

# Solar design For Wellbeing and Expression: Louis Kahn's Psychiatric Hospital Addition

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**ABSTRACT:** Immediately before completing the Yale Art Gallery, Kahn built a psychiatric hospital in Philadelphia which is a relative footnote in accounts of his institutional work. Although the subject of the building is burdened by stigma and access limited, the Radbill addition to the Philadelphia Psychiatric Hospital warrants renewed attention in light of a sophisticated design that introduced architectural order and deft detailing to a demanding building type. The hospital is organized so that spaces warranting more privacy are at higher levels, corresponding with glazing that is proportionally shorter than at the lower levels. Horizontal shading devices of three different depths are shallower at the upper levels in acknowledgement of a reduced shading burden when windows are shallower.

The psychiatric hospital was built at a time when the effects of post-war material rationing was still resonant in the planning of buildings, and institutional buildings were still designed for natural ventilation and conditioning. In this context, passive strategies to counter excessive solar heat gain when daylighting was desirable, since thermal discomfort could not be completely offset by mechanically. As mechanical conditioning became standard in the United States, passives solar control strategies receded and building facades flattened. Despite a scientific basis for shading devices provided by academics including the Olgyay brothers, solar design remains largely an intuitive process.

With the advent of digital modeling and analysis, predictability of solar device performance renews cause for exploiting their potential and maximizing daylight while minimizing corresponding liabilities of glazing. Digital analysis also permits better understanding of solar impact on existing buildings allowing for expanded methods of historical analysis and understanding of architectural significance. It advances a position where unseen characteristics of building design are given standing alongside visible characteristics. Central to this is the use academic study of the health benefits of daylighting.

**KEYWORDS:** Daylighting, Shading, Glazing

## 1.0 INTRODUCTION

The program of a psychological hospital has seldom been recognized in architectural histories and professional journals. Compared to general hospitals, psychological hospitals are typically sequestered from the public, and the individuals and conditions treated shrouded in stigma. Hospitals are also subject to demanding programmatic requirements that typically result in standard configurations that resist formal play and flexibility of silhouette. It is against this backdrop that Louis Kahn designed an addition to a psychological hospital in Philadelphia which is relatively unknown and was opened in 1953 when design and construction for the Yale Art Gallery was ongoing.

Kahn's buildings after, and including the Yale Art Gallery, were comprised of fundamental shapes, and had relatively flat and materially rich facades. Design of the hospital addition occurred when overt solar shading devices were in vogue, although it was the last time Kahn used projecting devices. Two aspects of the hospital project are unique. First, the horizontal shading devices are stepped so that they get progressively deeper toward the bottom of the building. Second, the resulting formality correlates with the vertical height of window opening, and to the nature of program on each level. Admittance of daylight to buildings in this climate is achieved at the cost of lost heat during the cooling season, and overheating in the summer due to solar radiation. Low insulation value of windows compared to solid walls during winter and summer is a liability, then as now. Shading devices help compensate by increasing the thermal performance of buildings, and greater justification of glazing.

The goal of this paper is to demonstrate that the use of solar shading in this building fulfills three design objectives that are intertwined, criteria for integrated design. As described in the prior paragraph, the first criterion mentioned is the effective management of thermal heat. The visual reading resulting from shape of the building, shading devices, and glazing is the second condition, and tied to the first. Finally, a goal is to connect the admittance of daylight supported by the shading devices to effectiveness of programmatic

objectives which is treatment of patients in a hospital setting. Kahn's building is better appreciated when artistry is evaluated along with performance.

### 1.1 Methodology

This paper utilizes three approaches to analysis. First is a normative historical approach and includes a programmatic and formal analysis necessary for understanding the significance of the building and its context. The second part of the paper accounts for digital analysis of the building performed by the author which sheds light into the effectiveness of the shading devices. In the latter part of the paper characteristics of the building are related to science based research in order to support techniques used in the building when most concepts of the value of natural light were understood more intuitively. At stake for this program is the connection between daylight, mental health, and healing.

## 2.0 BACKGROUND

Louis Kahn and his partner Oscar Stonorov gained a commission to design an addition to the Philadelphia Psychological Hospital which is located to the west of downtown near the city border. An initial unrealized scheme, different than the final, was developed in 1946. When the partnership disbanded, Kahn set up his own practice in 1947 which would survive until his death in 1974. Kahn continued to work for the hospital and develop the scheme which was realized. The plan of the four story annex called the Radbill Building can be described as a bent bar with a narrow extension at the knuckle.

The period in which the building was designed and built was transitional, between periods in which early experiments in minimal modernism were premised on ideals of transforming society to one in which the social and political agency of architecture was no longer paramount. Paul Overy dedicates a book called *Light, Air and Openness* toward the connection between cleanliness, light, air and healing in modern architecture between the great wars when it embodied a utopian inclination. The buildings he chronicles, health and non-health care structures, combined clear form, connections to nature, and openness; qualities that carried over into later periods. (Overy 2007)

Hospital design was transformed by modernity even earlier than office buildings which adopted glass curtain wall construction. Before the first war hospitals were typified by punched windows and large amounts of clutter including furniture, artwork and piping infrastructure resembling residential architecture. The post-war period, when Radbill was built, streamlined rooms with precise geometries and large amounts of light were accepted, largely due to the efforts of earlier architects to promote a connection between form, surface and health.



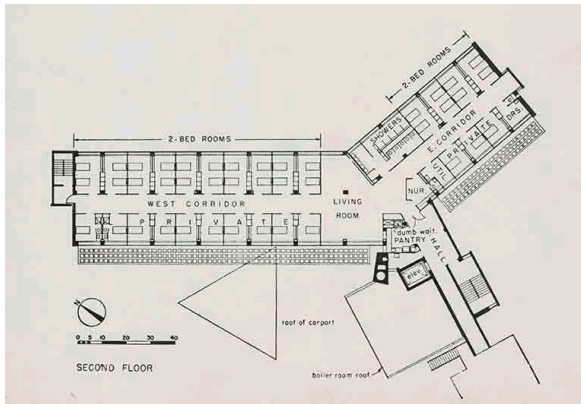
**Figure 1:** Photograph of Radbill addition to the Philadelphia Psychiatric Hospital circa 1953 (Source: The Louis I. Kahn Collection, University of Pennsylvania and the Pennsylvania Historical and Museum Commission).

### 2.1 Plan and Program Distribution

Kahn's Radbill Building (Fig. 1) is set into a sloping site to the north of the existing main building. Both the connection to the main building and main entry are on the southwest side which is effectively the second level of the building. The lowest level has an exterior exposure on north side so that four floors are visible rather than three at the entry elevation. Floor areas totals 30,000 feet, which is distributed evenly on all

levels. The plan form of the building is best described as a thirty-eight foot wide bent bar with a 40 degree shift off-center. A deviation is the stair tower which juts out at the north end of the bar and the connector passage to the main building. As a result of the cant, none of the elevation faces are of equal extent although the building incorporates regular column spacing with an exception of a half bay at the end of the building which is legible at the façade.

The main level building function is primarily administrative and includes a reception area, offices, a meeting room, a library and a records room. Service functions, including receiving and kitchen are the primary spaces at the basement, with a cafeteria at the short wing. A mechanical room is located under the connector. The long side of the second floor (Fig. 2) houses patient rooms on both sides of a double loaded corridor. At the short side of the same floor are doctor's offices. Located on the third, and top level, are two large open treatment rooms separated by a central service core, and operating rooms located at the short end.

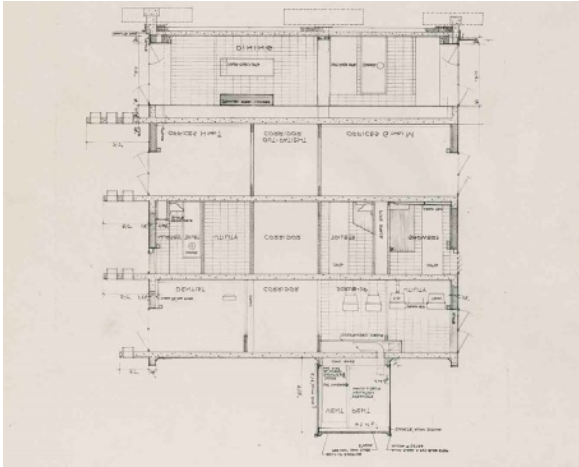


**Figure 2:** Plan drawing of second floor of Radbill addition to the Philadelphia Psychiatric Hospital, circa 1953. (Source: The Louis I. Kahn Collection, University of Pennsylvania and the Pennsylvania Historical and Museum Commission).

### 2.3 Elevation and Sections

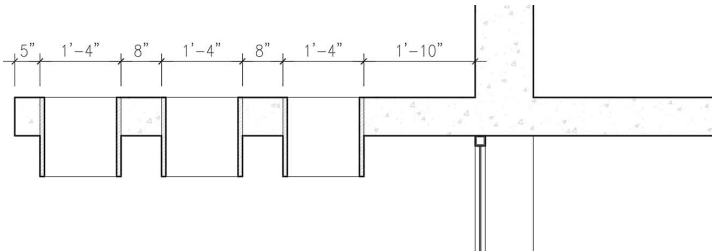
The openings on the long facades are strip windows with an opaque panel below. At the main level and at the cafeteria glazing is a storefront that spans from the floor slab to the underside of the concrete slab. At the north side the opaque panels were originally comprised of thin slate. At the ends the building surface is brick which covers the columns. The concrete columns are exposed and the windows between the columns are evenly spaced so that there are four sections of glass for the standard column spacing and two sections at the last bay.

The floors structure is comprised of flat concrete slab supported by concrete columns organized on a twenty foot increment running the length of the building at the perimeter. Another series of columns is located slightly off-center so that they fall to the side of the central corridor. The building floors are all spaced similarly which is visible on the elevations. Structural floor slabs extend outward of the building enclosure at the southerly faces of the building (Fig. 3) to form the shading canopies, which are perforated.



**Figure 3:** Section of the Radbill addition to the Philadelphia Psychiatric Hospital. (Source: The Louis I. Kahn Collection, University of Pennsylvania and the Pennsylvania Historical and Museum Commission).

Perforations in the concrete awnings are formed with terracotta tubes that are appropriate for forming a chimney flue. This results in canopies with one, two, and three tiles (Fig. 4) per corresponding depths. The tiles are deeper than the concrete slab so that they are visible in elevation and section. An effect that is visible in photos is stippled reflections of the sun on the façade of the building and ground that change during the day under different environmental conditions heightening a sense of dynamism.

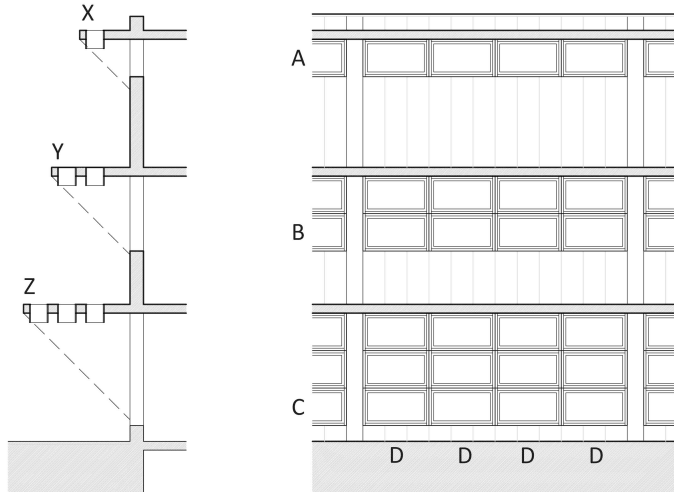


**Figure 4:** Detail Section at Lower Level Shading Device (Drawing by author).

## 2.4 Geometry and Style

Kahn's design for the hospital anticipates features that appear regularly in future buildings considered his masterworks including regular structural dimensions and infill between bays. Another central characteristic of his work is monumental, a quality that relates to timelessness through form and material. In later works, nuanced program elements are fit into fundamental shapes such as squares and perfect rectangles, something the mid-century moderns seldom considered. Similarly, Kahn's designs are fundamental in elevation and section, with legible repetitions of squares and triangles.

Radbill deviates from later projects in that the regular rectangular plan is bent at an odd angle, and met by the connector at an angle that does not have precedent as a classical geometry. The structural grid in plan is also close to regular but changes at the building ends. The result is a nod to function versus purity of form rendering the building less monumental that fluid. Besides the repetitive grid, and regular floor-to-floor dimensions, the building incorporates geometrical discipline and strong geometry when the regularly stepped awnings, which are triangular in silhouette, are factored (Fig.5).



**Figure 4:** Diagram Section and Elevation (Drawings by author).

### 2.5 Digital Analysis

The hospital was designed at a time when it was difficult to calculate and verify performance characteristics of a building largely due to time constraints and available tools. As a result, many decisions were made by rule-of-thumb, not verified, or verified on a limited basis. Contemporary tools allow for greater understanding of performance, particularly thermal and lighting which would have escaped earlier analysis. A digital model was constructed of the building from archival drawings by the author with the aim of determining if the solar shades functioned effectively. Energy analysis was conducted with the existing geometry, with no shades, and with shades on one of the two major façades, and not the other. Results confirmed the overall efficacy of the shading devices, with the devices on the shorter façade, which faces more directly south being more effective than the entry façade.

If the shading devices at the entry façade are not as effective, and served a more decorative function, other justifications are needed beyond objective performance. The devices could have been conceived of differently, responding to the western sun with different extents or geometry such as vertical fins. After, tweaking the devices, the author determined that aesthetic benefits of the awnings also have to be considered, particularly at the main elevation which provides the public image of the building (Fordham 2016). In this case, the effects of light passing through perforations in the awnings activate the façades adding value to the projections. Removing the projections from the main façade would also result in a less dynamic and flatter façade making the building susceptible to the critic that architecture from the era was inevitably boring.

### 3.0 PSYCHOLOGICAL EFFECTS OF LIGHT

Architecture has traditionally been subject to a visual assessment with non-visual features addressed with a criticism grounded in philosophy and post-modern theory. Science when applied to architecture is largely relegated to the functioning and expression of building systems, with the exception of lenses used to comprehend sustainability. Relating science and scientific methods of research to architecture has been more difficult largely tied to different notions of what is valuable considering resource limits and the prime skills of the architectural profession. Limiting architectural analysis to familiar content and relying on intuition extensively belies findings in other fields that when brought to architecture help bolster design decisions including the relationship between light and human health.

An early example of a study to link the sun's ray to health and rehabilitation can be found in William Atkinson's 1912 book, *Orientation of Buildings or Planning for Sunlight*. As an architect, Atkinson was mainly interested in the shape of buildings and the implication of those shapes with respect to the sun. In support of his study Atkinson refers to medical scholars and sanitarians that attribute daylight to better physical health. Although he mentions thermal heat gain as a resultant of admittance of light into buildings, the majority of text and diagrams are concerned with access to daylight and avoiding shadows on building surfaces with openings to important building spaces. In the case of his book, hospital spaces were the subject of an entire chapter of his study. Interestingly, along with hospital planning, Atkinson dedicates a

chapter of his book to urban design and the implications of building height in relation to street widths (Atkinson 1912).

An early twentieth-century example of the medical profession weighing the benefits of natural light from the sun can be found in an article published in the British Medical Journal in 1938 titled *Daylight in Relation to Climate and Health*. The article utilizes environmental data including daylight factor seasonally adjusted, comparing natural light to illumination qualities that can be expected from artificial light. This data is related to the healing potentials of sunlight for different afflictions and mental conditions. The positive conclusions can be related to the general sentiment of the age adopted by architects and chronicled by Paul Overy.

Another article in the British Medical Journal six years later called *Brightness, Wellbeing, and Work*, presaged the contemporary workplace improvement movement, relating suitable light levels to the workplace. Illumination is not just about being able to do work, something that can be reduced to productivity, but rather about comfort and health of the worker, a result that carries beyond the environment that affects the individual. Most importantly, eye strain, and body strain are correlated to mental effects of working in an under-illuminated environment (Weston 1944). This analysis equates artificial lighting as an adequate substitute for natural lighting but provides a good window into the awareness of how lighting conditions affect the performance of people in spaces.

Contemporary scientific research continues to relate lighting to human performance and the built environment. Mental health is widely believed to be affected by exposure to light and seasonal affective disorder is widely accepted and treated. Suicide rates have been recorded as higher in locations which receive little light during the day such as Finland and parts of Russia. In their article *Residential Light and Risk for Depression and Falls: Results from the LARES Study of Eight European Cities* authors Mary Jean Brown and David E. Jacobs support the correlation between light levels, building design, and depression, and that light levels are impactful regardless if medication is used as treatment (Brown and Jacobs 1974).

### 3.1 Evidence Based Design

The burgeoning field of evidence based design (EBD) unites results found in rigorous studies to outcomes in physical infrastructure, chiefly healthcare facilities. An important figure in the movement is Robert Ulrich who established a link between views from hospital windows healing after surgery (Ulrich, 1984, 420-421). He has taken part in studies which have found that pain can be reduced when patients are exposed to higher levels of daylight and nature (Malenbaum et al, 2008). This echoes recent evidence presented in a New York Times article which featured a recent study in a New Jersey Hospital where pain levels were reduced up to 30% through testing or a redesigned room (Kimmelman, 2004). Of particular relevance to a psychological hospital is evidence pointing to improved mood and reduced hospital stays in depressed patients as a result of differences in the built environment including exposure to natural light. Similar results have been found for patients with unipolar and bi-polar conditions (Ulrich, 2008)

Patients are not the only individuals in treatment settings to suffer from stress and compromised performance due to environmental conditions. In their article *Windows, views, and health status in hospital therapeutic environments*, Stephen Verderber and David Reuman find that patients and staff react differently to windowless environments in hospitals. They studied six hospitals comparing plans and other physical building characteristics, factoring questionnaire, individual characteristics such as affliction and occupations, exterior lighting levels and views. (Verderber 1987)

Although the older study determined that patients and staff do not benefit equally from light in hospitals, nurses are found benefit from access to light as a complement to artificial light due to the stressful nature of their work. A 2012 study in HERD focused on hospitals with intensive care units (ICU's) confirming similar results with staff and patients. They studied windows, daylight, and stress finding that any amount of natural light helps by the quality of light and geometries of the window are important. Windows should not be too far and not too high, but more specifically, horizontal windows are preferable (coincidentally consistent with mid-century design). Good views also factored into the analysis (Shiple et al, 2012).

A cautionary note is that actions of the architectural profession, other building interests, and the health community to shape healing environments have not always resulted in solutions found to satisfy patient needs. In the essay *The Natural History Of Windows: A Cautionary Tale* in the British Journal of Medicine, Lord Taylor makes an argument for windows in every room, operable windows, no room with all glass, and air-conditioning only when necessary. The argument coming from a physician might seem overly opinionated except that the study utilized scale drawings, comparative diagrams, and references from other medical journals. (Taylor 1974) If architects can relate non-architectural evidence to healing better, then blunt criticisms of characteristics of modern architecture can be tempered.

## 4.0 CONCLUSION

Louis Kahn designed during a period in which the science of light and its effects on building performance was generally understood intuitively with the architectural profession. Similarly, the impact of light on human health was less clearly understood and verified by scientists and health professionals. Today, relationships between light and health are better known, allowing for a fresh look at older structures in which light played a key role. Expanded perspective also provides a stronger link between aesthetic concerns and behavior outcomes since benefits of play between light and structure contribute to both facilitating a dependency which can be mutually beneficial if handled deliberately.

Lessons to be gained from the Radbill Addition to the Philadelphia Psychological Hospital include the use of shading devices to mediate thermal gains, form making, and activating a façade through the manipulation of indirect light. Kahn did not assume that equal amounts of transparency commonly associated with modern curtain walls was the appropriate response to the hospital program and rather correlated the amount and location of windows to the program. Anticipating later rigor, Kahn utilized three variations in window height and associated shading projections. Most importantly, linking studies to architectural outcomes can help recalibrate our appreciation of works of cannon in ways that can better serve cotemporary objectives of service to society.

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