

**A QUANTITATIVE AND QUALITATIVE ANALYSIS OF  
NATURAL DAYLIGHTING  
IN  
MODERN AND PRE-MODERN ARCHITECTURE:  
“LET THERE BE LIGHT”**

**Phillip Katz  
Graduate Student  
School of Architecture and Urban Planning  
University of Wisconsin-Milwaukee**

**ABSTRACT**

**SYNOPSIS:**

The aim of this case study is to gain a greater understanding of natural daylighting in architectural compositions. My goal as an architect will be to complete the world in a manner that will reduce chaos in the built environment and cultivate a universal peace. A comprehensive understanding of natural daylighting is critical in achieving that goal. This report represents my first formal attempt at understanding architectural natural daylighting.

The primary means of understanding daylighting techniques is through a comparative analysis of buildings that share similar daylighting approaches. The factors that organized my research are lighting typology: sidelit, toplit, and side/toplit. Lighting typology allowed me to compare buildings that should have similar performance because of solar orientation and light admitting strategy. The factors of; design intent, actual performance, and direct observation allowed me to greater understand the aims of the designer and the resultant light quality. I analyzed over 100 buildings with level one and two protocol<sup>1</sup> as I developed them based on the recommendations of Marc Schiller in his Vital Signs Curriculum: *Interior Illuminance, Daylight Controls, and Occupant Response*.

**MAJOR FINDINGS:**

The major findings are as varied as the buildings involved in the analysis and far exceeded my expectations. Architectural natural daylighting dominated my thoughts on every building visited during the six months of my European travels. Overall my findings helped me to understand the effects of lighting strategies and the appropriateness of each of these strategies to a given building function.

The effects of similar daylighting strategies varied widely as architects made small decisions that had large effects. I noted those small design changes and the resultant effects, I began to see how there are many factors which effect natural daylighting.

***“When finally, an architect discovers that light is the cornerstone of architecture,  
only then does he begin to understand something,  
and to become a true architect.”<sup>2</sup>***

Alberto Campo Baeza

<sup>1</sup> Level I Protocol consists of instantaneous observations with the naked eye, while Level II Protocol consists of careful illuminance measurements and more extended observation over several building visits.

<sup>2</sup> Alberto Campo Baeza “Architectura sine luce nulla architectura est”, *Domus* n.760, May 1994, p.86

## INTRODUCTION

I had completed a 'grand tour' of Europe as an architecture student with the traditional tools of analysis; a camera and sketchbook. I realized during my building visits that the single element that was consistently well resolved in all the hallmark buildings throughout architectural history was that careful admission of natural daylight.

A critical part of this study is that daylighting was studied as an element of building performance as it impacts many buildings, not a single building. This project is predicated on a comparative methodology of investigation. Light can not be understood unless there is some darkness to contrast it. Understanding and comprehension of an idea or effect is deepened when held in comparison to something, which is similar or different than it.

This report resulting from site visits adds a more empirical level of observation to the typical building visit in order to better understand the effect of natural daylight. I added a compass and lightmeter to my quiver of analytical tools and set off on a semester of study abroad, a semester spent trying to better understand light. I wanted to quantify the light through actual illumination readings and qualify the light through my careful observation. My observations and observational data were carefully recorded and maintained in sketchbooks from 1/15/98 through 6/1/98. Level I and Level II protocol were conducted in accordance with recommendations in Marc Schillers Vital Signs resource package.

The lighting analysis were conducted between January and June of 1998. The buildings contained in this study are all on the European continent: South of 50 degree latitude, north of 40 degree latitude, east of 0 degree longitude and west of 200 degree longitude. The buildings were all chosen based on their expert utilization of natural daylighting and because of their careful attention to natural daylighting as a primary compositional element.

I visited hundreds of buildings over my five months of travel in Europe, I performed formal natural daylighting analysis in over sixty buildings; it is impossible to include all those analysis in this report. Instead, I have chosen buildings from the overall building population, those that are most representative of the three general typologies I observed; sidelight, toplight, and side/toplight.

## HYPOTHESIS:

**Natural daylighting has the ability to:**

### *DESIGN INTENT*

(I) Act as a unifying element in an architectural composition.

### *ACTUAL PERFORMANCE*

(II) Provide adequate illumination levels for tasks completed Within the space during daylight hours under any sky conditions (according to IES standards).

### *DIRECT EXPERIENCE*

(III) Elevate the human experience and help cultivate an attractive, comfortable, and transcendent environment for building users and visitors.



Figure 1: The Eiffel Tower as seen from the River Seine just before sunset.

Figure 2: Map of the European continent. Cities highlighted contain buildings in this report.

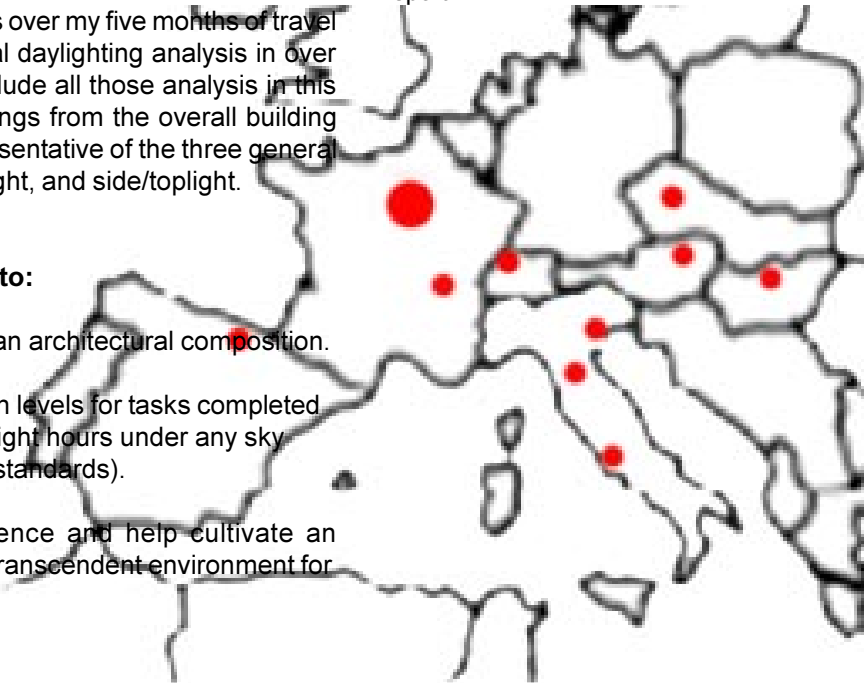




Figure 3: Letter of introduction prepared in French explaining my project.

Figure 4: INTERVIEW LIST.

- Alain Kronenbourg  
Building Manager-Arab World Institute
- Michel Planeix  
Owner Maison Planeix
- Ronnie Self: Renzo Piano Building Workshop  
Project Architect-Atelier Brancusi
- Mohamed El-Said  
Environmental Technician Louvre Museum
- Friar Jean Pierre Brice Olivier  
Resident La Tourette Monastery
- Pierre David  
Landscape Architect
- Rodo Tisnado  
Architecture Studio
- Martin Robain  
Architecture Studio
- Sophie Laphont  
Calatraca Valls
- Peter Chemetof
- Martin Mead
- Alain Guyard - Lighting Designer

## METHODS PROTOCOL:

The nature of the site visits was taken into account in developing protocol procedures. Most building visits were short in duration and instantaneous illumination measurements, sketches and observations had to be made. Some buildings were visited many times over the four month period that I resided in Paris.

Protocol procedures remained constant throughout all building analysis:

- (I) Interior illuminance measurements were taken at the level of the task being completed. In the case of art museums, galleries, etc where general diffuse light is the desirable light condition illumination readings were recorded at even intervals.
- (II) Exterior illumination readings were taken:
  - (a) Direct illumination readings were taken in unobstructed daylight.
  - (b) Diffuse illumination readings were taken beneath the shade of my hand at 8" above the light meter.  
\*Body positioning was always carefully considered as to not effect the light meter.
- (III) The context in which the building stands was carefully noted and recorded (urban detached, urban attached, rural, etc.) as the building location can have great effect on resultant daylighting. The urban landscape, landscape elements, and land formations, were recorded as they too can have profound effect on natural daylighting.
- (IV) The time, date, duration of visit, and sky conditions were always carefully recorded and re-recorded as they changed or remained constant throughout the site visit.
- (V) Whenever necessary I introduced myself to appropriate building officials, managers, users, maintenance personnel, etc. A letter of introduction prepared for me in French helped to dissolve language barriers. Occupant Surveys were conducted in an informal manner with these individuals in a limited fashion.
- (VI) Observation and analysis of all building elements that could have a possible effect on natural daylighting was carefully and painstakingly recorded. I.e. glazing type, solar controls, interior finishes and their absorption or reflectance, efficiency of interior organization, building shape, room shape, etc.

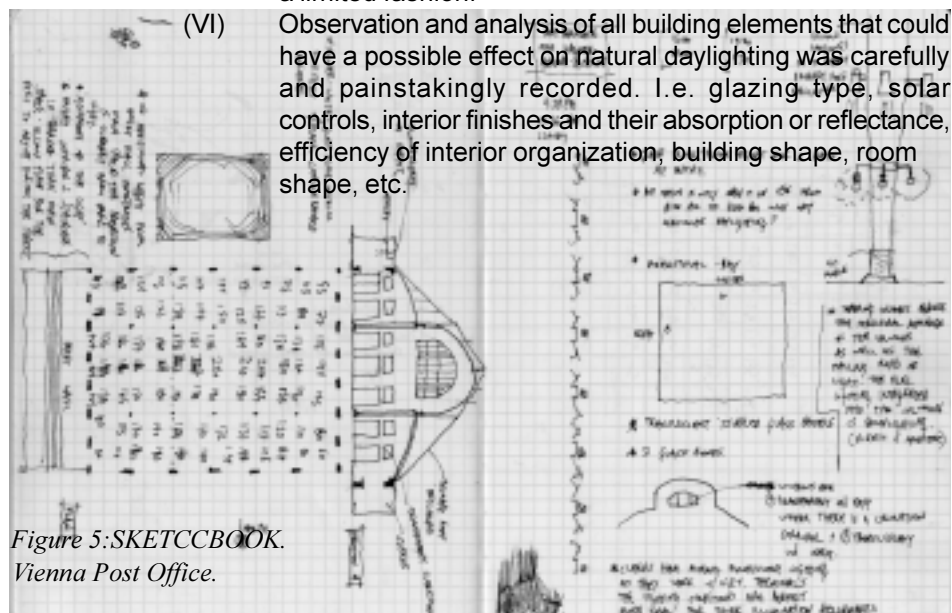


Figure 5: SKETCCBOOK.  
Vienna Post Office.

**PART I : SIDELIGHT  
DESIGN INTENT**

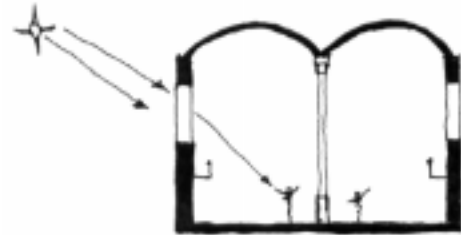
**BIBLIOTHEQUE STE. GENEVIEVE.**

**Henri Labrouste 1838 - 1850 Paris, France.**

The Biblioteque St. Genevieve is the first public library in Paris intended to be opened past sunset and hence it was designed with artificial lighting in mind. The library is in an urban context and admits daylight through large, arched, window openings at clerestory height that are intended to give good daylight penetration. The reading area is in the center of the rectangular main room and the book storage occurs in the wall thickness along the periphery of the main reading room. The primary exposure of the reading room along the long wall is to the South, with secondary exposure along the two short walls to the East, West, and North.



Figure 6: Interior, St. Genevieve Library.



The Biblioteque St. Genevieve is daylit from large arched openings located at more than half the room height. The resulting light is diffuse with minimal sunlight penetration.

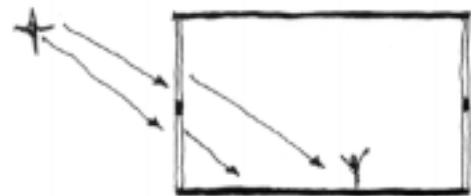
**INSTITUT DU MONDE ARABE Paris, France.**

**JEAN NOUVEL AND ARCHITECTURE STUDIO 1981 - 1987**

The Arab World Institute is a modern urban building on the banks of the River Seine. The large planar south facing façade is the trademark of this building. This façade alone has helped cultivate an image for the Arab World in the twentieth century. The south façade is composed of a modern interpretation of the 'masharabiya' a typical arabesque architectural element; a wooden, window shading device that helps to moderate and control the interior environment. The 'high tech masharabiya' that has been designed for the IMA is composed of 27,000 operable shutters reminiscent of a camera mechanism and the Iris of the human eye. The shutters open and close in relation to changing sunlight conditions. The shutters are contained in 240 square glazed areas that consist of a 4" window assembly of exterior double pane thermal glazing, and interior operable glazing panels to aid in maintenance. The shutters regulate daylight transmission from .10 to .30. The shutters suffer from mechanical difficulties but there is no doubt that the designer has made a positive contribution to modern architectural natural daylighting techniques.



Figure 7: Interior, Arab Institute Library.



The library at the Arab Instiute is daylit from a glaze south facing facade, with the only daylight control coming from the 'masharabiya' shutters. The resulting daylight is spotty with deep shade and direct sun.

**ACTUAL PERFORMANCE**

**BIBLIOTHEQUE STE. GENEVIEVE.** The average illumination level is 50 foot-candles on a sunny, early, winter morning, which is sufficient for reading. The electric incandescent desk lighting provides 35-61fc of illumination, almost identical to the average of natural daylighting. The wall's 4' thickness and rounded interior corners acts to significantly diffuse the sunlight. The brightest and most diffuse illumination occurs in the center of the room, as that is where the most high intensity visual tasks occur. The books are stored in the shade of the walls where they are not degraded by the ultraviolet rays of the sunlight.

**INSTIUT DU MONDE ARABE** The office users complained that they were, 'uncomfortable' and 'disturbed' by the masharabiya mechanisms and have made efforts to rearrange their offices in



Figure 8: Circulation corridor, Arab Institute.

order to be less effected by them.. The average illumination in the library is more than sufficient but highly inappropriate for a library setting. The silver metallic finish on the south façade produces reflected glare in excess of 2000 foot-candles, that degree of direct glare is both uncomfortable and unhealthy to the naked eye.

### ***DIRECT EXPERIENCE***

**BIBLIOTHEQUE STE. GENEVIEVE.** The reading room is on the second floor and the entry hallway and staircase were part of a procession from the uncontrolled brightness of the street, to the darkness of the entry hall, to the controlled diffuse brightness of the reading room. The movement from the uncontrolled brightness of the street to the deep shade of the entry procession to the controlled light of the second floor was gradual and allowed time for the eye to adjust and appreciate the careful controlled illumination of the reading room.

I visited the library with a group of architecture students before the electric lights had been turned on, most students were comfortable sketching and rendering watercolors without the aid of any artificial lighting. Librarians were performing tasks at their desks and returning books to the shelves without any aid from artificial lighting, the librarians ranged in age from 20- 60 years old and must have surely had differing visual capacities. There was a direct beam of light through the East façade that was very dramatic and not irritable in the least.

**INSTITUT DU MONDE ARABE** When first seeing the south façade of the Arab Institute you are absolutely certain that you are visiting a building related to Arab culture. The similarities are clear, but so are the differences. The light in the circulation areas is sufficient and seems to be an appropriate place for the resultant textured lighting. The light in Arabic cultures found in circulation areas is commonly varied; on the other hand the places usually intended for gathering such as the library are usually lit softly and diffusely and the library does not accomplish that light quality. I appreciate the intangible beauty of the building. Standing next to the façade when all 27,000 aluminum shutter elements react to the changing sun-light conditions is truly an illuminating experience.

Figure 9: Arab Institute, south facade.



BUILDING	AVG.ILLUM. <sup>1</sup>	DF <sup>2</sup>	TIME	DATE	SKY <sup>3</sup>
Biblioteque St. Genevieve	50 fc	1:10	9:30	2.25.98	Cloud
Institute Du Mode Arabe	200 fc	1:8	13:00	2.1.98	Clear Sky

<sup>1</sup> Average illumination, expressed in footcandles.

<sup>2</sup> Daylight factor. DF=(incident illumination)/exterior horizontal)=the amount of light available as a result of natural lighting.

<sup>3</sup> Sky conditions according to CIE (commision internationale de l'eclairage) standards.

**Clear sky** = <30% cloud cover with no obstruction of sun. **Cloud sky** = 30% - 70% cloud cover with sun obstructed. **Overcast** = 100% cloud cover.

**PART II : TOPLIGHT  
DESIGN INTENT**

**LOUVRE PYRAMID ADDITION**

**I.M. PEI & PARTNERS 1988, Paris, France.**

The Louvre Pyramid is a new entry to one of the world's largest art collections. The addition has been built in Cour Napoleon a sensitive, historic context. The nature of Pei's intervention is both bold and humble at the same time. The building form is monumental, although great effort has been placed on making a transparent building that will not cover or mask the courtyard facades from view.

The pyramid effectively admits light deep into the entry and surrounding shopping center, and at night the pyramid glows and illuminates the historic architectural context.



Figure 10: Louvre Pyramid, view of exterior in Cour Napoleon.

Figure 11: Louvre Pyramid, view of courtyard facades through transparent enclosure.



**PANTHEON Rome, Italy.**

**PROJECT DURING THE REIGN OF HADRIAN 118-128**

The Pantheon is a freestanding building in a dense urban piazza near the center of Rome, built by an unknown architect during the reign of Hadrian. The Pantheon is used for religious worship and tourist attraction. The space is daylight exclusively from one opening, a 30' wide oculus in the center of the large 142' diameter dome. The oculus admits a direct beam of light that is in continuous movement throughout the day. The building is oriented directly on the north-south axis, and the beam of sunlight moves in a clockwise direction throughout the day. The building is in fact a great dramatic sundial.

**ACTUAL PERFORMANCE**

**LOUVRE PYRAMID ADDITION** The Louvre Pyramid is not attempting to admit daylight in any controlled fashion; it is trying to merely admit as much light as it possibly can. The challenge in specifying the glazing and support structure was; to achieve maximum transparency, reduce reflection to a minimum, and reduce color distortion. The glazing chosen is double pane glazing panels 10-mm thick of laminated clear white glass panes. The pyramid glazing is supported by a highly technical tensile structure. The daylight factor on the main floor level is 1:1.25, revealing that the enclosure is doing very little in terms of regulating daylight. There is direct glare from the shiny floor finish as a result of direct sunlight penetration in a sense the daylight is amplified as a result of the direct and reflected glare. The entry pavilion can be an uncomfortable place visually.

**PANTHEON** The Pantheon is a building where daylight factors and average illumination mean very little. The illumination levels are very constant even though there is a concentrated direct beam component. The domed building form, cornice height moulding, and open air oculus are very successful at diffusing light. Illumination levels at mid-day with the sun directly overhead increased 50% in six minutes at one point as the beam moved towards that point. Late in the day and early in the morning when the



Figure 12: Pantheon: Exterior view.

Porticoe entry and urban piazza.  
Figure 13: Pantheon, interior view at light





afternoon.  
Figure 14: Louvre Pyramid, interior view.

The Louvre Pyramid's building surface is transparent, the interior space has the feel of an urban plaza and has daylighting characteristic of an outdoor space in both quantity and quality.

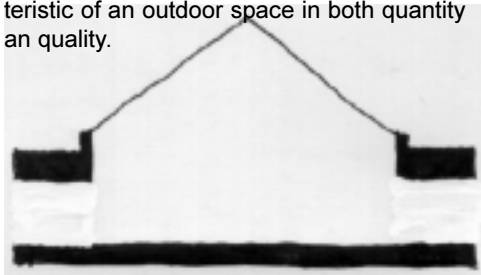
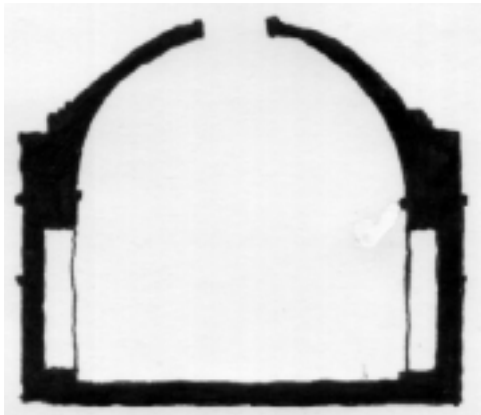


Figure 15: Pantheon interior view at mid-day.

The Pantheon has an opaque enclosure with a transparent oculus, without any glazing.



direct sun beam falls high up on the dome and not at all on the wall surface, the daylight is highly diffuse and virtually unchanged from one side of the building to the other.

**DIRECT EXPERIENCE**

**LOUVRE** The Louvre Pyramid and the Cour Napoleon are both busy tourist attractions and very lively animated spaces. The feeling on the floor beneath the pyramid is that of being outside; the enclosure and structural system are so transparent that the buildings are not visually obstructed, and the daylighting is nearly the same as it is outside the pyramid. The lighting from inside the pyramid illuminates the buildings of the Cour Napoleon at night, the pyramid glows and diffuses light onto all its surroundings.

**PANTHEON** The Pantheon is brought to life by means of the light admitted through the oculus. I was amazed at the amount of illumination in the space. The oculus is only 4.5% of the total floor space and yet it sufficiently illuminates the interior. The porticoed entry is critical in introducing the building visitor to the scale of the building as well as allowing time for the eye to adjust from the brightness of the urban piazza to the soft diffuse glow of the interior space.

BUILDING	AVG. ILLUM.	DF	TIME	DATE	SKY
Louvre Pyramid	536	1:1.25	12:00	3.9.98	Clear
Pantheon	322	1:4	13:22	4.20.98	Clear

**PART III : TOP/SIDE LIGHT  
DESIGN INTENT**

**L'ATELIER BRANCUSI Paris, France.  
Renzo Piano Building Workshop 1994**

The Atelier Brancusi is on the northwest corner of the Centre Pompidou's Piazza. The building is a museum gallery for the Romanian sculptor Constantin Brancusi. Brancusi's original studio had north facing skylights that instilled the space with cool north light, and part of the program brief insisted that the new building design have north facing skylights, as well as being reminiscent of the original studio and the light quality that existed there.

The studio is implanted as Brancusi left it, in the center of the building is the studio and is surrounded by an ambulatory. The north facing light monitors primarily illuminate the studio space. The ambulatory is lit by a sophisticated ceiling sandwich that consists of; operable louvers, metallic grills, cloth vellum, curved glass skylights with UV reducing coating, and clerestory windows.

**MAISON PLANEIX Paris, France.  
Le Corbusier, 1924**

Maison Planeix is an attached urban residential building with north and south exposure. The rooftop studio was designed for a sculptor and therefore required highly varied lighting types. The room is bisected; half is illuminated by south facing roof monitors, while the other half has nearly full height north facing glazing.

**ACTUAL PERFORMANCE**

**L'ATELIER BRANCUSI** The Atelier is filled with cool white light. The north facing monitors, and ceiling sandwich is successful at achieving an even diffuse light that is superb for viewing sculpture and in particular the work of Constantin Brancusi. The clerestory and skylight that illuminate the ambulatory are contained in a ceiling sandwich that is covered on the interior by a specially designed white cloth.

There are operable louvers over the southeast exhibit space that helps to protect the drawings, rare photographs, and newspaper articles. The louvres are effective at reducing illumination intensity by 10 fc.

**MAISON PLANEIX** The studio space of Maison Planeix is successful at providing a variety of light qualities. The area beneath the south facing monitors has a very consistent average from wall to wall. The half of the room that is illuminated by the floor to ceiling north facing vertical window is brightest near the window, but diffuses rapidly (9' from window).

BUILDING	AVG. ILLUM	DF	TIME	DATE	SKY
Atelier Brancusi	63	1:5	16:00	4.2.98	overcast
Maison Planeix	100	1:7	15:30	3.2.98	overcast



Figure 16: Atelier Brancusi, interior view of gallery space.



Figure 17: Maison Planeix, interior view.



The daylight in Atelier Brancusi is admitted through the roof monitors from the north, wherever sunlight is admitted from another solar orientation it is diffused through a translucent cloth dropped ceiling



The daylight in Maison Planeix is admitted through roof monitors from the south, direct sunlight is admitted. There are full height north and south window openings.

The Atelier Brancusi and Maison Planeix are both spaces designed as sculptor's galleries. The daylighting within the two spaces is radically different: The Atelier Brancusi has flat, even, diffuse light that is consistent throughout, and the studio at Maison Planeix has dynamic light with direct sunlight and diffuse light from the north. The dropped ceiling and flat white interior finishes at Brancusi is successful at unifying all of the daylighting elements, and transmitting the cool, white, northern light.

## ***DIRECT EXPERIENCE***

L'ATELIER BRANCUSI I had the opportunity to meet and cultivate a relationship with the project architect, Mr. Ronnie Self, who was responsible for the design and construction of the building. Through interviews we discussed many aspects of the building design, daylighting design, and building construction process. I visited the building on over two dozen different occasions, each time learning more and gathering more questions to ask Mr. Self.

The building is removed half a story from street grade and I always felt that it was a pleasant retreat from the streets of Paris. Regardless of the sky or weather conditions, the Atelier was always filled with flat even light that was very peaceful and relaxing. I always appreciated the building and how it did not compete with the art. The building is merely in service to the art and it serves it well. I began to see parallels between Piano's building and Brancusi's sculpture; Brancusi, in his sculpture, is concerned with the resolution of space and light as the two are unified in matter. The same can be said for Piano's building space and light are resolved with mastery in the architectural composition.

MAISON PLANEIX The studio space has a very dynamic feeling for such a regularly shaped room, I believe that is due to the fact that the room is enclosing light from many different solar orientations, room heights, etc. I had the opportunity to speak with Mr. Michel Planeix, the man who was born, raised, and still lives in the house. Mr. Planeix's insights were valuable and much enjoyed. Sitting and chatting with Mr. Planeix I could see the light moving through the room throughout the day. The light from the south facing roof monitors fell in a solid band on the opaque north wall and moved down it as the morning progressed. The north wall became a light source in itself. The variety of light was marvelous. Even though the lighting in the room was generally diffuse, one could see how an artist could position his work in specific parts of the room to take advantage of unique light conditions.

Figure 18: Maison Planeix, exterior view of



## CONCLUSION

*(I) Natural daylighting acts as a unifying element in an architectural composition.*

**SIDELIGHT:** The natural daylight is integral to the success of the libraries and is a major element in the quality of the space.

**TOPLIGHT:** The Louvre and the Pantheon are both public gathering spaces, they do not need specific light levels in order to perform designated tasks; the Louvre benefits from its' abundance of daylight and the Pantheon supports its' spiritual function with its' eye to the sky and lone shaft of light.

**TOP / SIDE LIGHT:** Although the strategy was similar, the design intent was executed differently. The daylight in Maison Plainex is dynamic, while the light in Atelier Brancusi is serene and luminescent.

Without natural daylighting all the important and successful design decisions would have no or very little effect. Natural daylight illuminates a space physically and spiritually and allows all the compositional elements to read as one.

*(II) Natural daylighting can provide adequate illumination levels for tasks completed within the space during daylight hours under any sky conditions.*

My illumination measurements proved that buildings can provide ample amounts of illumination under any sky conditions. Most buildings in this study were intended to be daylit spaces, and they proved they could function in the absence of artificial lighting. I appreciate the work of these architects, because it is through their efforts and careful attention to natural daylighting that their buildings use less energy and help building users appreciate the natural (sunlit) world over the artificial (electrical) world.

The proof is in the pudding: people were reading in the libraries without artificial light at St. Geneveive and the Arab Institute, people were orienting themselves, congregating, and communicating with the heavens at the Louvre Pyramid and the Pantheon, and people were enjoying sculpture and producing artwork at Maison Planeix and Atelier Brancusi. All without the aid of artificial lighting!

(III) *Natural daylighting can elevate the human experience and help cultivate an attractive, desirable, and transcendent environment for building visitors and users.*

*“The key is light.  
And light illuminates shapes.  
And shapes have emotional power.”*

Le Corbusier  
Ronchamp

Man’s physical and spiritual existence is directly linked to The Light. Light is that which connects man to earth and sky, and those building which respect that connection are recognized as remarkable Architecture, those buildings are hymns to the sun and they repeat their liturgy daily.

*“**Man** in and of himself is good - as he was created in the image of God. And also the **world** in and of itself is good - as God created it so. Although in the meeting between man and the world there is complications. But it is the **time** which joins man the world and makes his life holy. And it is the **light** which determines the time.”*

*Shlomo Avner<sup>4</sup>*

*16th century philosopher and Bible commentator.*

Light or the absence of light sanctifies and makes possible all of our activities. Light determines our lives to a great extent, as it organizes both our sacred and profane activities. Would we not be different creatures if night never fell? Or the sun never rose?

Building occupants and users that were interviewed expressed their deep satisfaction with the environment in the building, with the minor exception of office workers and library users at the Arab Institute. People generally appreciated the ability to live and work by natural daylight over artificial light. Most of the buildings analyzed in this report are ‘tourist magnets’ and are packed to capacity year round. The fact that people who know next to nothing about architectural history choose to visit these buildings, and enjoy using these buildings, and have a special experience is testament to the quality and emotional impact of the architecture.

Figure 19: Chartres Cathedral, rose window.



<sup>4</sup> Tal Chermon - The Dew of the Hermon. Parshat Emor- Lesson IV.

## LESSON LEARNED

I have spent the last six months in serious contemplation as to what the effects and meaning of natural daylighting are to the performance of architecture and the impact on the life of man. I have had no tools at my disposal beyond a lightmeter, sketchbook, compass, architectural drawings, and careful, patient, and determined analytical eye.

On more than one occasion I was moved emotionally by a superb daylit space, more often than not the building was a religious building that was intended to be daylit. Religious buildings were designed to relate to the cosmic cycles, to connect man (earth) and sky (heavens). These buildings were intended to become a point of intersection between two cosmic planes. These buildings were intended to unify two opposite worlds, the two worlds man strives to reconcile.

***“And God said ‘let there be light’ and there was light.  
And God saw the light, that it was good;  
And God divided the light from the Darkness.”<sup>5</sup>***

The whole nature of my study was comparative in nature. I believe there could be no understanding of one building if it was to be studied in an isolated context. I structured my analysis to enable me to understand natural daylighting in one building as it was similar or different from other buildings.

Light can only be understood in comparison to darkness.

The most successful daylighting schemes I saw and recorded were not bright, white, spaces with amplified daylighting. On the contrary they were carefully lit spaces that allowed areas of darkness to contrast with the light, or spaces with an even white luminous glow. There is no light with darkness, light and dark are always together and are always understood in comparison or contrast to one another.

There is an architectural lineage I began to see emerge. When I stood in the Chapel at La Tourette I could see all the travels that Le Corbusier and I had in common. When I visited Aalto's church in Bologna I could see Aalto nodding his head to Ronchamp, La Tourette, and the classical ecclesiastical architectural traditions. The lineage is below the surface but it slowly becomes apparent.

I also began to see the difference between modern and pre-modern architecture: in the case of the pre-modern buildings St. Genevieve and the Pantheon the buildings are more massive the light apertures are minimal the majority of the building surface is opaque, and in the case of the modern buildings the Arab Institute and the Louvre the window apertures as the entire building surface is transparent. The idiom of 'less is more' rings true. The buildings provided ample daylight to accommodate the tasks completed within the space but in the case of the pre-modern buildings the light was adequate and generally diffuse, whereas the light in the modern buildings was adequate but often excessive and inappropriate.

<sup>5</sup> Genesis I, 3.

The field work involved in this report has trained my eye to understand and quantify natural daylighting in modern and pre-modern architecture, I am now able to judge adequate and appropriate illumination levels for a given building function. The sketchbook and camera were my primary tools for building analysis, and now the lightmeter and compass have deepened my comprehension of architectural ensembles, I look forward to the next trip when I can bring my comprehension of architecture to another level with new analytical tools, whether they be mechanical/physical or mental/spiritual or, most likely, a combination of the two.

**SIDELIGHT:**

(I) LYON TGV STATION, Santiago Calatrava.

Daylight brings rhythm and depth to the structure.

(II) FOUNDATION CARTIER, Jean Nouvel.

Exterior Daylight control devices are the elements that define the rhythm, scale, and proportion of the facade.



(I)



(II)

**TOPLIGHT:**

(III) SANTA MARIA ASSUNTA, Alvar Aalto.

The north facing light monitors and white interior space make this church a luminous meditative environment,

(IV) VIENNA POST OFFICE, Otto Wagner.

The courtyard atrium is effective at illuminating the space and creates a brighter area for public gathering in the center.



(III)



(IV)

**SIDE/TOP LIGHT:**

(V) MAIRIE D'IVRY POOL.

The window openings face various directions capturing a dynamic light quality within the space, without glare from direct sunlight.

(VI) LA TOURETTE Le Corbusier.

The space is a trademark for successful daylighting strategy. Functional needs are met at the pews where daylight falls directly on the bookstands. Spiritual

needs are served by the uplifting and emotional natural daylight that dances through the space.



(V)



(VI)

## BUILDING LIST:

Institute du Monde Arabe*	Jean Nouvel	1987	Paris, France
Gymnasium*	Dominique Perrault	1990's	Paris, France
Gymnasium Mairie: Rue St. Charles*	Detrare & Ronin	1990	Paris, France
Gymnasium: Bercy 2*	unknown	1990's	Paris, France
Gymnasium: Rue Edgar Favre*	Jordy + Viguer	1995	Paris, France
Mairie D'Ivry Swimming Pool*	unknown	1980's	Paris, France
Maison De Verre*	Pierre Charreau	1931	Paris, France
Guggenheim Museum Bilbao*	Frank Gehry	1997	Bilboa, Spain
Atelier Brancusi*	Renzo Piano	1995	Paris, France
Maison Planeix*	Le Corbusier	1924	Paris, France
Villa Savoye*	Le Corbusier	1928	Poissy, France
Villa Laroche*	Le Corbusier	1923	Paris, France
La Tourette*	Le Corbusier	1953	Arbeisles, France
Chapel of Notre Dame Du Haut Ronchamp*	Le Corbusier	1951	
Cite de Refuge*	Le Corbusier	1929	Paris, France
Pavillion Suisse, Cite Universitaire	Le Corbusier	1930	Paris, France
Atelier Peter Chemetof*	Peter Chemetof	1980's	Paris, France
Canal + Headquarters*	Richard Meier	1991	Paris, France
Louvre Pyramid*	I.M. Pei	1989	Paris, France
Meditation Center*	Tadao Ando		
Vitra Museum*	Frank Gehry		
Foundation Beyler*	Renzo Piano		Basel, Switzerland
Post Office*	Otto Wagner		Vienna, Austria
Hotel Gallert and Thermal Baths	?	?	Budapest, Hungary
Prague Central Post Office	?	?	Prague, Czech Republic
Querini Stempala-Museum	Carlos Scarpa	rennovation	Venezia, Italy
Absess Metro Entrance Shelter	Hector Guimard	1920's	Paris, France
Sacre-Coeur	?	1919	Paris, France
Hotel Industriel*	Dominique Perrault	1990	Paris, France
Firenze Central Train Station	?	?	Firenze, Italy
Gare Du Nord	?	?	Paris, France
Gare Ste. Lazarre	?	?	Paris, France
Rome Central Train Station	?	?	Rome, Italy
Amsterdam Central Train Station	?	?	Amsterdam, Holland
Guggenheim Museum	Frank Lloyd Wright	?	NYC, NY
MOMA	Goodwin & Stone	1939	NYC, NY
Passage Nove Mesto	?	?	Prague, Czech Republic
Hotel Europa	Bendelmayer, Letzl, Hysman	1905	Prague, Czech Republic
INB Bank-'Fred and Ginger'	Frank O. Gehry	1995	Prague, Czech Republic
Passage Wahliss	Coop Himmelblau	1986	Vienna, Austria
Central Post	Adolf Krischanitz	1994	Vienna, Austria
Dohany Synagouge	Ludwig Foster	1931	Budapest, Hungary
Rumbach Synagouge	Otto Wagner	1873	Budapest, Hungary
Orthodox Synagouge	Bela, Sandor Loffler	1912	Budapest, Hungary
Gare Montparnasse	?	?	Paris, France
Gare d'Austerlitz	?	?	Paris, France
Gare De L'Est	?	?	Paris, France
Gare de Lyon	?	?	Paris, France
Le Samaritaine department store	Henri Sauvage	1928	Paris, France
Place du Marche' office building	Ricardo Bofill	1997	Paris, France
Centre Pompidou	Piano & Rogers	1977	Paris, France
Bilblioteque National*	Henri Labrouste	1838	Paris, France
Biblioteque National*	Dominique Perrault	1997	Paris, France
Biblioteque Ste. Genevive*	Henri Labrouste		Paris, France
Foundation Cartier	Jean Nouvel	1993	Paris, France
Brazil Pavillion, Cite Universitaire	Corbusier & Costa	1959	Paris, France
Parc Citroen - Greenhouses	Patrick Berger	1992	Paris, France
Japan Foundation	Yamanaka & Armstrong	1997	Paris, France
#25 Rue Franklin	Auguste Perret	1904	Paris, France
CNIT Exjibition Hall	Zehrfuss	1989	Paris, France
L'Arche de la Defense	J.O. Spreckelsen	1989	Paris, France

Gallery of Apollo - Louvre*	?	?	Paris, France
Grand Gallery - Louvre*	?	?	Paris, France
Porte De LaVillette*	Nichoulas Ledoux	?	Paris, France
Ecole De Beaux Artes*	Lenoir, Debret, & Duban	1600 - 1900	Paris, France
Theatro Olimpico*	Andrea Palladio	1580	Vicenza, Italy
Chapel Sistina*	?	?	Rome, Italy
Pantheon*	unknown	128	Rome, Italy
St. Maria Assunta*	Alvar Aalto	?	Bologna, Italy
#23 Rue De Mail	?	?	Paris, France
St. Giorgio Maggiore	Andrea Palladio	?	Venezia, Italia
Pompidou Tipi	?	?	Paris, France
Café Beauborg	Christian de'Portzamparc	?	Paris, France
Ircam - extension	Renzo Piano	1990	Paris, France
Peggy Guggenheim Museum	?	?	Venezia, Italia
Ste. Chapelle*	?	1248	Paris, France
Mont. St.-Michel*	?	708	Mont. St.-Michel, France
St. Sulpice	?	?	Paris, France
Versailles-Hall of Mirrors*	?	?	Paris, France
TGV station	Santiago Calatrava	?	Lyon, France
Arc-et Senans Royal Saltworks	Nichoulas Ledoux	?	France
Duomo	Fillipo Brunelleschi	?	Firenze, Italy
Uffizi Gallery*	G. Vasari	1574	Firenze, Italy
Piazza dei Pitti	Fillipo Brunelleschi	1457	Firenze, Italy
San Spirito*	Fillipo Brunelleschi	1446	Firenze, Italy
Piazza San Lorenzo	?	?	Firenze, Italy
Capelle Medici	Michelangelo	1520	Firenze, Italy
Biblioteca Laureziana	Michelangelo	1524	Firenze, Italy
Santa Maria Del Fiore	Fillipo Bruneschi	?	Firenze, Italy
Cappella de'Pazzi*	Fillipo Brunelleschi	1430	Firenze, Italy
Santa Croce	?	?	Firenze, Italy
Vienna City Temple	Joseph Kornhausel	1810	Vienna, Austria
Musee d'Orsay	?	?	Paris, France
Musee Rodin	Jean Aubert	1728	Paris, France

\*asterix denotes building that unerwent level II protocol.

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