From Sears & Roebuck to Skyscrapers:

A History of Prefabricated and Modular Housing

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Introduction

While prefabrication and modularity are commonly considered in concert with technological and material innovations, the origins of prefabricated building involve neither factory nor mass-produced materials. The process of sending complete, ready-cut building components to be assembled has been part of the construction process in America since the 17th century. In the 1850s, the balloon frame system of construction revolutionized the speed with which new housing could be built. In the early 20th century, families could order a Sears, Roebuck & Co. home out of a catalog and wait for an assembly kit to arrive. During World War II, prefabrication allowed soldiers to be housed in mobile shelters and then spawned the comfortable suburbs inhabited by returning GIs.

Prefabrication and modularity have made recent strides as architects and developers find new applications for the technology beyond the single family home: now urban towers can be constructed from modular and prefabricated components. While the technology has grown with the building practice itself, the widespread adoption of these design components has faced challenges. Modularity's association with trailer housing has led to its public perception as unsightly and unstable, the difficulties of coordinating delivery systems and personnel has made the new construction process challenging in dense urban areas, and its lack of integration into the design process has ensured its exclusion from many projects. Given the advent of new technology like Building Information Modeling (BIM) software, it is now easier to integrate modular components, delivery systems, and personnel. With growing public acceptance, in spite of the challenges, modular construction is a less costly, faster, and simpler means of construction with wide applications across many building needs.

Colonialism through the 19th Century

Prefabricated construction stretches back to 1624 when a disassembled house was shipped from England to Cape Ann, Massachusetts to house a fishing fleet using ready-made—and trusted—English building techniques, familiar to settlers who had just arrived in America in 1620.[1] Twenty-five years later, in about 1650, the domestic shipment of pre-cut wood for a house from Plymouth Colony to southern Connecticut eased the settlement of new land by providing immediate shelter and negating the need to gather and fit lumber onsite.[2] Though neither of these examples conforms to the current view of a modern, industrial solution to building, it is clear that a sense of the convenience of assembling building materials offsite predates many of the technologies and much of the development with which these techniques have become synonymous.

In 1833, Chicago saw the first "balloon frame" building, St. Mary's Church, erected on Lake Street.[3] Credited to, alternately, a man named George W. Snow and a carpenter named Augustine Deodat Taylor, the innovation of the balloon frame involved using uniform, slender wood studs held together with newly mass-produced nails, rather than with more complex joinery. The technique, so called due to its lightness and precarious appearance, proved to be an expedient way of creating much-needed housing in burgeoning urban centers. By 1834, a simple balloon frame "shack" would take no more than a week to construct. Within a decade, the new mode of construction had spread

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[1] Allison Arieff. *Prefab*. Layton: Gibbs Smith, 2002. 13.
Graff, Raymond K., Rudolph A. Matern, and Henry Lionel Williams. *The Prefabricated House*. Garden City: Doubleday & Company, Inc., 1947. 7.
[2] *Ibid.* 2.
[3] Colin Davies. *The Prefabricated Home*. Trowbridge, Wiltshire: Cromwell Press, 2005. 44.

from the Midwest throughout the nation.[4] By 1849 railroads carried prefabricated housing "kits" to California to provide expedient shelter for prospectors during the gold rush.

The Industrial Revolution and World War I

England's industrial revolution, beginning in the mid-eighteenth century, also expanded to America, ushering in factory production powered by new machines.[5] Companies subsequently began offering homes through catalogs to be assembled by the client onsite.[6] While Aladdin Readi-Cut Houses was the first company to offer prefabricated houses on the market in 1906, Sears, Roebuck & Co.'s mail-order houses proved the best-known example. The company's designs, sold between 1908 and 1940, offered designs to suit nearly all aesthetic sensibilities, and the homes came complete with all necessary materials including nails and house paint.[7] The cost of assembling one's home from a box was significantly lower than the custom-built alternative, and there was little need to fear one's neighbor might end up with the same house; nearly 450 different Sears home types have been identified.[8] Sears houses were particularly popular due to their lack of iconography—though many of the houses' floor plans are the same, there was little to betray the origins of the "factory made" house to the untrained eye. Many of the designs evoked classic Americana and would not be out of place on any suburban street.[9]

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[4] *Ibid.* 46.
[5] Phyllis Deane. *The First Industrial Revolution*. 2nd ed. Cambridge: University of Cambridge, 1979. 65.
[6] Amanda Cooke and Avi Friedman. "Ahead of their Time: The Sears Catalogue Prefabricated Houses." *Journal of Design History* 14, no. 1 (2001): 53-70. http://www.jstor.org/stable/3527272. 68.
[7] *Ibid.*
[8] Cooke and Friedman 53.
[9] Davies 53.

In the early twentieth century, both domestically and abroad, architects and engineers were grappling with the question of how to efficiently and simply house a rapidly growing population. At the onset of World War I, well-known modernist Le Corbusier's Dom-ino House of 1914 proposed a simple reinforced concrete structure supported by slender beams. Cheaply and easily reproducible, the project explored simple housing concepts, though it was never built.[10]

World War II and Postwar Housing

During World War II, prefabricated sheet-metal construction achieved widespread use in the form of military barracks and mobile trailers.[11] In *The Science Newsletter*, an anonymous author lauded the mobility of trailer housing and the usefulness of temporary housing: "No ghost town will be left after the war," states the author, "for the entire community can be folded up and moved elsewhere."[12] Cornell University professor Svend Riemer wrote in 1945 that "on the basis of mass production and backed up by experiences with large scale industrial conversions during the war, the fateful dilemma of modern residential housing may finally come to a solution." Referring to trailer homes, he spoke conservatively regarding the future of American housing: "*These family homes…will be of extremely limited size.* This differs from our expectations…Today, we

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[10] Arieff 14.
[11] Daniel A. Hodes 1970. The Modular Housing Industry. *Financial Analysts Journal* 26 (3) (May - Jun.): pp. 80-87, http://www.jstor.org/stable/4470681. 80.
"Mobile Housing Popular in War Industry Sections." *The Science News-Letter* 43, no. 26 (Jun. 26, 1943): pp. 403-404. http://www.jstor.org/stable/25171570. 403.
Harvey M. Bernstein et al. *Prefabrication and Modularization: Increasing Productivity in the Construction Industry*. Bedford: McGraw Hill Construction, 2011. 9.
[12] *Ibid.*
Foster 280.

know that (trailers) are here to stay, whether we like it or not."[13] By the end of the war, Sears, Roebuck & Co. had ceased production on homes and the notion of prefabrication had lost its charm. By 1946, a *Fortune* magazine survey indicated a sharp turn against prefabricated houses, with only 16% of respondents saying they would choose to live in one.[14] With the subsequent postwar housing shortage, the use of prefabricated materials was necessary to shelter a severely underhoused population.

Modularity and prefabrication were not wholly ignored or criticized after the war; the suburban boom relied heavily on precut, standardized housing designs and economies of scale. Levittown, perhaps the best-known example of the American postwar suburb, thrived on the replicability of house after house. William J. Levitt, the town's namesake, even graced the cover of Time Magazine on June 3, 1950.[15] The production was so streamlined that Time reported a house rose from the ground every fifteen minutes: "Every 100 feet, (the) trucks stopped and dumped identical bundles of lumber, pipes, bricks, shingles and copper tubing… Near the bundles, giant machines with an endless chain of buckets ate into the earth, taking just 13 minutes to dig a narrow, four-foot trench around a 25-by-32 ft. rectangle. Then came more trucks, loaded with cement, and laid a four-inch foundation for a house…"[16] Moving from site to site, a team of two or three workers would then quickly assemble the house from its component parts.[17] The developments—three Levittowns in all—are still inhabited today.

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[13] Svend Riemer and Ellis Ash. 1945. The Family Home Prefabricated. *Marriage and Family Living* 7 (1, Winter) (Feb.): pp. 9-11, http://www.jstor.org/stable/348989. 9.
[14] Cooke and Friedman 68.
[15] Alan D. Wallis. 1991. *Wheel Estate: The Rise and Decline of Mobile Homes*. New York: Oxford University Press. 118.
Dolores Hayden. 2003. *Building Suburbia: Green Fields and Urban Growth, 1820-2000*. New York: Knopf. 134.
[16] "Up from the Potato Fields." *Time Magazine* (7/3/50, 1950).
[17] *Ibid.*

But suburban tract homes, though often relying on prefabricated techniques, did not become emblematic of the concept of modular or manufactured housing. During the 1950s and 1960s, a public pushback against the aesthetics of "trailers" along with the complex legislative practices barring the housing type from certain areas, spoke to a narrow view of manufactured housing.[18] Perhaps as a holdover from earlier war efforts, when soldiers lived in mobile homes as emergency shelters, the concept of modularity seemed to evoke inexpensive, shoddy, and most importantly, impermanent housing.[19]

1960-1990

By 1967, modularity was once again thrust into public consciousness with Moshe Safdie's Habitat '67, constructed for the Montreal World's Fair. The large apartment building consisted of individual "modules" made from precast concrete and fitted together like a puzzle.[20] The fully-assembled structure was well-received critically, and is considered a Canadian landmark.[21] Safdie's Habitat design was meant to be easily duplicated as the modules could be assembled anywhere, regardless of location. In spite of the architect's plans for additional such structures, the project was never built elsewhere, but prefabrication and modularity were garnering renewed interest—and a newfound association with high art—after images of the war had faded. The 1960s also brought a growing trend of mobile home purchases as well as advocacy for modular

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[18] Betsy Brown. "Officials, in Visits to Factories, Explore Modular Homes." *The New York Times,* 4/20/86, 1986.
Ronda Kaysen . "Squeezing Costs, Builders Take New Look at Prefab." *The New York Times* (6/14/11, 2011).
Mark McCain. "Modular Housing Gaining Acceptance." *The New York Times,* 1989.
Amy Gunderson. "Fresh from the Factory." *The New York Times* (11/22/06, 2006).
Hodes 80-82.
[19] *Ibid.*
[20] Bergdoll and Christensen 124-126.
[21] *Ibid.*

housing to accommodate the needs of lower-income families. In 1970, economist Daniel A. Hodes noted that "There (is) a large number of people now occupying mobile homes on a temporary basis, even though they could afford more costly housing, simply because they can't find suitable shelter in their price range. Very little conventionally-built housing is being produced today in the $12.000 to $25,000 price range. This segment of the market is, essentially, wide open to the modular housing industry."[22] Hodes also, however, noted the lingering bias against modular design: "For years, the greatest barrier to the growth of modular housing has been a negative attitude on the part of the consumer toward prefabrication and factory-assembly of housing."[23]

While modularity touched both ends of the housing spectrum—that of high design and that of low-income necessity—the general pushback against it, the 1980s brought a renewed interest in urban applications for modular and prefabricated building practices. One of the greatest obstacles to widespread modular design, though, was the challenge of disassociating it with the unappealing image of the trailer, and instead expanding the concept to include large, well-constructed, and attractive spaces. By 1985, modular housing became an attractive option for rebuilding much of the blighted urban areas that had been abandoned in the 1960s and 1970s. Even New York City embraced modular construction for low-income, single family structures in Brooklyn and the Bronx, in some cases mimicking the suburban tract home aesthetic rather than an urban one.[24] Writing for the *New York Times* in 1986, Betsy Brown discussed the need for affordable housing and the surprise of New York State legislators who visited a manufactured housing factory; "Sandra R. Galef, Democratic legislator from Ossining and New Castle, said that 'people

[22] Hodes 82.
[23] *Ibid.* 83.
[24] Kirk Johnson. "Factory-Built Homes Widen their Reach." *The New York Times* (8/4/85, 1985).

think of trailers when they think of modular, and these aren't that - these are attractive, made well, and fairly large.' Robert Sawyer, director of housing for Mount Vernon, said modular housing had 'a sort of stigma, as something that wasn't permanent,' and he added that the visit had changed his outlook."[25] By the late 1980s, modular homes were modifying their designs to enable spatial configurations untethered to the width and length restrictions on modules in order to allow for highway transport; the single-story structures associated with manufactured housing were no longer the only option. As builders became more creative, design options followed, allowing for large, even sprawling, structures on multiple levels.[26] In the 1990s, consumers and even developers began to take to modular construction for its convenience, low cost, and efficiency. In 1999, Lisa Prevost wrote about a modular Georgian-style mansion in Greenwich, Connecticut that sprawled to 8,900 square feet. The house used modular components for the exterior framing while adding custom, opulent detail to the interior.[27] Seemingly at odds with the concept, modular companies were now offering the option of customization: traditional "stick-built" home design could now be mimicked using modules.[28] Still, modular and prefabricated housing struggled with the image of the mobile home and trailer and of assumed inferior construction; though modular housing companies could build mansions and large single family split-levels, the same factories also continued to produce mobile homes, thus making conflation nearly inevitable.[29]

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[25] Brown.
[26] McCain.
[27] Lisa Prevost. "Fresh from the Factory: Upscale Homes." *The New York Times* (1/24/99, 1999)
[28] *Ibid.*
[29] Barry Rehfeld. "Even some Contractors are Choosing Modular Homes." *The New York Times* (9/30/06, 2006).

Modular Design Today and Continuing Adoption

By 2006, modular housing comprised only 3% of single-family homes, despite potential cost savings of 5% to 15%.[30] One explanation was the reluctance of the consumer to contend with the possibility of being associated with mobile homes while the difficulty of transporting modules from factory to site proved another obstacle. But modularity is not always driven by the consumer; a 2011 report by McGraw Hill Construction indicated that architects often failed to incorporate modularity into their designs, thereby ensuring a project would rely on traditional building techniques instead.[31] In spite of this slower, but steady adoption, the report also highlights the contractor and client-specific benefits of reduced cost and time spent per project.[32]As newer design programs, like BIM, become integrated into the process, the potential for modular elements greatly increases: the McGraw Hill report indicated that one quarter of architects currently using BIM software also incorporate modularity into their plans.[33] By considering a building's design holistically, from the design process to the delivery of modular components and construction, BIM enables architects, engineers, and developers to overcome previous challenges.

Modularity and prefabrication have once again emerged into the cutting edge as a solution to cost and energy savings; the new face of modularity is its smaller environmental impact and its potential for enabling greener construction practices. While associations with mobile housing have not been entirely shed, conspicuous prefabrication has recently become a sought-after design element in contemporary family homes. In

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[30] *Ibid.*
[31] Harvey M. Bernstein, et al. *Prefabrication and Modularization: Increasing Productivity in the Construction Industry*. Bedford: McGraw Hill Construction, 2011.
[32] *Ibid.* 4, 18-19.
[33] *Ibid.* 7.

2008, The Museum of Modern Art showcased an entire exhibition on prefabrication complete with built prototypes.[34] By cementing the medium's association with high design and a historic tradition, the exhibition, entitled *Home Delivery: Fabricating the Modern Dwelling*, drew crowds and sparked a newfound interest in the possibilities of prefabricated and modular building elements as indistinguishable from traditional materials and design, if not a wholly desirable addition to a project. Since the exhibition, modularity has only increased in popularity and in previously unseen applications—rather than simply being reserved for detached single family homes, the method is now being used for skyscraper construction as well. In Manchester, England, a twenty-four story modular dormitory took only 27 weeks to construct, and currently holds the record as the tallest modular building in the world.[35] Though most American modular structures do not exceed ten stories, the climate for modular projects, their potential to reduce both environmental and fixed costs, and the aesthetic considerations are moving toward broader acceptance, thus continuing the tradition of prefabricated construction through the twenty-first century.

Modular construction is quickly becoming a natural design choice in spite of a lingering bias toward traditional materials and techniques. In order for modular building to become increasingly prominent, however, modular techniques must be integrated during the design process; BIM modeling and architects who are aware of prefabricated and modular options are essential. Though modularity has been a longstanding part of

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[34] Bergdoll and Christensen.
[35] O'Connel East Architects Design 24-Story Modular. in Modular Building Institute [database online]. 2009 [cited 9/20 2013]. Available from http://www.modular.org/htmlPage.aspx?name=24_story_modular. Bagli, Charles V. "At Atlantic Yards, Ready to Test Plans for Prefab Tower." *The New York Times* (11/27/12, 2012).

construction, its adoption is still hampered by an association with poor quality components and design limitations. Modular building, however, is slowly shedding its reputation for low structural quality and unappealing looks; the ease of construction and its stylistic diversity allow for a final product which appears indistinguishable from those built with traditional methods. When appropriate, modular components should be considered during the design process and employed in construction in order to take advantage of the newest, most sustainable, and fastest construction techniques and innovations.

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