From Bauhaus to m-[h]ouse: The Concept of the Ready-Made and the Kit-Built House

Paul J. Armstrong
University of Illinois Urbana-Champaign

Abstract

This paper addresses the concept of the ready-made—the off-the-shelf industrial artifact—and the development of the kit-built house. It argues that the popularity of prefabrication stems from its economic benefits and the degree of control afforded by factory manufacturing, but its aesthetic expression does not have to be compromised by cost alone. Prefabrication can combine traditional materials with contemporary aesthetics to create innovative solutions and still be affordable. It traces the ready-made from its inception in modernism to today’s kit-built and prefabricated houses.

Introduction

The trajectories of the ready-made in art and prototypes for prefabricated architecture intersect during the Modern Movement. The ideal of the “machine made” house produced in assembly line fashion from a kit of parts was instrumental to the modernist architects’ ethos of producing affordable, functional housing (Fig. 1). This paper illustrates how architects, inspired by technological advances and challenged by social and economic realities, have pushed the boundaries of not just prefabricated houses but the idea of housing itself from the Bauhaus to today.

In art, the ready-made liberated the objet d’art from its craft-based origins and elevated functional, mass-produced objects from utilitarian performance to contemplative objects in the service of art. In architecture, two countervailing tendencies overlapped. The first was the Bauhaus goal of wedding craft techniques with machine production by incorporating a “machine aesthetic” into design as a product of modern materials and manufacturing processes. The second approach, espoused by Le Corbusier and others, involved the selection of ready-made components and objects that were already capable of expressing aesthetic intentions. In the ready-made, artistic intent was predicated on choice rather than technique.

The Usonian house was based on a modular building system that promoted flexibility. Frank Lloyd Wright believed an organic whole is not a state, but a dynamic process in which no organic building can be “finished.” Therefore, the goal of the ideal of organic architecture can never be completely achieved. The Usonian houses introduced many influential concepts including the open floor plan, zoned services, the carport, and natural rather than mechanical ventilation.

The concepts of the ready-made and prefabrication in housing have been investigated in the kit-of-parts approach employed in the Case Study houses, designed by Charles and Ray Eames, Pierre Koenig, and Craig Elwood. It includes recent examples of prefabricated houses in the light of the “organic” versus the “machine aesthetic” using on custom made or standardized components including Shigeru Ban’s factory-produced Furniture House, Richard Wintersole’s all-steel Young Residence, KFN Systems wood-framed

Fig. 1. Lustron House Parts, ca. 1944.
mobile FRED and SU-SI structures, and Tim Pyne’s prefabricated m-house.

**Readi-Cut and Ready-Made**

At the turn of the 20th century, the existence of new materials, such as sheet roofing and linoleum, as well as improved methods of transportation made it possible for thousands of middle-class Americans to become homeowners by ordering a house from a catalogue. Prefabricated homes, offered through catalogues published by Aladdin, Gordon Van Tine, Montgomery Ward, the Hodgson Company, and Sears, Roebuck and Co., offered a relatively inexpensive option. Aladdin’s Readi-Cut House, introduced in 1906, was the first true kit house composed of precut, numbered pieces. Altogether, the company sold 65,000 Readi-Cut model homes with 450 models ranging from Bungalow types to larger Craftsman and Georgian Colonial Revival homes.

In Europe, the devastation of World War I and the surplus of steel that followed its end led architects to prefabricate systems of concrete and steel for housing developments and single-family residences. Le Corbusier’s Domino house, designed with Max Dubois, featured a new type of framework from reinforced concrete that eliminated the need for load-bearing walls. It was conceived as a prefabricated house with three flat floor slabs supported by six columns and linked by a cantilevered concrete stair. Units could be mass-produced and lined up on the site like dominoes and infilled with block-work walls and standard doors and windows to make cheap, flexible dwellings. In 1923, Walter Gropius and Adolf Meyer developed a “building block” system of standardized flat roof housing and designed a construction system for the Toerten-Dessau housing system. These modern innovations heralded a new era of mass-produced homes that would do away with “dead concepts in regard to the house” and helped to inspire the International Style of architecture.

Reyner Banham notes that “Functionalism, as a creed or program, may have a certain austere nobility, but it is poverty-stricken symbolically.” While Le Corbusier extolled the virtues of the “aesthetics of the engineer” and Walter Gropius exhorted architects “to invent and create forms symbolizing the world,” the new machine-age architecture was defended more on logical and economic grounds than on grounds of aesthetics and symbolism.

Early in the Modern Movement a disjuncture occurred regarding the objet-type. The Bauhaus architects and designers in their embrace of the “finesse of the machine” sought to bring together earlier craft traditions with machine production. This, they reasoned, would yield new types of utilitarian objects that would have both the humanizing imprint of the designer as well as a “machine aesthetic” intrinsic to industrial materials and fabrication. While the Bauhaus designers tempered their idealism with pragmatism, the Purists were motivated by ideology and pursued universal “constants” through design.

According to William Curtis, the Purists thought that neither the human figure nor landscape were relevant to their aims and were also suspicious of Mondrian’s non-objective painting. So instead they turned to still life—the lowest genre in academic painting—and elevated it to a role through which it would “crystallize the heroics of modern life.” Thus Purist painting supplied a visual language which answered to private intuitions and to demands of “modernity” simultaneously, while also touching universal qualities of design. Le Corbusier’s translation of the formal principles investigated in painting to his villas led him to declare “Architecture is the masterly, correct and magnificent play of volumes brought together in light.”

It was Marcel Duchamp, however, who gave the ready-made its heroic status as subject matter without any transformation or qualification. The Bottle Rack of 1914 eliminated the stages of the traditional process of making art altogether that separated subject from artist from public. More important, this was the first time that an ordinary engineering product had, in physical fact, been translated
to the realm of art. Thus with a single artistic gesture Duchamp confirmed what the Purists and Bauhaus designers were striving to express: absolute beauty could reside in geometrical and manufactured objects.

In *Vers une architecture*, Le Corbusier juxtaposed images of Greek temples with automobiles to reinforce the idea of “standards” as “type forms” which, once defined and related as a system, might then evolve toward perfection. Automobiles, ocean liners, and airplanes became machine-age counterparts of the classical temple. His analogy of the house as “machine for living in” led to the Maison Citrohan of 1922, which could be mass-produced using industrial assembly processes. It was only in 1924 in the Workers Housing project at Pessac that he managed to find someone to carry out his ideas for mass-production houses on a large scale.

The Pavilion l’Esprit Nouveau, which Le Corbusier designed for the Exposition des Arts Decoratifs of 1925, embodied the Purist way of life and suggested even more explicitly than the Citrohan had what an industrial aesthetic could achieve (Fig. 2). It was an “apartment type” furnished with Thonet chairs and Purist pictures. Significantly, Le Corbusier eschewed suave artifacts for simple off-the-shelf utilitarian objects. Like Duchamp’s ready-mades, he selected ordinary mass-produced objects for their inherent utilitarian value. This marked a departure from the Bauhaus designers who believed that the architect should create the building, its furnishings, and its objects.

The Machine-Made House

The problem that eluded most architects and designers at the time was how to manufacture prefabricated housing on a large scale. Le Corbusier and the Bauhaus architects knew that automation and assembly line were key components, but they lacked both the means and manufacturing expertise. The automobile and aircraft industries, equipped with machines, factories, and skilled workers, were best suited for the production of prefabricated houses.

Walter Gropius had long been fascinated by the possibilities of applying innovative techniques to create mass-produced housing kits. While Sears was equipping its traditional homes with precut timber frames and historical flourishes, Gropius, as early as 1910, had begun to think about factory-prefabricated houses made from industrial materials such as steel.

The concept of the house as an industrial product was consistent with the Bauhaus philosophy—the unity of art and technology. In 1942 Gropius and Konrad Wachsmann formed the General Panel Corporation hoping to capitalize on their extensive knowledge of prefabrication and Wachsmann’s advanced panel system. The Packaged House System was a kit home made from a system of framed wood panels. The first prototypes were created in 1943, with production expected to be 10,000 houses a year. But malfunctioning equipment and Wachsmann’s tendency to get sidetracked by perfecting details led to its demise. To compound matters, neither Wachsmann nor Gropius were involved or experienced enough in sales and marketing. By
1948 they had managed to produce and sell just fifteen houses.12

The most significant contribution, however, came from an engineer, not an architect. In 1944 R. Buckminster Fuller, who is best known for patenting the geodesic dome, convinced the Board of Economic Warfare in Washington, D.C. to convert aircraft manufacturing facilities to the manufacture of prefabricated housing. Fuller had experience in designing prefabricated structures. The Dymaxion House of 1928 was a hexagonal metal house suspended by cables from a central mast. He also designed the Dymaxion Deployment Unit (DDU) and the Dymaxion Bathroom. The Wichita House (Fig. 3) applied the principles of the Dymaxion projects to create the most technically advanced single-family house of its era. Fuller Houses Inc. was set up in the Beech Aircraft Factory site at Wichita, Kansas. Designed using aircraft principles and materials, it employed curved sheets of Duralumin, a circular plan, and shallow dome-like roof to create an aerodynamic form that was ten times more efficient than a rectangular house.13 A large, keel-shaped rotating vent directed airflow to the interior for natural ventilation. An almost continuous ribbon window, made of Plexiglas, was also inspired by aircraft design. The whole house, including the profiled steel floor deck and allowable live load of 120 people, was suspended from a central stainless-steel mast by a combination of tension cables and compression rings. The house weighed only 6,000 pounds (2,722 kg) and all the components could be packed into a single truck. Once delivered to the site, it could be erected by six people in a single day.

The prefabricated house is a recurring theme with Frank Lloyd Wright as well. As early as 1916 he had designed a “Ready-Cut” prefabrication system for individual houses and duplex flats based on conventional American balloon frame construction. In 1937 he designed an all-steel prefabrication system for housing in Los Angeles but failed to find a sponsor. The opportunity to realize his vision of an “assembled house” made up of standard room sizes came in 1956 when The Marshall Erdman Company of Madison, Wisconsin began to manufacture and market prefabricated houses to Wright’s design specifications (Fig. 4). Despite the prestige of owning a Wright design, however, construction was only conventional. Wright’s Usonian houses, designed to provide low-cost alternatives for middle-class American families, have become his most famous examples of standardized construction. While they were not mass-produced, they used a 4 foot by 2 foot (1200 by 1600 mm) planning grid and a standard vertical grid, worked out to conform to both brick courses and standard lumber sizes.14

During the 1950s and 1960s the dream of building mass-produced, affordable houses using industrial materials persisted. In France, Jean Prouvé developed prototypes for prefabricated houses using light-weight structural frames and industrial cladding systems, and some were mass-produced. In 1949 he designed “The Meudon Houses” located in a suburb of Paris but their potential for mass-production was never realized.15

In the U.S., steel-frame construction and off-the-shelf materials were used in many of the Case Study Houses. The Case Study program was initiated by John Entenza, the editor of Art & Architecture, to promote the design of mod-
ern houses that were "simple in plan, modu-
lated in structure, classically ordered in aes-
thetic." The glass-and-steel houses designed
by Charles and Ray Eames, Eero Saarinen,
Craig Elwood, and Pierre Koenig are the most
well-known. Both the Entenza House of 1945,
designed by Charles Eames and Saarinen, and
the Eames House of 1949, designed by Charles
and Ray Eames for themselves, used standard-
ized industrial materials to create playful jux-
tapositions between indoor and outdoor spaces
designed for living and working. As Charles
Eames noted, "Most of the qualities that
proved satisfying were inherent in the materi-
als themselves...and of the relation of [the]
house to nature."17

While the Case Study Houses were never
mass-produced, architects such as Elwood and
Koenig were committed to the ideal of
producing affordable, prefabricated houses. In
1956 Craig Ellwood noted that "More and more
the increasing cost of labor is moving
construction to the factory." His Case Study
House #17 of 1956 has a U-shaped plan
organized around a pool. It uses a structural
frame composed of 4-inch H-columns and 5-
inch I-beams. The infilling between columns is
8-inch clay block and glass. The clay block was
chosen for its cost and "the natural beauty of
the burned red clay...the high-density strength,
weatherproofing, and modular dimensions for
ease of design detail and construction." Koenig’s Case Study House #21 of 1958, for
example, eschews 4-foot and 8-foot modules
for bay sizes of 10 and 22 feet wide and 9 feet
high (Fig. 4). The governing factor in his
design was "economy, not only in cost, but in
variety of materials." The frames were shop-
fabricated and delivered to the site in one
piece. He believed in using pre-fabricated
mono-planar walls and placing utilities
underground.

Prefabricated Systems

Many mass-produced house have been
designed in a manner similar to the Sears
Ready-Cut House, a made-to-order kit-of-parts
that could be assembled on site. In 1948, the
Lustron Corporation began producing
prefabricated, all-steel houses in a surplus
wartime aircraft factory. The company was not
able to market it for appreciably less than a
conventional house. After all, a Lustron
required over 3,000 component parts totaling
over 12 tons of steel for each house. Consequently, only 2,500 Lustron homes were
built before the company folded in 1950.21

In Australia, Harry Seidler was commissioned
to design a prototype industrial production
house, which was built in 1954. Constructed
from locally available materials, the
prefabricated sections, columns, and open web
beams could be erected by four people in just
day. "Extreme flexibility" of different
layouts could be achieved using a system of
panels he developed, in contrast to the
"monotonous sameness" of typical
prefabricated houses.22

Prefabricated industrial materials are attractive
because cost and quality can be controlled in
factory environments. Like the Case Study
Houses, today’s prefabricated houses take
advantage of their sites, making a view of the
landscape part of the interior. The LV (Leguna
Verde) Home designed by Rocio Romero is a
complete kit house that costs $75,000 to
$120,000.23 Designed as a 1,150-square-foot
vacation house, it uses Galvalume (aluminum-
coated tin) exterior cladding, glass, and wood
for the frame.

Architects have also been exploring
prefabricated building techniques for custom
projects. David Hertz’s innovative Tilt-Up Slab
House uses prefabricated building techniques
to create a house for a corner lot for an
extended family. The panels are made of
Syndcrete, a precast lightweight concrete
surfacing material, require minimal
maintenance and can be assembled rapidly.
They are attached to a steel frame and
represent an efficient way to enclose space on
a large scale.24 Richard Wintersole approached
Classic Steel Frame Homes with plans for a
950-square-foot steel-frame house. The
company fabricated a package that included
everything from roof purlins to floor joists.
Once it was delivered to the site, construction
of the house took about six months and cost
just $120,000.25

Fuller’s Dymaxion introduced self-contained
prefabricated modular systems that could be
used in a flexible building system that prefig-
ured today’s sustainable designs. Great Britain
already had its own tradition of prefabricated
building systems, beginning with Joseph Pax-
ton’s Crystal Palace of 1851. In 1968 Richard
Rogers developed the Zip-Up Enclosures, a
series of inexpensive, low-maintenance shel-
ters that offered a high degree of environ-
mental control and a wide range of design choices. Later he developed a concept for an Autonomous House that would function as an artificial ecosystem, recycling its own water and waste, heating or cooling itself using natural energy, and generating its own power. Rogers was able to apply prefabrication methods on a large scale to the Lloyd's Building in London in 1980. The toilet rooms were prefabricated as complete modules and delivered ready to plug into the structure of the building.

Rogers was able to apply prefabrication methods on a large scale to the Lloyd's Building in London in 1980. The toilet rooms were prefabricated as complete modules and delivered ready to plug into the structure of the building. Raines Court consists of 127 rectangular steel-framed modules joined together to create one-, two-, and three-bedroom apartment units. Each module is assembled off-site and comes fully furnished and equipped with built-in partitions, wiring, plumbing, kitchens, and bathrooms. By using a factory-quality product, the architects contend, they can achieve greater predictability, test building performance, minimize the impact on adjacent properties during construction, and provide for a clean and safer construction method.

Technology transfer plays a role in the Spacebox, a series of self-contained studio apartment units created by the Dutch firm De Vijf (Fig. 5). The outer shell is made from a high grade composite used in shipping and aircraft construction.

Prefabrication has always been suspect because it is most often applied to temporary buildings such as Quonset huts. However, there are scenarios in which temporary buildings using ready-made components is a virtue. At first glance Adam Kalkin’s own glass-and-steel house in Bernardsville, New Jersey is reminiscent of the Eames house. However, upon investigation one realizes that it is made primarily of transoceanic shipping containers, a steel shell, aluminum garage doors, and cinder blocks to form interior rooms. And there is another surprise. Within the 33-foot high steel-and-shipping-container home, Kalkin has preserved a cottage from the 1800s that was already on the land. The clapboard cottage has been kept as a domestic space, with the porch retained as a dining area, and the inside holding the kitchen, a library, and a guest room with a second-story balcony that overlooks the interior of the house. As Jill Herbers notes “By putting a house within a house, particularly a historic one within an industrial-style one, the idea of what a house is gets raised and explored.” Its industrial aesthetic may be an homage to the Eames house, but its construction, recycled elements, and preservation of an existing, historical building all speak to both an individual
aesthetic as well as to broad issues of sustainable design.

The industrial aesthetic is maintained in Adam Kalkin’s 99K Quik House, so named for its price of $99,000. He also uses Butler Building steel shells to compose what he calls Seven Utopian Houses that can be ordered from a “catalogue” of standard components.

The Benthem House was designed for a competition that required the house to be dismantled and removed after five years. The architects decided to design “a new type of housing that could be prefabricated in large numbers” that uses “an absolute minimum in terms of program, materials, and weight.”

A proprietary steel space-frame is used to support the house instead of concrete pilings. The floor decking and walls are composite panels made form high-density polyurethane foam faced on both sides with plywood, a technique normally used for refrigerator truck bodies. The walls of the main living space consist entirely of 12-mm-thick panels of reinforced glass and act as the main support of the roof deck. The austere industrial aesthetic of the Benthem House recalls earlier experiments in prefabrication—notably Richard Rogers’ Zip-Up system. Like the Bauhaus and High Tech designers, the architects’ goal was “to apply modern technology in a user-friendly way.”

The Portable House (Fig. 6), designed by Jennifer Siegel and the Office of Mobile Design, challenges “the poverty of form” of mobile housing in several ways—by putting light into the structure, opening up the interior, and using high-quality, innovative materials. The idea is to create a layered experience in a very basic form. It uses a 40-foot by 12-foot shipping container frame to create a box-within-a-box that can be hydraulically extended to add 10 more feet of living space. There is a central kitchen and bath core, with sleeping spaces on one side and the expandable living space on the other. The expandable space is translucent to let light in and the entire structure can be put in different locations to take the best advantage of natural light and airflow.

The Austrian firm KFN Products is dedicated to providing high-quality, prefabricated housing to budget-minded clients. The 1,400-square foot SU-SI House, designed for a photographer and his wife and located on a 130-acre plot in Sullivan County, New York, was assembled in five days and cost $145,000. Designed to be shipped on a flatbed truck, the three bedroom, two bathroom house comes in different sizes, with options to customize both the interior and exterior.

KFN is also noted for their compact FRED modular home-building system. FRED, essentially a room unit that can be electronically expanded with controllable sliding walls, has been likened to a child’s set of building blocks. Available in different sizes, the wood and glass modular components of the units can vary in square footage.

Shigeru Ban’s Furniture House of 1995 also uses a systems approach to design walls that act as an element of space composition and as the main structural element of the house. Wall units were built in a furniture factory in two modular sizes, assembled at the site, and joined together by a wood girder placed on their upper surfaces.

The iT House employs individuality, choice, and the benefits of mass customization to create an
architectural version of a beautifully designed watch. Like the Eames House, it is a kit of parts assembled from readily available off-the-shelf components. Unlike the average prefabricated house, everything in the iT House speaks of quality—from the ready-for-assembly high-grade Bosch aluminum frames to a freestanding Bulthaup Kitchen Workbench, complete with sink and tap fixtures. Vinyl “outFits” bonded onto the sliding glass doors and windows, give the house its unique decorative design. The iT House can be constructed in eight weeks and costs $175,000.38

Tim Pyne’s m-house ("mouse") is intended to sit easily on the landscape and look both progressive and timeless (Fig. 6). Designed to be completely portable and assembled by two people in a day, it can be ordered from London for anywhere from $160,000 for the basic shell to $240,000 for the fully outfitted luxury model. The house is virtually maintenance free and is designed to last at least 50 years. Its self-supporting steel structure distinguishes it from traditional mobile homes and provides 1,000 square feet of flexible interior space.39

Conclusion

According to Charles Jencks, the Modernists believed “that somehow the desires of the body and the impersonality of the machine can be united” and that modern technology can be humanized. Their interpretation of functionalism made efficient and refined through a "machine aesthetic" complemented their beliefs that modern architecture must be used in the service of human needs as well as artistic ends. Le Corbusier, Gropius, Fuller, and Wright envisioned not only the prototypical concepts of the modern prefabricated house, but also believed passionately in the life-enhancing values of prefabrication as a sustainable housing system. The values that they have instilled through their architecture endure with a new generation of architects who are committed to the development of high-quality, affordable, and aesthetically pleasing prefabricated buildings. Since Wachsmann’s day the twin revolutions of "lean production" and computer-aided manufacture have transformed modern industry. The assembly-line practices developed by Ford are dead, and so is standardization as it was once conceived where everything mass-produced was identical. As Colin Davies points out, the arrival of numerically-controlled machines and CAD/CAM technology has made customization easier. Prefabricated houses are no longer cheap, temporary buildings, but have become high-quality, up-market industrial products.40

Years after he designed the Packaged House, Wachsmann analyzed various examples of industrialized building, from the Crystal Palace to his own space-frame hangar projects of the 1950s. “In discarding many of our old ideas about building,” he wrote, "we have reached a turning point. The decisions about what constitutes the formative energies of the age have been made and the principles that will guide the developing forward movement are now apparent.”41 The “turning point” Wachsmann was addressing foreshadowed the developments in prefabricated architecture and building that have occurred during the later half the twentieth century and are informing the most avant-garde concepts of prefabricated houses today.

Endnotes


2. Ibid., p. 17.


4. The Purists wrote “…objects tend toward a type that is determined by the evolution of forms between the ideal of maximum utility and the necessities of economical manufacture which conforms inevitably to the laws of nature. This double play of laws results in the creation of a certain number of objects that may be called standardized.”


5. Le Corbusier, Towards a New Architecture, trans. by Frederick Etchells in 1927.


7. The Purists traced the universal ideals of perfection expressed through geometry and form directly to the Greeks: “...understand me to mean straight lines and circles, and the plane or solid figures which are formed out of them by lathes, rulers and protractors; for these I affirm to be...eternal and absolutely beautiful.”

[Plato, Philebus.]

9. Le Corbusier persuaded Henri Fruges to build housing for his workers at Pessac along the guidelines of the Citrohan. Despite cost overruns and technical problems, part of this Garden City suburb was constructed. However, there was relatively little opportunity for public housing in France in the 1920s, so Le Corbusier had to forgo his ambition of effecting a major change of the modern housing environment and be content with designing elegant demonstrations of his general principles on small lots around Paris.


10. In his book *L’Art decorative d’aujourd’hui* (1925), Le Corbusier criticized mass-produced kitsch, and held up dentists’ chairs, folding camp furniture, and utilitarian tools for emulation: “In all ages and with all people man has created for his use objects of prime necessity...associated with his organism and helping to complete it.”

11. According to Herbert Gropius conceived of forming a General Housing-Construction Company while in the employ of Walter Behrens at AEG in 1910. After much formulation and research, Gropius claimed it represented “the sum total of all practical, technical, and aesthetic experience.”


15. Davies writes that the Minister of Reconstruction had ordered 25 “experimental, prefabricated but permanent, well-appointed” houses from the Prouve workshop. Prouve had produced all the necessary components, but no delivery instructions were issued and the houses were stored for a year in the workshop until they were erected in the suburb of Meudon.

[Davies, *Prefabricated House*, p. 34.]


23. Romero wanted to produce a prefabricated house for under $30,000. The cost for the basic shell is $29,195 plus shipping. The final cost varies according to interior finishes and other factors. The house can be shipped anywhere in the U.S. as well internationally.

[Hebers, *Prefab Modern*, pp. 62-64.]


28. Arieff and Burkhart, *Prefab*, p. 34.


31. Ebong, *Kit Homes Modern b*, p. 34.


