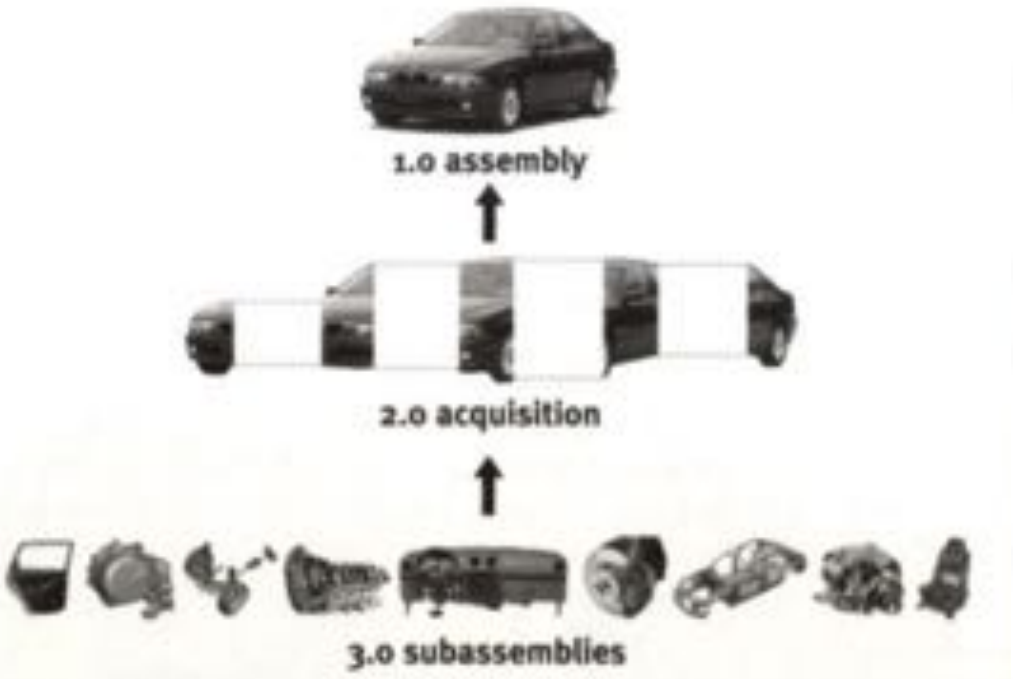
Theoretical and Application Work

- Work by Stephen Kieran, FAIA, and James Timberlake, FAIA, in 2004 book *refabricating ARCHITECTURE*
  - Focus is on how manufacturing methodologies can be used to transform the way buildings are constructed
  - Identifies concept of “mass customization”: using standard parts to create custom solutions in quantities for mass consumption

Prefabrication Evolution

Theoretical and Application Work

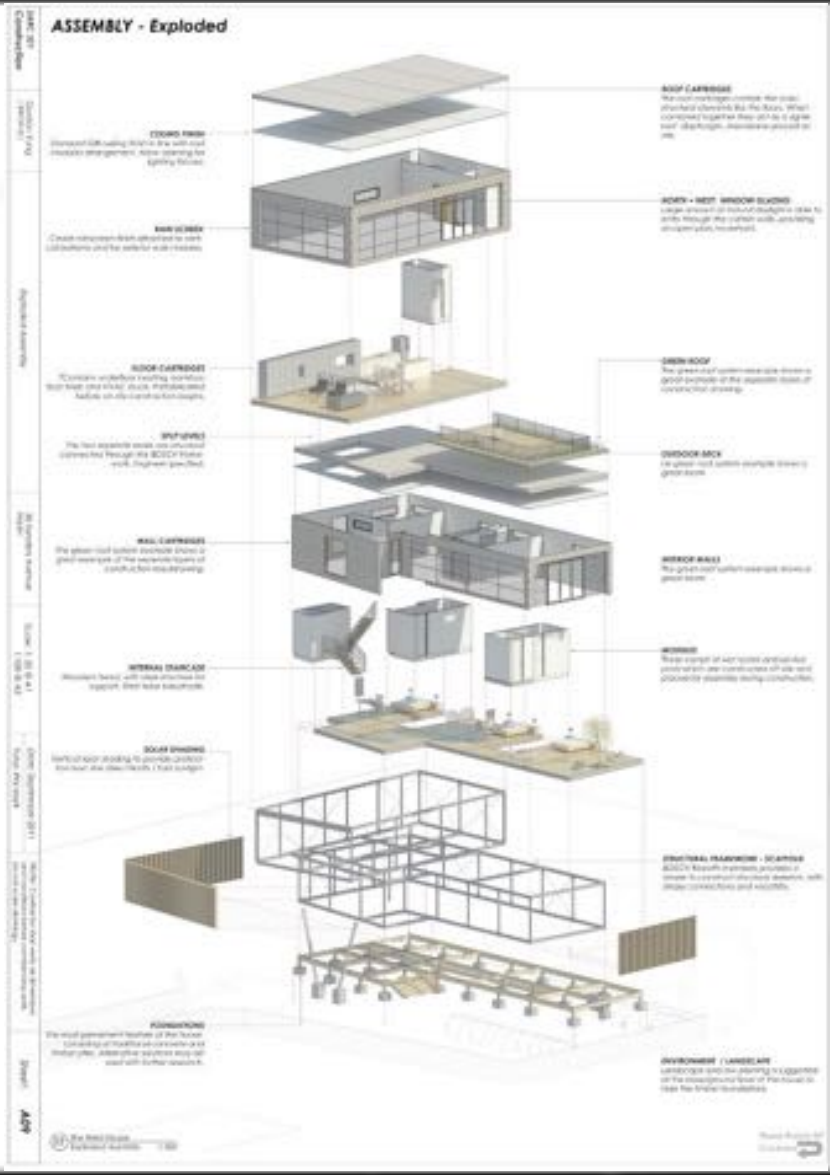
- Kieran and Timberlake
  - Use aircraft, automotive, and computer industries as examples of creating products from predesigned, premanufactured parts or systems that are assembled into the final total product



Prefabrication Evolution

Theoretical and Application Work

- Kieran and Timberlake
  - Apply same principles to building design and construction
  - Benefit to architects is greater control of the total process
  - Describe opportunity to assume a new, modernized role of the traditional "master builder" that architects were historically known for



Prefabrication Is Here: It's Growth Is Inevitable

- All of this evolution and work by many different people is demonstrating the inevitability of the growth of prefabrication.
  - Technology and direct marketing/ delivery are opening up more options.
  - Amazon is now offering prefabricated hospital rooms.
- Things have matured to the point where prefabrication is now commonplace and expected.

amazon

MedModular hospital room is available fully equipped from Amazon

Part 2
Productivity Advantages of Prefabrication

Traditional construction vs. prefabrication

On-site Construction vs. Prefabrication

Management: Traditional On-Site Construction

- Separate contracts between owner and
  - Design professionals
  - Construction companies
- Further separation of roles and responsibilities
  - Trade-based subcontractors
  - Material suppliers
  - Equipment suppliers

On-site Construction vs. Prefabrication

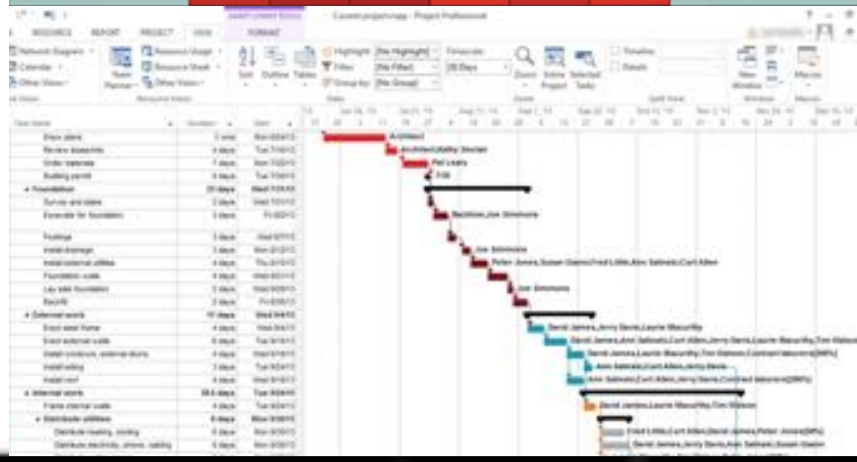
Management: Prefabrication

- Encourages more direct interaction between design professionals and construction companies
- Easier supervision by architects at an off-site/factory location than at job site
- Can bring multiple trades together in one process
- Simplified coordination with fewer subcontracts

On-site Construction vs. Prefabrication

Process: Traditional On-Site Construction

- Construction process rooted in sequence of trades and work:
  - Sitework
  - Foundation
  - Frame
  - Skin/enclosure
  - MEP systems/equipment
  - Finishes
- Time schedules rely on many separate people
- Costs related to delay of sequence of construction



On-site Construction vs. Prefabrication

Process: Prefabrication

- Construction process is no longer tied to sequence of trades and work.
  - Different activities can happen concurrently in different locations.
  - On-site and off-site work can happen independently of each other (e.g., wall fabrication during foundation work).
- Time schedules can overlap with built-in buffers.
- Delays and associated costs can be better managed.

On-site Construction vs. Prefabrication

Challenge: Traditional On-Site Construction

1. Very weather dependent
2. Relies on availability of skilled and semi-skilled labor
3. Worker safety is a major concern
4. Availability of on-site staging and storage

On-site Construction vs. Prefabrication

Solutions: Prefabrication

1. No longer weather dependent because work is done in a closed, sheltered “factory” environment that is temperature controlled
2. Skilled and semi-skilled labor are concentrated with tools in place
3. Indoor conditions are usually safer
4. Storage off-site until ready

Advantages of Prefabrication

Solutions: Prefabrication

- Improved quality control over traditional on-site construction methods
  - Supervision is easier in a factory setting
  - Allows for a more defined division of labor with smoother, more predictable flow
  - Allows for more testing during assembly

Advantages of Prefabrication

Solutions: Prefabrication

- "Lean manufacturing" can be employed
  - Technique to maximize efficiency and minimize waste
  - Repetitive nature of work allows for identification of bottle necks in process so they can be solved or eliminated
  - Adjustments can be made in either process or by using different products that eliminate steps

Advantages of Prefabrication

Solutions: Prefabrication

- "Just-in-time" delivery can be scheduled
  - Prefabricated units are delivered when needed and set directly onto building
  - Reduces or eliminates need for onsite staging
  - Very helpful on urban sites or any site with minimal staging area available

Advantages of Prefabrication

Prefabrication: Overall

- Compared to on-site construction, prefabrication provides:
  - More options
  - Greater flexibility
  - Better control of the project

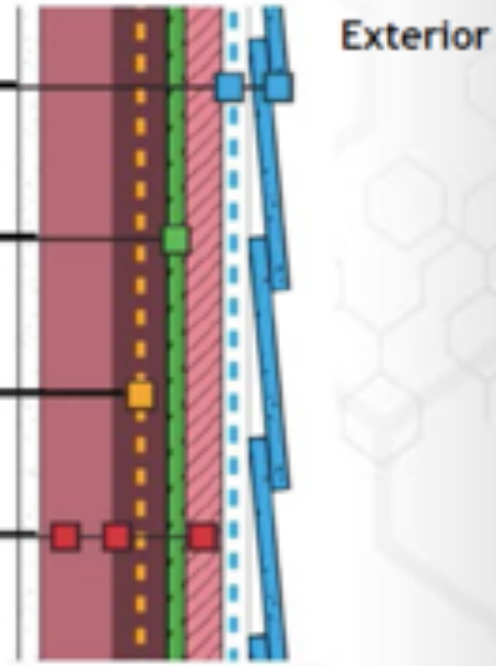
- All of these can translate into:
  - Real productivity increases
  - Notable time savings
  - Cost savings
  - Better buildings

Part 3
Prefabricating Exterior Walls

Using integrated sheathing for better results

Four Different Construction Layers Needed

- There are 4 different control layers of a building envelope:
  (in order of importance)
  - A **Water** control layer
  - An **Air** control layer
  - A **Vapor** control layer
  - A **Thermal** control layer



Exterior Walls

Conventional, Multi-product, Multilayer Solutions

- Requires many different products
- Involves separate labor tasks
- Needs assurance of compatibility
- May require cure times for fluids, primers, etc. when installed

Exterior Walls

Conventional, Multi-product, Multilayer Solutions

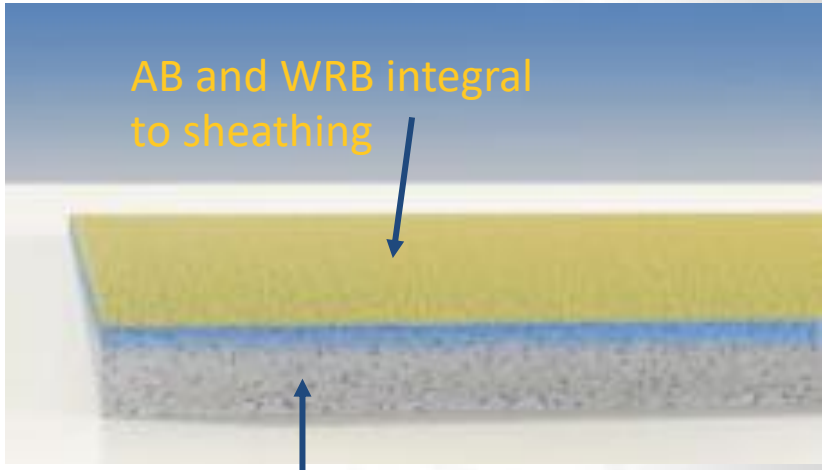
- Conventional, multilayer products are adhered or applied systems that are not integral to the sheathing.
- When used in prefabricated wall panels, conventional air and water barriers are at risk of damage during transport and installation.

Exterior Walls

Integrated Sheathing Solutions

- Allows one engineered product to provide air and water control layers with a single installation of exterior sheathing
- Eliminates step of applying air and water barriers separately reducing production time
- Simpler installation means less labor and less time to fabricate
- Ideal for use in prefabricated exterior wall panels

INTEGRATED SHEATHING



Exterior Walls

Integrated Sheathing in Prefabrication

- AB and WRB preinstalled on sheathing
- Sheathing attached onto framing
- Fasteners, openings, and some seams can be treated
- Panel is made continuous unto itself during prefabrication
- Transports as a complete wall panel system

Integrated Sheathing: Panel Installation

- Once installed on building, final panel seams are sealed at panel joints
- Finished prefabricated system serves as a:
  - Continuous air barrier
  - Continuous water-resistive barrier/drainage plane
- No additional application needed on-site
- Ready to receive final cladding

Exterior Walls

Integrated Sheathing Is Still Sheathing

- The exterior gypsum is still the wall sheathing serving as the base of many complete wall assemblies.
- Versatility of exterior gypsum board allows for complete design freedom.
  - Full range of cladding types can be applied
  - Fire barrier is still maintained
  - Air and water barriers in proper place

Exterior Walls

Integrated Sheathing

- Overall, the use of integrated gypsum sheathing reduces:
  - Complexity
  - Waste
  - Variability
- All of which leads to better productivity and quality of construction

Part 4
Case Study

Les Diplomates 3

Controlling variables with panelized construction

Case Study: Les Diplomates 3

Controlling Variables with Panelized Construction

Project: Les Diplomates 3 (rental condominiums built in three stages)
Location: Québec City
Developer: Huot Real Estate Company
Contractor: Canam Group

Case Study: Les Diplomates 3

About the Project

Diplomates provides bright open spaces, contemporary kitchen design, and contemporary materials. Common living areas are set up on the site: a swimming pool, a terrace, and an urban BBQ create a dynamic living environment in a growing neighborhood known as the Meanders. Diplomates' condos provide a safe living environment with indoor parking and secure access.

Case Study: Les Diplomates 3

The Project Challenges

- 50 inches of rain per year
- Ongoing lack of skilled labor
- Needed an affordable WRB-AB that could provide protection from water and air infiltration

Case Study: Les Diplomates 3

The Fabrication Challenge

- Canam specializes in panelized construction
- Panels assembled in off-site controlled environment
- Can rapidly build panels to meet specifications and ship to site

"It was challenging to find a performance-based WRB-AB that is compatible with our production line. The process needed for peel-and-stick installation was too much of a burden."

—Georges-Etienne Bouffard, Project Manager, Canam Group

Case Study: Les Diplomates 3

The Solution:
Prefabricated Panels with Integrated Sheathing

- Installation is faster.
- Canam was able to reduce on-site labor by sealing all windows, penetrations, and fasteners before each panel reached the job site.

Case Study: Les Diplomates 3

The Solution:
Prefabricated Panels with Integrated Sheathing

- *"We wanted to reduce the amount of labor on-site as much as possible. No matter how experienced you are, installing liquid membrane at negative 20 degrees Celsius isn't fun, so we wanted to install as much as possible in the factory. By the time we reached the job site, all we had to worry about was sealing the perimeter."*

  —Georges-Etienne Bouffard, Project Manager, Canam Group

Case Study – Les Diplomates 3

The Solution:
Prefabricated Panels with Integrated Sheathing

- **Versatility:** The wall assembly surrounding the Les Diplomates 3 building utilizes fiber cement cladding with which the integrated sheathing system can be seamlessly integrated.

Case Study: Les Diplomates 3

The Results

"Some of our competitors go with building wrap for their panels because it's cheap, but we've encountered leaking problems, and that's why I have stopped using those products on our panels. It's not worth it to put our reputation at risk to save a few dollars when it's just going to cause problems down the line."

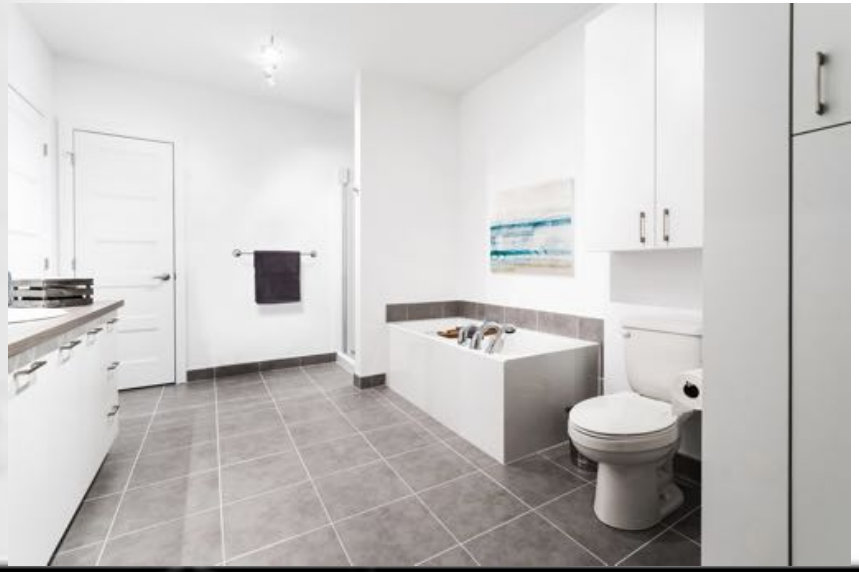
—Georges-Etienne Bouffard, Project Manager, Canam Group

Case Study – Les Diplomates 3

The Results

"Our customers will see the work we have done here and demand that our competitors match this level of quality. I already recommend integrated sheathing systems to clients and colleagues, and I plan to continue doing so."

—Georges-Etienne Bouffard, Project Manager, Canam Group



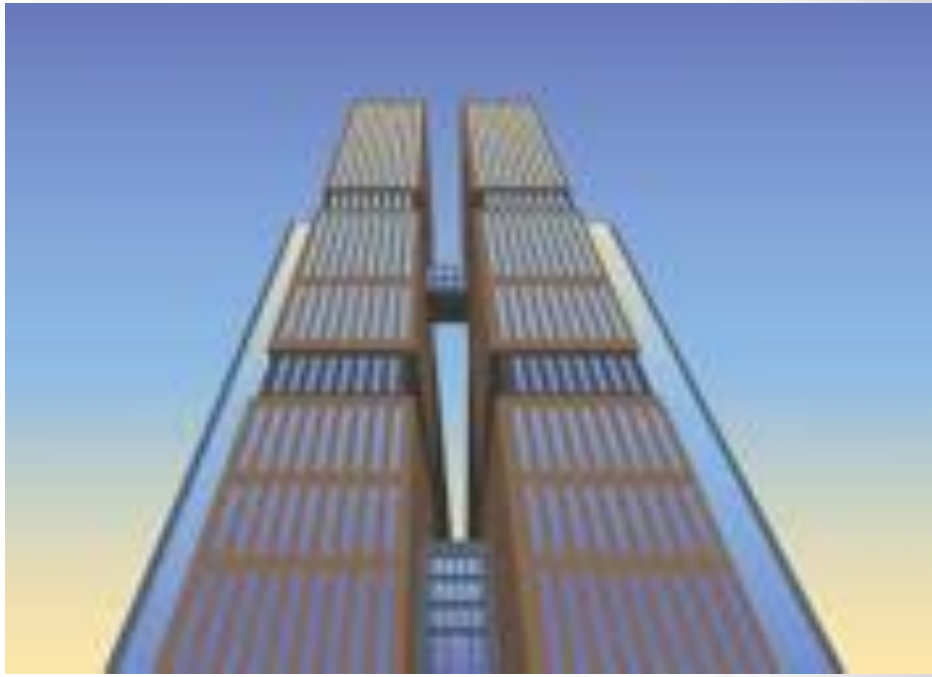
Conclusions

Takeaways

Conclusions

1. Prefabrication Has Evolved

- From WWII beginnings to now, prefabrication has become:
  - More sophisticated
  - More popular
  - Much more prevalent



Conclusions

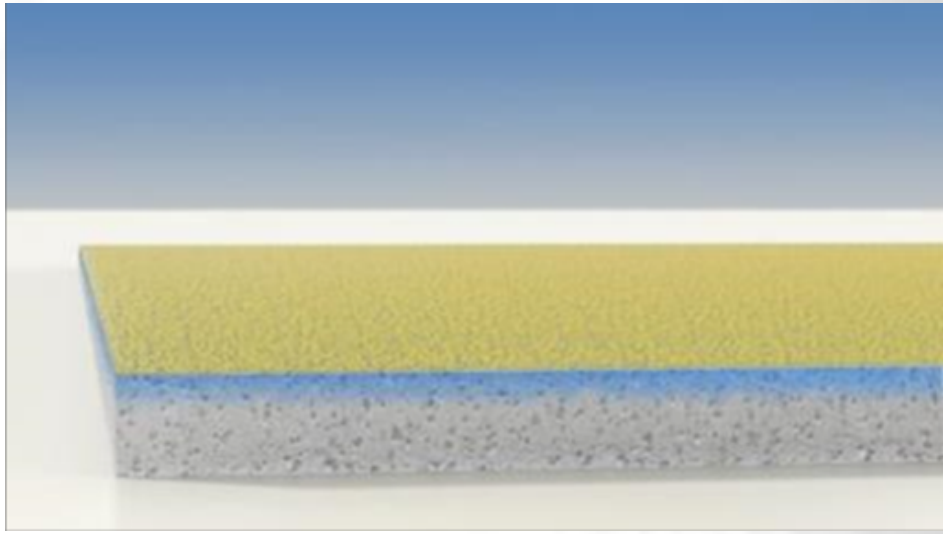
2. Prefabrication Solves Many Problems

- Better quality control and observation of work for designers
- Simplified and streamlined construction process
- Better control of schedule and costs

Conclusions

3. Prefabricated Exterior Walls Benefit from Integrated Sheathing

- The use of integrated gypsum sheathing in prefabricated walls creates:
  - Compatibility
  - Durability
  - Flexibility
- All of which leads to better productivity and better buildings.



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