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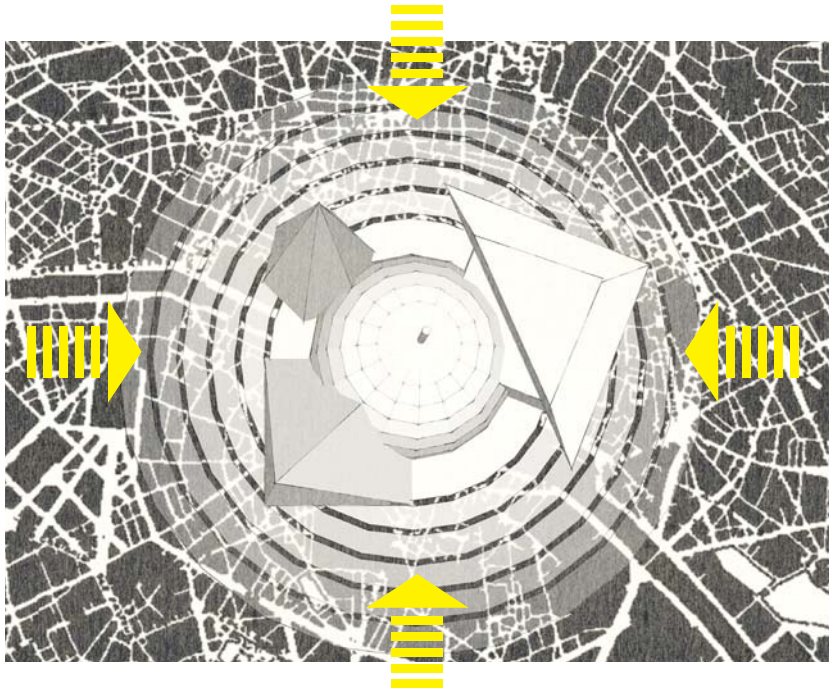
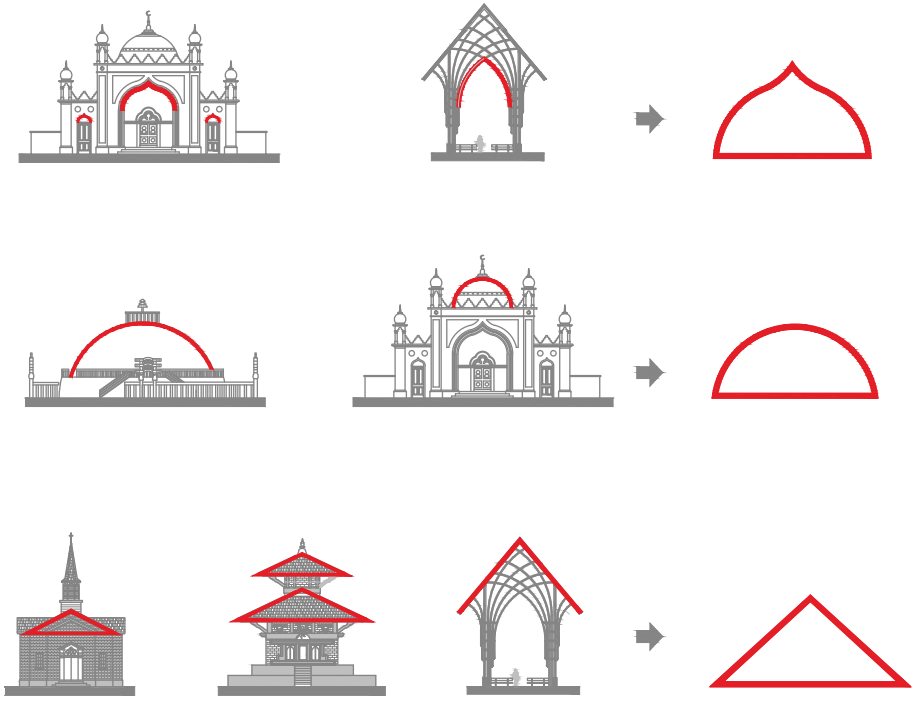
SACRED ARCHITECTURE

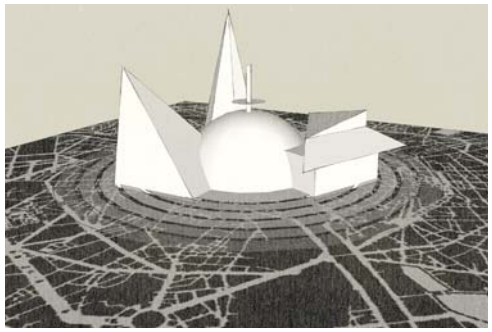
JULY 2014 | ARC 550 REGIONAL DESIGN STUDIO I OPEN AIR MUSEUM DESIGN

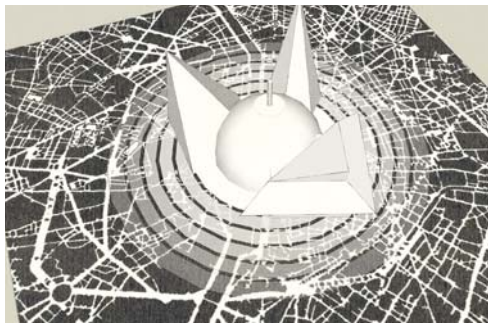
Sacred Architecture - Exhibition Model

In order to establish a connection with the unalterable reality, man created the language of symbols. A symbol hits the mental process more precisely and more clearly than the most precise notion.[1] The model is an abstract representation of the sacred architecture and the symbolism involved in the sacred buildings. Different religions involve different symbolism denoted by geometric shapes, elaborate artworks, figurative structures, light sources or other elements. In general, the symbolism indicates that the sacred space is pure, powerful, serene, spiritual and superior with respect to the outside space.





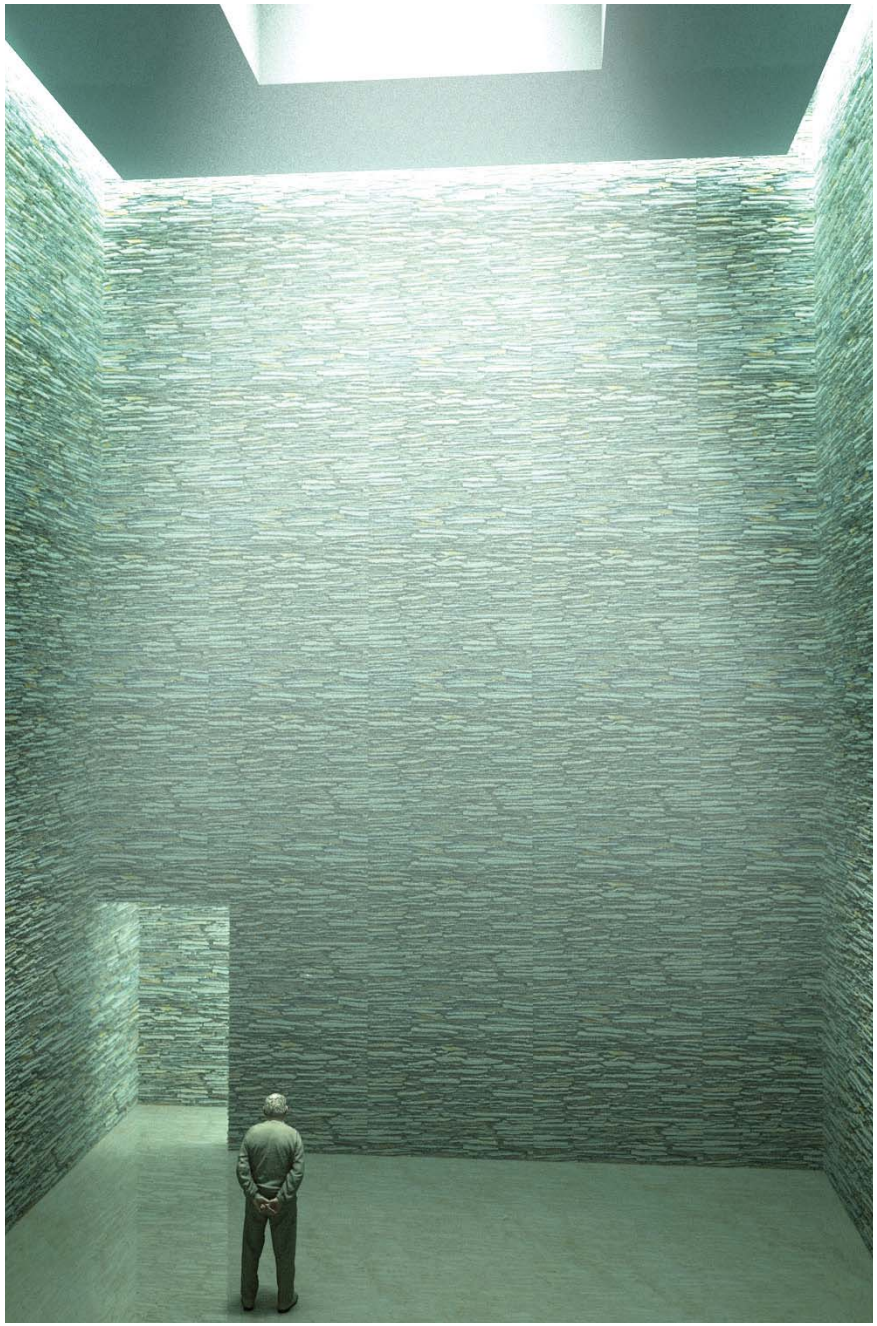




1. Alfons Rogenberg (1984): Einfuhrung in das Symbolverstandnis

Content

Entering into a religious building is a metaphor for entering into spiritual relationship. -
Richard Kieckhefer, Theology in Stone: Church Architecture from Byzantium to Berkeley



Abstract

Every religion has their own beliefs, interpretations and symbolizations of the forms, but at the same time they also share some or other commonalities between them. Most sacred buildings share common ideology, it is the place where people pray, meditate and experience the spirituality within themselves. It is a secluded place which is conceived to be pure and powerful. "The temple is a building that houses images of divinity for the human purpose of worship. As perfection was the nature of god, an idea of a perfect building is conveyed by the design and ritual organization of a temple." [2] In many cultures, people expend extensive amount of resources to build their sacred architecture,and it is considered to be superior to other structures in every religion. The sacred building is considered to be the house for the god and depending on the religion, every sacred building has a hearth, the space where the deity or shrine is located, which is considered to be more powerful and pure.

Different religions involve different symbolism denoted by geometric shapes, elaborate artworks, figurative structures, light sources or other elements. In general, the symbolism indicates that the sacred space is pure, powerful, serene, spiritual and superior with respect to the outside space. The religious building separates this pure, spiritual space from the outside world acting as a boundary between the two. In Islamic architecture, arcades with pointed arches symbolize boundaries; once one has passed through the arcade into the open courtyard, one is in a sacred space[3], similarly in many Hindu temples, the main sanctum room is guarded by the figures of giant animals or mythological creatures denoting the boundary from where the sacred space begins.[2]

The project 'The museum for Sacred Architecture' is envisaged as an open air museum which will showcase six sacred buildings, each from a different major religion. The selected site, located at Wayne Fitzgerrell State Park, Illinois, is surrounded by the trees and secluded from its surrounding. The 'Museum building' consisting of different functional spaces, will be the entrance to the site which will also play the role of the boundary that separates the sacred space (exhibition space) to the outside world. Once entered, the building will make the visitors feel the transition from the secular to the spiritual space.

2. Sudarshan Raj Tiwari: Temples of Nepal Valley
3. Tasha Brandstatter: Symbolism in Islamic Architecture

Reading 1: The case for the Tectonic - Kenneth Frampton

‘A building is ontological, a presence or a thing as opposed to a sign.’ [4]

In this article, Frampton talks about the importance of tectonic form and opposes scenographic approach toward architecture. Frampton suggests there is an art and poetry in the construction of a building and it should be reflected in the choice of material and structure of a project. Tectonic refers not just to the activity of constructing the building using the certain material to fulfill the requirements, but rather to the activity that raises this construction to an art form.

Building material is the important part of any society. The Newari architecture of Kathmandu valley has unique identity consisting of the local building material like timber and brick as structural element and jhingati tiles on sloped roof supported by the wooden struts. The structural form was governed directly by the local climatic condition, structure, materials available locally and the cultural activities of the city. The identity thus evolved became the architectural style which became the part of the culture. But with the advent of the new building materials like concrete, aluminium cladded panels (ACP) etc., people started to construct in new ways: governed by façade and money, the trend of reducing architecture to scenography or the decorated shed. Gradually, the whole city metamorphosed itself into a jungle of concrete structures and the unique identity of the city lost amidst.

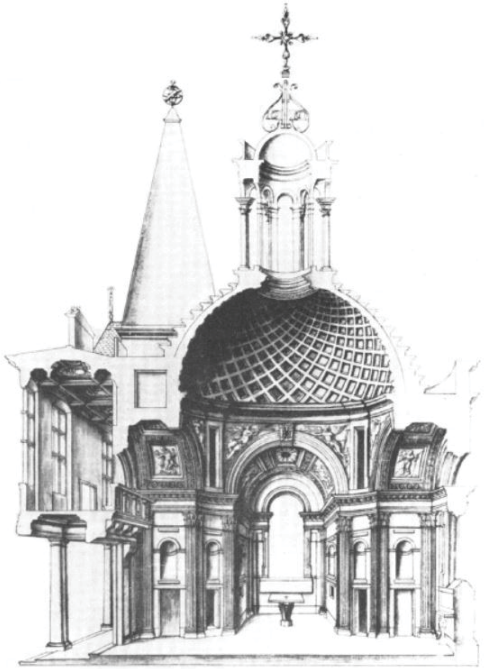
Frampton makes a valid argument of an architectural approach that is expressive of its structure and materiality. Had the people of Kathmandu followed the approach of Tectonic, the Newari Architecture would not have lost its identity.

4. Kenneth Frampton: The case for the Tectonic

Reading 2 : Architecture and Stereotomy - The Relation Between the “Construction Apparatus” and the “Decorative Apparatus” of the Cut-Stone Vaults and Domes of Philibert de l’Orme and Andrés de Vandelvira - Francesco Defilippis

“..that architecture must of necessity be embodied in structural and constructional from”- Kenneth Frampton. In the previous article, Frampton criticizes about the postmodern scenographic approach towards shelter. Reflected in Venturi’s ‘Decorated Shed’, he describes the current tendency to reduce architecture to scenography has become a response to architecture as commodity: “syndrome in which shelter is packaged like a giant commodity.”

In this article ‘Architecture and Stereotomy’ by Francesco Defilippis, the author somehow disagrees with the Framptons tectonic approach to the architecture. He states: “The construction system is not “expressive” in itself; its immediate forms are essentially technical forms, which refer exclusively to their own static function and are devoid of aesthetic intentionality”. The form of the construction element themselves are also responsible for the identity of the elements in relation to the tectonic. “Indeed, the translation of technical form into architectonic form comes about through “a process of formal identification of the construction elements”. He mentions the Vitruvian principle of ‘décor’ according to which each construction element assumes the form that best “identifies” it in relation to “convenience, custom and nature”. According to him, the tectonic or any technical form is translated into architectonic form through ‘décor ‘ and it is through decoration that the construction elements assume a formal and figurative identity and become architectonic elements. For example, In the case of Greek architecture, the Doric columns are tectonic, the mass and sizes denotes the strength and power, however the carvings and the intricate design is what transforms it to the architectonic.



Section of the chapel - Architecture and Stereotomy - The Relation Between the “Construction Apparatus” and the “Decorative Apparatus” of the Cut-Stone Vaults and Domes of Philibert de l’Orme and Andrés de Vandelvira -Francesco Defilippisd Andrés de Vandelvira -Francesco Defilippis

In the article, he shows the comparison between the two domes: the dome of the chapel of Salvador at Úbeda by Andrés de Vandelvira, built between 1536 and 1542, and the dome of the chapel at Anet by Philibert De l'Orme, built between 1548 and 1553. In these cut-stone domes, when the ornaments are stripped off, they both have same basic geometric and construction matrix, they are both spherical domes raised on a circular plan. From which he conceives the relation between the "constructive apparatus" and "decorative apparatus",linked to two different principles in the definition of architectonic form.

I agree with Frampton regarding the tectonic being the important aspect to provide identity to any design element, but the aesthetics is also the part of architecture which cannot be ignored. If we take the example of the stone architecture of different places: rock-cut temples of India, pyramid of Egypt, Acropolis of Athens etc. the tectonic is on one part but the moldings and carvings, the intricate designs or the shape and stereotomy is what make them unique and separate from others, provide them with the formal identity.

Similarly, the traditional 'newari architecture' of Nepal is based on the basic construction material like timber and brick as the main structural element and jhingati tiles as the roofing material. Besides the newari architecture, there are other style of architecture that roots from the same basic material, mostly the vernacular architecture of different other towns. But as the Doric columns, the elaborate detailing and carving of the woodwork, use of the glazing material on the brick and telia tiles, the sloping nature of the roof etc are the decorations which makes the newari architecture stand out among the others. The age old tiered temples and squares, stupas and chaityas, palaces and monasteries which are the mainstay of traditional Nepalese architecture have this formal identity and are architectonic because of these characters.

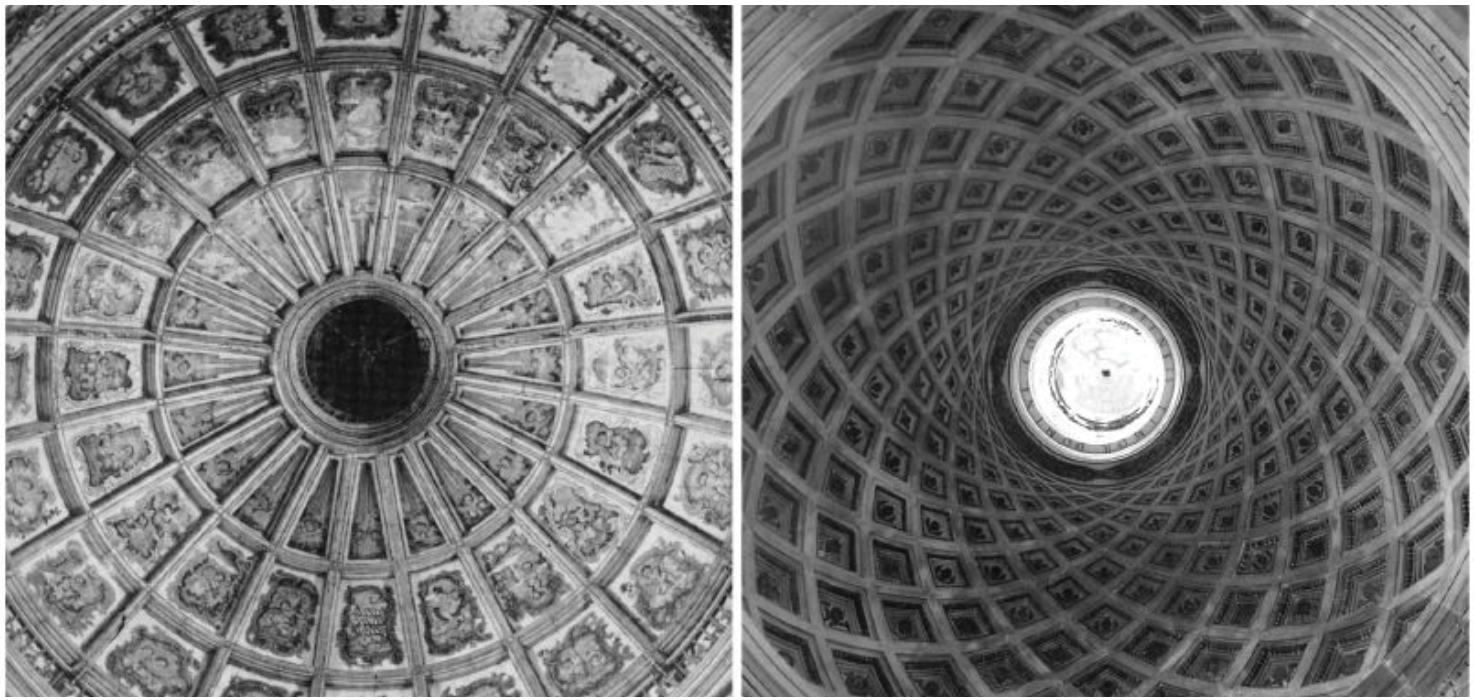
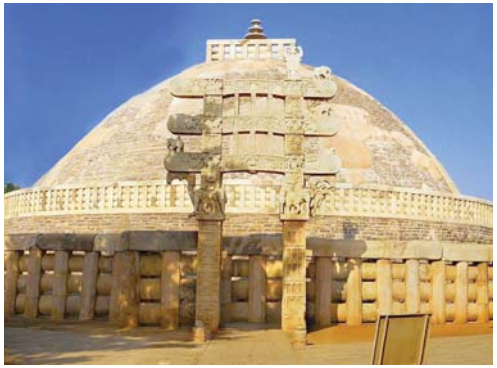


Figure 1. Intrados of the domes of the Salvador chapel at Úbeda and the chapel at Anet Architecture and Stereotomy - The Relation Between the "Construction Apparatus" and the "Decorative Apparatus" of the Cut-Stone Vaults and Domes of Philibert de l'Orme and Andrés de Vandelvira -Francesco Defilippis

Building Set Collection



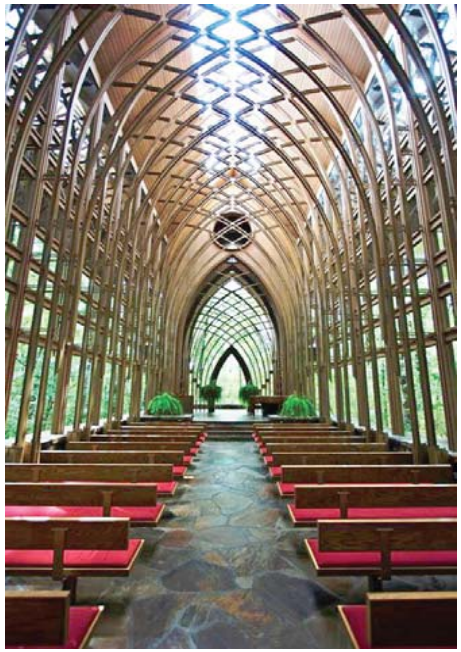


1. Mildred B. Cooper Memorial Chapel - Arkansas, USA. *http://www.panoramio.com/photo/12780360*
2. Church of Light - Osaka, Japan. *http://mooponto.files.wordpress.com/2012/09/094.jpg*
3. Shah Jahan Mosque - Woking, England. *http://www.victorianweb.org/art/architecture/indian/14.jpg*
4. Lincoln Marriage Temple - Kentucky, USA. *https://returningtokentucky.files.wordpress.com/2013/09/lincolnmarriagetemple_6678.jpg*
5. Charnarayan Temple - Patan, Nepal. *http://commons.wikimedia.org/wiki/File:Char_narayan_temple_patan_sunita_(3).JPG*
6. Sanchi Stupa - Sanchi, India. *http://en.wikipedia.org/wiki/Sanchi*

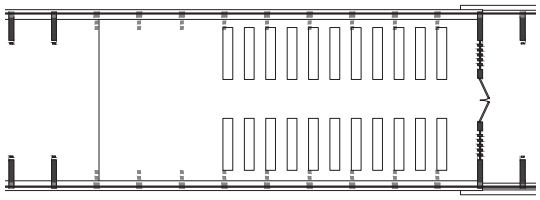
Mildred B. Cooper Memorial Chapel: Case study

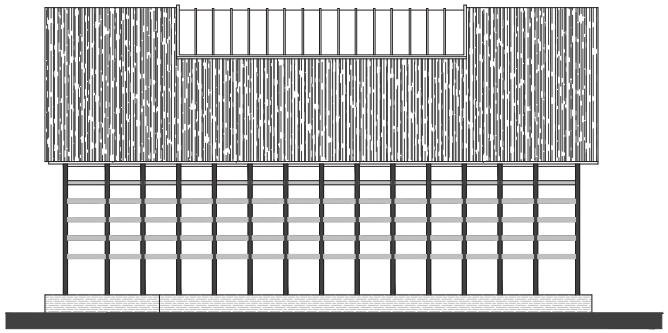
Location:	Bella Vista, Arkansas
Date:	1986
Style:	Chapel
Material:	Steel, Wood, Glass
Architect:	E. Fay Jones

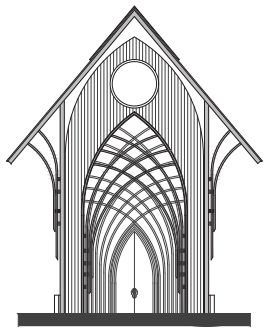


CHARACTERISTICS:

- The design recalls the Prairie School of architecture popularized by Frank Lloyd Wright, with whom Jones had apprenticed.
- features a dramatic progression of Gothic pointed arches that begins at its entrance and continues through the interior.
- The tall, narrow, wood-and-steel frame structure is rectangular and rests on a low stone foundation
- The use of steel, in addition to wood, in the framing allowed for a design even more delicate in appearance than Thorncrown Chapel







FORM:

- Single lofty rectangular room with its long side walls infilled with glass and resting on low stone foundation walls.
- Pointed arches symbolizing the gothic architecture.
- “a steel building inside a wood building,” –Jones.
- while steel channels are used extensively as columns and brackets, the impression that the building gives is one of being made of wood.

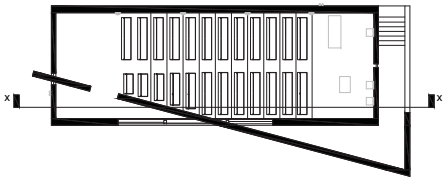
http://www.pinterest.com/pin/236650155391055206/

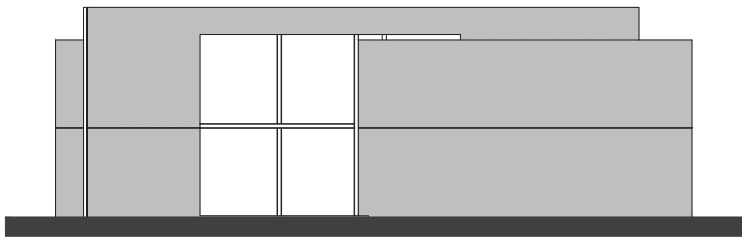
Church of Light: Case study

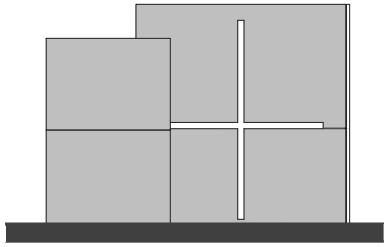
Location:	Ibaraki, Osaka, Japan
Date:	1989
Style:	Church
Material:	Re-inforced concrete
Architect:	Tadao Aando

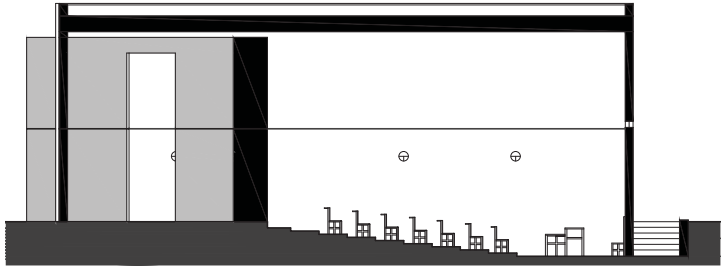
CHARACTERISTICS

- size of the building is only 113.3 square meters (roughly the size of a small house.)
- consists of three 5.9m high concrete cubes penetrated by a wall angled at 15°, dividing the cube into the chapel and the entrance area.
- A cruciform is cut into the concrete behind the altar, and lit during the morning (as it is facing east).
- The benches, along with the floor boards, are made of re-purposed scaffolding used in the construction
- Concrete load bearing wall- traditional and simple –disagreed with the notion of modern architecture of the time.
- Le Corbusier's new ideas (5 points of architecture) that the wall would no longer be a structural element but a mere membrane on the outer shell, severely contrasts that of Ando's work.









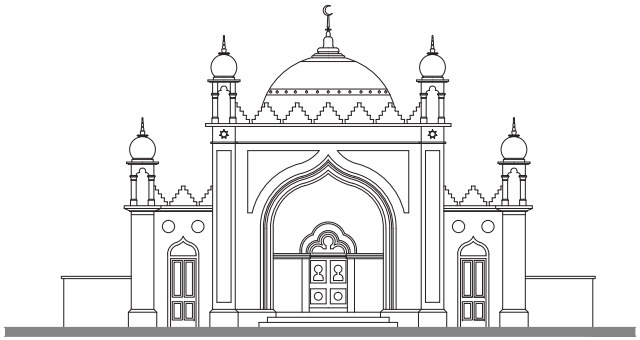
http://arch5541.wordpress.com/2012/10/12/tadao-ando-church-of-light/
http://whiterabbitchase.com/245/church-of-light/

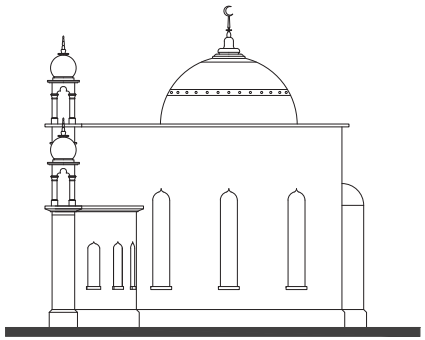
Shah Jahan Mosque: Case study

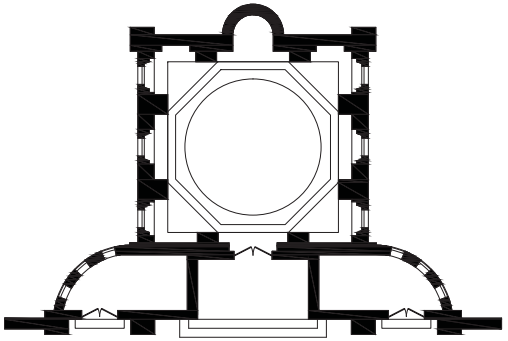
Location:	Woking, England
Date:	1889
Style:	Mosque
Material:	Stone, Timber
Architect:	Gottlieb Wilhelm Leitner
Religion:	Islamic

CHARACTERISTICS

- One of the first mosques in Western Europe by Gottlieb Wilhelm Leitner.
- Built in Bath and Bargate stone in indo-saracenic style.
- A drawing of the Woking Mosque by the architect W. I. Chambers was published in The Building News and Engineering Journal, dated 2 August 1889, shortly before the Mosque was completed.
- The mosque fell into disuse briefly between 1900 and 1912. And in 1913, Leitner's son was on the point of selling the mosque to a developer.
- Indian lawyer Khwaja Kamal-ud-Din took the case to court, arguing that the mosque was consecrated ground and enjoyed the same rights and status as a church and he won



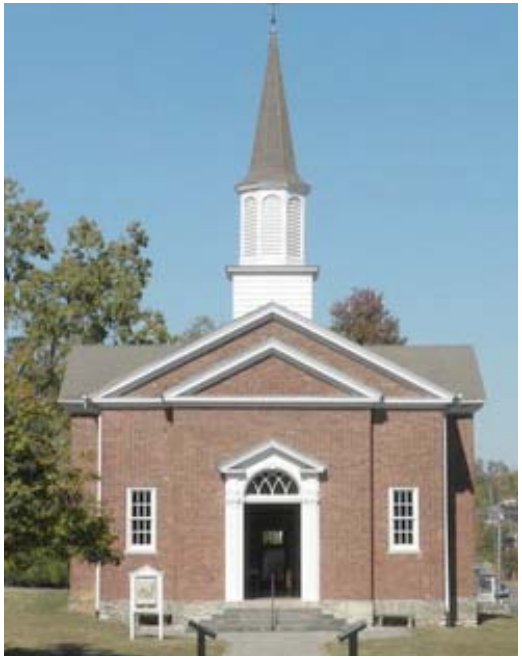




http://www.shahjahanmosque.org.uk
http://en.wikipedia.org/wiki/Shah_Jahan_Mosque,_Woking

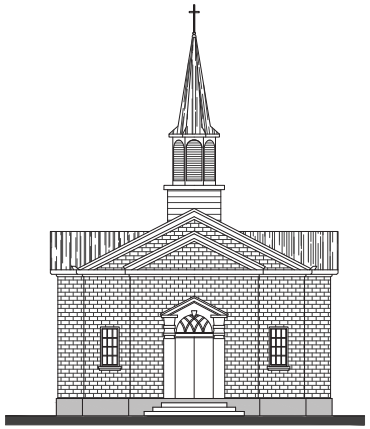
Lincoln Marriage Temple : Case study

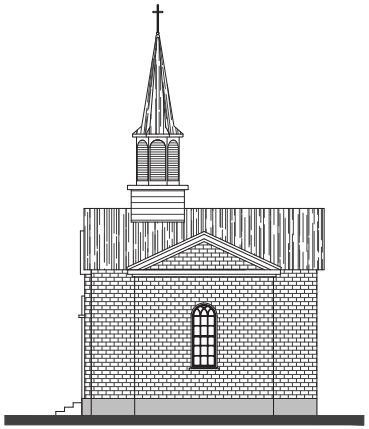
Location:	Kentucky, United States
Date:	1935
Style:	Chapel
Material:	Brick, Timber
Religion:	n/a

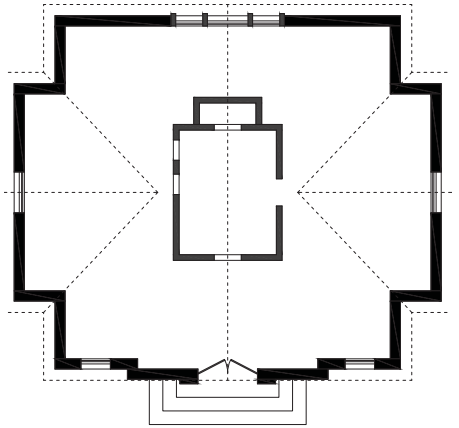


CHARACTERISTICS

- The chapel houses the little log cabin in which the parents of Abraham Lincoln, Thomas Lincoln and Nancy Hanks, were married.
- Cabin was moved from its original location at Beechland in Washington to Old Fort Harrod.
- Constructed of handmade brick in Flemish bond in the shape of a cross
- is cross-shaped in plan with four wings topped by the spire.
- The cabin is directly under the intersection under an opening which leads to a spire and belfry







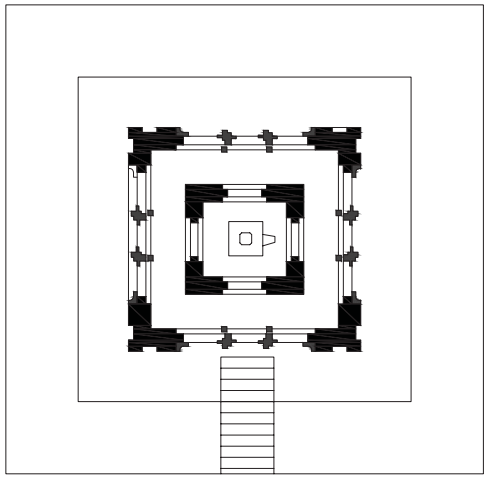
http://commons.wikimedia.org/wiki/File:Lincoln_Marriage_Temple.jpg
https://returningtokentucky.wordpress.com/tag/richard-berry-cabin/

Charnarayana Temple : Case study

Location:	Patan Dubar Square, Nepal
Date:	17th Century
Style:	Pagoda
Material:	Brick- primary building material, Timber, roof tiles (jhingati)
Religion:	Hindu

CHARACTERISTICS

- Two tiered roof covering the sanctum room with the Gajur (Pinnacle) on top
- One of the oldest temple constructed in the Patan Durbar Square.
- Built on a Plinth- common to all temples built at the time.
- Plan based on the Vaastu Purush mandala (constitutes the mathematical and diagrammatic basis for generating design) 1



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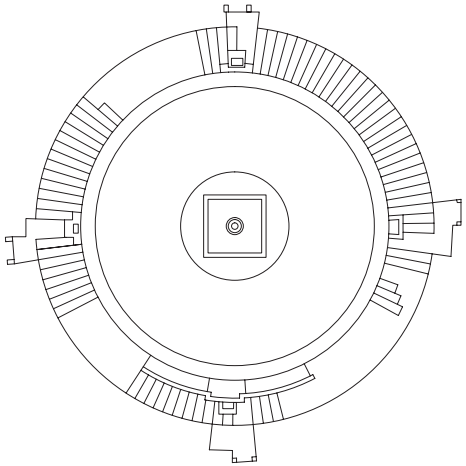
kathmandu-valley-temples.com/ktmvalley_php/main.php?site=rundgang&object=10__Patan_Darb/2__Mangal_Baz/2__Patan_Darb/5__Char_Naray

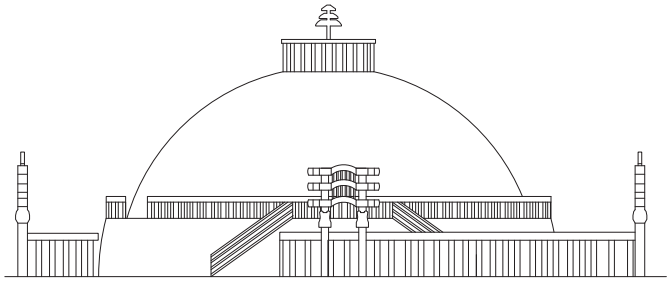
Sanchi Stupa : Case study

Location:	Madhya pradesh, India
Date:	3rd Century BCE
Style:	Stupa
Material:	Stone, brick and timber
Religion:	Budhism

CHARACTERISTICS

- the oldest stone structure in India
- originally commissioned by the emperor Ashoka
- Originally consisted of simple hemispherical brick structure built over the relics of the Buddha, crowned by the chatra (parasol) symbolizing high rank, which was intended to honor and shelter the relics
- The stupa was later expanded with stone slabs to almost twice its original size and four monumental gateways (Torana) and the balustrade were added
- Torana: carved and constructed in the manner of wood and the gateways were covered with narrative sculptures of life of Buddha





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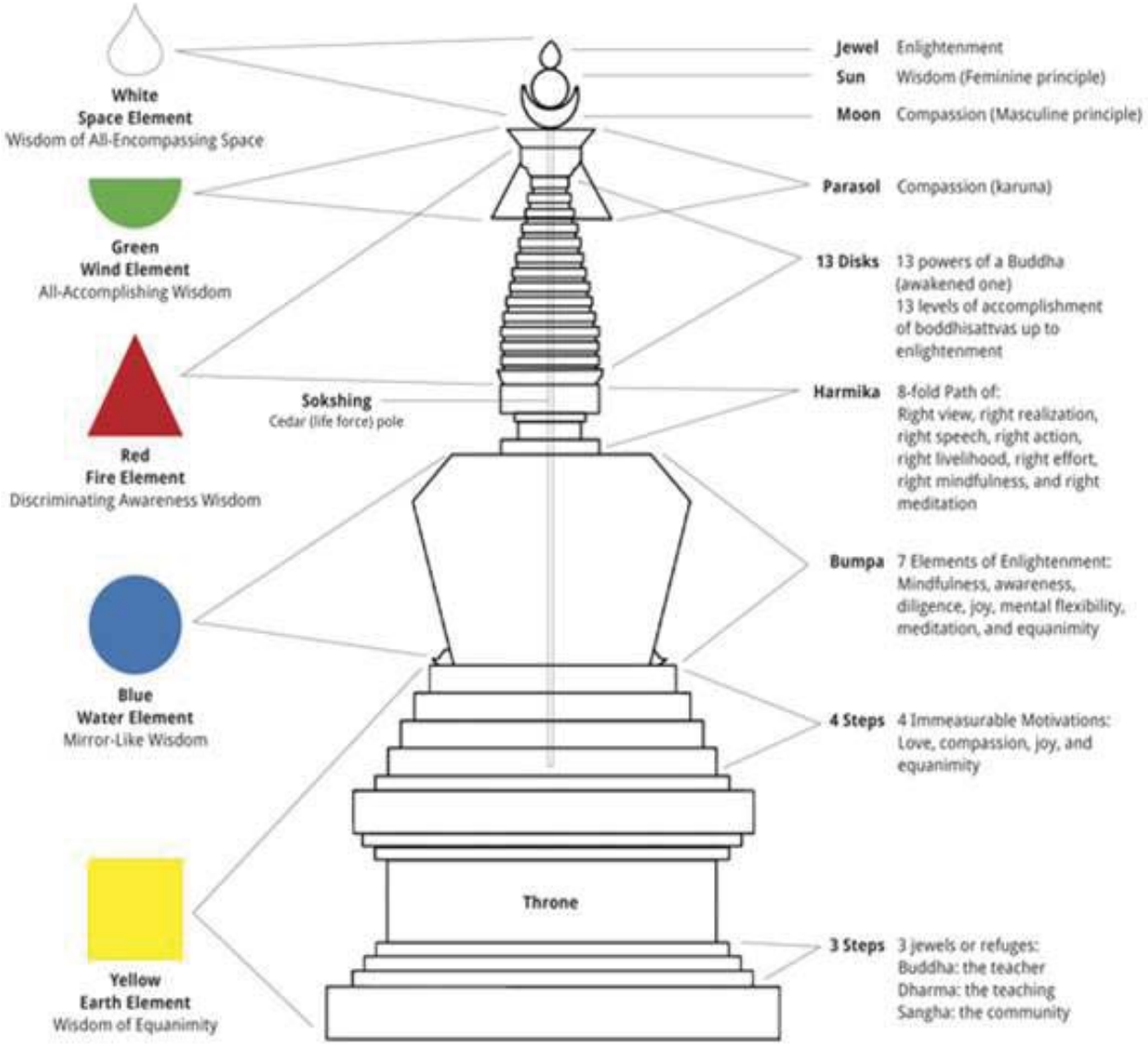
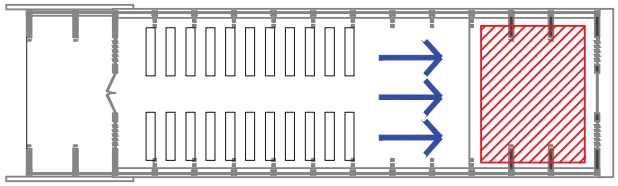
SYMBOLISM IN STUPA



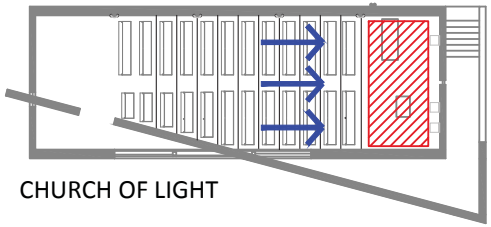
http://www.elephantjournal.com/2009/07/want-70s-groovin-polyester-swinger-music-tron-style-3d-animation-buddhism-here-you-go/

Analysis - Hearth of the building and its access:

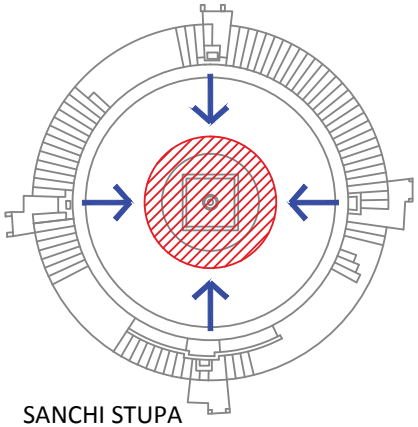
The sacred building is considered to be the house for the god and depending on the religion, every sacred building has a hearth, the space where the deity or shrine is located. This space is considered to be more powerful and pure and its access vary with the religion.



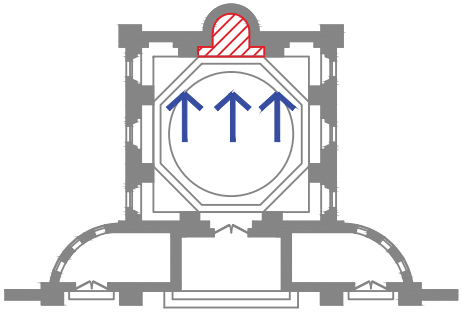
MALDRID B. COOPER MEM. CHAPEL



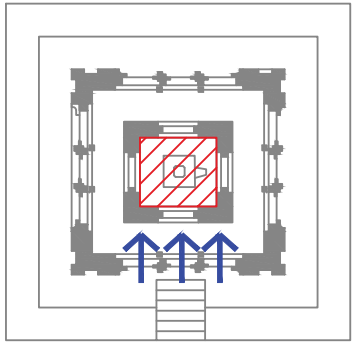
CHURCH OF LIGHT



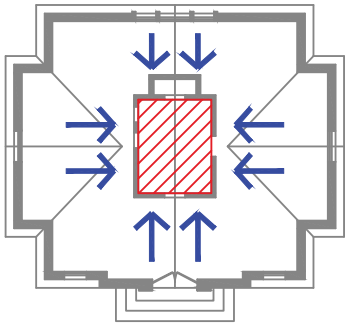
SANCHI STUPA



SHAH JAHAN MOSQUE



CHARNARAYAN TEMPLE

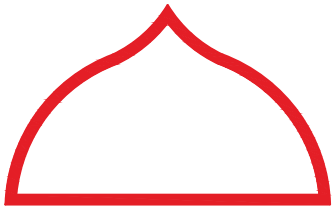


LINCOLN MARRIAGE TEMPLE

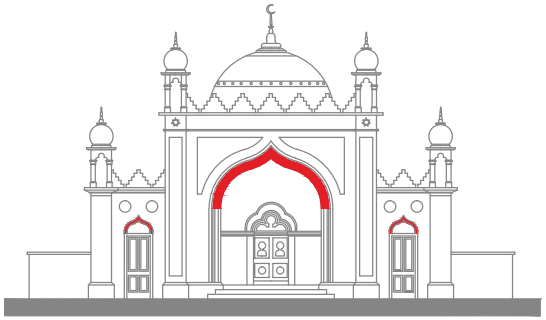
HEARTH

ACCESS TO HEARTH

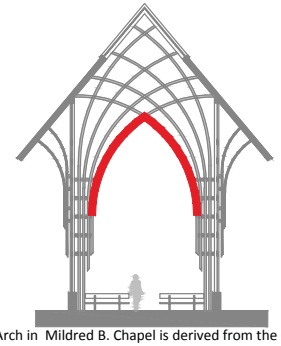
Analysis - Shape and Symbolism



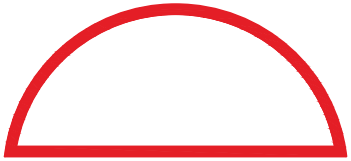
POINTED ARCH



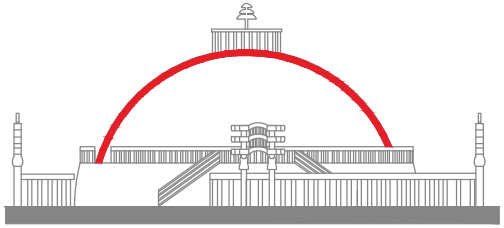
Arcades with pointed arch symbolize boundaries in Islamic Architecture; once one has passed through the arcade into the open courtyard, one is in a sacred space.



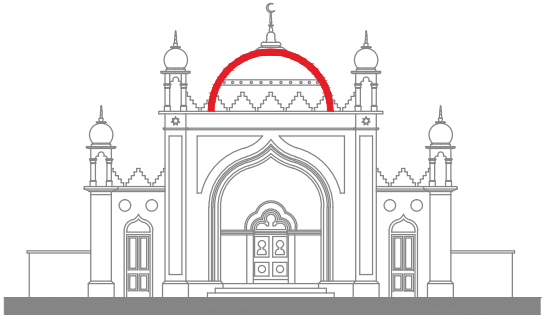
Pointed Arch in Mildred B. Chapel is derived from the Gothic Architecture. characteristics of Gothic Architecture include the pointed arch, the ribbed vault and the flying buttress



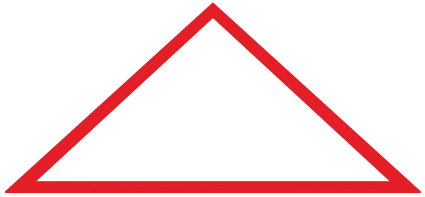
DOME SHAPE



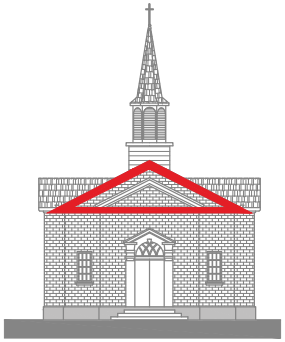
Sanchi Stupa is one of the earliest form of Stupa structure from which many of the modern form of Stupas have evolved. The Stupa form represents the peace and harmony in Buddhism.



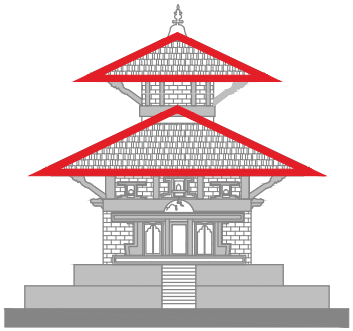
Dome shape in the ISLAMIC ARCHITECTURE representats the vault of heaven and a symbol of divine dominance engulfing the emotional and physical being of the faithful



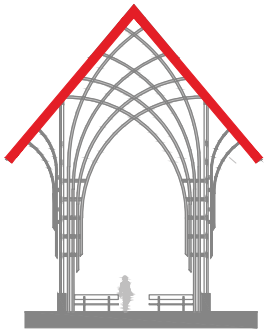
TRIANGULAR SHAPE



Triangular shape in the LINCOLN MARRIAGE TEMPLE is derived from the traditional pediment design



Triangular shape in the HINDU PAGODA TEMPLE is derived from the pointed Himalayas

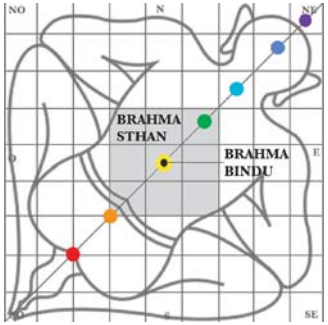


Triangular shape in Maldrid B. Cooper Memorial Chapel with the skylight above, directs people upward (towards heaven)

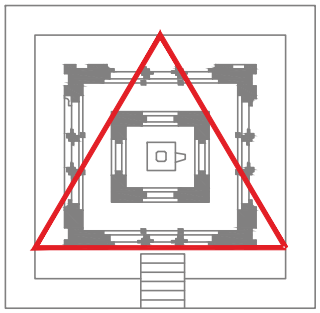
Analysis - Evolution of form, tectonic and materialism

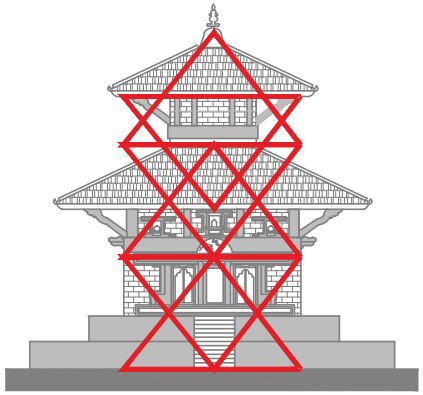
Charnarayan Temple

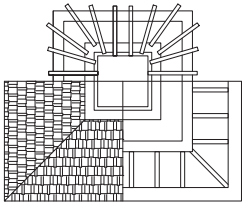
- Pagoda style hindu temple. The basic plan of the temple is derived from the Vaastu Purush mandala, the diagram with the set of squares arranged around the human figure. Then the proportion of the elevation is derived from the plan with respect to the length of the side of an imaginery triangle drawn on the plan
- wThe building material involved in the construction are: Brick masonry wall and timber as the primary structural element and stone for the plinth and jhingati tiles for the roof covering.
- Construction was done in traditional way for eg. using the bamboo scaffolding, using classical joints for wood such as mortise and tenon joint, dove tail joint etc.

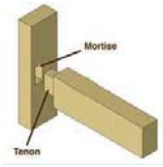


VAASTU PURUSH MANDALA

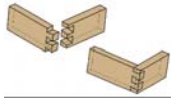

FLOOR PLAN OF CHARNARAYAN TEMPLE


ELEVATION OF CHARNARAYAN TEMPLE

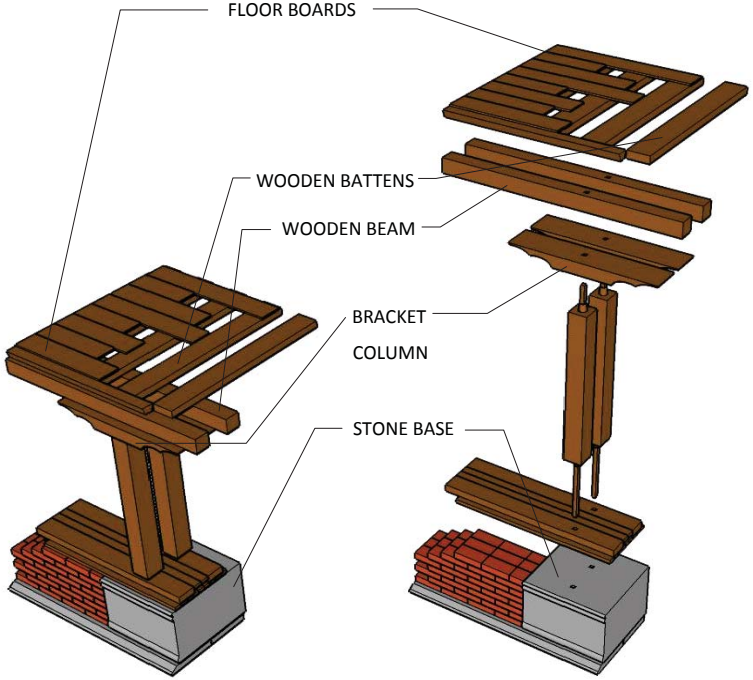

TYPICAL TIMBER LAYOUT DETAIL OF PAGODA ROOF



Mortise and Tenon Joint detail


Dovetail Joint detail


Tongue and groove joint detail

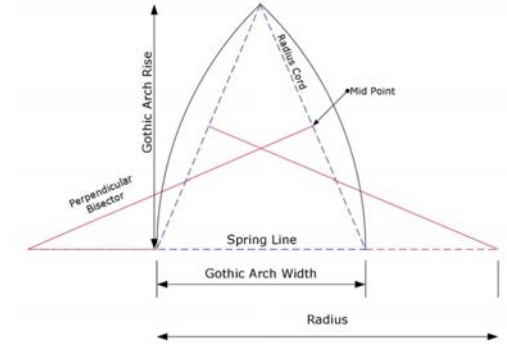


TYPICAL JOINT DETAIL OF THE WOOD WORK AND BRICK STONE MASONRY OF THE HINDU PAGODA STYLE TEMPLE

Analysis - Evolution of form, tectonic and materialism

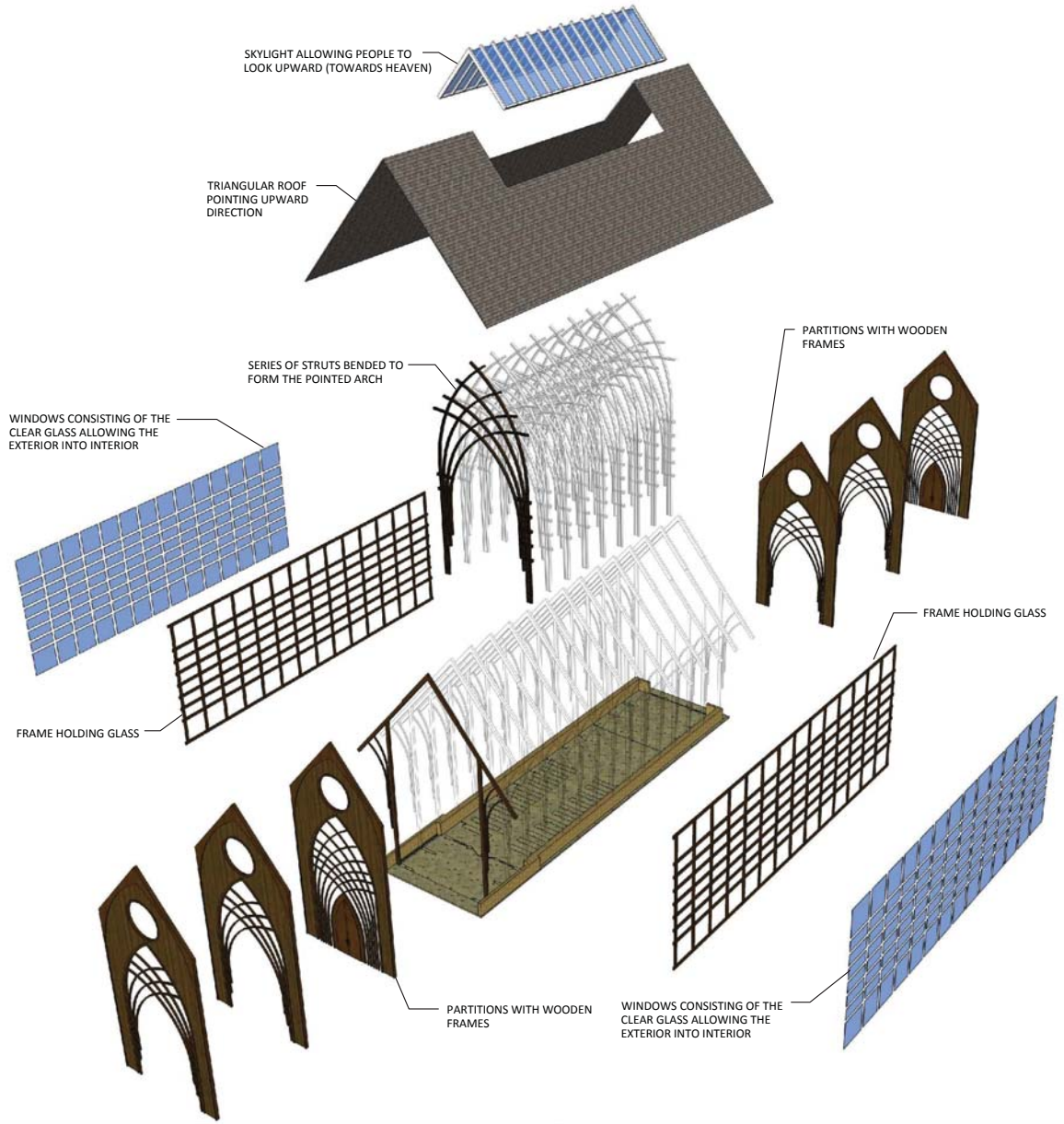
Mildred B Cooper memorial Chapel

Section of the building on site

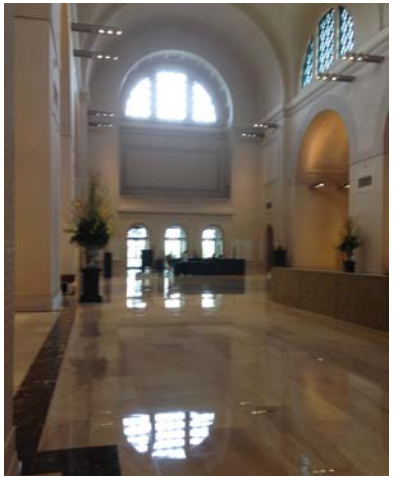


Geometry for the Gothic pointed arch

Formation of pointed arch by combination of the series of curved struts also serving as support for the roof



Analysis of the building components of Mildred B. Cooper memorial Chapel



Program Information: Museum for Sacred Architecture

The project 'The museum for Sacred Architecture' is envisaged as an open air museum which will showcase six sacred buildings, each from a different major religion. The selected site, located at Wayne Fitzgerrell State Park, Illinois, is surroun. Sacred building, also known as religious building, house of god, Temple, Church, Mosque etc. varies from place to place depending on the region, the kind of religion they belong to, locally available materials, cultural evolution, contemporary architectural style, religious symbolism, available construction technology etc.

Along with the six sacred buildings, the museum will also function as a research centre for scholars and researchers who wants to explore deeper in the sacred architecture. Museum Building will consist of the library and the gallery where the photographs, historical records and detailed information about the important sacred architecture around the world from different religions and six exhibits of museum itself, will be displayed. It will also consist of the multipurpose hall that can be used as classroom, A/V room, Exhibition space etc for educational and other purposes.

1. Entry lobby

a. Transition space	600
Tall hallway without any opening on wall	
b. Entry vestibule + waiting space	700
The greeting space for the visitors. It shall be connected to the reception area where visitors can get the general information about the museum and head towards the exhibition space	
c. Reception	60
Inviting entry with direction for your visit.	
d. Men's Restroom	170
accessible to the public/ visitors	
e. Women's Restroom	190
accessible to the public/ visitors	
Total Square Footage	*1720*

Program Information: Museum for Sacred Architecture

2. Administrative Unit

a. Staff office (5 staffs) 250
Office room for the administrative staffs. Individual or combined workstations. Used for the different administrative, marketting and research task.

b. Manager office 100
Office room for the manager of the museum

c. Staff meeting 150
Used by the administrative staffs only

d. Restroom (men and women) 70
Accessible to the administrative staffs only. 35 S.ft for men 35 S.ft for women

e. Custodial room 60
Includes mechanical, electrical, and plumbing equipment for maintaining the overall services of the building.

f. General Storage room 80
Office supply storage as well as employee records and exhibit records.

Total Square Footage *710*

3. Halls

a. Gallery 600
Display the photographs, historical records and detailed information about the important sacred architec ture around the world from different religions and exhibits of museum itself.

b. Multipurpose hall 1000
Perfom different functions. Can be used as exhibition hall, audio/visual room to show different documenta ries, and as class room to discuss and educate the visitors about the exhibits.

c. Storage room 200
Used by the administrative staffs only

d. Library 500
consist of the records (digital and hard copies) and books with the detailed information about the exhibits

Total Square Footage *2300*

Program Information: Museum for Sacred Architecture

4. Maintenance Unit

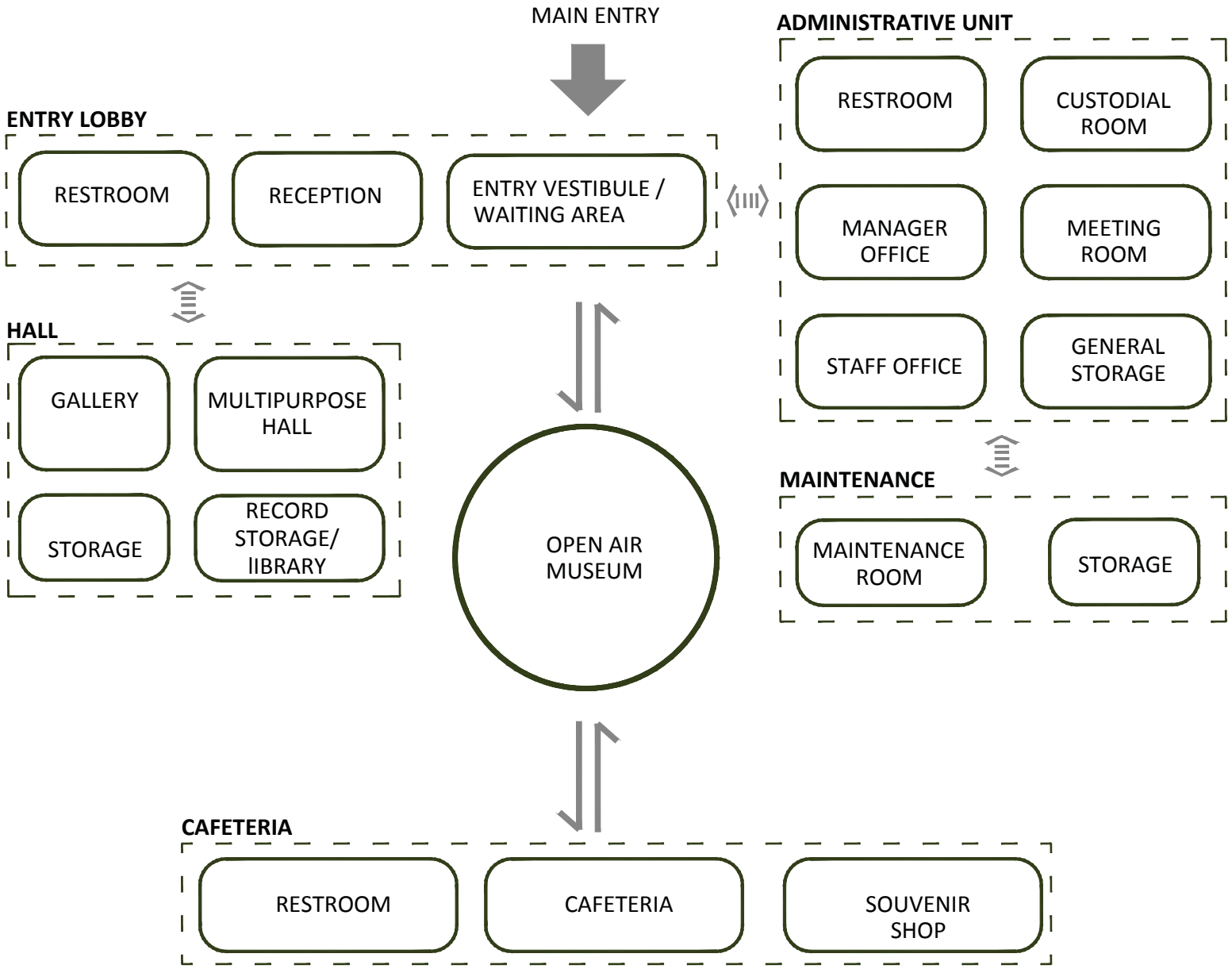
a. Maintenance room	400
consist of the working space and tools required to maintain the exhibits as well as other equipments.	
b. Storage room	100
to store the tools and other equipments from the maintenance room	
Total Square Footage	*500*

5. shop

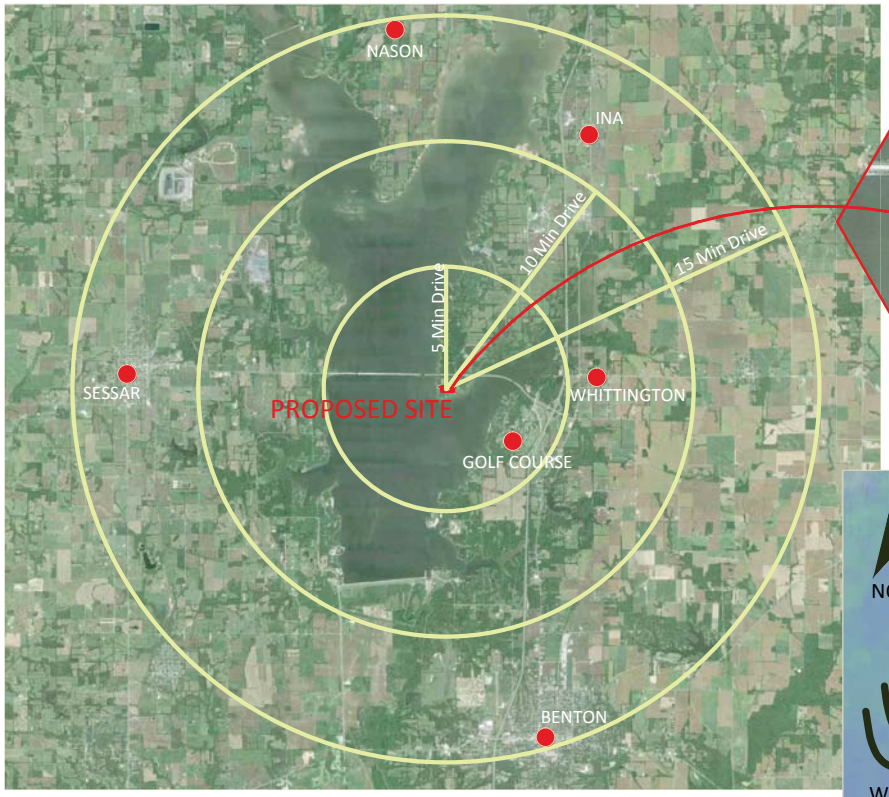
a. Cafeteria	500
Display the photographs, historical records and detailed information about the important sacred architecture around the world from different religions and exhibits of museum itself.	
b. kitchen	200
Perfom different functions. Can be used as exhibition hall, audio/visual room to show different documentaries, and as class room to discuss and educate the visitors about the exhibits.	
c. Storage room	80
Used by the administrative staffs only	
d. Men's Restroom	100
accessible to the public/ visitors	
e. Women's Restroom	120
accessible to the public/ visitors	
f. ADA accessible Restroom	25
accessible to the public/ visitors	
g. Souvenir shop	200
visitors can buy the souvenier for the museum experience which can be small replicas of the exhibits or minia ture model or accessories related to Sacred Architecture.	
Total Square Footage	*2300*

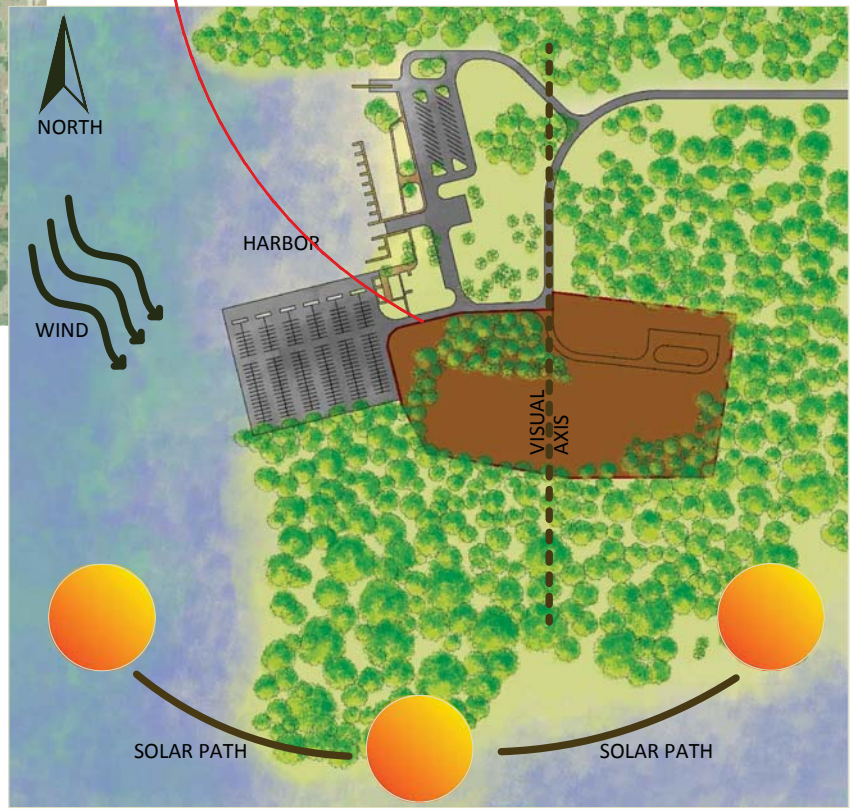
Total Net Area of the builtup space	***7530 SFt***
Total Gross Area (including Wall, circulation etc.) , 25% addition	*9412 SFt*

Relationship Diagram of spaces



Site Analysis



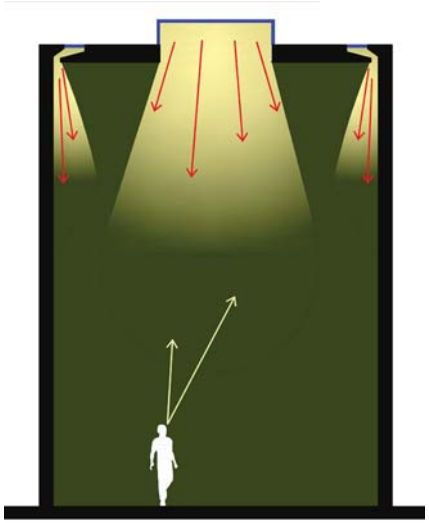


Location: Wayne Fitzgerrell State Park
Accessibility: Existing road available
Topography: Site is almost flat, surrounded by trees on all sides

SITE FEATURES

- Secluded from the busy public area by nature itself.
- Secluded but easily accessible via existing road.
- Scenic view of the lake can be obtained by cutting few trees on west side.

Design Concept

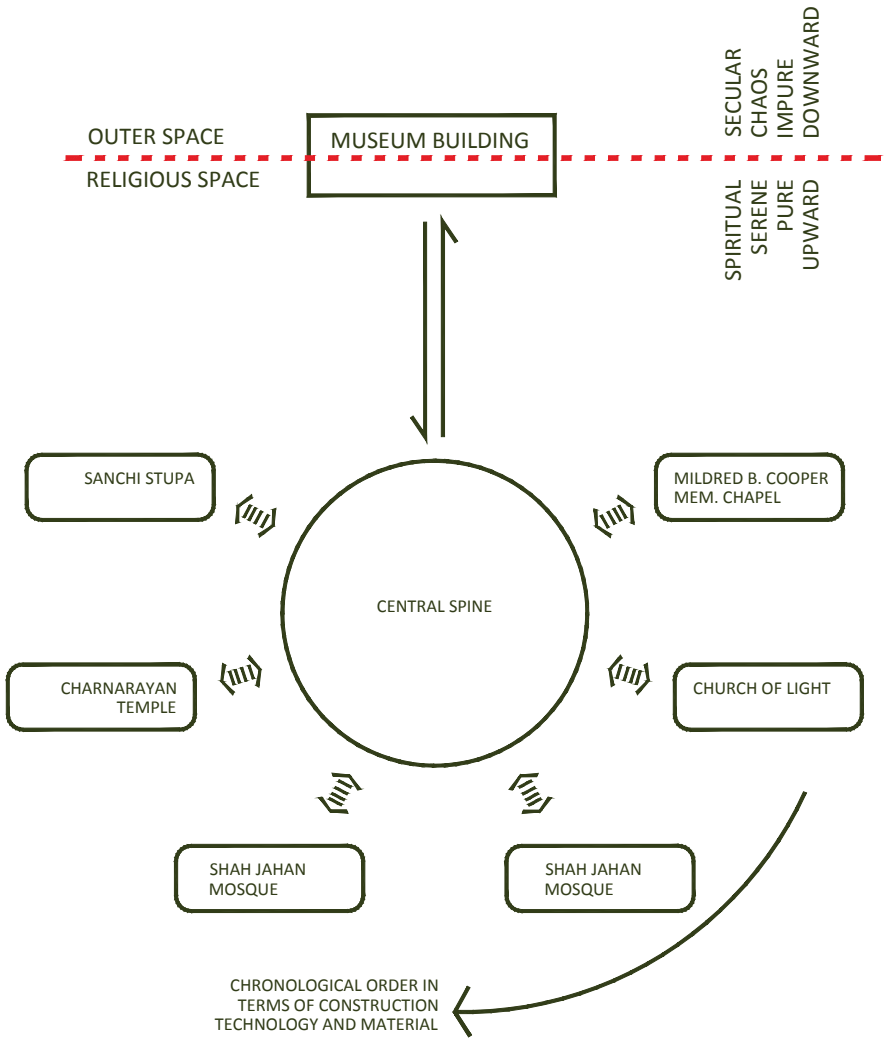


Tall hallway with blank walls, lit only by the skylight, symbolizing the transition space

Every religion have their own beliefs, interpretations and symbolizations of the forms, but at the same time they also share some or other commonalities between them. Most sacred buildings share common ideology, it is the place where people pray, meditate and experience the spirituality within themselves. It is a secluded place which is conceived to be pure and powerful. The selected site is located at Wayne Fitzgerrell State Park, Illinois. The fact that the site is surrounded by the trees from all around and secluded in itself is one of the main reasons for its selection. Moreover, it is easily accessible via the existing road and also it can be visually linked from the main road that leads to the existing harbor next to the site. This visual axis can be utilized as the magnet element to draw the attraction of the people visiting the harbor towards the museum.

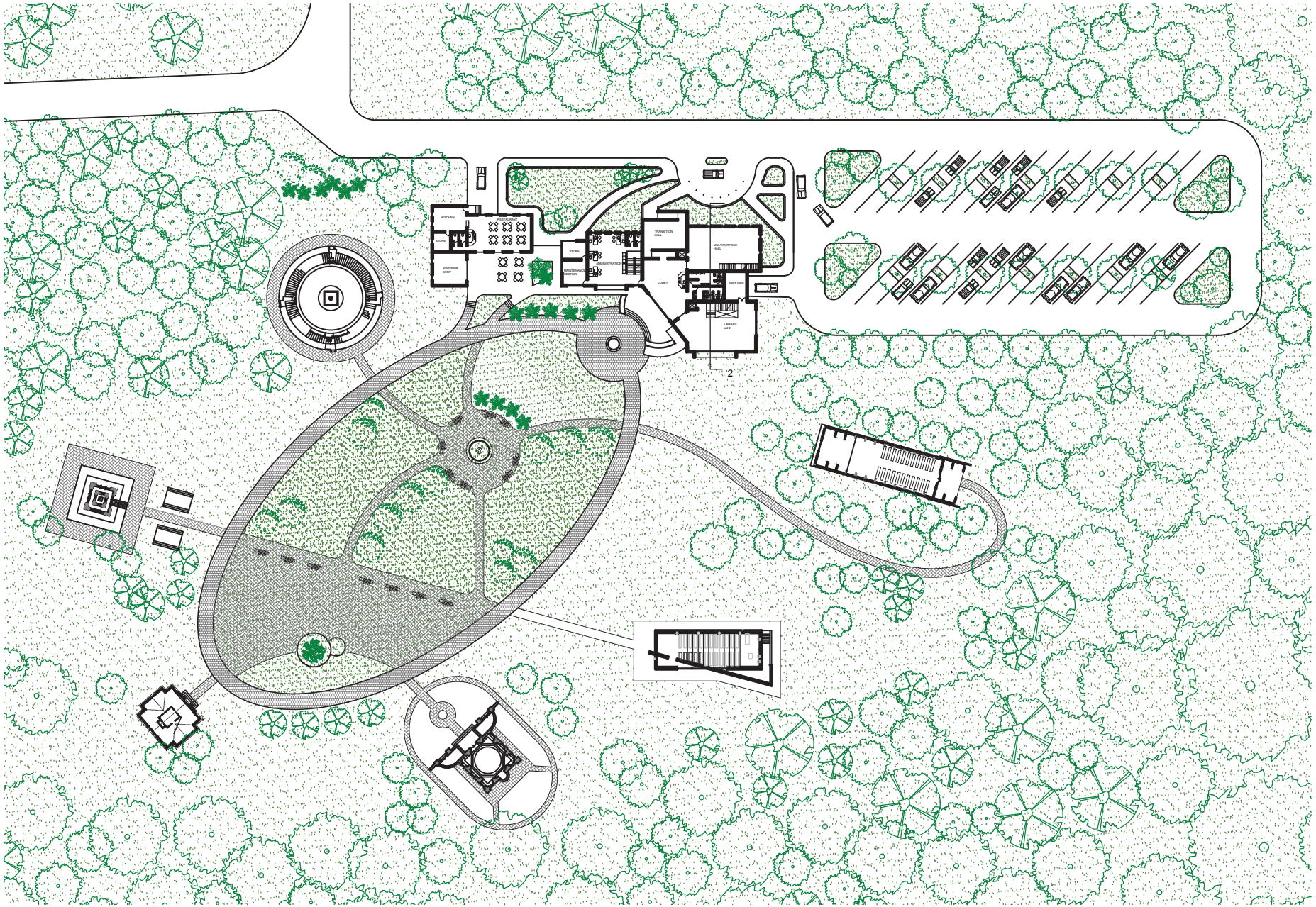
Apart from the museum activity, the project will also serve as the study and research center for the sacred buildings. The researchers and scholars can study and observe all the exhibits and will be able to compare them with each other in terms of materiality, symbolism, tectonics etc. The exhibits will have to be spaced within the walking distance, so that the researchers can easily access all the buildings in short time. The extensive library and the gallery will also be provided which will consist of the information, historical records, photographs etc. of the six exhibits as well as other religious buildings around the world.

The museum building will be the entrance to the site which will also play the role of the boundary that separates the sacred space (exhibition space) to the outside world. Once entered, the building will make the visitors feel the transition from the secular to the spiritual space and lead to the open space consisting of the six exhibit buildings. The buildings are arranged in the loop in the chronological order in terms of their materiality, such that the visitors will observe the building that uses the modern building technology and material like steel and concrete at the beginning and then gradually leading to more primitive material and technologies like brick, timber mud and stone.

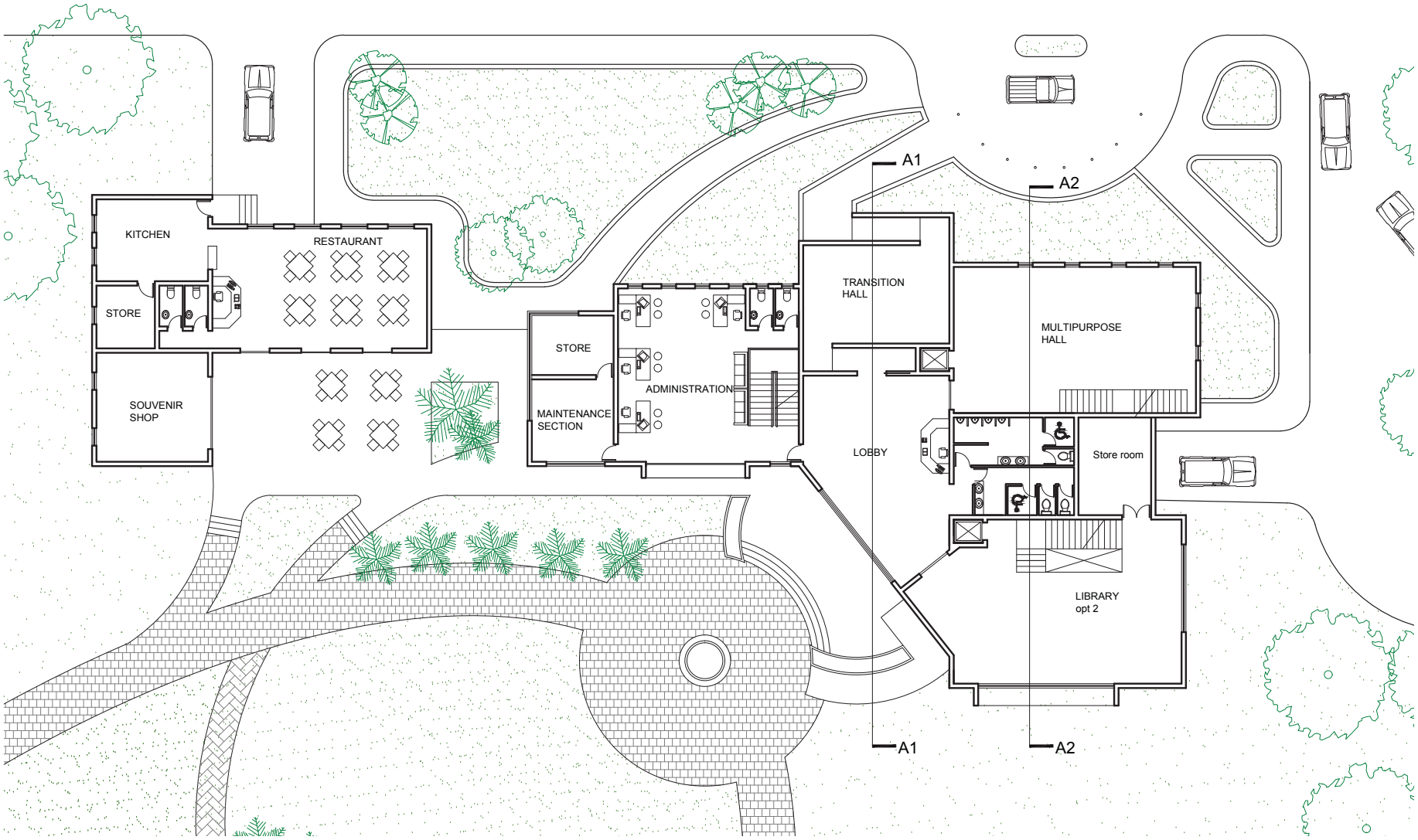


Relationship and circulation diagram: Museum building to act as a transition space between the outside world to the spiritual world. Once entered the site, all of the exhibit buildings are accessible via the secondary pathway which is branched out from the looped central pathway (Central Spine).

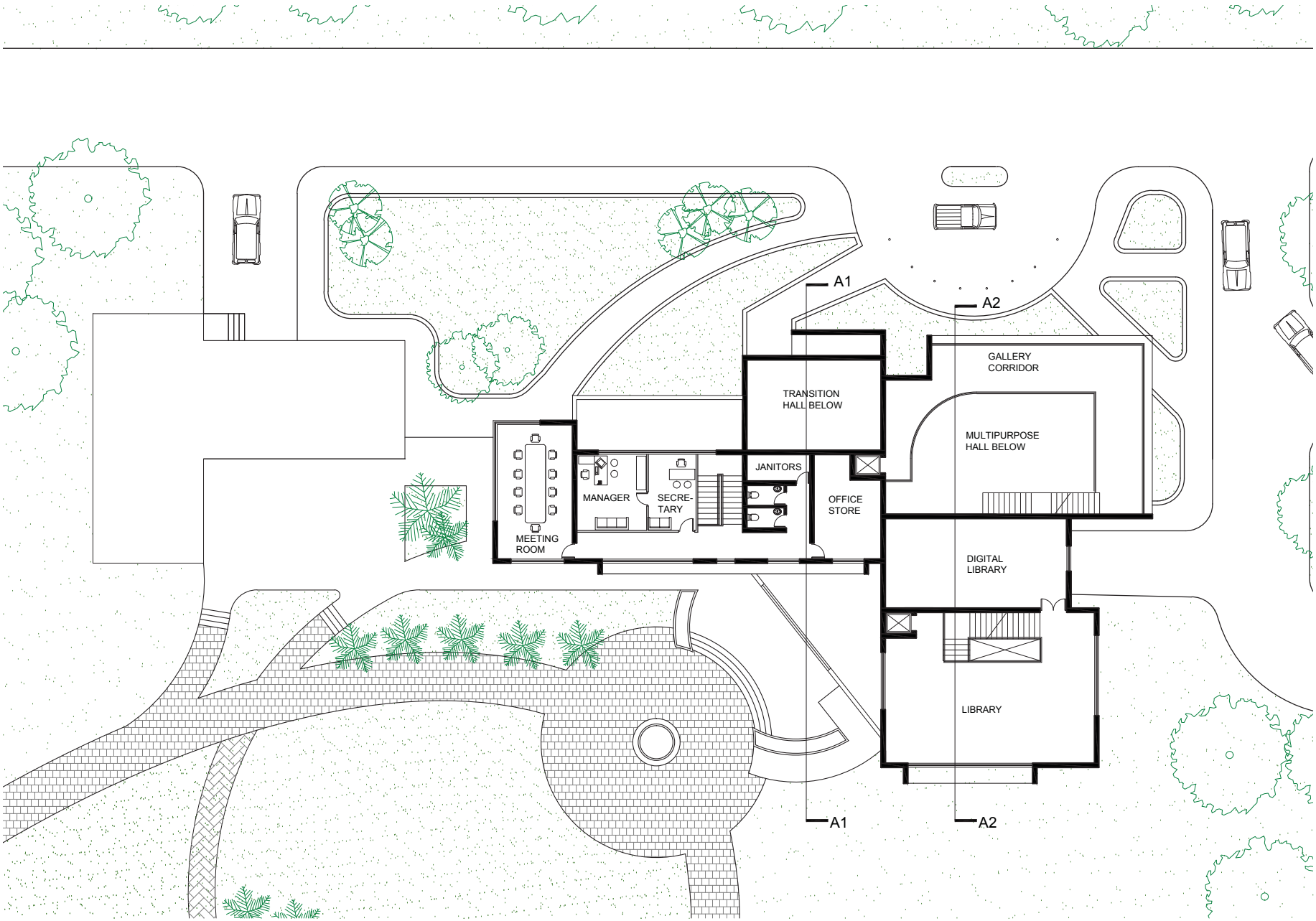
Site Plan


KITCHEN
STORE
SOUVENIR SHOP
STORE
MAINTENANCE SECTION
TRANSITION HALL
MULTI-PURPOSE HALL
LOBBY
LIBRARY
2

Ground Floor Plan

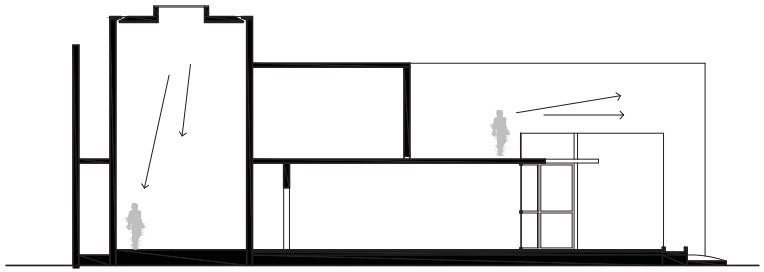


First Floor Plan



Site and sections

Site Section - Site is almost flat and surrounded by trees



Section at A1

Section at A2

Site Arial View: Site is surrounded by trees from all sides

Site Experience

View from the road leading the site, which is also the road leading to the harbor. The exhitbit building in the axis of the road draws the attention of the people visiting the harbor.

Museum building front facade: parapet height increases as the visitor approach towards the building.

Site Experience

View of Parking lot: Trees in every alternate parking space provide shade to the car/ vehicle

View of Site from the terrace of Library.

Site Experience

View of outdoor space at the back of the museum building. The visitors are can take any path from this place

View of Pathways: Main spine pathway and secondary pathways

Site Experience

View of the open air museum: landscaping and resting area

Arial view of the whole site

Energy Analysis

AUTODESK.

Energy Analysis Compare Report

Report created at 2014-08-01 11:07:53 AM

Series of Energy simulations were run to compare how the building orientation, amount of openings, provision of shading devices etc affect the energy consumption by the building. Following diagram illustrates how the energy consumption in the building is reduced by simply adding the shading device in the openings. The left column is the reading from the building without any projections over the window and the right column is the reading when the projection of 3 feet slab is added to the same building.

Museum building With projection

Museum building Without projection

Building Performance Factors

Location:	Benton, IL
Weather Station:	36920
Outdoor Temperature:	Max: 95°F/Min: -4°F
Floor Area:	7,294 sf
Exterior Wall Area:	5,565 sf
Average Lighting Power:	1.10 W / ft²
People:	227 people
Exterior Window Ratio:	0.31
Electrical Cost:	$0.08 / kWh
Fuel Cost:	$0.79 / Therm

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Electrical Cost:	$0.08 / kWh
Fuel Cost:	$0.79 / Therm

Energy Use Intensity

Electricity EUI:	13 kWh / sf / yr
Fuel EUI:	90 kBtu / sf / yr
Total EUI:	136 kBtu / sf / yr

Electricity EUI:	14 kWh / sf / yr
Fuel EUI:	96 kBtu / sf / yr
Total EUI:	143 kBtu / sf / yr

Life Cycle Energy Use/Cost

Life Cycle Electricity Use:	2,898,526 kWh
Life Cycle Fuel Use:	197,733 Therms
Life Cycle Energy Cost:	$178,101

*30-year life and 6.1% discount rate for costs

Life Cycle Electricity Use:	3,000,930 kWh
Life Cycle Fuel Use:	209,894 Therms
Life Cycle Energy Cost:	$186,255

*30-year life and 6.1% discount rate for costs

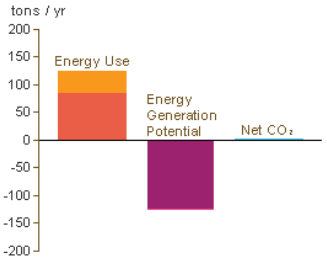
Museum building With projection

ewable Energy Potential

Roof Mounted PV System (Low efficiency):	45,483 kWh / yr
Roof Mounted PV System (Medium efficiency):	90,967 kWh / yr
Roof Mounted PV System (High efficiency):	136,450 kWh / yr
Single 15' Wind Turbine Potential:	1,201 kWh / yr

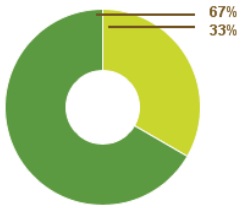
*PV efficiencies are assumed to be 5%, 10% and 15% for low, medium and high efficiency systems

Annual Carbon Emissions



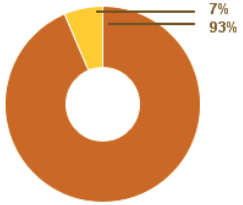
	(tons / yr)
Electricity Consumption	86
Fuel Consumption	38
Roof PV Potential (High Efficiency)	-122
Single 15' Wind Turbine Potential	-1
Net CO₂	1

Use/Cost



Electricity	33%	$7,855	96,617	kWh
Fuel	67%	$5,221	6,591	Therms
		$13,076		

Energy Use: Fuel

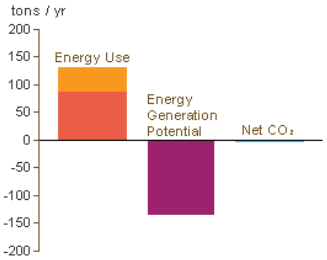


			(Therms)
HVAC	93%	$4,885	6,167
Domestic Hot Water	7%	$335	423
		$5,220	6,590

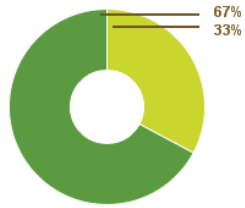
Museum building Without projection

Roof Mounted PV System (Low efficiency):	49,046 kWh / yr
Roof Mounted PV System (Medium efficiency):	98,092 kWh / yr
Roof Mounted PV System (High efficiency):	147,138 kWh / yr
Single 15' Wind Turbine Potential:	1,201 kWh / yr

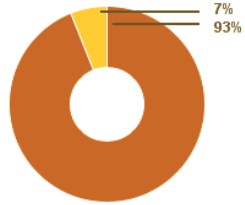
*PV efficiencies are assumed to be 5%, 10% and 15% for low, medium and high efficiency systems



	(tons / yr)
Electricity Consumption	89
Fuel Consumption	40
Roof PV Potential (High Efficiency)	-132
Single 15' Wind Turbine Potential	-1
Net CO₂	-4

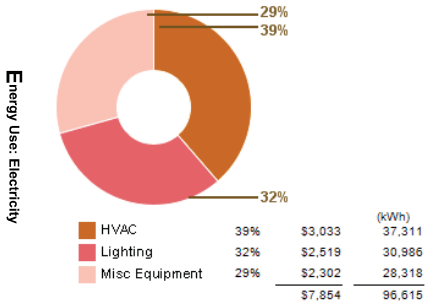


Electricity	33%	$8,133	100,031	kWh
Fuel	67%	$5,543	6,996	Therms
		$13,675		



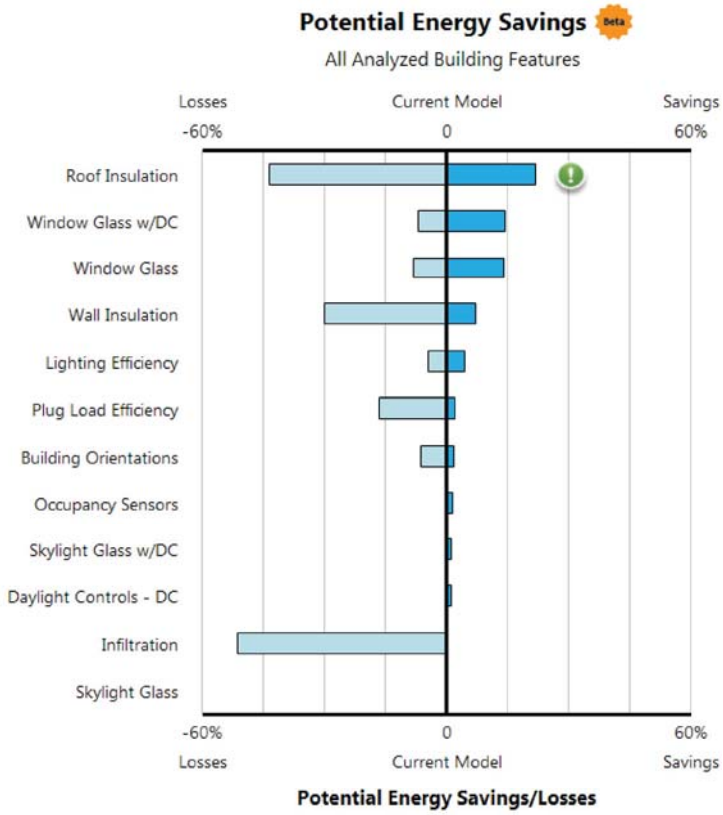
			(Therms)
HVAC	93%	$5,206	6,572
Domestic Hot Water	7%	$335	423
		$5,541	6,995

Museum building With projection



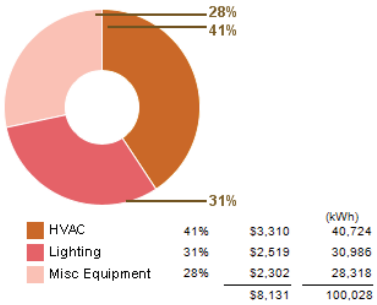
			(kWh)
HVAC	39%	$3,033	37,311
Lighting	32%	$2,519	30,986
Misc Equipment	29%	$2,302	28,318
		$7,854	96,615

Energy Use: Electricity

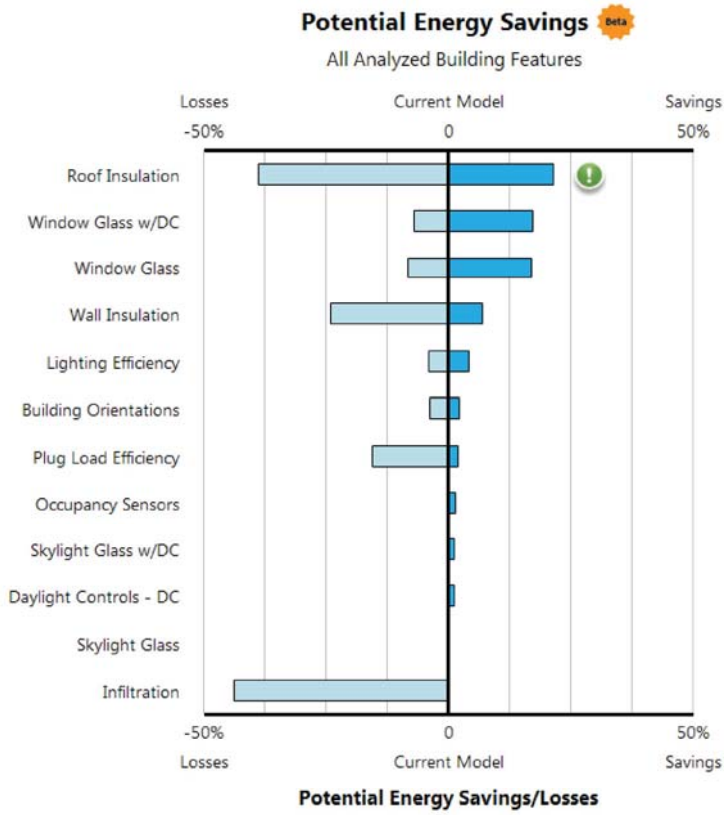


Potential Energy Savings

Museum building Without projection



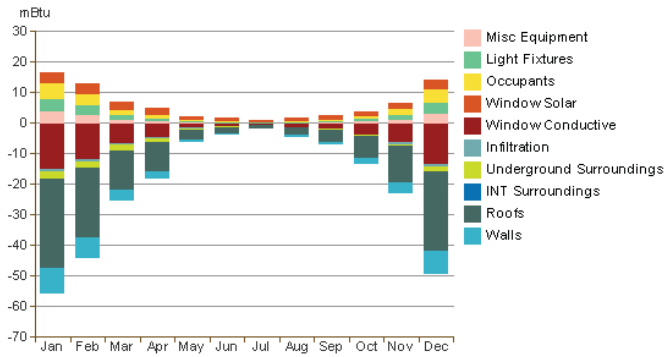
			(kWh)
HVAC	41%	$3,310	40,724
Lighting	31%	$2,519	30,986
Misc Equipment	28%	$2,302	28,318
		$8,131	100,028

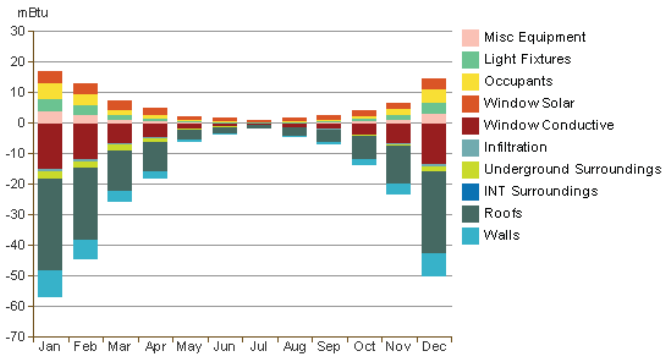


Museum building With projection

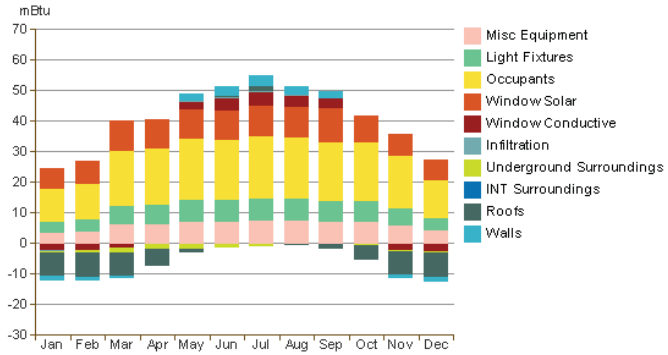
Museum building Without projection

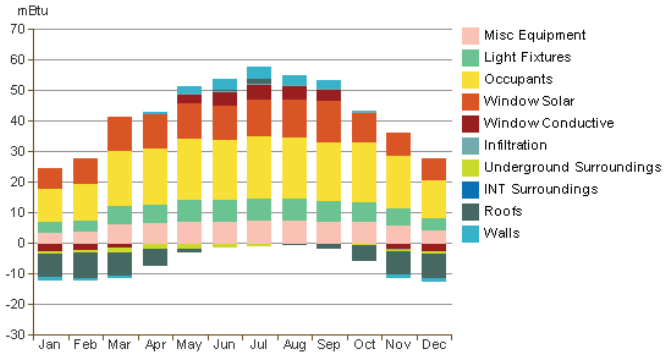
Monthly Heating Load



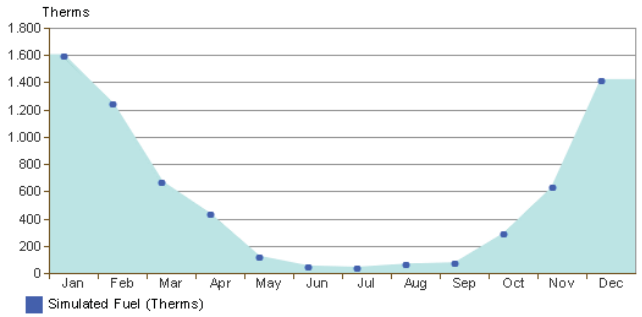


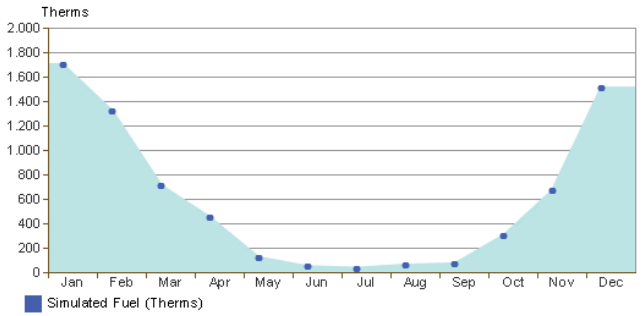
Monthly Cooling Load





Monthly Fuel Consumption





Bibliography

1. Alfons Rogenberg (1984): Einfuhrung in das Symbolverstandnis
2. Sudarshan Raj Tiwari: Temples of Nepal Valley
3. Tasha Brandstatter: Symbolism in Islamic Architecture
4. Kenneth Frampton: The case for the Tectonic
5. Francesco Defilippis - Architecture and Stereotomy - The Relation Between the “Construction Apparatus” and the “Decorative Apparatus” of the Cut-Stone Vaults and Domes of Philibert de l’Orme and Andrés de Vandelvira -Francesco Defilippisd Andrés de Vandelvira
6. http://www.panoramio.com/photo/12780360
7. http://mooponto.files.wordpress.com/2012/09/094.jpg
8. http://www.victorianweb.org/art/architecture/indian/14.jpg
9. https://returningtokentucky.files.wordpress.com/2013/09/lincolnmarriagetemple_6678.jpg
10. http://commons.wikimedia.org/wiki/File:Char_narayan_temple_patan_sunita_(3).JPG
11. http://en.wikipedia.org/wiki/Sanchi
12. http://www.pinterest.com/pin/236650155391055206/
13. http://arch5541.wordpress.com/2012/10/12/tadao-ando-church-of-light/
14. http://whiterabbitchase.com/245/church-of-light/
15. http://www.shahjahanmosque.org.uk
16. http://en.wikipedia.org/wiki/Shah_Jahan_Mosque,_Woking
17. http://commons.wikimedia.org/wiki/File:Lincoln_Marriage_Temple.jpg
18. https://returningtokentucky.wordpress.com/tag/richard-berry-cabin/
19. http://commons.wikimedia.org/wiki/File:Char_narayan_temple_patan_sunita_(3).JPG
20. http://kathmandu-valley-temples.com/ktmvalley_php/main.php?site=rundgang&object=10__Patan_Darb/2__Mangal_Baz/2__Patan_Darb/5__Char_Naray
21. http://www.panoramio.com/photo/65881743
22. http://www.elephantjournal.com/2009/07/want-70s-groovin-polyester-swinger-music-tron-style-3d-animation-buddhism-here-you-go/