# Beech Aircraft Corporation and R. Buckminster Fuller's Dymaxion house

Peter Lobner, 15 June 2020

## 1. The 4D Dymaxion house

In 1929, R. Buckminster Fuller unveiled a design for a novel singlefamily metal dwelling he called the Dymaxion (acronym for "**DY**namic, **MAX**imum, tens**ION**"), which could be mass-produced to help address housing problems of the time. The 50 foot (15.2 meter) diameter, 1,600 ft<sup>2</sup> (149 m<sup>2</sup>) 4D Dymaxion house made efficient use of materials and weighed only three tons (6,000 lb / 2,722 kg). The primary load-bearing structure was a central steel mast anchored to a small foundation and supporting two hexagonal decks with a network of tension cables. Fuller stated that this strong, rigid metal structure was designed to withstand fire, flood, tornados, and electrical storms.



This Dymaxion House did not advance beyond the design stage.

Fuller and a model of his 1929 4D Dymaxion House. Source: <u>https://www.minniemuse.com/</u>



The 1929 4D Dymaxion House. Source: <u>https://www.minniemuse.com/</u>



The 1929 4D Dymaxion House. Source: Modern Mechanix magazine, Sep. 1932, via <u>https://www.archdaily.com/401528/ad-</u> <u>classics-the-dymaxion-house-buckminster-fuller</u>

## 2. The WW II Dymaxion Deployment Unit (DDU)

During WW II, Fuller was engaged by the British War Relief Organization to develop a small, low-cost, light-weight shelter that became known as a Dymaxion Deployment Unit (DDU). While the 20 foot (6.1 meter) diameter DDU employed Fuller's Dymaxion principles, its structural design departed significantly from his 1929 4D Dymaxion house. The DDU does not have a central mast and it sits on a pad or on the ground. In 1944, Fuller was granted the following two patents related to the design of the DDU:

- US2343764A, "Building Construction," filed 21 March 1941, issued 7 March 1944: <u>https://patents.google.com/patent/US2343764A/en</u>
- US 2351419, "Building Construction," filed 9 April 1941, issued 13 June 1944: <u>https://patents.google.com/patent/US2351419A/en</u>

In these patents Fuller described the Dymaxion principles behind the DDU structure:

"The invention relates to the fabrication of structures suitable for small houses, or for storage bins and the like, and more particularly to structures of this class which have walls of sheet metal or other sheet material arranged to form a shell or enclosure which is of substantially cylindrical form. It is an object of my invention to fabricate structures of the class described in such a manner that the walls of sheet metal or other material can be of extremely light gauge by reason of distribution of stresses throughout the entire structure."

"A further object of my invention is to provide a stressed-wall structure in combination with a semi-flexible supporting framework so as to segregate tensile and compression forces in such a manner that tensile forces are confined substantially entirely to the wall covering whereas compression forces are confined substantially entirely to the supporting framework."

In 1942, Butler Manufacturing Company produced 200 Fuller DDUs for the US Army Signal Corps. Several still exist at Ft. Evans, NJ.



Fuller's Dymaxion Deployment Unit (DDU). Source: <u>http://architectuul.com/architecture/dymaxion-house</u>



DDU apex vent at Ft. Evans, with no central mast. https://infoage.org/dymaxion-deployment-units-ddus/

# 3. The post-WW II Dymaxion House that Beech Aircraft and Fuller almost built

Early interest in applying aircraft aluminum manufacturing techniques to post-WW II housing construction was expressed by Beech Aircraft Corp. In 1944, Beech established a joint project with Dymaxion Dwelling Machines, Inc. (later renamed Fuller Houses, Inc.), and the International Association of Machinists to manufacture an updated prototype Dymaxion house (also known as the Fuller house) in a Beech Aircraft factory in Wichita, Kansas.



Dymaxion house model. Source: Aviation News magazine, 1 April 1946



Dymaxion house model. Source: Wikipedia



Cross-section and structural views of the Dymaxion House illustrate the mast-hung double wire-wheel structure. Source: Library of Congress / Henry Ford Museum



A model of a "Dymaxion Dwelling Machines" community, circa 1946. Source: From an exhibit at the Contemporary Art Museum in Chicago via <u>http://b2dymaxionhouse.blogspot.com</u>



Sequence for assembling a Dymaxion House. Source: Estate of R. Buckminster Fuller

The primary load bearing structure of the Dymaxion House is a 22foot (6.7 meter), 72 pound (32.6 kg) central stainless steel mast anchored to a concrete post in the ground. Large circular compression rings and the floor platform are suspended from the central mast by 12 cables that are anchored to the ground for stability with perimeter tension rods. After the self-supporting aluminum dome roof is assembled in the floor platform, it is raised and secured to the central mast and the floor joists via the tensioned cables, establishing a rigid structure. The sides of the structure are completed with sheet aluminum walls and Plexiglas windows, and the rotating ventilator is installed on top of the dome roof.

Author AnnMarie Brennan reported, "With the mast in compression and the roof and walls in tension due to the double curvature shape, the structure, modeled upon the idea of a Chinese lantern, was substantially rigid and did not require additional bracing, columns, or trusses for support." The house is 36 feet (11 meters) in diameter, providing 1,017 ft<sup>2</sup> (94.5 m<sup>2</sup>) of floor space. The circular floor plan includes a combined living and dining room, two bedrooms, two self-contained bathrooms with a toilet and a shower, and a completely equipped kitchen. Electrical, plumbing, heating, air conditioning and whole-house vacuum systems are included. The mast houses all electrical and plumbing components and an internal rain gutter system that collects water into a cistern below the house. The rotating ventilator at the top of the house is designed to promote airflow and completely change the air in the house every six minutes. With this effective ventilation system, the panoramic Plexiglas windows are not designed to open.

The house weighted about four tons (8,000 lb / 3,629 kg) and was designed to withstand severe weather, including tornados. The house was not damaged by a 1964 tornado that passed only a few hundred yards away.



Dymaxion house floor plan. Source: <u>https://www.buckminsterfuller.net/images/shelter.html</u>

You'll find a short (1:29 minutes) 1946 video introduction to the Dymaxion House prototype here: https://www.youtube.com/watch?v=Vx5VJ1yd3HQ

The Dymaxion house was designed for onsite assembly using massproduced components built on an assembly line. All of the components for a Dymaxion house were packaged in a 16 x 4-1/2 foot metal tube and shipped in a fraction of the space needed for a conventionally constructed house. The only foundation structure required was the concrete support post for the central steel mast. After unpacking, the house could be assembled in one day.

In late 1944, *Aviation News* magazine reported that Beech hoped "hundreds of thousands of dwelling machines would be built for war and post-war use once the original prototype has been 'ground tested'."

Beech manufactured two prototype houses in 1945, the indoor "Barwise" prototype and the outdoor "Danbury" prototype.



A Dymaxion House next to its shipping container. Source: <u>https://blogs.uoregon.edu/dymaxionhouse/a-house-is-a-</u> <u>machine-for-living-in/</u>

By early 1946, Beech personnel director Warren Blazier, in an address to the Kansas Engineering Society, said the Dymaxion house had attracted interest from US government and some foreign officials. He noted that the aluminum prefabricated houses could be built on airplane assembly lines without additional manufacturing equipment.

Shortly thereafter, the 1 April 1946 issue of *Aviation News* magazine reported:

"Beech Aircraft Corp. expected to build 200 of these houses a day soon after the start of 1947, according to Herman Wolf, president of Fuller Homes, Inc., which will market the dwelling designed by R. Buckminster Fuller......The houses will be subcontracted to construction firms which will combine aircraft technology and auto mass production methods. Wolf and Fuller see the new dwellings, which will sell for \$6,500 erected, as the answer to the veterans housing problem. City building codes are the big imponderable in forecasting the success of this dwelling."

In spite of these optimistic business prospects in early 1946 and the receipt of more than 3,500 advance orders, the Beech – Fuller housing venture failed later in 1946. Several factors that contributed to this business failure are:

- Fuller refused to sign off on a final production version, wanting several more years to refine the version that would be put into production.
- Construction trade unions, specifically licensed electricians and plumbers, had indicated that their members would refuse to connect electrical and plumbing services for prefabricated houses that had been manufactured by other unions.
- Investors were getting anxious.
- Beech was unable to raise the funds needed for full-scale production.

#### 4. The Wichita House

In 1948, William Graham, a former investor in the project, purchased both prototypes and assembled a single, hybrid version that combined structural elements from both prototypes. This is the version of the Dymaxion House that became known as the "Wichita House." This house was moved to a lakeside site on Graham's 600 acre farm and assembled on a foundation with its own basement and an adjacent foundation for future expansion. The Graham family lived in the Wichita House into the 1970s and built an adjacent large, conventionally constructed house that was not architecturally harmonious with the Wichita House.



The Wichita House. Source: TournaTalk, tournatalk.wordpress.com



The Wichita House after assembly on William Graham's farm, with the foundation for an adjacent conventionally constructed house to the right. Source: The Henry Ford Museum via the Wichita Eagle



The Wichita House in its later days as part of William Graham's greatly expanded family home. Source: <u>https://www.usga.org/</u>

After Graham's death in the 1970s, the Wichita House was abandoned and left in disrepair until 1991, when the Graham family donated it to the Henry Ford Museum of American Innovation along with the remaining stored, unused parts and documentation from the original prototypes. The Graham farm subsequently became the site of the Flint Hills National Golf Club.

A photo essay by Robert Duchesnay documents the state of the abandoned Wichita House in 1990 and its dismantling in 1992 by an international team. Three photos are reproduced below. See the complete article and photos here:

http://robertduchesnay.com/en/dymaxion-en/



View from the opposite shoreline of the lake.



Aluminum floor joists supporting the living area.



Crew removing roof panels. This view also reveals the central mast, the roof cable network, and spiral staircase.

### 5. Fuller's Dymaxion House at the Henry Ford Museum

Museum conservators needed more than six years to sort, catalog and clean the 3,600 pieces from the two prototypes. After conservation, a single Dymaxion House was reassembled in 2001.



Dymaxion House on display. Source, both photos. The Henry Ford Museum.





Dymaxion House, view from outside through the Plexiglas panoramic living room window. Source: The Henry Ford Museum.



Dymaxion kitchen. Source: Michael Barera via Wikimedia Commons



The ceiling and central mast of the Dymaxion House. Source: Michael Barera via Wikimedia Commons

You can visit the Dymaxion House exhibit at the Henry Ford Museum of American Innovation in Dearborn, Michigan. A link to that exhibit is here: <u>https://www.thehenryford.org/visit/henry-ford-</u>museum/exhibits/dymaxion-house/

#### 6. For more information, see the following resources:

- The Estate of R. Buckminster Fuller: <u>https://www.buckminsterfuller.net/images/shelter.html</u>
- J. Baldwin, "Dymaxion House," Buckminster Fuller Institute: <u>http://www.bfi.org/about-fuller/big-ideas/dymaxion-</u> world/dymaxion-house
- Tara Seaver, "Buckminster Fuller and the Dymaxion House," University of Oregon, 2020, <u>https://blogs.uoregon.edu/dymaxionhouse/</u>

- "The Dymaxion House," <u>http://b2dymaxionhouse.blogspot.com/p/mass-production.html</u>
- Robert Duchesnay, "The Dymaxion Dwelling Machine," 2020: http://robertduchesnay.com/en/dymaxion-en/
- Gili Merin, "AD Classics: The Dymaxion House / Buckminster Fuller," ArchDaily: <u>https://www.archdaily.com/401528/ad-</u> <u>classics-the-dymaxion-house-buckminster-fuller</u>
- Colby Mugrabi, "Buckminster Fuller's Dymaxion House," MinnieMuse, 16 October 2019: <u>https://www.minniemuse.com/articles/musings/buckminster-fullers-dymaxion-house</u>
- Kashann Kilson, "Forget Geodesic Domes, Buckminster Fuller's Dymaxion House Was His Masterpiece," Inverse.com, 4 April 2016: <u>https://www.inverse.com/article/13715-forget-geodesicdomes-buckminster-fuller-s-dymaxion-house-was-hismasterpiece</u>
- AnnMarie Brennan, "Dymaxion House: Ship Shape," The Companions to the History of Architecture, Volume IV, Twentieth-Century Architecture, John Wiley & Sons, Inc. 2017:: <u>https://www.academia.edu/34666028/DYMAXION\_HOUSE\_Ship\_Shape</u>
- James Ashby, "Preserving a Prototype: Buckminster Fuller's Dymaxion House," Henry Ford Museum & Greenfield Village, Dearborn, Michigan: <u>https://www.hpef.us/publications/preserving-the-recent-past-</u>

publications/preserving-a-prototype

- Rose Heichelbech, "1940s Dymaxion House is an Incredible Vision of a Future That Never Happened," Dusty old Things: <u>https://dustyoldthing.com/1940s-dymaxion-house/</u>
- "Beech to Use Reconverted Plants for New Type Home manufacture," *Aviation News* magazine, p. 34, 20 November 1944.
- "Houses that Hang From Poles," Modern Mechanix magazine, September 1932: <u>http://blog.modernmechanix.com/houses-</u> <u>that-hang-from-poles/#mmGal</u>

## Books:

- Federico Neder, "Fuller Houses: R. Buckminster Fuller's Dymaxion Dwellings and Other Domestic Adventures," Lars Muller, September 2008, ISBN-13: 978-3037781418
- Michael John Gorman, "Buckminster Fuller: Designing for Mobility," Skira, 2005, ISBN-13: 978-8876242656

### Videos:

- "Buckminster Fuller's Dymaxion House," (1:22 minutes), Ford Museum, 2008: https://www.youtube.com/watch?v=tcB9JPlgaoM
- "Buckminster Fuller, Dymaxion House, 1940s Futuristic Architecture," (1:30 minutes), TheKinoLibrary, 2013: <u>https://www.youtube.com/watch?v=Hz4tcNL8gsk</u>
- "Tour of Tiny House Dymaxion Deployment Unit Camp Evans By Buckminster Fuller (10:49), 2017: <u>https://www.youtube.com/watch?v=HRtV77\_3rWA</u>