ARTHUR T. BROWN:
PIONEER OF PASSIVE SOLAR ARCHITECTURE

ABSTRACT

Though he is not well remembered, Arizona architect Arthur T. Brown was among the first generation of Americans who experimented with solar architecture. In a series of fascinating buildings in the 1940s, Brown tested ways solar heat could be accepted and stored, or rejected, using building design. He spoke of his desire “to use solar heat in a part of the world where the usual stress is to combat it.”

Brown built a very early example of an indirect gain system, as well as one of the first transpired solar collectors. He also designed numerous inventive shade structures and brought several traditional methods of dealing with solar heat to the modern movement. Within the mid-century solar architecture movement, Brown remains a figure of great importance.

This paper reconstructs the history of Brown’s projects and discusses his philosophy, influences, and legacy. It also analyzes his contributions within the context of contemporary solar house experiments.

1. INTRODUCTION

Arizona architect Arthur T. Brown was “Tucson’s pioneer of solar design,”[1] but his importance transcends his locality. Beginning in the 1940s, decades before energy-efficiency became a broad concern for architects, even before ‘passive solar heating’ had its name, Brown created numerous structures that are some of America’s earliest examples of experimental solar architecture.

Brown’s solar projects deserve close attention, first, for their architectural quality alone, their extraordinary ingenuity in responding to hot arid climate. Furthermore, Brown’s work has a larger cultural importance, as it exemplifies an ethic with regard to conserving energy. This ethic aligned him with a small but important critical ‘movement’ in the 1940s and 50s, and against mainstream building practices which increasingly relied on mechanical heating and cooling.

2. BIOGRAPHY

Arthur Thomas Brown was born in 1900 in Tarkio, Missouri. His father, John Brown, taught Greek Languages as a professor, and his mother, Ada May Brown, painted watercolors and oils. In his autobiography, Brown remembered his family’s Victorian house, including its old standards of comfort such as a lack of running water and kerosene lamps.[2] The steam-operated power house and the old bridge in Tarkio fascinated him as a child.

Fig. 1: Arthur T. Brown (1900-1993).[1]

After receiving a degree in chemistry from a local college, Brown entered the architectural program at the Ohio State
University in 1924, where he received training in the spirit of the École des Beaux-Arts. He graduated in 1927 and moved to Chicago, where he found himself immersed in the modern architecture movement. He worked in David Adler’s office for 14 months, and began to study the works of Louis Sullivan and Frank Lloyd Wright which influenced his own thinking. Brown remembered a remark from a critic all his life: “Never design in a style. If you have to design in a style, remove everything that makes it a style.”[2]

Professionally, he was a child of the Depression; like many architects he was involved in numerous different jobs after 1929. He entered engineering competitions and worked as a publisher. In 1933, he worked for the Century of Progress exhibition in Chicago helping to design auxiliary buildings and signage, and in the “Architectural Gadget Design Department” where he designed small items such as light fixtures and ticket booths. Following a former classmate’s invitation, he moved to Phoenix and then to Tucson, Arizona, where worked for Richard Morse and soon became his partner. In 1941, Arthur Brown opened his own architectural practice.

Brown later described himself as an “Architect, Artist, Inventor,” and emphasized his love for painting. But in retrospect it is clear that his successes in art and invention were minor, while he made a true and substantial contribution as an architect. He was elected a Fellow of the American Institute of Architects (FAIA) in 1961, the first Arizona architect so honored. In total, he completed 309 projects. He died in Tucson in 1993, and left his architectural practice to his son Gordon, who had been his partner since 1970.

3. SOLAR ARCHITECTURE

Brown’s interest in solar architecture was not initially motivated by ideology, but rather a ‘happy accident’. In 1945 he designed a home in Tucson for “Jardy” Jardella. For aesthetic reasons, the client asked that the house be painted black. Later, Brown walked along the south side of the house and realized how much heat was stored and radiated back into the environment: “I could feel it five feet away … and I thought that the next time we do a house, we’ll paint the wall inside the hall black so that we won’t lose the heat.”[3]

3.1 Passive Heating

Brown applied what he had learned at the Jardella house just one year later, at the Rosenberg house (Tucson, 1946). For this project, Brown designed a long, narrow building aligned along the east-west axis (see Fig. 2). Much of south wall was made of floor-to-ceiling glass with appropriate shading devices to maximize solar gain in the winter and avoid it in the summer. Behind the south-facing glass, a concrete block wall, covered in plaster and painted dark, was installed at the center of the house (see Fig. 3).

The storage wall, Brown estimated, should be eight inches thick because he “had estimated that heat moves through concrete at the rate of one inch an hour,”[3] so it would collect heat for approximately eight hours a day and emit it at the same rate each night. Additionally, the concrete floor worked as a radiant heater, and ½-inch of asphalt-permeated rigid insulation insulated it from the ground.

The use of a storage wall to collect heat on one side and radiate it later to the other side would later become known as an indirect-gain system, though that term did not exist in 1946 and Brown did not cite any precedents for his idea. In essence, Brown’s system worked much like the system that Felix Trombe would popularize and patent ten years later, except Brown conceived the cavity between the glass and storage wall as occupiable space. The Rosenberg house may well be the first example of this strategy anywhere (see discussion below).

Fig. 2: Rosenberg House plan (Tucson, 1946).[4]

Fig. 3: Rosenberg House (Tucson, 1946).[4]

Helen Kessler described the Rosenberg House as, “…in many ways, a classic solar design.”[5] But it is only classic in retrospect—the “sunspace” of course would become a
common technique when solar architecture flourished in the 1970s—to Brown, these techniques were essentially experimental and untested.

Interestingly, though it functioned as a storage wall, Brown also called it a “barrier wall.” As noted in Progressive Architecture: “This enables the owner to be in or out of the sun as the weather—or his pleasure—may dictate.”[4] In the context of the late 1940s, when mainstream architecture focused almost exclusively on producing uniform temperatures with mechanical systems, this emphasis on variability appears a striking critical insight.

The system performed well. Temperature readings were collected by the owners on a cool winter day in 1947, showing that the rooms behind the wall were kept comfortable and stable (see Fig. 4). After the first winter, Brown reported: “It has not been necessary to use the furnace at night, after a clear day, or in the morning, after nine o’clock.”[4]

<table>
<thead>
<tr>
<th>Time</th>
<th>Outside (north wall)</th>
<th>Solar wall</th>
<th>Inside (living room)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10:00AM</td>
<td>50°</td>
<td>94°</td>
<td>72°</td>
</tr>
<tr>
<td>2:00PM</td>
<td>62°</td>
<td>102°</td>
<td>72°</td>
</tr>
<tr>
<td>6:00PM</td>
<td>59°</td>
<td>81°</td>
<td>72°</td>
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Fig. 4: Rosenberg House, temperatures (in °F) measured by the owners in February 1947.[5]

Decades later, Brown was asked if he would change anything in the Rosenberg house retrospectively: “he replied that he might cut down the number and size of the openings in the solar wall to retain more mass; but on the whole, he is pleased with the house’s design and performance.”[5]

In the next iteration, the Hirsch house (Tucson, 1949), Brown designed a uniquely-shaped storage wall, sloped at its base to catch the inclined rays of the winter sun (see Fig. 5). As before, the Hirsch house was one room deep, and the storage wall would provide indirect gain to the rooms behind it. However, here he refined the Rosenberg plan by eliminating the solar wall in front of the living room and allowing this important space to operate with direct gain alone.[6]

### 3.2 Shading

Brown understood that effective passive solar design required shading. “Shade is very important on the desert,” he wrote. “There is, sometimes, a 25°F difference between sun and shade.”[7] In all his projects he paid careful attention to orientation and using overhangs appropriate to the solar geometry to block unwanted heat gain. In some projects he transformed the prosaic need for shading into an architectural feature. The Rosenberg house (see Fig. 9) featured a prominent system of metal louvers, fixed at an angle of 34° above horizontal and space appropriately, to eliminate the direct gain from the sunspace in summer.

Brown developed a novel shading strategy for the Ball-Paylore House (Tucson, 1950), a hexagonal plan with circular “revolving porches” (as he called them). These were movable shades connected to the house which rolled on casters at the rim of the patio slab and were connected to a track in the eave line. The south-facing walls behind these porches were completely glazed, with floors of brown concrete and masonry walls to the rear for thermal mass.

![Fig. 6: Ball-Paylore House (Tucson, 1950).][8]

In a period publication, Brown noted that the Ball-Paylore shading system “does three jobs”: preventing unwanted direct gain; shading the concrete terrace to prevent indirect gain; and protecting the interior from indirect glare.[8]

Why a hexagon? The clients, Phyllis Ball and Patricia Paylore, “found the typical house for the average American family unsuitable for two independent adults who wanted to share a home.”[1] Brown recalled: “It was the architect’s first concern to see that the owners had rooms of equal importance and separated from the general living area. As
the plan worked out, each person had access to the terrace and patio from her own room. If desired, each could even have a segment of the revolving porch."[2] In other words, Brown found the hexagonal plan to be non-hierarchical, and the revolving porches contributed to the feeling of equality by providing equal access to shade.

Significantly, Paylore later co-edited a book with Kenneth N. Clark entitled *Desert Housing* (1980). In her introduction, “From Cave to Cave,” she wrote: “Housing for the arid environment takes a special kind of understanding…”[9]

Brown’s 1952 Tucson Chamber of Commerce building featured a large south-facing terrace with a retractable roof. Brown later described the system as: “two bi-fold bat-wings which operated by pressing a button.”[2] His Tucson General Hospital (1963-70), which required a four-story south façade, was protected by “a delightful and inventive golden aluminum shading device”[1] in a folded diamond pattern, which created an origami-like effect.

In numerous projects that would not necessarily be called ‘solar houses’, Brown controlled unwanted heat gains with simple passive strategies that reflected his awareness of traditional methods. For instance, the courtyard-style Altaffer house (Tucson, 1958) used vegetation to shade the east walls and flagstone paving. Its interior was said to have a “cool, cavelike aspect … very desirable in desert climate.”[10] The O’Neil House (Tucson, 1953) included a triangular “ramada,” a shade structure loosely borrowed from local Native American traditions.

There were some ‘lessons learned’ along the way. For the Hirsch house, Brown relied, to some extent, on interior curtains to reject unwanted gains. Brown later reflected: “The solar wall worked fairly well, sometimes too well. Victor [Hirsch] told me there should be some way to control the amount of heat that was brought in by the wall.”[2]

### 3.3 Ventilation and Cooling

Brown also understood that effective passive solar design required air movement. In the Rosenberg House, Brown designed convection vents above the south windows; hopper doors were installed on the inside of the south wall and the openings were screened on the outside. As reported in *Progressive Architecture*: “Excess warmth is drained out of northern windows and ventilator units at top of glass wall.”[11] Additionally, Brown provided louvered doors in the central solar wall and jalousie on the north for cross-ventilation. The roof was painted white.

### 3.4 The Solar Roof

One of Brown’s most significant solar projects—indeed the first solar-heated public building in the United States—did not use direct gain at all. The Rose Elementary School (Tucson, 1948) used a novel hollow construction that heated chambers of air inside the roof structure.

The school was organized in three one-story rows of classrooms, space repetitively north-to-south, with each building one-room deep and stretched east-to-west (see Fig. 7). Shed roofs sloped gently to the south. Brown used overhangs to create outdoor corridors (reminiscent of traditional portales) and to shade the south walls. Glazing was only installed on the north side of the building.

The ‘solar roof’ (see Fig. 8) was constructed of heavy-gauge aluminum pans, a shallow pan inside a deep pan, forming parallel air ducts heated by the sun. A horizontal duct at the highest point of the roof distributed the warm air to each room, and return air was drawn back into the roof from the opposite diagonal corner in each space.

![Fig. 7: Rose Elementary School (Tucson, 1948).](image1)

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![Fig. 8: Rose Elementary School roof system. Drawing by Polina Novikova-Kinney.](image2)
In winter, this system would pre-heat outdoor air by 10-15°F. The system was not purely ‘passive’, requiring fan power. Storage of heat was not provided because the school would only be occupied from 9 a.m. to 3 p.m. A furnace could provide auxiliary heat on cloudy days. In summer, the heated air was exhausted at the ridge, keeping the building cool by convection.

In essence, this system prefigured the technique, somewhat common today, called a transpired solar collector. (It is generally used vertically; Solarwall® is one trade name.) Brown, curiously, did not patent his system despite the fact that he patented several other (non-solar) architectural systems in this period that appear in retrospect to have been much less marketable.

At the Rose School, this system provided 86% of the school’s heat in the first ten years of operation, and effectively “kept the Rose School warm in winter and cool in May and September—the two hottest months of the school year.”[3]

4. DISCUSSION

4.1. Brown’s Philosophy

Like the small number of other architects and engineers who experimented with solar heat in the 1940s, Brown self-consciously pursued priorities that were different from the general trends of the period. An article on the Rose School contrasted Brown’s approach with the typical practice: “we are building into our structures increasing quantities of mechanical and electrical equipment … In a way our progress is almost circular, like the route of a dog chasing his tail.”[12] Brown seems to have been motivated by a general ethic of frugality, certainly conditioned by his experiences in the Depression, that may have lacked an immediate economic impetus in an era when energy was plentiful. “I did these things,” he later recalled, “at a time when gas was so cheap that people didn’t have an interest in solar heating.”[3]

Brown also recognized that, to a national audience, the notion of solar heating in the desert might seem peculiar, even though Tucson’s heating needs are not trivial. He spoke of his attempts “to use solar heat in a part of the world where the usual stress is to combat it.”[4]

Brown did not follow a prescriptive design method, or even a consistent commitment to solar heating. In his many church structures, solar heating plays no role. The 1947 Clothier house was one room deep and elongated east-to-west, but in this case the large expanses of glass faced north—towards a mountain view. It was called “a ‘solar’ house in reverse.”[13]

4.2. Influences

Since Brown was a junior member of the architectural team for the 1933 Century of Progress exhibition in Chicago, he certainly knew George Fred Keck’s all-glass “House of Tomorrow,” the project where Keck ‘discovered’ passive solar heating. (There is no evidence Brown and Keck worked together, or even met.) Brown must studied Keck’s subsequent passive solar houses in the Chicago area. Beginning with the 1940 Sloan house, Keck developed a palette of planning strategies for the “solar house” (a term coined by the Chicago Tribune for the Sloan house). He created a one-room-deep plan, elongated east-to-west with a south-facing glass wall, opaque east and west walls (sometimes wing walls), and appropriate overhangs.

![Rosenberg House by Brown (Tucson, 1946)]](attachment:Rosenberg_House.jpg)

Brown adopted all of these patterns—using the term “in a line house”—and of course modified them to suit the local conditions and solar geometry. Like Keck, Brown placed the living room at the center of the solar house and emphasized it in the massing. There is an uncanny similarity between Keck’s Sloan house and Brown’s Rosenberg house completed six years later (see Fig. 9 and Fig. 10), suggesting that Brown followed Keck in a quiet effort to establish a symbolic language for the emergent ‘solar house’.

![Sloan House by Keck (Chicago, 1940)]](attachment:Sloan_House.jpg)

Furthermore, Brown’s technique of passive ventilation within the solar wall came directly from Keck. Keck began
to use a wood louver system at the top and bottom of the “solar wall” for natural ventilation in 1942, in projects such as Sloan’s Solar Park house II, the Hanshe house, and the Green Ready-Built system. [14] Keck also used radiant floor heating in his 1940s solar houses; Brown did the same in several projects beginning in the early 1950s. Notably, Brown did not attempt to emulate Keck’s use of a roof pond for natural cooling.

Brown also seems to have sided with Keck, against Frank Lloyd Wright, in an implicit disagreement over the best orientation for a semi-circular solar house. Wright’s 1944 “Solar Hemicycle” for Herbert Jacobs in rural Wisconsin was oriented concave relative to the path of the sun, as it was meant to “track” the sun during the course of the day, while the major wall area on the north side of the house was earth-bermed. Keck had created an earlier circle-based plan (though not a full ‘hemicycle’): the 1937 Cahn house, which presented its outer face to the sun. In other words, both Keck and Wright were interested in the poetic symbolic aspects of making the solar house half-round, but arrived at opposite forms. Brown’s circular Van Sicklen house (1959) followed Keck’s solar orientation, though it apparently did not seek to use passive solar heating. It also included a unique wedge-shaped garage roof whose point emanated from the center of the circle, giving the entire project a clear resemblance to a sundial.

4.3. Historiography

Brown worked in sympathy with a fairly robust solar house ‘movement’ in the 1940s and 50s, but apparently he was not directly involved with specific events that helped define that movement. He did not contribute to the 1947 Your Solar House project by the Libbey-Owens-Ford Glass Company, which commissioned a solar house design for each of the United States. [15] This is understandable, as architects were selected in 1945, before Brown had demonstrated his interest in solar architecture. (Arizona’s architect, in fact, was Brown’s former partner Richard Morse; their partnership had ended in 1941. Morse’s solar house was overglazed on the south, with insufficient shading, and Morse wrote: “artificial cooling is a daily necessity in the summer”—one suspects Brown would have reached a different conclusion.)

Brown did not participate in the seminal 1950 “Space Heating with Solar Energy” symposium at MIT, where architects such as Keck and Eleanor Raymond discussed their work alongside engineers who were pursuing active systems. In essence, the MIT symposium was a great ‘summit meeting’ of solar architects and engineers, where it was first recognized that the technical and aesthetic challenges of the solar house should be addressed in an integrated fashion. Furthermore, Brown did not present his work at the 1955 “World Symposium on Applied Solar Energy” in Phoenix, where over 1000 people famously dined on pheasant at the keynote banquet—perhaps solar architecture’s defining moment prior to the 1970s.

Curiously, Brown’s work was not documented in William Shurcliff’s epic series Solar Heated Buildings: A Brief Survey, which attempted to document “the great majority” of solar heated buildings worldwide. [16] An AIA report by John Yellott and Arizona State University students entitled Solar-Oriented Architecture also omitted Brown’s projects. [17] Certainly the Rosenberg House, Hirsch house, and Rose Elementary School merited inclusion in each case. None of Brown’s innovative shading techniques earned mention in the comprehensive Solar Control and Shading Devices by Olgyay and Olgyay. [18] These omissions can not be simply explained by underexposure, as Brown’s work was widely published in the major architectural and home magazines.

4.4. The Trombe Question

Did Brown, effectively, invent the Trombe wall ten years before Felix Trombe? There are earlier examples of remarkably similar systems. For instance, Edward Sylvester Morse created a solar device in 1881 that consisted of glass, airspace, and a slate wall with vented openings at the bottom and the top. [3] The space between the glass and storage wall is narrow; it is essentially identical in concept to Trombe’s ‘invention’.

It is unknown whether Brown knew of Morse’s system. He certainly would have known of Keck’s work, as discussed above, and the general notion of ‘the solar house’ (direct gain), which was widely discussed in the mid-1940s. But there are no earlier known examples of a ‘sunspace’—a south-facing space fronted by glass and backed by a storage wall, which is allowed to overheat and overcool—prior to Brown’s Rosenberg house. Brown never patented this idea, although he considered himself an inventor and patented several other architectural designs. If the Trombe wall should rightfully be called the ‘Morse wall’, the sunspace could reasonably have Brown’s name attached.

4.5. Criticism

The storage-wall system Brown developed for the Rosenberg house “raises both scientific and aesthetic issues,” according to Colin Porteous. “A wall painted black as a solar absorber is functional as long as there is enough short-wave radiation to charge it. At night, and on overcast days, it is simply a rather gloomy surface of an uninsulated wall that is able to ‘leak’ heat outwards.”[19] Two points can be made here. First, ‘gloomy’ is a purely subjective assessment; an objective critique would also discuss the
ideology of functionalist modern architecture—that the results of scientific optimization would be found beautiful—which Brown believed at least in part. In any case, the wall was later painted light blue. Second, any heat that ‘leaked’ outward (from the storage wall to the sunspace) would remain thermally beneficial as a buffer. Ideally, the glass could be covered with insulating curtains at night; it is unknown if the Rosenberg house included a method to control emissivity (the glass was single-pane with continuous metal frames).

It is certainly true that Brown’s solar houses had no provision for heat storage beyond eight hours. Consequently, he never claimed 100% solar heating in any project, and all of his solar houses included furnaces for supplemental needs. His approach emphasized savings but not energy independence. Some other projects of this period, particularly the Dover Sun House by Eleanor Raymond and Maria Telkes, and the MIT solar houses, did indeed strive to store solar heat for a period of days, but these required active technologies.

5. CONCLUSION

Brown’s contributions are somewhat difficult to contextualize, historically, because he did not discuss his influences and did not cite any precedents for his ideas about solar architecture. Furthermore, he did not play an active role in the solar house ‘movement’ that formed in the late 1940s and early 1950s. And most oddly, when the solar house movement exploded in the 1970s, Brown was generally not recognized as one of its forerunners (with the important exception of Butti and Perlin [3]). Like all of the ‘first generation’ solar architects, Brown is absent from broader histories of modern architecture.

But Brown’s historical importance is manifest through his contributions: he built some of the first examples of an indirect gain system and a transpired solar collector, plus numerous inventive shade structures and modern versions of traditional techniques. Brown’s legacy within the passive solar movement is simply enormous, and the word ‘pioneer’ is truly applicable.

6. REFERENCES


