

# 7 | MODULAR

## UNDERSTANDING THE MANUFACTURER

It is worth noting that the design research of modular manufacturing would not have been possible without the people of Terrace Homes in Friendship, Wisconsin. In particular, Sarah Manternach-Wiedmeyer and Jim Stommel provided invaluable information and support to the students and instructors involved with the AIA150 Studio.

Prefabrication and modularity has a long and interesting history in architecture. Designers and builders have always struggled with the issues of protecting building materials from water and temperature during the construction process. Site built homes are especially vulnerable to damage as they are primarily light frame wood structures. Plywood and dimensional lumber exposed to rain, snow, and extremes of heat and cold for even limited amounts of time can experience warping and splitting. Furthermore, if a wall is sealed before it has fully dried, mold can form and spread throughout the insulation rendering a home unlivable.

One solution to this problem is prefabrication- if components or even whole sections of a home can be built off site and indoors, none of these weather related concerns will be an issue. Prefabrication also allows a home to be constructed just as easily during the middle of winter as in June- not so with site-built homes. Many variations of modular construction have been proposed over the years, from Buckminster Fuller's geodesic domes to Albert Frey's Aluminaire House.

None of these prototypes has ever been as successful as the mobile or trailer home- much to the dismay of architects. Despite its shortcomings, it is cheap, easy to build and is designed precisely to be transported over roadways. Unfortunately, the mobile home has become associated with poverty, a last resort for those who cannot afford a "normal" home. Some manufacturers have sought to shed this stigma by using the efficiencies of modular construction to produce homes that look just like any other house in a neighborhood at reduced cost.

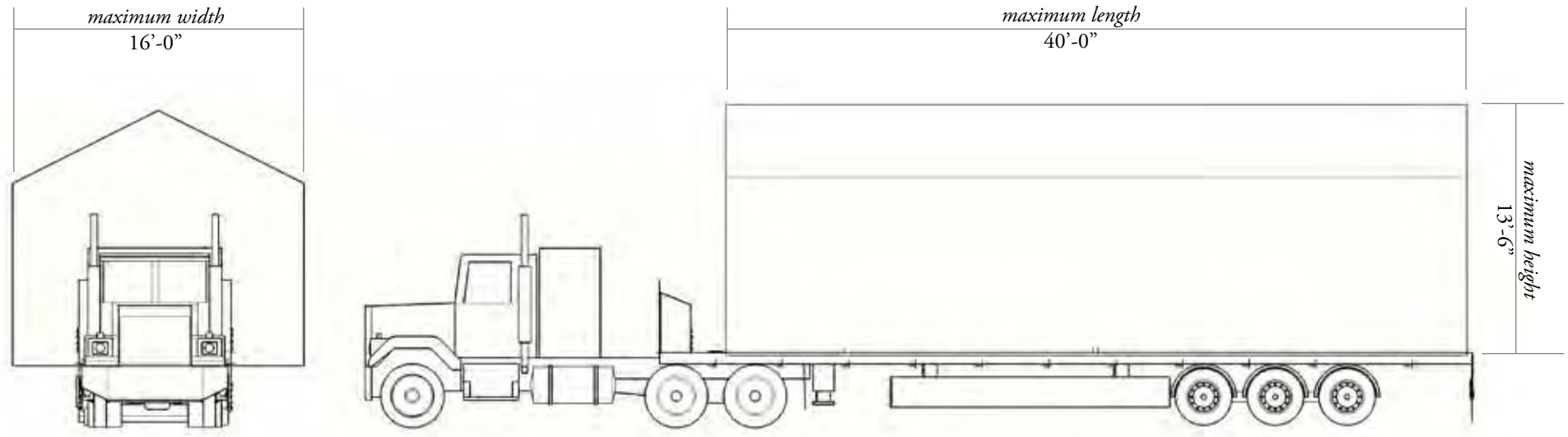


**Above**

Modular homes under construction.  
*courtesy US Department of Housing and Urban Development*

Instead of retaining their wheels once they arrive to a site, they are craned into their final position and seamed together with other modules to create multistory buildings. Plumbing connections are made using an ingenious system of flexible pipes that can even be connected and inspected before the home is delivered to the site. Interiors arrive completely finished and only minimal exterior work is required, allowing homes to be occupied within a day or two of delivery. Since the modules must be able to withstand the vibrations of transport, they are given extra structural reinforcement resulting in a home that is not only more durable but literally road tested.

The modular manufacturing process, however, has some special requirements that must be taken into account by the designer. First of all, each module must be transported to the site by a flatbed semi truck. Due to the length of the bed, the width of highway lanes, and height of overhead obstructions, certain dimensional limitations apply. There are also different regulations from state to state and even from one community to another. Manufacturers have become skilled at figuring out how to cut up a plan with these restrictions, but it is much easier to start with the requirements as a given condition.



“Nothing is as dangerous in architecture as dealing with separated problems. If we split life into separated problems we split the possibilities to make good building art at the same time.”

Alvar Aalto

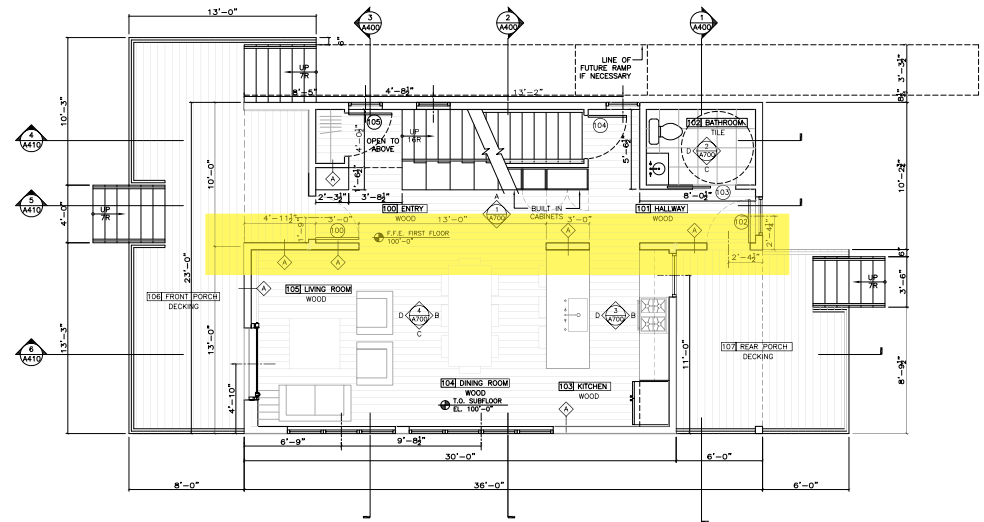
## A Happy Marriage

Another interesting artifact of modular construction is the “mate” or “marriage” wall. Because modules must be transported separately, they must be structurally independent and be able to stand on their own. Even large open spaces that occur across modules must have temporary framing across the opening while in transit. Inevitably, this results in a double-thick wall and a double thick floor plate wherever modules meet. Planning for and even exploiting these conditions became a key issue for the architecture students.

## Process Innovation

Rather than simply taking traditional on-site, stick-built construction methods into a indoors, modular manufacturers have sought to improve the process. On-site construction typically progresses from the outside in, focusing on getting the building weather-tight first. This requires multiple stages of electrical work, plumbing, and finish carpentry because all of the trades need to work from the same side of the wall.

Modular builders, having no weather concerns, can work from the inside out, saving the sheathing of the frame for last. This allows multiple trades to work simultaneously from both sides of the wall. Walking through a modular manufacturing facility, one sees the unusual sight of framed houses with drywall and electrical but no exterior.



**Above**

Plan showing highlighted mate wall.

**Below**

Images of modular construction and transport.





**Top, Middle and Left**  
Sequence showing the setting of a module for a house in Milwaukee.

### *Convenience and Security*

Without having to secure or strike a work site at the end of each day, workers can maximize their productivity. A carpenter arrives at the beginning of the day, rain or shine, works for eight hours without ever having to wait for materials to arrive. They never need to wait for other trades to finish and the process is so well coordinated that workers simply move from one module to the next with very little interruption. Finally, at the end of the day, they all set their tool belts down wherever they are, picking up again the following morning.

### *A Machine for Building In*

This whole operation takes place in a carefully choreographed sequence. This sequence begins with rough framing at one end of the warehouse and continues with the modules being delivered to each stage of construction rather than having workers constantly travelling between workstations. The modules are built on large tables elevated to about waist height, alleviating back strain from bending down. The steel frames of these tables are transported all over the warehouse by a series of overhead cranes. The build process is laid out so that all of the finished modules end up at the loading doors where they are placed on flatbed trucks for delivery. As a result of all these efficiencies, the entire process of completing a home is accomplished, on average, in a staggering two weeks!