Houses at Fifty Cents a Pound: Buckminster Fuller's Conception of Domestic Space

ROBERT M. ARENS
Kansas State University

Buckminster Fuller conducted some of the most compelling architectural experiments of the century, among them his single-family housing designs based on efficient use of modern materials and prefabricated methods of construction. These designs are usually critiqued in isolation or as engineering developments rather than as works of architecture which propose site, space, program, and the relationships contained therein.

This paper addresses the reasons for Fuller's isolation, primary among them being the technological emphasis he applied to his work and the rhetoric he used to defend it. An analysis is then made of his proposals for low-cost, prefabricated housing. Three of his Dymaxion house designs are examined as *houses*, that is, not solely for the technology they employed, but rather for the domestic environment they proposed and the evolution of these proposals from 1927-46.

The critique focuses on the first house (the 4D of 1927) as the raw embodiment of Fuller's design intentions, and discussionrelates it to precedents from the US (Beecher's American Women's Home) and parallels in Europe (Gropius's House 17 at Weissenhof). Developments in Fuller's approach to domestic space are then traced from the first design to the culmination of his housing experiment, the iconic Wichita house of 1946. By expanding the architectural critique of the evolution of his single-family housing designs, Fuller's location in the discussion of modern domestic architecture may be more clearly assessed.

INTRODUCTION

Modernity is a complex and slippery issue, but at very least a framework for its discussion must be advanced if the position of contributors to its definition may be assessed. In his introduction to *Architecture, Ethics, and Technology* Alberto Perez-Gomez underscores the salient current of technology in the definition of modernity and then goes on to establish the undeniable link between technology and culture:

> Technology is far more than a question of machines; it is more than just one of the many determinants of our culture. It has become clear that there is an intimate link between the nature of technology and a number of cultural traits that define both modernity and postmodernity. Technology, especially after the Industrial Revolution, opened up the possibility of a human world that is fully constructed.'

In terms of architecture, technology not only makes possible a world that is fully constructed, but is potentially constructed in a far different manner than the preindustrial world. Dalibor Vesely, among others, maintains that the intensification of technology and its influence on architecture may be most strongly witnessed in structure, and by extension of his argument, may be most clearly felt in the modern space made possible with structural developments.?The predominance of space in discussions of modernity is also established by Kenneth Frampton:

> Space has become such an integral part of our thinking about architecture that we are practically incapable of thinking about it at all without putting our main emphasis on the spatial displacement of the subject in time. This quintessentially modern viewpoint has clearly underlain innumerable texts treating the intrinsic nature of modern architecture...[3]

Technology, an inherent component of modernity, must be examined then, not in isolation, but in relation to culture and space. Isn't it ironic that discussions of Buckminster Fuller, the consummate modern man, have focused narrowly on his technological objectives and realities? This paper considers some of the reasons for Fuller's exclusion from expanded discussions of architecture and then widens the critique of his architectural work, specifically his designs for low-cost single family housing created during his Dymaxion phase, 1927-1946.[4] The wider context for their consideration will focus on the cultural and spatial implications of the houses rather than the technical developments which have been well documented by Marks, Ward, McHale, Pawley, and most recently Ford.

BUCKY'S ISOLATION

In 1944 Fuller made this prediction:

> If and when adequate time, money, resources, and know-how have been invested in the Dymaxion houses they will be installable anywhere around the world with the same speed with which telephones can be installed...We will set up a new industry that promises to rehouse the whole world and employ the whole world in the continuous wealth-making of improving living advantages.[5]

Two years later he reported:

> ...We have now actually met the original theoretical requirements of the physical problem. We have gotten down to the proper weight. We are down, not including the bathroom and the partitions, to 5400 pounds. The partitions, two bathrooms, kitchen, laundry, and energy unit will probably come to not more than 2000 pounds. We will be right on our curve of the size of things man can mass produce in 1946. In other words, due to the development of the airplane industry, this house has become an extremely practical and now very real affair.[6]

These statements convey the objectives and fruits of Fuller's twenty year obsession with low-cost housing. They capture his unwavering belief that technology was the means to create and supply housing universal enough for the world over. Having found ways to transfer aeronautic technology and mass production to the problem of housing America and the world, he was convinced that the technological tenets of efficiency and economy had been successfully applied to architecture as maximum volume with minimum material and energy investment. Domestic spaces could be evaluated on the basis of their weight and derive meaning through their practicality. Implied was Dymaxion as destiny.

Fuller's extreme stance on technology led to his alienation from architectural discussions. His housing designs were and still are mainly discussed in isolation, as engineering or industrial design developments, or alongside fringe genre of architecture such as temporary or movable buildings. Bucky's isolation also stemmed from his refusal to participate in what had become international forums on architecture except in an incendiary way. Fuller felt that unless his criterion of "maximum performance per pound of material" was central to the discussion of architectural merit, then the discussion was misdirected. The lack of common ground between Fuller and his contemporaries paralyzed the exchange of views and ideas. In addition, his disregard of the architectural profession may have bred the same in return. His animosity is transparent in an interview with New *York Times:*

> Architecture is voodoo. The architects don't initiate anything; they just go to work when the client says so. They know how to draw, but they don't know how to design an airplane. They don't go to Douglas and say tell me what you've found out today about the tensile strength of that new steel or aluminum. They have approximately nothing to do with evolution.'

Fuller's relentless pursuit of technology, in word and deed, resulted in designs which were and still are, difficult to assess as *houses.* Or are they?

ORIGINS OF DYMAXION DOMESTICITY

The Wichita House of 1946, referred to as the "Dymaxion Dwelling Machine" and the "house of the century," was the culmination of Fuller's low-cost, mass-production housing designs. When it was introduced to the press *Fortune* magazine wrote that it was "likely to produce greater social consequences than the introduction of the automobile."* To better understand the last Dymaxion and the reaction to it, we must look at its progenitors, all belonging to an unmistakable lineage which originated almost twenty years earlier, and all subsumed by the compelling image of a metallic hemisphere hovering above the Kansas prairie.

Fuller's first design of 1927, called the 4D house, anticipates the major technical characteristics of later Dymaxion designs and represents his domestic design intentions in their rawest and clearest form; it also offers the opportunity for interesting comparisons with parallel approaches by other architects.[9] In the 4D, a central tower contains all utilities, is used for air distribution, and serves as the sole compressive column in the structure; the rest of the house is suspended from, and held off the ground by this central mast. Fuller's approach simplified structural and mechanical systems and reduced weight allowing perimeter walls to be thin curtains, in this case metal punctured with large, ungainly windows. The bathroom foretells of the compact, one-piece Dymaxion unit yet to follow, and storage walls anticipate the pods found in both the Dymaxion and Wichita designs. For some reason, the 4D house had two revolving doors, undoubtedly the first residential use and presumably the last.

Within the cubic volume which is capped by a low-slope roof, interior spaces are organized on two levels. The spaces on the first floor have a pinwheel arrangement around a well-defined core, whereas spaces on the second floor are symmetrically arranged around an exploded core; this results in a variety of plan proportions for the first level mechanical, living, dining, and kitchen spaces, and a uniformity of plan proportions for the second level bedroom, library and study spaces. Since all spaces are defined by their own ceiling or walls, they may be said to create their own volumetric proportions. Large windows provided daylight to each room and served to further dissolve the very thin walls.

THE 4D IN THE AMERICAN CONTEXT

As Reyner Banham noted in *The Architecture of the Well-Tempered Environment,* an interesting precedent for Fuller's early approach to domestic space may be found in Catherine Beecher's American Women's Home of 1869. Of it Banham writes:

> It seems to introduce for the first time the conception of an unified central core of services, around which the floors of the house are deployed less as agglomerations

> of rooms, than as free space, open in layout but differentiated functionally by specialized built-in furniture and equipment, thus anticipating the basic functional organization of Buckminster Fuller's Dymaxion house of 1927.[10]

Both Beecher and Fuller utilized a core to organize mechanical systems and circulation, and both used specially designed storage units to organize household items. The cores served to simplify mechanical services, centralize vertical circulation, eliminate partitions from perimeter spaces, and free exterior walls from fixed elements. The storage units simplified management of household items and lent flexibility to the major spaces of the houses. Both devices lent practical efficiency and spatial flexibility and represented a modern approach to the domestic landscape. Although neither Beecher nor Fuller exploited the flexibility of space or skin in these houses, Fuller would take greater advantage in subsequent designs.

For all the discussion about the weight of Fuller's houses, the ease of their transport, the speed of their construction, for all of the focus on his technological imperative, it is enlightening to observe that his approach to domestic space and the cultural implications therein were grounded, although Fuller would vehemently deny this, in a calculated architectural tradition.

THE 4D IN A EUROPEAN CONTEXT

While Fuller was submitting his 4D house for patent approval, Europeans were touring the exhibit of experimental housing at Weissenhof. Ludwig Mies van der Rohe, artistic director of the Seidlung reflected twenty five years later on the importance of the two houses designed by Walter Gropius there. Of the houses Mies said:

> I am glad that I had once the possibility in Stuttgart to give Gropius a hand so that he could demonstrate his ideas on industrialization and standardization and on prefabrication. He built two houses there, which were the most interesting houses in the exhibition."

Although Bucky dismissed the Seidlung as mere flirtation with rational construction methods and low-cost housing solutions, a comparison of his 4D design with Gropius's experimental House 17 is practically unavoidable given the temporal and ideological proximity between the two. Gropius, like Fuller, was determined to pursue solutions to low-cost housing by employing modern technologies to materials and methods of construction. At House 17 these intentions were translated into standardized structural elements, prefabricated wall panels, and entirely dry construction above the foundation. Less concerned than Fuller with weight or distribution, Gropius stated his objectives as standardization for the sake of freedom, openness to nature, harmonious and free spaces, and proportion of parts.[12]

The entire house was designed on a one meter by one meter module and interior spaces were organized into three unevenly-sized corridors of space on two levels. The first level consisted of entrance hall, living/ dining (which could be separated with an accordion wall), kitchen, pantry, storage and utility; the second level was organized with three bedrooms, bath and laundry grouped around a hall.

Gropius concentrated fewer of the services in the center corridor of the plan creating less mechanical efficiency and spatial flexibility than was found in the 4D although storage was handled in a similar fashion with closets built-in back-to-back. The envelope of the house revealedits standardized and prefabricated nature in its articulated panels and uniform windows, yet each elevation was a different composition of the wall system's components; elevations of House 17 were far more artfully designed than those of the clumsy 4D house.

The aspect of House 17 which distinguished it most from the 4D was its relationship to its site. Whereas Fuller's design was held precariously above the ground by the central mast, Gropius's design firmly engaged its site with its full concrete foundation. The relationship between house and site was important enough to Gropius for him to ask Mies to change his overall layout slightly to better accommodate House 17. Integration of house and landscape may also be seen in the covered terrace spaces, one wrapping the corner of the main entry, the other creating a large outdoor space adjacent to the kitchen and dining areas. This synthesis of interior and exterior spaces cannot be found in Fuller's 4D design.

The twodesigns are different not for their overall objective of low-cost industrialized housing, but rather their approach to achieving it. While Fuller sought to standardize houses, Gropius attempted to rationalize a system of constructing houses with mass-produced, standardized components. Although Gropius, the architect, undoubtedly gave more consideration to qualitative aspects of site, space and composition, the results cannot be said to be vastly different than those of Fuller, the engineer.

DYMAXION EVOLUTION

In 1929 Fuller published the second generation of his single-family design, the Minimum Dymaxion house. It represents a shift to a centralized form, from a rectangle to a hexagon, justified by Fuller on the grounds that the hexagon allowed for more standardization of components. The central mast is still present as is the core, but is given a more prominent role in both the form and function of the house. The structural system is refined into a series of compression rings suspended from the mast and guyed with triangulated tension cables, a system which will appear again in the Wichita house. The house was said to have a central vacuum system, atomizing showers and toilets, and an early precursor to the dishwasher.

Formal and spatial changes are immediately apparent in the second design. The form, raised off the ground one complete level, was comprised of six even-length sides which established an undifferentiated perimeter; this was reinforced by the use of continuous floor-to-ceiling curtains of casein and/or aluminum sheets. The hexagonal form also established an undeniable center to the plan, occupied by a circular stair

in one scheme and an elevator in another. Herein lies a condition which will characterize Fuller's subsequent designs: interior spaces become triangular or pie-shaped and establish a spatial emphasis towards the core; the light and view, however, occur at the exterior wall lending a perceptual emphasis to the perimeter. A spatial tension thus results from this vacillation of emphasis, a tension not found in the rectangular spaces of the 4D house.

Interior spaces are organized on one level which is raised above grade. Rooms correspond to segments of the hexagon and are defined by floor-to-ceiling storage units located only on the primary rays. The one level of interior space is sandwiched between two levels of exterior space. Covered outdoor spaces are located below in the form of a carpark and entrance, and above the living spaces in the form of a terrace; these create a dynamic not found in any of Fuller's other house designs and which relates it to others of the same period. Fuller's sandwich of outdoor space has the effect of extending the space and logic of the interior to the site, not horizontally as with Gropius's House 17 at Stuttgart, but vertically as with the Double House by Le Corbusier.

Also apparent in this Dymaxion house is Fuller's struggle with design issues. Drawings reveal rigorous searches for a planning module, for a proper core design, and for clear circulation in and around the core. At this point in the development of the design, formal and spatial relationships were not yet prescribed by technology andqualitative, as well as quantitative criteria, were considered in the decision-making process. All of this would change in the next generation of Dymaxion development.

HOUSE BECOMES MACHINE

At first glance, the image of the Dymaxion Dwelling Machine, which came to be known as the Wichita house, is compelling even now. When it was unveiled to the press in 1946 it was absolutely stunning. The hemispherical form, the aeronautic age materials, and the technological approach to everything from lighting to storage gave the house a mystique which tended to overwhelm objective commentary. The response of an editor of Fortune magazine who toured one of the two prototypes produced by Beech Aircraft Corporation in Wichita, Kansas hinted at the difficulty of both creating a critical foothold from which to discuss the design and a framework with which to locate Fuller's design in the discussion of postwar housing:

> Because it is so completely radical there is no basis for comparison with the traditional dwelling...In the living room one sees considerable exposed aluminum; the thin cable supporting the floor pass in front of the Plexiglas windows, which are riveted together. In Fuller's house this all seems so appropriate that it rarely causes comment. The circular form, which arouses such doubts at first, looks quite unremarkable from inside and rather pleasant. Most unexpected of all, perhaps, is the general impression of luxury.[13]

The house was a metallic hemisphere hovering above its site. Fuller justified this form as the most efficient, that is, capable of enclosing the maximum volume with the minimum surface area. The lowering of the house to just above the site and the elimination of the outdoor terrace had two effects on the scheme. First, it enabled the space taken by the stairs in the Dymaxion to be reclaimed as usable floor area in the Wichita house. On the other hand, it eliminated outdoor spaces which allowed some integration of the house with its site; at Wichita we see the house clearly at odds with its surroundings and extreme differentiation between inside and out. Curiously, one of the prototypes was erected for use by a Beech executive who grounded it in the side of a lakeside slope and created an outdoor deck, both of which violated Fuller's design intent.

The interior spaces were organized much as they were in the Dymaxion; the earlier library was omitted, but bedrooms became larger and the kitchen, formerly included in the living/dining space, was now given more definition. Rooms were once again defined by storage units, but at Wichita they were elliptically shaped and held down from the ceiling to allow for a balcony above. Movement from space to space occurred at the perimeter through fabric "modernfold" doors.

In the Wichita house one cannot help but notice familiar oddities: every space is pie-shaped, normal furniture is difficult to arrange, and there is hierarchical tension between perimeter and core. In other words, Fuller did not solve the design problems characteristic of centralized forms containing more than one use area. The sectional aspect of the house reveals new peculiarities not found in the other designs. Although the interior volume is 16' tall at the central mast, the storage units reach only to 8'. Mechanically, this open space above the rooms was advantageous since the fabric attached to the roof curvature was used to efficiently distribute conditioned air as well as indirect light projected up from the pods. Spatial effects, on the other hand, must have been disastrous, as there was no sensory separation between spaces. No reasonable containment of light, sound, odors, temperature or sight was possible, leaving all spaces with disturbingly generic qualities.

The technical specifications of the house were impressive if overstated and speculative. It enclosed over 1000 square feet yet weighed only 7500 pounds. No individual component weighed more than ten pounds nor was larger than could be handled by one man. The house could be erected by six men in one day or one man with a truck in a week. All components nested together and could fit in a reusable stain-less steel cylinder, which in Fuller's mind enabled shipping by ground or air to any area of the world. Initial production costs were estimated as $3500 ($0.54 per pound), with a cost-to-consumer of $6500 compared to $12,000 for conventional 1946 houses.

In the Wichita house, Fuller's pursuit of these technical traits displaced all other pursuits. Spatial and functional aspects which had been developed in earlier designs parallel with technical considerations, were eclipsed in the later

design. Refinements to the house were purely technical and if one looks beyond the slick skin they see a design which is nearly identical to the Dymaxion from 16 years earlier. Functional and spatial changes are purely coincidental to technical changes and most are, unfortunately, detrimental to the overall design.

CONCLUSION

In conclusion, Buckminster Fuller's intentions regarding the single-family house are best understood by looking beyond the iconic image of the Wichita house at his early designs and by tracing his residential work to its origins. By doing so, one can see beneath the veil of technology and examine the new domestic environment he was proposing as well as his approach to site, space, program and the inter-relationships between them. Examination of subsequent designs show that many of these concerns become secondary and eventually coincidental to technical issues when new post-war technologies become available.

A re-examination of Fuller cautions us that technology may be intoxicating. It may cloud discussions of cultural meaning and tradition, of political and social relevance, and of space and time. Fuller's work also reminds us that technology may reduce or oversimplify the thinking, making, and discussion of architecture. Not only did Fuller's obsession with technology come to cloud his proposals for the modern house, but our fascination with technology may easily inhibit the discussion of Fuller's houses as fully-vested works of architecture. Lastly, this discussion of architecture and technology perhaps returns us to Martin Heidegger who wrote:

> Because the essence of technology is nothing technological, essential reflection upon technology and decisive coming to terms with it must happen in a realm that is, on the one hand, akin to the essence of technology, and on the other, fundamentally different from it. Such a realm is art.[14]

NOTES

1 Alberto Perez-Gomez in the introduction to *Architecture, Ethics, and Technology,* (Montreal: McGill-Queen's University Press, 1994), p. 5.

2 Vesely discusses the'difference between a technological world and a world that is profoundly influenced and shaped by technology in "Architecture and the Question of Technology," in *Architecture, Ethics, and Technology,* (Montreal: McGill-Queen's University Press, 1994), pp. 28-49.

3 Kenneth Frampton, *Studies in Tectonic Culture,* (Cambridge: MIT Press, 1995), p. 1.

4 The most comprehensive documentation of Fuller's work may be found in the four volume collection entitled *The Artifacts of R. Buckminster Fuller,* edited by James Ward, (New York: Garland Publishing, 1984-6). The Dymaxion years are documented in volumes 1 and 2.

5 Buckminster Fuller quoted in Martin Pawley, *Buckminster Fuller,* (New York: Taplinger, 1990), p. 112.

6 Buckminster Fuller in a speech to Beech Aircraft employees in January 1946, published in *Designing* a *New Industry,* (Wichita: Fuller Research Institute, 1946), p. 38.

7 Buckminster Fuller in an interview in the *New York Times* (April *23,* 1967), reprinted in Pawley, p. 147.

8 From *Fortune* magazine, (April 1946) quoted in Pawley, p. 85.

9 A solid argument to support the 4D house as the first design and a summary of the controversy may be found in Pawley, p. 49.

10 Reyner Banham, *The Architecture of the Well-Tempered Environment,* (Chicago: University of Chicago Press, 1969), p. 96.

11 Mies speaking on the occasion of Gropius's seventieth birthday, quoted by Karin Kirsch in *The Weissenhofsiedlung,* (New York: Rizzoli International, 1989), p. 120.

12 For a discussion of housing designs executed around the time of the Weissenhof exhibit by Gropius, see Richard Pommer and Christian F. Otto, *The Weissenhof 1927 and the Modern Movement in Architecture,* (Chicago: University of Chicago Press, 1991), pp. 88-92.

13 An editor of *Fortune* magazine writing in 1946 and quoted in Robert W. Marks, *The Dymaxion World of Buckminster Fuller,* (Carbondale: Southern Illinois University Press, 1960), p. 37.

14 Martin Heidegger, *Vortrage und Aufsaize,* (Pfullingen: Neske, 1959), p. 43.