

An Introduction to Prefab

The basic principle of prefab, whereby a home is fabricated in one location and then delivered to another, has been around for at least a few hundred years. An early example, the Manning Portable Colonial Cottage, provided the means for reliable shelter in British colonial outposts located far from anything that might have resembled a Victorian-era Home Depot.

Between 1908 and 1940, Sears, Roebuck, and Company sold over 70,000 prefabricated house kits by mail to enterprising do-it-yourselfers across North America. These ready-to-assemble homes featured pre-cut wooden components cross-referenced to a blueprint. Thanks to robust engineering, durable materials, and some

good craftsmanship, many of these homes are still in use.

After World War II the United States faced a severe housing shortage, and several ventures attempted to use industrialized factory-built housing to solve the crisis, including Lustron Homes and the General Panel Corporation. The Eames House, in Pacific Palisades, California (1949), explored the idea that a home could be constructed from off-the-shelf industrial parts and harness economies of scale for ready-made components.

In the 1970s the U.S. Department of Housing and Urban Development (HUD) sponsored Operation Breakthrough, which advocated the use of factory-based industrialization and

mass production in the national home-building industry as a way to drive down costs and make housing more affordable. Unfortunately, Operation Breakthrough did not break through, and the entrenched method of site-building homes remained in place.

Throughout the 20th century, the promise of prefab captivated architects and designers. Luminaries like Frank Lloyd Wright, Walter Gropius, and Buckminster Fuller were among many who experimented with prototypes intended for mass production—a goal none of them achieved.

The last decade has seen a resurgence of interest in prefab as entrepreneurial architects redefine the architect-client relationship around

a product-based business rather than a service-based practice. Most of today's models are manufactured in small quantities to the same codes and with similar materials to site-built houses.

The most widely cited benefit of prefab is economy of scale, as components or entire homes can be produced in large quantities. But this is not a prerequisite for success. There's value in faster project schedules, fewer weather delays, and more efficient use of materials thanks to optimization and quality control. One of the primary benefits for the buyer is predictability: Predefined design details and construction processes give the client a degree of surety about the outcome that is often absent in custom projects.

The Future of Prefab

Joel Turkel, Principal, Turkel Design

The future of prefab is an increasingly nonarchitectural problem. Traditionally, architects have tried to design things to be prefabricated using either existing or new means, as opposed to designing functional and integrated delivery methods. Prefab will continue to be a niche approach until we can add to the understanding of what is possible. This means recognizing that design is only one of many imperatives in the prefab question.

Real development for the industry will come from young designers who are able to approach the problem from a more globalized vantage point. This group is able to think in terms of complete front-to-back business models. They are aware of the needs and limits of manufacturing processes but also are versed in new technologies, entrepreneurial methods, how capital works, strategic partnerships, and the importance of marketing and branding. This group will not design buildings but rather solutions for distributed delivery methods like those promoted by Kent Larson at MIT, who is leading the way toward rationalized industry-wide changes to benefit us all, rather than just promoting an individual vision or aesthetic. ▮



Story by Michael Sylvester
Illustration by Tim Tomkinson

Prefab in Your Daily Life: Much of our built environment is at least partially prefabricated. We've dug up some facts on the oft-overlooked matter.

① Sears Modern Homes were shipped via boxcar and came with a 75-page instruction book. Each kit contained up to 30,000 pieces, not counting nails and screws.

② Most states require special permits for transporting oversized modular homes. In California, a police escort is required for anything over 14 feet wide.

Pretty Fabulous

In order to fairly evaluate the pros and cons of today's prefab design, we broke it down according to various criteria. Here are just a few examples of the benefits prefab has to offer.

Affordable

The sticker price is not the only sign of affordability. Rocio Romero's prefab homes come in kit form, allowing the buyer to decide how much to participate in the onsite assembly process. A buyer can hire a contractor or work with some generous friends and a bit of gumption to build the house him or herself. Subsidizing the cost of the house through the provision of labor makes home ownership attainable for some people, creating sweat equity along the way.

Mobile

Want to take your home with you? If so, your prefab will need a chassis and some wheels, making it a close cousin of the mobile home (or "manufactured home," in building industry parlance). The HOM product from KAA Design Group in Los Angeles is an example of a relocatable architecture product, as is the miniHome from Sustain Design



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DONE RIGHT

Studio. Although technically related to the trailer home, these sharp-looking houses are from a very different part of the family tree.

Reconfigurable

The KT line from KieranTimberlake and LivingHomes is designed to fit easily on urban infill lots. A reconfigurable design allows you to add rooms and entire floors as your living needs change. One model features 19-foot ceilings in the family room.

Transportable

While only mobile homes actually have wheels attached, many prefabs are designed to be transportable, though some can be relocated more easily than others. System 3 by Oskar Leo Kaufmann and Albert Rűf features modules and components that fit perfectly inside a cargo container, which acts like a steel shipping sleeve. The modules are combined with Austrian precision, resulting in a structure that almost resembles fine furniture.

Completely Custom

Some prefabs feature fixed floor plans while others are customizable, designed for a specific client and utilizing a defined methodology, such as steel- or timber-frame modular construction. Custom projects are usually more expensive, but the final design is unique. These homes are available from many companies, including Hive Modular, Marmol Radziner Prefab, and Resolution: 4 Architecture.



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Recycled

Many architects now specify materials derived from recycled products, such as insulation made with discarded denim. Logical Homes use repurposed cargo containers as steel-frame modules, thus combining the benefits of recycling and prefab. A customizable skin system keeps the container surfaces under wraps, for those who don't want to feel at sea when at home.

Responsible

Prefab home factories produce far less waste than traditional job sites, making prefab lower impact by definition. Several prefab companies, including Michelle Kaufmann Designs, are now raising the bar above and beyond the inherent sustainability of the process, using renewable materials and integrating efficient technologies.

Completely Digital

In Japan, digital design and automated fabrication is employed at Toyota Home (yes, Toyota also makes homes), Matsushita's PanaHome division, and Sekisui House, offering high levels of dimensional accuracy. The homes vary in style from modern interpretations of classic forms to sleek shelter products that resemble the style of Muji—another company that markets prefab homes in Japan.

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1. MUJI.net Co., Ltd., Mado no ie
 2. Resolution: 4 Architecture, Bronx Box
 3. KAA Design Group, HOM Escape in Style

Photo by Karyn Miller (HOM Design Group)

Photos by Martha Holmes/Getty Images (exterior), Robert Kelley/Getty Images (portrait)

Taking Care of Business

A look back through the history of prefab reveals a few failures that proved to be great opportunities for learning and improvement.

The history of prefab has offered

us some ingenious architecture and engineering. The Dymaxion House by Buckminster Fuller was made of aluminum and featured an efficient heating and passive air-conditioning system based on the physical properties of the round structure. From 1948 to 1950, Lustron Corporation made steel houses with porcelain-enamel-coated panels that could be cleaned with a garden hose. The kitchen featured an unusual combination dishwasher-kitchen sink-washing machine appliance. The Packaged House, devised in the 1940s by Walter Gropius and Konrad Wachsmann for General Panel Corporation, could be erected or dismantled in a single day.

Consumer interest in these design innovations was high, with over 60,000 people touring a Lustron show home in New York City in 1948, and a single advertisement in *Life* magazine generating more than 150,000 inquiries. The problem was that none of them succeeded commercially. This is prefab at its worst: a host of engineering marvels and a litany of business failures.

There are several recurring flaws of failed prefab companies. Financial problems often include inadequate or unsuitable business capitalization. Lustron Homes, for example, although very well funded, was saddled with debt payments before any significant income was achieved. Common management problems include over-optimism about sales figures and fundamental strategic errors, such as assuming that the incumbent forces of the construction industry would reor-

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ganize to allow a new idea to succeed.

From the home buyer's perspective, too many architects and engineers have assumed that the self-evident genius of a construction system will compel buyers to purchase the product. The truth is that home buyers are more interested in the features of the finished home, its durability, and its resale value than in the building system that delivered the house.

The prevalence of unrealized ideas is even greater today given that architects can quickly conjure up a photo-realistic image of a concept using CAD software and post it online for millions of people to see. Configuring an efficient fabrication and fulfillment system is not as much fun as designing eye candy, but it's necessary if an idea is to avoid the prefab scrap heap.

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1. Lustron Prefab House
 2. Carl G. Strandlund, Lustron Corporation President

ⓐ Mobile homes within 1,500 feet of the coast in hurricane-areas are called "D-sticker homes" for the American Society of Civil Engineers code 7-88 exposure D criteria.

THE FUTURE OF PREFAB

Peter DeMaria, Principal Architect, Logical Homes

Some people assume that yet-to-be-invented high-tech materials and systems will be the saviors of our construction industry. New technology can be great, but some of the answers to our building challenges are right in front of us. We need to look more closely at existing materials and systems from commercial construction and other industries and ask how they might be adapted, adjusted, or recycled to meet our domestic architecture needs. It's less glamorous than creating renderings of new home designs, but we need to look at how to design efficient processes that leverage the economies of scale inherent in existing industrial components and systems. Within this framework, a good architect can create more affordable housing and yet still have design freedoms.

Leo Marmol, Marmol Radziner Prefab

More and more people are coming to us informed about the complete benefits of prefab construction. In the beginning, the focus was always on the cost savings related to the process. Now people are more interested in the green benefits. Potential homeowners are looking for ways to reduce their impact on the planet and want to surround their families with safe, eco-friendly materials. People are also starting to grasp how prefab can save them time and reduce the burden associated with the building process. It's exciting. The general public is starting to understand that prefab can help reduce their impact on the planet and streamline their lives without forcing them to sacrifice on design. We feel this is only the beginning. ▮

ⓐ Renting a crane for positioning a module costs \$750 to \$5,000 per day. City permit fees for closing a street during delivery sometimes cost more than the crane rental.

ⓐ Shipping containers were introduced in the 1950s and sizes were standardized in the 1960s. The most common size is 8 feet wide by 8 feet high by 20 feet long.

ⓐ Log homes are one form of prefab kit home. There are more than 500,000 log homes in the United States. As of 2003, more than 25,000 were sold annually.

The Big Easy

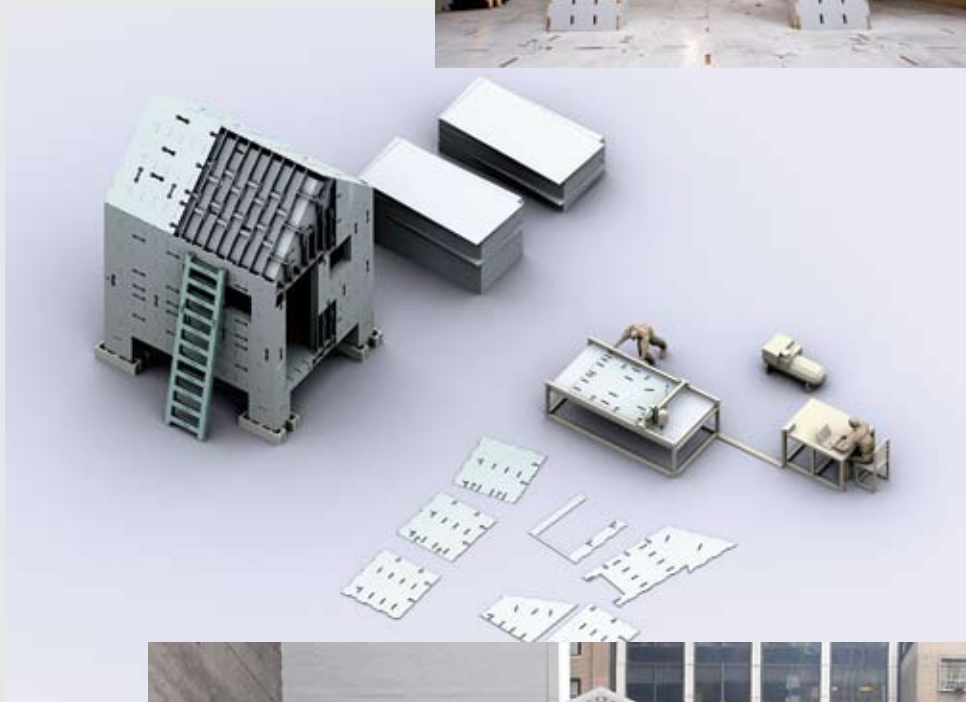
Most prefab manufacturing facilities house loads of heavy machinery, but not every design must be constructed on the factory line.

The construction of most houses requires large-scale equipment, power tools, and thousands of screws, but Larry Sass, an assistant professor at the Massachusetts Institute of Technology, contends that all you really need in order to build a sound structure is a rubber mallet.

Sass is director of the Digital Design Fabrication Group in the Department of Architecture at MIT. His research, which focuses broadly on computer modeling and prototyping, recently yielded a design and fabrication system based on the extensive use of computer numerically controlled (CNC) milling machines. It sounds complex, but the product looks like an oversized doll house.

A built example of this system, called Digitally Fabricated Housing for New Orleans, was recently displayed at the Museum of Modern Art in New York. The house was made with plywood panels, precut with joints and notches. The precision-cut, friction-fit components come as a kit that completely eliminates the need for mechanical fasteners like screws and nails. In simple terms, the assembly instructions for the house are "Insert tab A into slot B. Hammer with a mallet."

This marriage of high-tech fabrication with low-tech assembly has potential applications for humanitarian projects such as low-income and disaster-relief housing. The system demonstrates the potential of digital technology to scale a simple idea into a viable shelter. At just \$2,500 (with furniture built in), the one-room cabin could be a real solution where housing and resources are scarce. ▮



Photos by Richard Barnes (interior), Larry Sass (exterior)

📌 In 2004, 42,700 modular homes were constructed in the United States. From 1992 to 2002, modular housing production increased 48 percent nationally.

📌 While the cost of building materials changes constantly, it is generally true that a home built from steel is more expensive than a home built from wood.

In a 2002 study by the National Association of Home Builders Research Center, a steel-framed home cost 14.2 percent more to build than an identical wood home.

Bookshelf

At Home with Tomorrow

Carl Koch with Andy Lewis
Rinehart, 1958

An out-of-print look at experiments in industrialized home building by the designer of the Techbuilt House, which was created to meet postwar housing needs in the U.S.

Loblolly House: Elements of a New Architecture

Stephen Kieran and James Timberlake
Princeton Architectural Press, 2008

An in-depth look at the design, fabrication, and assembly of Stephen Kieran's own award-winning summer house.

The Lustron Home: The History of a Postwar Prefabricated Housing Experiment

Thomas T. Fetters and Vincent Kohler
McFarland & Company, Inc., 2006

If you think prefab is something new or easy, this account of the trials and tribulations at Lustron Home will change your mind.

Prefab

Bryan Burkhart and Allison Arieff
Gibbs Smith, 2002

Helping reawaken interest in prefab among

both architects and homebuyers, *Prefab* is more than a coffee-table book—it's a good primer.

Prefab Prototypes: Site-Specific Design for Offsite Construction

Mark and Peter Anderson
Princeton Architectural Press, 2006

A detailed guide to six different prefab systems, weighing the pros and cons of each and explaining how they work.

The Prefabricated Home

Colin Davies
Reaktion Books, 2005

If you read only one book on prefab, this well-researched, very readable tome by an architect-academic should be it.

Refabricating Architecture: How Manufacturing Methodologies Are Poised to Transform Building Construction

Stephen Kieran and James Timberlake
McGraw-Hill Professional, 2003

This book compares the construction process of buildings to those of the automobile, shipbuilding, and aerospace industries. The coolest idea in the book? "Chunking."

Click on It

FabPrefab

An online clearinghouse for prefab information.
fabprefab.com

Inhabitat

Regular updates on what's happening in sustainable technology, design, and architecture, including a special weekly feature called Prefab Friday.
inhabitat.com

Jetson Green

A broad look at green building, regularly featuring new sustainable prefab systems.
jetsongreen.com/prefab

Open Architecture Network

An online community for architects and designers to share ideas and arrange collaborations. Focused on humanitarian projects, it includes lots of prefab.
openarchitecturenetwork.org

Big Words

Building code: A law containing a set of rules related to the construction and occupancy of buildings that specify the minimum acceptable level of safety in order to protect public health and general welfare. Building codes can vary by jurisdiction.

CNC-based fabrication: A method of materials cutting featuring a computer controller that drives an automated machine tool, resulting in great dimensional accuracy.

Fixed-plan home: A prefab home with a floor plan that cannot be altered. This differs from custom prefab, which has a floor plan developed for a specific client and site, a process that adds to the time and cost of a project.

HUD-code home: A type of home colloquially known as a mobile or trailer home that adheres to a specific building code set by the U.S. Department of Housing and Urban Development. The correct name for these homes is "manufactured housing." A common misunderstanding about prefab homes is that they are all HUD-code homes.

Kit home: Also known as a precut package, a form of prefab where components of

differing shapes, sizes, and materials are shipped as a kit and assembled onsite. Imagine the biggest Ikea box in the world containing pieces of a house.

Model home: A display version of a house used to demonstrate the available features and options. Some home marketers use tricks to make model homes appear larger than they are, like using small furniture and removing internal doors from door frames.

Modular construction system: A building system composed of 3-D modules, usually rectangular in shape, made from timber or steel, and typically between 12 and 16 feet wide and up to 60 feet long. If you've seen a truck with a large piece of house on the back, then you've likely seen a module.

Panelized construction system: A building system composed of wall panels, typically timber or steel framed, that are joined with other materials onsite.

Parametric modeling: A design process that uses a complex set of equations to model the characteristics of a building and measure the impact when certain variables are changed. Parametric design software allows

an architect to manipulate designs and see the impact on the bill of materials and the energy performance of the building.

State-certified factory-built housing:

A program in some states whereby factory-built homes can be inspected and approved in the factory, and thus do not require a visit by local building inspectors upon delivery to the home site. This can be advantageous because the prefab can be shipped in a more complete state.

Stick frame: The most common form of construction in North America. It's based on structural members called studs, which provide a frame to which wall coverings are attached, with a roof typically composed of horizontal ceiling joists and sloping rafters. Studs are usually made from timber "sticks," but can also be steel.

Structural insulated panels (SIPs):

Building panels typically made by sandwiching a core of rigid foam plastic insulation between two structural skins of oriented strand board (OSB). SIPs are used in floors, walls, and roofs for residential and light commercial buildings. ■■■

☉ Prefab is more efficient than stick-built construction. The National Association of Homebuilders and Wood Truss Council of America found that a 2,600-square-foot

home with trusses and panels used 26 percent less lumber, generated 76 percent less waste, and was constructed in 37 percent of the labor hours of a similar stick-built home.