Ain Shams University
Faculty of Engineering
Department of Architecture

REFLECTION OF TECHNOLOGY ON THE INHERITED CONCEPTUAL DESIGN OF MOSQUES

A thesis submitted to the Faculty of Engineering - Ain Shams University in partial fulfillment of the requirements for
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Statement

I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

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In the Name of God,

The Most Gracious, The Most Merciful

"The mosques of Allah shall be visited and maintained by such as believe in Allah and the Last Day, establish regular prayers, and practice regular charity, and fear non except Allah. It is they who are expected to be on true guidance"

God Almighty has spoken the truth

Al-Tawba (9:18)

Acknowledgment

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Abstract

The purpose of this study was to investigate the potentials of the new technology and its contribution in developing design concepts and the inherited values of mosques. Also the purpose of this study was to classify mosques architecture according to the architectural design approaches and describe the characteristics and development of each approach. The thesis also introduced the latest twenty first century technology applications, including materials, construction systems and techniques, building facilities, using computer aided software, and proposed the appropriate tools and techniques that can be used in mosques design in general. In this research, the analytical study was conducted in two procedures; firstly, thirty mosques projects, selected in a timeline from 1975 to 2010 A.D, were analyzed and evaluated accordingly in terms of a design analysis framework (Design concept, design approach, functional values, symbolic, aesthetic aspects and technology used). Secondly, a comparative analysis table was plotted to show the weight of the technologies used in mosques case studies on each value using the same framework. Finally, a detailed analysis was illustrated to verify the new technologies used in the case studies, and how it affected the inherited values of the mosque.

The results showed that the use of technologies advanced and developed the innovative aspects of architects imaginations and design concept, which led to a new mosque images and types, and also developed the technological aspects represented in the use of new innovative construction elements, configuration elements, materials and building facilities that utilized rapid development in building systems and integrated services, ensuring a degree of comfort for its occupants, rather than a concern for aesthetic emotions or spiritual contemplation, which are the main essence of Islam.

Key words: Inherited Values of Traditional Mosque Architecture, Spirituality and Mosque Architecture, Traditional Typologies of Mosques, Mosque Design Approaches, Technologies of Mosques Architecture.

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Glossary of Terms

A.D. — Is the Latin abbreviation for Anno Domini, the term has long been used to indicate the number of years that have passed since the birth of Jesus Christ.A.D. is used with dates in the current era (C.E), which is considered the era since the birth of Christ.The counterpart to Anno Domini is B.C. for "Before Christ."

adhan—the daily call to prayer, delivered by the muezzin

A.H. — Is the Latin abbreviation for Anno Hijra,is the year-numbering system used in the Islamic calendar. It commemorates the Hijra or emigration of the prophet Muhammad (pbuh) and his followers to the city of Yathrib, the first capital of the Islamic religion, known as Medina in 622 A.D.

Caliph—Arabic for successor. The Qur'an (II: 30) describes Adam as the primordial norm and as Caliph, the representative of God on earth. Man in this sense is the vicegerent of God on earth. In a historical context however, the word Caliph referred first to the four rightly guided caliphs after the death of the Prophet Muhammad (Abu Bakr, 'Umar, 'Uthman and 'Ali) and subsequently to any Muslim ruler, in various dynasties.

dar al-imara—governor or ruler's palace in early Islam. Often located behind the *qibla* wall of Friday mosques.

dikka— raised platform from which the words and actions of the *imam* are relayed to members of a congregation

gahiliyya—the pre-Islamic state of paganism.

hadith — a saying or action traditionally attributed to the prophet Muhammed

hajj — pilgrimage to Mecca

hanafi— One of the four Sunni legal schools. The originator of this school was Abu Hanifa al-Nu'man ibn Thabit ibn Zuta (699-767 A.D.), a Persian who studied with Ja'far al-Sadiq in Madina.

hanbali—One of the four Sunni legal schools. The originator of this school was Ahmad ibn Hanbal (780-855 A.D.). His school of law was the strictest amongst the four.

haram — sanctuary within the mosque

hijra — the departure and journey of the prophet Muhammed and his followers from Mecca to Medina in AD 622, thus marking the beginning of the Muslim Era

imam— leader; any adult male who leads prayers during congregational worship in a mosque

isra'—Isra and Mi'raj are the two parts of a Night Journey that, according to Islamic tradition, the Islamic prophetMuhammad took during a single night around the year 621. It has been described as both a physical and spiritual journey The Hadith, supplemental writings about the life of Muhammad. In the journey, Muhammad travels on the steed Buraq to "the farthest mosque" where he leads other prophets in prayer. He then ascends to heaven where he speaks to God, who gives Muhammad instructions to take back to the faithful regarding the details of prayer.

iwan— a chamber that is roofed or vaulted and open on one side (e.g. facing on to the courtyard of a mosque)

jami'—From the Arabic root *jam'*, which means to 'gather things' and literally means mosque. This is why it is used to denote the mosque where the Friday noon prayer is celebrated. It is the principal religious building of Islam. The simplest and earliest form it took was the *riwaq*-mosque; opened arcades overlooking a squarish or rectangular open courtyard.

kaaba—The house of God which is located in Mecca. Muslims face the Kaʻba when they pray and this is the direction to which mihrabs point. It was Ibrahim (Abraham) and his son Ismaʻil who rebuilt the Kaʻba as ordered by God. The Qur'an tells us that God ordered Ibrahim to build a sanctuary at a specific spot in Bacca (XXII:26), another name for Mecca. Ibrahim and Ismaʻil were told that it should be a cube and around a celestial stone, which was preserved nearby a hill in Mecca and then given to Ibrahim by an Angel. This black stone was kept at the eastern corner of the Kaʻba. God then informed Ibrahim to institute the rite of pilgrimage to Mecca.

Khanqah—is a building designed specifically for gatherings of a Sufi brotherhood, and is a place for spiritual retreat and character reformation. A monastery or hostel for sufis or dervishes.

khedive— The title given to the sovereign ruling Egypt from 1867 until 1914 A.D. under the command of the Ottoman Sultan. The first Khedive was Ismaʻil, son of Muhammad Ali.

khutba—Literally means 'speech' or 'sermon', but generally refers to the Friday sermon.

kufi—a rectangular script and one of the oldest types of Arabic calligraphy and the first calligraphic perfection of Islam. Its name derives from the Iraqi town Kufa, which was one of the earliest centeres of Islamic learning. Kufic has many derivatives; *al-kufi al-farisi* or *al-kufi al-baghdadi* and *al-kufi al-maghribi*. It is also the direct ancestor of all the calligraphic styles of Andalusia and of North-West Africa

kursi — a lectern, especially a stand used for a Quran

madrasa — an enclosed loge in a mosque (formerly used by rulers and dignitaries for privacy and self-protection)

maqsura—a protected area at the *qibla* wall of a mosque where the caliph of *imam* leads prayers. Not a feature of mosques at present.

masjid—in general, 'mosque'. The derivation in Arabic of the place-noun is from the root *sjd*, to prostrate. Johns argues however, that the word is a loan word from Aramaic indicating temple, praying place or oratory.

masjid jami'—Friday mosque, Congregational mosque, mosque where the Friday sermon is delivered.

mawlawya—a spiral tower.

musalla—an open courtyard, sometimes with a wall, sometimes without used for worship, but also seems to be historically associated with the smaller *mirbad* and its agricultural uses.

mihrab — the recess or niche in a mosque indicating the direction of Mecca

minaret—tower from which the *adhan* is delivered by the muezzin

minbar — pulpit in a mosque, used for the delivery of the *khutba*

muezzin—the official at the mosque who delivers the *adhan* five times daily

muqarnas — One of the most important decorative elements of Islamic architecture; also called stalactites. They are composed of small arches carved of the building material and arranged on top of each other forming honeycombs. Another definition would be the division of a squinch into a number of small niches.

musalla — an open air place for communal prayer

naskhi—Literally means 'copied'. It is a type of calligraphy that was developed by the wazir Ibn Muqala, and is one of the most widespread styles. This rounded, clearly written script is considered one of the six 'classical hand.

nastal'iq— A type of calligraphy developed in Iran and known also as the farsi script or ta'liq. This script is composed of elongated sweeping diagonals and short ascending strokes. Popularly used for non-Qur'anic Iranian manuscripts, this type of calligraphy was also extensively used by the Ottomans on their buildings and in their manuscripts. Calligraphers who excelled at this script included Sultan Ali al-Mashhadi, Mir Ali and Mir 'Imad

pendetive—curved or faceted inverted triangle of masonry supporting a dome

qibla—the direction of prayer towards Mecca, indicated by the presence of the *mihrab* set in the wall of a mosque.

qubba— Literally 'dome,' often used to refer to a domed mausoleum which contains the grave of a saint or some important personage.

quran— The Word of God revealed to the Prophet Muhammad.

riwaq — portico, a covered area usually along side of a mosque courtyard.

sahn — courtyard of a mosque.

salat—Prayers. Derives from the Arabic root *silla*, meaning link. These are the second pillar of Islam and are performed by Muslims five times a day. In the context of the root, these prayers are a constant link to God. An individual must be ritually pure by performing *wudu'*, ablution, beforehand, and must pray in any clean place oriented towards the *qibla*, i.e. towards the Ka'ba in Mecca. Prayers can be individually or in congregation. The Friday prayer taking place at noon however needs to be in congregation.

sawma'a—a cell or minaret.

sunnah—The traditions of the Prophet Muhammad that forms a huge body of literature. It supplements the Qur'an and acts as a source of guidance for the followers of Islam. Ranging over topics as varied as doctrine, prayer, taxation, government, fasting, pilgrimage, and spirituality, this unique reservoir of religious guidance is an indispensable foundation for the study and understanding of any aspect of Islam.

sura—quran chapter.

squinch—an arch-shaped element spanning a corner, forming the octagonal base of a circular dome.

stucco— Fine plaster carved into low-relief decoration used both in interiors and on exteriors of monuments.

thuluth—a cursive script

Voussoir—Stones shaped like wedges used in the construction of arches.

waqf — a charitable endowment

wudu'— Ablution required to make the believer ritually pure. It is obligatory before prayer, and is composed of washing hands, mouth, face, arms, head and feet.

zulla—'shade', 'shadow', in this context the covered portions of early mosques.

Introduction

The mosque has been the centre of social life for all Muslim communities throughout history since the beginning of Islam, and became an edifice of special significance in the Muslim world. Starting with the simple house of the prophet (pbuh), in course of modification through time and regions has attained a certain degree of architectural magnificence and was established as a distinguished building type that can be categorized as a simple and strictly functional mosque.[1] Hence, in addition to the main function as a place for prayer, the mosque has provided spaces for education, community gatherings, shelters for travellers, and food distribution to the poor. In later periods, the architectural history of the mosque witnessed a gradual evolution from simple spaces to more sophisticated monuments and magnificence of Ummayad's, Abbasid's, Fatimid's', Mamluk's, Timurid's and Ottoman's. These forms were developed over the centuries into distinctive architectural forms including the hypostyle, the four *iwan*, the domed central space, the three-domed and the pavilion style mosque. [2]

In the nineteenth century, the mosque architecture was influenced by direct imitation of the Western models, and there was a combination of eastern and western styles. Conversely, in the twentieth century, several architectural schools appeared in the west, focusing on the materialistic values of the industrial revolution, the schools called for an architectural reformation in which shapes are simplified to replace former decorations. Nowadays, the twenty first century is witnessing the highest point of the High-Tech movement, in introducing new materials, construction techniques, and building facilities that has been developed during the past thirty years. Digital design technologies play a significant role in assisting architects through conceptual architectural design, in generating various images of the early design phase and can contribute to seeking alternative architectural forms. The idea is to ease the building

[1] Serageldin, Ismail & Steele, James (Eds.). *Architecture of the contemporary mosque*. Great Britain: Academy Editions, 1996, pp.8-10.
[2] Dogan, Kuban. *The mosque and its Early Development*, part I, Netherlands: Leidene E.J Brill, 1974, p.1.

realization and create a degree of comfort for its occupants. This has led to the evolution of a new concept of intelligent buildings that integrates new technologies from such areas as computer automation, new building materials, energy management and operation technology. The resulting building/space has the ability to adjust and adapt to its occupants**.** The modern mosque to a great extent has gained complexity and many specialized professionals from many related disciplines participated in the design process.[1]

Research Problem

Nothing generates a higher degree of critical polemicist today than the question of appropriate connection between the spiritual and secular aspects of religious architecture in Muslim and Non-Muslim societies. In the past, mosque architecture was clearly the product of manual aesthetics, based on recognisable traditional forms, today it has become the product of machine aesthetics producing stereotyped buildings quickly, using the full range of industrial materials and technology available without specific conceptual and methodological tools for creation and execution. It has become more difficult, therefore, to define the typology of the mosque, and to track the development occurred in each approach.[2]

The research main problem is the lack of design framework and critical approach of the architecture of the mosque, which will provide a conceptual matrix into which projects should be analyzed, and evaluated to enrich the understanding of the mosque significance examined, taking into account its inherent design challenges, principally the reconciliation of tradition and innovation.[3]

[1] "What impact has technology had on architecture of the 20th century." Web. 24 April 2012.

[2] Fethi, Ihsan (Au.) & Cantacuzino, Sherban (Ed.). *Architecture in Continuity*: *The mosque today*. New York: Aperture, 1985, pp.53-59.

[3] Serageldin, Ismail & Steele, James (Eds.). *Architecture of the contemporary mosque*. Great Britain: Academy Editions, 1996, p.7.

Research Goal

The research main goal is setting a design analysis framework within which projects should be analyzed, based on the traditional concepts, values that were used throughout Islamic periods in mosques design, and technologies. In order to identify the potentials of new technology and its contribution in the development of mosques design concepts and approaches.

Research Objectives

To fulfill the research goal, the following objectives must be achieved:

1. Explore the origins, the historical evolution of mosques architecture and different typological forms during Islamic Eras.

2. Identify mosques' key concepts and principles derived from *quran* and *hadith*.

3. Identify the design approaches of mosques and describe the characteristics of each approach.

4. Identify the potentials of new technology and its contribution in the development of mosques design concepts and approaches.

5. Explore the potential of digital architecture, intelligent technologies, and computer aided technologies, and also explore the latest applications of these technologies in the twenty first century, that can be used in mosques.

6. Analyzing mosques projects built during late 20^{th} and early 21^{st} centuries, using the design framework.

Research Scope and Limitations

The scope of the research focuses on the contribution of new technology, and its impact in developing traditional design values and concepts. The case studies selection focuses on the mosque as a praying space rather than focusing on the secondary spaces incorporated to the mosque, and will be selected with respect to high architectural significance and a strong representation to a design approach. The analysis will be based on the framework derived from the studies in chapter one and two, and will be applied on mosques' projects constructed within the last three decades, during a time period between late 20th and early 21st centuries (1975s-2010th), in Muslim and Non-Muslim societies.

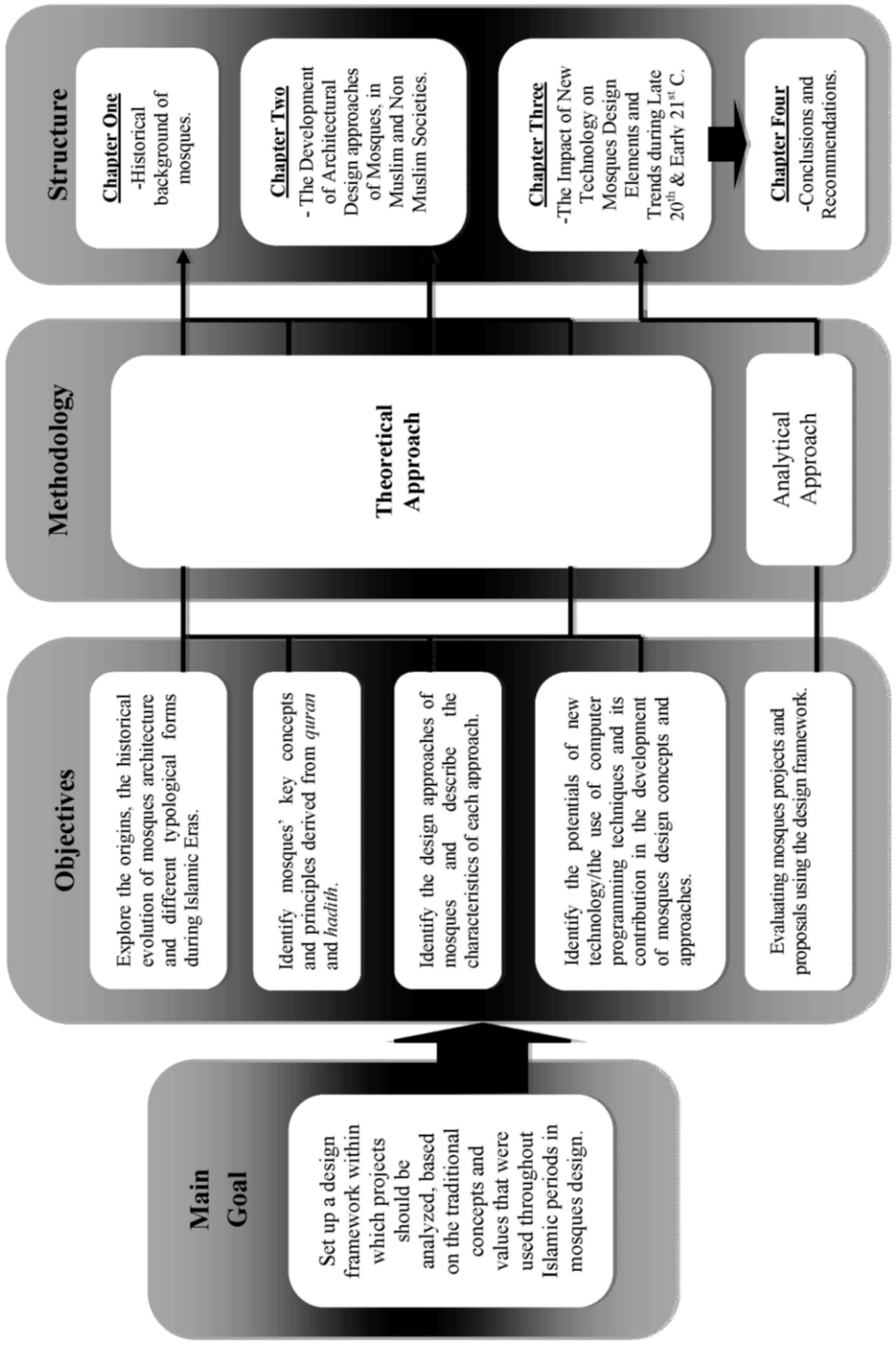
Research Methodology

The research follows Theoretical and Analytical methodologies to fulfil the objectives previously mentioned.

- **The Theoretical Methodology** will be applied on objectives 1 and 2, to explore the origins and historical development of mosques architecture during Islamic eras, the different typological forms, as well as mosques' key concepts and principles derived from *quran* and *hadith,* in chapter one, in order to derive the inherited values of the traditional mosque design. This Methodology will also be applied on objective 3, to understand mosques' architectural approaches, by describing the range of characteristics of each approach, and will be applied on objectives 4, and 5, to introduce the latest applications of high technology architecture of the 21st century, in chapter two, in order to derive the common design approaches, and the technologies of the 21st century.

- **The Analytical Methodology** will be applied on objective 6, where mosques' built during late 20th and early 21st centuries will be evaluated using the design analysis framework derived from the theoretical study that was mentioned previously, in chapter three.

The following diagram shows the relation between the goals, the objectives, the methodology, and the content of the research.



Research Contents

The research comprises four chapters presenting the following:

Chapter One: Historical Background of Mosques' Architecture.

This chapter will discuss the meaning and early functions of the mosque, its early origin starting from the house of the prophet (pbuh) in Medina, till the Ottoman Patronage era, from Spain and North Africa to China and South East Asia. The chapter will also define mosques' key concepts and principles derived from *quran* and *hadith* and the Islamic values of architectural expressions. In addition to that the chapter will study briefly the historical development of mosques architecture as well as the inherited values of the traditional mosque and the different typological forms.

Chapter Two: The Development of Architectural Design approaches of Mosques, in Muslim and Non Muslim Societies.

This chapter will discuss the mosque architecture design approaches, the relation between the traditional development and the modern technology, the effect of colonization on Muslim societies and how modernism and western models have dominated design concepts in eastern societies, and the role regionalism played in diverse Muslim countries.

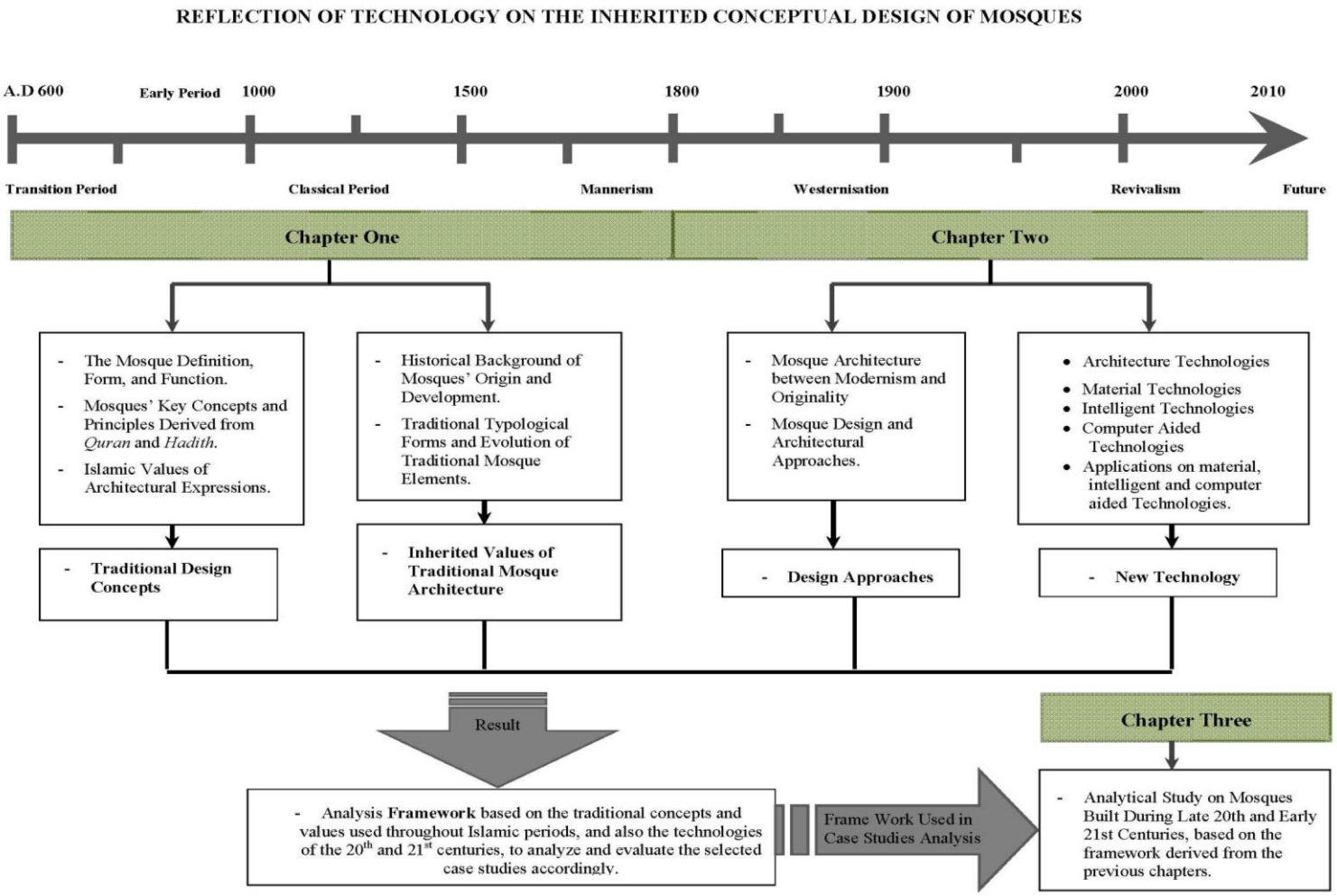
The chapter will describe briefly the meaning, characteristics and concepts of technology, and will shed some light on digital architecture, and using computer software programming techniques. Intelligent building technologies and the use of smart materials will also be mentioned, which provide both the building operator and occupant with an environment that is flexible, effective, comfortable, and secure. The chapter also will introduce applications of architecture technology of the 21st century, in order to identify the appropriate tools and techniques to be used in mosques.

Chapter Three: The Impact of New Technology on Mosques Design elements and Trends During Late 20th and Early 21st Centuries.

This chapter will analyze mosques constructed during the late 20th and early 21st centuries using the design analysis framework derived from chapter one and two, in order to identify the contribution of new technology in developing design concepts and elements of mosques.

Chapter Four: Conclusions and Recommendations.

The following diagram shows the research structure.


REFLECTION OF TECHNOLOGY ON THE INHERITED CONCEPTUAL DESIGN OF MOSQUES
A.D 600
Early Period
1000
1500
1800
1900
2000
2010
Transition Period
Classical Period
Mannerism
Westernisation
Revivalism
Future
Chapter One
Chapter Two
- The Mosque Definition, Form, and Function.
- Mosques' Key Concepts and Principles Derived from Quran and Hadith.
- Islamic Values of Architectural Expressions.
- Historical Background of Mosques' Origin and Development.
- Traditional Typological Forms and Evolution of Traditional Mosque Elements.
- Mosque Architecture between Modernism and Originality
- Mosque Design and Architectural Approaches.
- Architecture Technologies
- Material Technologies
- Intelligent Technologies
- Computer Aided Technologies
- Applications on material, intelligent and computer aided Technologies.
- Traditional Design Concepts
- Inherited Values of Traditional Mosque Architecture
- Design Approaches
- New Technology
Result
Chapter Three
- Analysis Framework based on the traditional concepts and values used throughout Islamic periods, and also the technologies of the 20th and 21st centuries, to analyze and evaluate the selected case studies accordingly.
Frame Work Used in Case Studies Analysis
- Analytical Study on Mosques Built During Late 20th and Early 21st Centuries, based on the framework derived from the previous chapters.

REFLECTION OF TECHNOLOGY ON THE INHERITED CONCEPTUAL DESIGN OF MOSQUES

Chapter One: Historical Background of Mosque Architecture

Explores the origins and historical development of mosques architecture during Islamic eras, as well as the inherited values of the traditional mosque design, and different typological forms. The chapter will also identify mosques' key concepts and principles derived from *quran* and *hadith.*

1. The Mosque: Meaning and Function
-Definition
- Defining Mosques' Key Concepts and Principles derived From Quran and Hadith.
- Islamic Values of Architectural expressions

2. Historical Background of Mosques' Architecture
- The Mosque of the Prophet, Historical Background
- A Brief History of Mosques Architecture During Islamic Periods

3. The Traditional Architectural Typologies of Mosques
- The Hypostyle Mosque
- The Dominant Central-Dome Mosque
- The Four Iwan Mosque
- The Triple-domed Mosque
- The Detached Pavilions Mosque

4. The Inherited Values of Traditional Mosque Architecture

- **The Functional Values**
- Architectural Elements
- Structural Elements
- Materials
- Illumination and Ventilation Principles of Mosques
- **Aesthetic Values**
- **Symbolic values**

Conclusion

The mosque represents Islamic culture, civilization and identification. The specific liturgy and functional requirements of most mosques did not dictate any particular architectural and physical layout other than a clean space with an indication showing the direction to Mecca.

Architecture of mosques in the early period of Islam was characterized by simplicity and relied fully on local building materials and domestic techniques. The form of the mosque evolved not only to synthesize local architectural elements, but also more importantly to integrate details resulting from the availability of material and responses to climatic conditions, cultural traditions and available technologies.

Studying briefly the historical development of mosques, elements and typologies showed that the functional values, the aesthetic values and the symbolic values, form the inherited values of the traditional mosque design.

Chapter One

Historical Background of Mosque Architecture

In all Muslim societies, the mosque was the most important building in the community. The mosque provided a sense of identity and place, and has a special central role on Fridays, as it may be equal to that of the cathedral in Christian societies of the west, and it was developed as a landmark and congregational point.[1] The Muslim world stretched from Spain and North Africa to China and South East Asia and the history of its architecture began in the seventh century of the Christian era.[2]

This chapter will discuss the early origin of the mosque, starting with the house of the prophet (pbuh) in Medina; which was intended to abide by the commandment of Allah, convey His message to the whole humankind and serve the society, till the Ottoman Patronage era, in addition to the development of the traditional elements of the mosque, and the different styles that reflected the characteristics of different regions, through the Islamic history. The chapter will also discuss the design concepts and Islamic values of Muslims architecture and its direct relation to the design approach that affects the functional and the aesthetic inheritance of the mosque.

[1] Serageldin, Ismail & Steele, James (Eds.). *Architecture of The Contemporary Mosque*. Great Britain: Academy Editions, 1996, p.8.

[2] Frishman, Martin & khan, Hasan-uddin (Eds.). *The Mosque; History, Architectural Development and Regional Diversity*. London: Thames & Hudson, 1994, p.11.

1.1 Definitions

1.1.1 Mosque

The 'Mosque' is the principle religious building of Islam, the word "mosque" comes from the Arabic word *'masjid',* and it is derived from the root *sajada,* 'to prostrate', it is used in the *Quran* to denote a place of worship for daily private prayer. The *jami',* which derives from the Arabic root meaning 'to assemble', the place has to accommodate thousands of worshippers in praying times, "Goma'a" Friday prayer and feasts.[1]

1.1.2 Tradition

The word tradition refers to set of beliefs or practices that are common to and in current usage among a specific group. Beliefs encompass a worldview, cosmological concepts, values and ethics. Tradition is an essential part of the living culture of people. Traditions usually pass from one generation to the next. Perhaps due to its longevity, tradition acquires a common identity with its respective social group and is deeply embedded in the culture. The fundamental principal or prerequisite for Islamic architecture is the Islamic faith upon which its traditions are built and are based upon divine principals stated in the *quran* and the *hadith.*[2]

1.2 The Mosque: Meaning and Function

Mosques are quite simple oriented and enclosed spaces dedicated for prayer. *Salat* is one of the five pillars of Islam, as all Muslims should worship five times a day and in congregation at noon on Fridays. Congregational prayer is lead by an *imam* who then delivers the *khutba* and leads the congregation in synchronized prayer with prescribed movements. The *Salat* is performed facing Mecca and consists of specific ritual stances (bowing, genuflection, prostration)

[1] Hillenbrand, Robert. *Islamic Architecture: Form, Function and Meaning*. New York: Columbia university press, 1994, pp.43-44.

[2] Petruccioli, Attilio & Pirani, Khalil K. (Eds.). *Understanding Islamic Architecture*, London: Routledge/Curzon, 2003, p.27.

and speaking the worship liturgy. The physical movements of the *salat* require a minimum space of 1 × 2 meters for each worshipper, forming relatively few and long rows parallel to the *qibla* direction and a clear view of the *imam* to facilitate precise timing. The short rows and depth of Christian basilicas made them impractical for Muslim worship and were rejected as an inspiration for mosque design early on pushing Islamic architects to develop a unique typology.[1]

Islam is a monotheistic religion originated in the Arabian Peninsula in 610 A.D, when its adherents believe that the Angel *Gabriel* revealed to the Prophet Muhammad (pbuh). At that time most people in the region were polytheistic and practiced paganism. The Prophet has received the divine messages and started to preach to the people of Mecca, urged them to believe in one indivisible Allah and in the *quran*. The *quran* formulates the traditional Islamic laws that worshipers shall follow and live thereupon.[2]

One of the primary functions of the mosque is to serve the community. As for charity, or *zakat*, it is one of the five pillars of Islam, mosques are also supposed to help the poor Muslims in their communities, and another role the mosque has to play is to embody the socio-political activities. Mosques formed the nucleus of the Muslim community and were located at the centre of the city, and also served as space used to promote civic participation, protests and to sign petitions.

Additionally, mosques have a major educational role to play, as they provide learning activities as a kind of Islamic institutions or schools. Traditionally, *Madrasas* are separate buildings that have an important educational role helping Muslims to study and to prepare them to be *imams*.[3]

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[1] Hillenbrand, Robert. *Islamic Architecture: Form, Function and Meaning*. New York: Columbia university press, 1994, p.36.

[2] Piotrovosky, Mikhail B., *Art of Islam: Heavenly Art Earth Beauty*. Amsterdam: Lund Humphries, 2000.

[3] Khachan, Lucie G., "Form and Function of Northeast Ohio Mosques." Msc. Dissertation, University of Akron, 2008, pp.18-19.

1.2.1 Defining Mosques' Key Concepts and Principles Derived From *Quran* and *Hadith.*

1.2.1.1 The Mosque in *Quran*

In the houses [of worship], which God has allowed to be raised so that His name is remembered in them, there [are such as] extol His limitless glory at morn and evening – (Quran, 24:36). Unlike other religions the notion of sacred space does not apply to the Mosque.

Concept derived: The Mosque is a congregation point of the community.

1.2.1.2 The Idea of the Mosque in the *Hadith*

'I was not commanded to build high mosques'…Thus, from the *Hadith* we can understand that the idea of the mosque does not approach a monumental building meant for a single ritual worship act. The Prophet's Mosque in Medina was used as a social, political and religious centre. The approach of the mosque is not only for a single set of ritual worship but more of a kind of social centre.

Concept derived: The Mosque is a synergic space – Multiuse of space

1.2.1.3 Prayer and the Mosque

Prayer is universally accepted to be the basic reason for the existence of the mosque. Hence, this forms the most important function that the Mosque should cater for. This space defining the mosque has to be suitable for prayer – clean as one prostrates with his face in this surface.

Concept derived: Cleanness of Space

The congregational prayer is performed in straight rows parallel to *qibla* wall. The Prophet said, "Straighten your rows as the straightening of rows is essential for a perfect and correct prayer"

Concept derived: Rows of prayer

1.2.1.4 The Mosque and the Spatiality of Prayer

Several prophetic sayings, such as, “Wherever you pray, that place is a mosque,” and, “I have been given the whole earth as a sanctuary,” raise questions about how and why an identifiable mosque architecture emerged and developed. In its formal and compositional characteristics, the typical mosque remains an intriguing phenomenon that is at once simple and complex.

Concept derived: The importance and relevance of space versus expression

1.2.1.5 Prayer as Visualization

Islamic prayer requires no tangible object, such as an icon or a statue, to induce a sense of divine presence and serve as a support for worship. Visual engagement is therefore unnecessary. The only visual engagement it requires is that whereby Muslims orient themselves toward the *qibla*.

"And from whence-so-ever you start forth (for prayers) turn your face in the direction of (the Sacred Mosque of Mecca) Al-Masjid-ul Haram."(Quran: 2:149)

Concept derived: Directionality

From these definitions of Mosque under the light of *qur'an* and *hadith*, the conceptual features of the Mosque, which could serve as principles and criteria for generating the Mosque as a multivalent space can be sorted to:

1. Directionality

2. Prayer space

3. Cleanness of space

4. Rows of prayer

5. Multiuse of space [1]

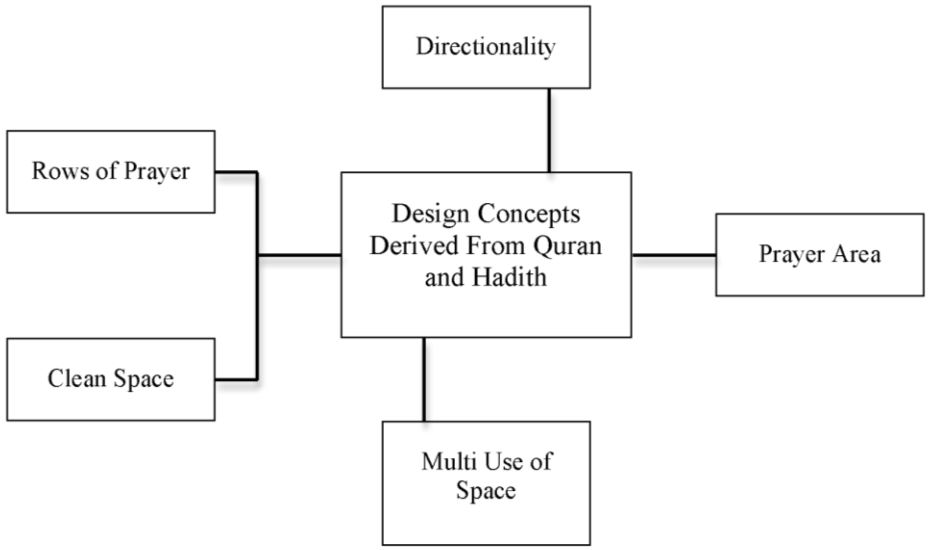

Diagram (1.1): The Idea of the mosque in Quran and Hadith (Source: Author)

1.2.2 Islamic Values of Architectural Expressions

The *quran* and the *hadith* have provided the main sources of values and legislation for Muslims as a society and individuals at the same time. Muslims have introduced new building typology, elements and techniques and used the available construction methods, skills and materials that were locally available to build their cities.

1.2.2.1 Islamic Values

- Privacy

Islam introduced a strong base of social privacy, which has had a direct effect on buildings designs. The entrance hall became indirectly accessible through a bent entrance, and also providing separate entrances for both men and women.

[1] Shyqeriu, Banush. "Synergic Spaces – Mosque." Msc. Dissertation, Anhalt University of Applied Science, Germany, 2009. 17 April 2009. Web. August 2011.

- Simplicity

Simplicity is one of the Islamic concepts that encourage Muslims to respect others and to show unpretentiousness. Humbleness also implied a simple and human scale structure and to avoid the grandiose look to emphasize on the belief of Muslims goal to achieve the eternal reward in Heaven rather than the current short life. Simplicity also encouraged cost effective solutions in buildings, by utilizing the available materials, skills, construction methods and style.

- Abstract elements for ornamentation

Islam strictly prohibited embodiment in arts, as well as the use of human figures and animals. Therefore, Muslims seek abstract elements for decorations. Floral and plant motifs with the use of Arabic calligraphy and geometric patterns became the main elements of ornaments in mosques.

1.2.2.2 Techniques and elements adopted by Muslims

- Comfort and climatic Adaptation

Muslims have adapted and developed climatic solutions in harsh areas. Cooling the microclimate within the living spaces, blocking dust and providing extensive shading. The courtyard has provided negative pressure element that worked within the wind catchers to create an aerodynamic system within the space. Moving the air within the built environment, and attracting the breeze has effectively provided comfortable spaces.

- Architectural/Structural Elements

The most important element in the mosque is the indication of the *qibla* direction; this idea was interpreted into a praying space identified by a wall with an inserted niche indicating the *qibla.* The other inherited elements as the domes, arches, *mihrab*, *minbar*, etc. were added according to functional purposes and also inherited by local builders from their byzantine legacy during the Umayyad, Abbasids, Mamluks, and Ottomans architecture.[1]

[1] Stierlin, Henri. *Encyclopedia of World Architecture*. United Kingdom: Macmillan Press, 1983.

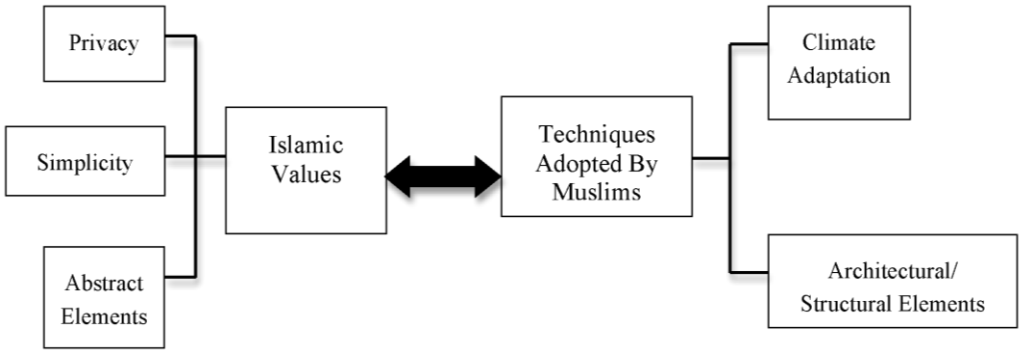

Diagram (1.2): Islamic values and adopted techniques (Source: Author)

1.3 The Historical Development of Mosques' Architecture

The history of the mosque shows a slow but definite evolution from the simple utilitarian models of early Islam to the unsurpassed monumentality and magnificence of Ummayad's, Abbasid's, Fatimid's', Seljuk's', Safavid's, Mughal, and Ottoman's. The history also shows a continuous evolution in mosque architecture, even within one region. Islamic architecture as known today is the result of a long synthesis of a number of cultural interactions and adaptations, and what gives Islamic architecture its vitality comes from the great variety of regional contexts that together form an overall unity.[1] (Fig.1.1)

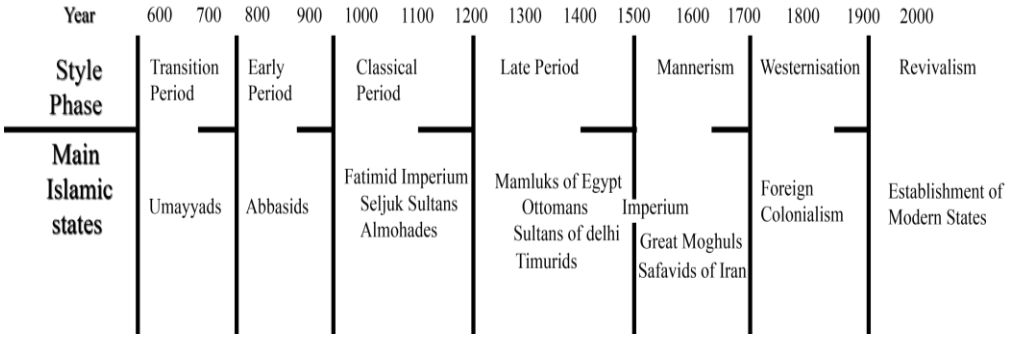

Fig. (1.1): A general classification of the Islamic architecture periods. (Source: Introduction to Islamic Architecture, 1986, p22)

[1] Fethi, Ihsan (Au.) & Cantacuzino, Sherban (Ed.). *Architecture in Continuity*: *The mosque today*. New York: Aperture, 1985, p.60.

1.3.1 The Mosque of the Prophet, Historical Background.

Historically, the development of the mosque architecture started with the Prophet's house in Medina in 622 A.D, the house was a mud brick structure with a square large courtyard at its centre, and it contained two rooms, which was increased later to nine for the accommodation of the Prophet and his wives, which were erected outside the wall. This building became the model for the mosque architecture; an open or covered courtyard with a prayer area against the *qibla* wall, which at first faced the direction of Jerusalem and then turned to face Mecca in 624 A.D. The roofs of the prayers area were supported by columns made of wood, double row of palm trunks carrying a roof of palm leaves, plastered with mud. This feature was not part of the original design but was added later as one of the prophets companions complained of the discomfort of the sun during prayer.[1]

There were three entrances to the courtyard; the main entrance lied on the *qibla* wall axis. Bilal[*], the first muezzin of Islam, called to prayer from the roof of the mosque. There was no *minaret* or *mihrab* at that time. A two-stepped platform was provided for the prophet to address the congregation, thus becoming the first *minbar*. The Prophet's mosque was also more than a prayer yard, it was a place where people learned from the prophet and was the centre of civic activities in Medina.[2] (Fig.1.2).

The simple design was a direct response to the functional needs of the community of worshippers; it didn't ascribe any complicated significance to the structure or the layout and underlined the simplicity of the radical monotheism of Islam, where the bond between Allah; the Creator and His submissive subjects is direct and without intermediation.[3]

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[1] Hillenbrand, Robert. *Islamic Architecture: Form, Function and Meaning*. New York: Columbia university press, 1994, p.39-40.

[*] Bilal, (580-640 A.D.) was an Ethiopian companion of the prophet Muhammad, born in Mecca who is considered as the first muezzin.

[2] Frishman, Martin & khan, Hasan-uddin (Eds.). *The Mosque; History, Architectural Development and Regional Diversity*. London: Thames & Hudson, 1994, p.77.

[3] Serageldin, Ismail & Steele, James (Eds.). *Architecture of The Contemporary Mosque*. Great Britain: Academy Editions, 1996, p.9.

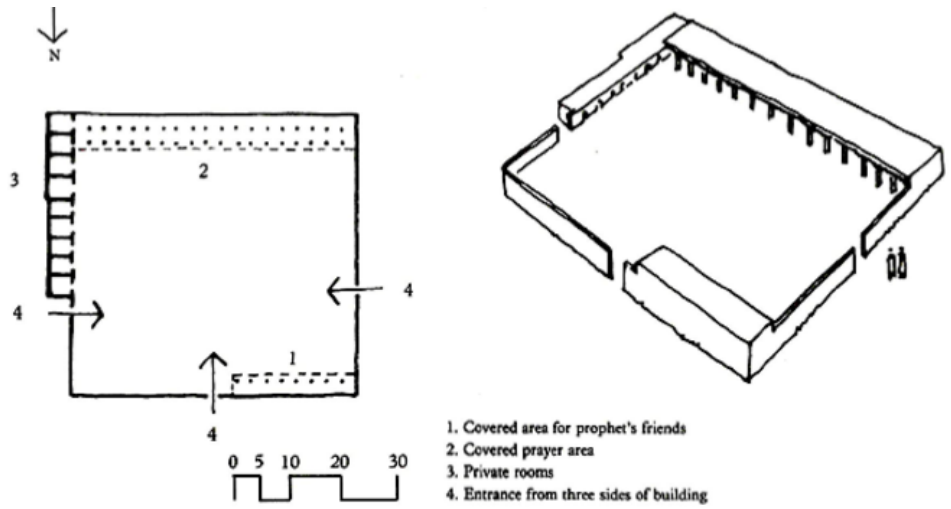

Fig. (1.2): The house of the prophet in Medina, Saudi Arabia. (Source: Hakim, 1986, p.70)

1.3.2 A Brief History of Mosques Architecture During Islamic Periods.

Frequently during the early Arab conquests, churches, synagogues or fire temples were converted into mosques. The common use of churches by Christians and Muslims occurred in many newly conquered cities. The mosque built in Basra (635 A.D.), was a *musalla*; an open area delimited by a line traced on the ground. Tabari[*] said that the mosque built in kufa (636 A.D.), covered a square area, the dimensions of which was determined by shooting arrows from a central point and was set-off by ditches from the surrounding area with a roofed but wall-less shelter on the *qibla* direction. Of similar simplicity was the first mosque at Fustat, built by Amr Ibn Al-As[**] (641-2 A.D.); an enclosed shelter with a low ceiling, trunks of palm trees supported the roof.[1]

The next stage in the development of mosque design came after the death of the prophet (pbuh) with the Ummayad dynasty (661-950 A.D.), where

[*] Tabari, (838–923 A.D.) was a prominent and influential scholar, historian and exegete of the quran from Tabaristan, in Iran.

[**] Amr Ibn Al-As (573-664 A.D) was an Arab military commander who is most noted for leading the Muslim conquest of Egypt in 640.

[1] Dogan, Kuban. *The mosque and its Early Development*, part I, Netherlands: Leidene E.J Brill, 1974, p.12.

the first dynasty of Islam was established and architecture expressed the power of this period, although no Umayyad mosques has survived, but the descriptions of the re-building of mosques at Basra (665 A.D.) and Kufa (670 A.D.), showed that the scheme remained the same. In both mosques, there were five aisles on the *qibla* side and two on each of the other sides with flat wooden roofs carried by columns of stone. The *riwaqs* surrounding the courtyard became formal rather than functional element. There was no evidence to the existence of any *minbars* or *maqsuras*. The mosque of 'Amr at Fustat was re-built in (673 A.D.), adopting the similar plan. It was the first mosque to have *sawma'a* at the four corners, by permission of Mu'awiya[*].[1]

The great mosque of Damascus (8th C. A.D.) became the new model, much larger than the modest house of the Prophet; it took a rectangular layout with four *riwaqs*, the *qibla riwaq* being deeper than the other three. An axial dome over the central part of the *qibla riwaq* was used to highlight the importance of the space. A minaret served the dual function of landmark and place from which the *muezzin* called for prayer. This basic design was to spread far and wide into the newly Islamic lands from Spain to India. It is important to note that several other structures have a profound influence on the evolution of the architectural vocabulary of Muslim societies, which don't directly fit into this archetype, (Fig.1.3). One such building is the dome of the rock in Jerusalem, built by Abdel-Malik Ibn Marawan[**] (685-91 A.D.), to mark the place of the Prophet's ascension to heaven in the *Isra'*. The hexagonal scheme adopted for this building reflected the influence of the byzantine church architecture.

[*] Mu'awiya, (602-680 A.D.) was the first Caliph of the Umayyad Dynasty.
[1] Ibid., p.13.
[**] Abdel-Malik Ibn Marawan, (646-705 A.D) was the 5th Umayyad Caliph.

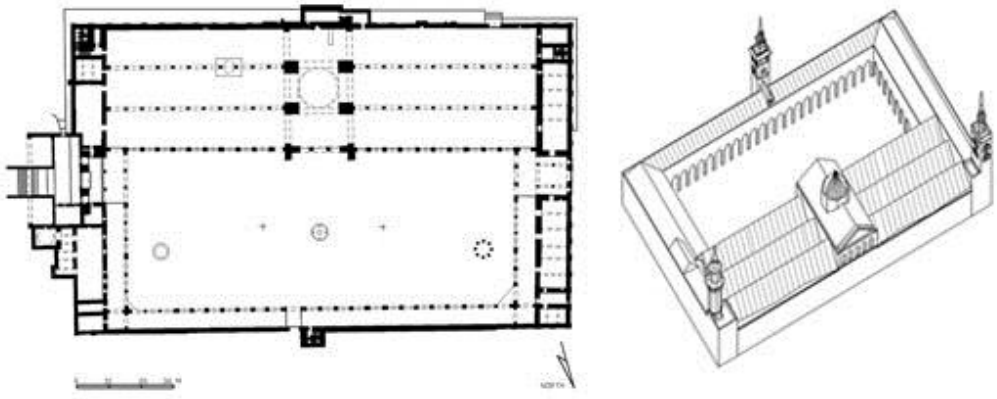

Fig. (1.3): Plan and general view of Great mosque of Damascus. (Source: Archnet.org)

The Abbasid revolution and rule (750-1258 A.D.) didn't bring major changes in the architecture of the mosque, although the evolution of the minaret was influenced by the unusual *mawlwiya* tower of Samarra (842-52 A.D.), the minaret of the mosque stood apart from the north wall and rose above a square base with an external spiral ziggurats stairway. The only other famous minaret with an external spiral stairway is the Ibn Tulun mosque in Cairo, built shortly afterwards in 876-79 A.D. and undoubtedly influenced by it. The *riwaqs* continued to be built with variations of arcades or colonnades, and sometimes with a series of small domes in the squares between columns, as in the mosque of Cordoba, Spain (786 A.D.).[1] The great mosque of Cordoba was an elaboration of the Syrian design, built during the reign of Abdul Rahman I* (785 A.D.), and was enlarged considerably afterwards by his successors. The mosque design had early simple scheme of a courtyard and a hall covered with a wooden roof supported by arcades, apparently were created in the necessity of reusing of columns with insufficient height to which pilasters were added, after which both columns and the upper pilasters were linked by individual arches, (Fig.1.4).

[1] Serageldin, Ismail & Steele, James (Eds.). *Architecture of the Contemporary Mosque*. Great Britain: Academy Editions, 1996, pp.9-10.

* Abdul Rahman I, (731-788 A.D.) was the founder of the Umayyad Emirate of Córdoba (755 A.D.)

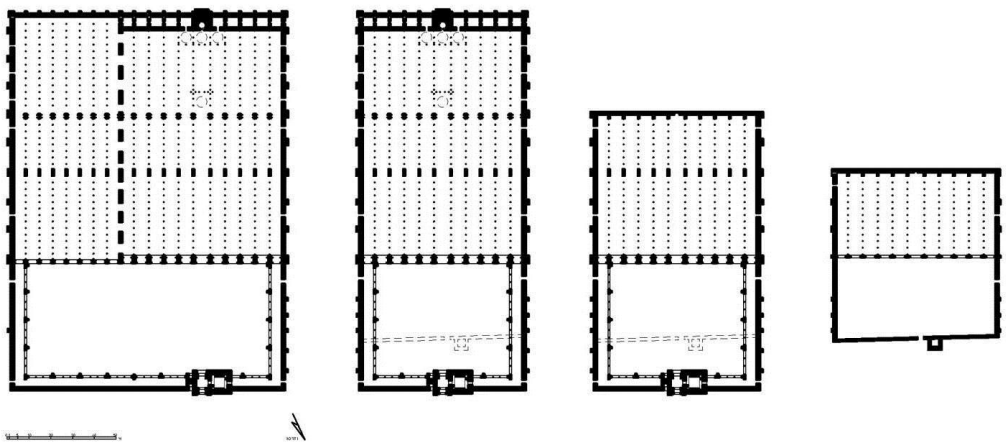

Fig. (1.4): Floor plans of the Great mosque of Cordoba, showing the four phases of development. (Source: Archnet.org)

Variants of this design were found in the Indian subcontinent, with a greater emphasis on the three domed accentuation of the *qibla riwaq* and a larger *sahn* than those found in the central Islamic lands from Morocco to Iran.[1] The Iranian mosque, like some North African mosques, merges with the surroundings; all the surviving mosques were assemblies of building of different periods, domed chambers, and pillared halls, yet having the courtyard with four *iwans* at their core. The *masjid-I jami'* of Isfahan (1366-1367 A.D.), was the most distinguished example of Iranian mosques; its core was the courtyard with four *iwans*, the scheme which became generalized during the Seljuk period. The courtyard was surrounded by arcades with four-*iwans* on its main axes. At the rear of the *qibla iwan*, which was decorated with colossal *muqarnas* elements, with the famous domed chamber for the sultan, where the domed chamber before the *mihrab* approached by four-*iwan* courtyard has been since that time the principal model for all major mosques of Iran and central Asia.[2]

[1] Dogan, Kuban. *The mosque and its Early Development*, part II, Netherlands: Leidene E.J Brill, 1985, p.20.
[2] Ibid.p.7-10.

The political decline of the Fatimid's began in the late eleventh century A.D. with the loss of the Syrian territories to the Seljuks and with invading crusaders. Salah al-din* seized control of Egypt from the crusaders in 1174 A.D, and creating stronger Syrian-Egyptian empire, and introduced the *madrasas* in Egypt, a new *iwan*-type mosque, influenced by Syria and Asia, where the mosque consists of four *iwans* surrounding the *sahn*, each *iwan* was reserved for one sect of Sunni doctrine: *Shaf'i, Malki, Hanafi,* and *Hanbali*. Bent entrances appeared and vestibules were widely used in religious buildings. One or more *mihrabs* were built in the *qibla iwan.* The number of entrances decreased, and became more related to the minaret location. The general scheme was found in the madrasa of al Malik al-Salih Negm al-din Ayub (1242-4 A.D.), and in the mosque of Sultan Hasan in Cairo (1356-62 A.D.).[1]

The evolution of the dome, the vault and the arch all laid to the foundation of the Ottoman domed mosque. This masterpiece of design, pioneered by the incomparable Sinan in the sixteenth century A.D, divided the mosque space into a large courtyard surrounded by a colonnade with arches or domes and then an equal covered area on the *qibla* side covered by a huge central dome supported on half domes and subsidiary structures. The whole complex was framed with two, four or six pencil point minarets to create an ensemble where the whole is much more than the sum of the parts.[2]

1.4 The Traditional Architectural Typologies of Mosques.

A typology is a systematic organization of elements into types based upon shared attributes. The form of the mosque evolved not only to synthesize local architectural elements, but also more importantly to integrate details resulting from the availability of material and responses to climatic conditions, cultural traditions and available technologies. The monumental style of the

* Salah al-din, (1138-1193 A.D.) was the first Sultan of Egypt and Syria, and founded the Ayyubid dynasty.

[1] Michell, George (Ed.). *Architecture of the Islamic World: Its History And Social Meaning*. London: Thames and Hudson Ltd, 1978, p.222.

[2] Serageldin, Ismail & Steele, James (Eds.). *Architecture of The Contemporary Mosque*. Great Britain: Academy Editions, 1996, pp.9-10.

mosque was developed and expanded into numerous types of mosque styles around the world. However, several scholars such as Robert Hillenbrand, Martin J. Frishman and Hasan Udin Khan categorize them under five distinct geographical regions. Each region is being identified with certain typological peculiarities.[1]

These typologies are known as, the Arabian or hypostyle, Turkish or central- dome, Iranian or *Iwan*, Indian, Chinese and Southeast Asia types. The most popular mosque types in the Islamic world are the hypostyle mosque, the central-dome mosque, and the *Iwan* type mosque. The other forms are derived essentially from the three most popular types.[2] These typological peculiarities can be identified as the following:

1.4.1 The Hypostyle Mosque

The hypostyle mosque is commonly found in the Arabian Peninsula, extreme South Western Europe and North African regions. The word hypostyle means "under pillars" and the design allows the construction of large spaces. The hypostyle mosque was introduced by the Umayyads in Syria and later adopted by the Abbasid dynasty that ruled Persia and Iraq. The hypostyle mosque features a large courtyard and a flat-roofed sanctuary,[3] and possibly one or more small domes. It can be described as a walled rectilinear enclosure comprising a rectangular open courtyard; mostly with colonnades laid on a grid pattern around the four sides of it and a pitched roof covering the prayer area located near the *qibla*. This area is known as the sanctuary space supported by either multiple columns or a number of arcades. Commonly, they were made of either slim marble or stone. Some of them were reused from older buildings. Grid patterns of columns created parallel aisles. Such examples are found in the

[1] Buhlfaia, Saeid A., "Historical Background of Libyan Mosque Architecture: Assessment and Criticism of Mosques in Ajdabiya City." Msc. Dissertation, Technical University of Middle East, 2006, p.12.

[2] Rasdi, Mohamad Tajuddin Mohamed, *Muslim architecture in peninsular Malaysia*, faculty of built environment, 2001.

[3] Khachan, Lucie G., *Form and function of northeast Ohio mosques*, Master dissertation, University of Akron, 2008, p 11-16.

mosque of Amr Ibn Al-As mosque in Fustat, Egypt (642 A.D.), the great mosque of Qairawan, Tunisis (670 A.D.), the great mosque of Kufa, Iraq (670 A.D) (Fig.1.5), the great mosque of Cordoba, Spain (784-987 A.D.), and the Great Mosque of Damascus, Syria (709-15 A.D.). [1]

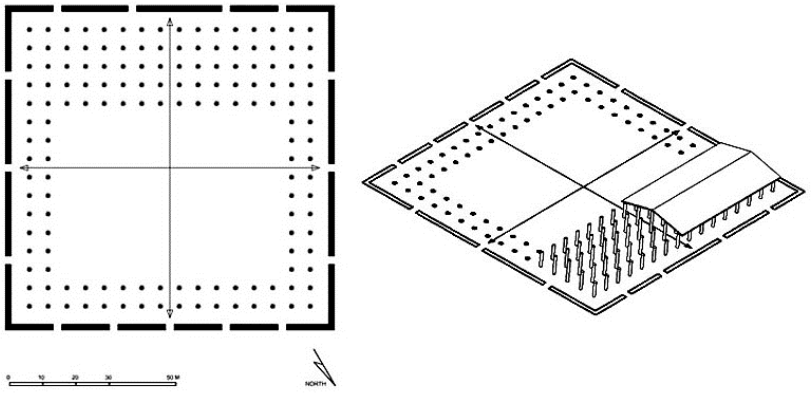

Fig. (1.5): Plan and general view of Kufa mosque, showing the square plan with five aisles on the *qibla* side. (Source: Archnet.org)

1.4.2 The Dominant Central-Dome Mosque

The Ottomans introduced the central dome typology in the fifteenth century. This style mainly gained prominence in the Ottoman period; it can be described as the vertical structure rising into the sky. It is dominated by its massive central dome, which covered most of the interior space; buttressed by a number of smaller domes. This typology of mosque provides an ambulatory and more illuminated space, and is framed by high slender minarets. Due to the progression from shorter to taller expressed with gradual advance from small domes that rising towards the central one, the thing that promote the dominant dome as skyline.[2] Examples of this typology are the Dome of the Rock in Jerusalem (691-692 A.D.), the Sehzade Mehmet mosque, turkey (1544-8 A.D.), and the Selimye Mosque in Edirne, Turkey (1568-1574 A.D.), (Fig.1.6).

[1] Hillenbrand, Robert. *Islamic Architecture: Form, Function and Meaning*. New York: Columbia university press, 1994, pp.66-92.

[2] Buhlfaia, Saeid A., "Historical Background of Libyan Mosque Architecture: Assessment and Criticism of Mosques in Ajdabiya City." Msc. Dissertation, Technical University of Middle East, 2006, p.15.

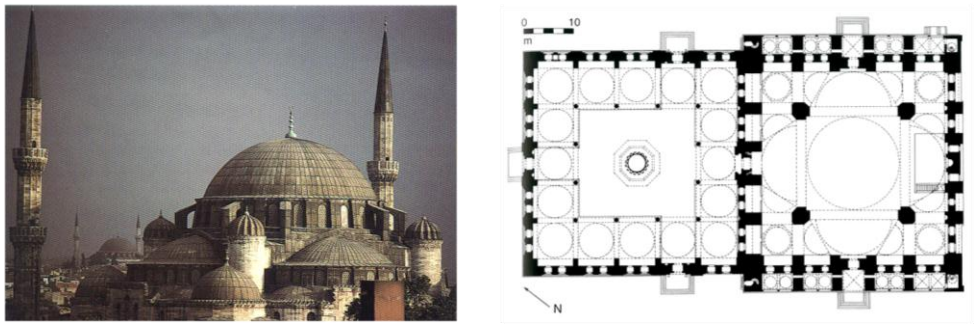

Fig. (1.6): General view and plan of the Sehzade Mehmet mosque, Turkey (1544-8 A.D.) showing the central prayer hall covered by a dome and half domes, and the courtyard, where the mosque is symmetrically arranged. (Source: The Mosque, 1994, p.146, 155)

1.4.3 The Four Iwan Mosque

This style gained prominence in Iran, Egypt and central Asia, where the most significant feature of this kind of mosques is the *Iwan*. This mosque type composes of one or multiple *Iwan*; mostly four *Iwan*. *Iwan* in traditional Islamic architecture is defined as a recessed and high vaulted space and it has only three built walls. *Iwan* serves as a great entrance leading to a sacred domed space. Some times, it leads to a courtyard. A courtyard surrounded by arcades and four *Iwan*, each of them is located in the middle of each of the four walls. The mosque has a unique decoration composed mainly of *Muqarnas*. The first appearance of the *Iwan* style mosque was in the Friday Mosque of Isfahan, Iran (890 A.D.), and was also found in the Bibi Khanim Mosque in Samarkand, Iran (1399-1404 A.D)[1], (Fig.1.7). Also the mosque and *Madrasa* of Sultan Hassan, (1356-63 A.D.), is the most renowned example of this combination with its monumental dimensions, the enormous construction include four *Iwan Madrasas* for each sect, and the mosque design avoids direct entrance into any *Iwan* [2], (Fig.1.8).

[1] Hillenbrand, Robert. *Islamic Architecture: Form, Function and Meaning*. New York: Columbia university press, 1994, pp.100-114.

[2] Michell, George (Ed.). *Architecture of the Islamic World: Its History And Social Meaning*. London: Thames and Hudson Ltd, 1978, p.227.

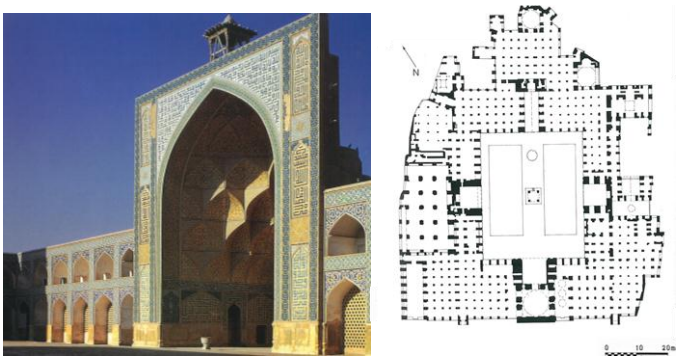

Fig. (1.7): General view and plan of the rectangular central courtyard with four-*iwan* configuration of the Friday mosque, Isfahan, Iran (8^{th} -17^{th} C. A.D.) (Source: The Mosque, 1994, p. 131, 123).

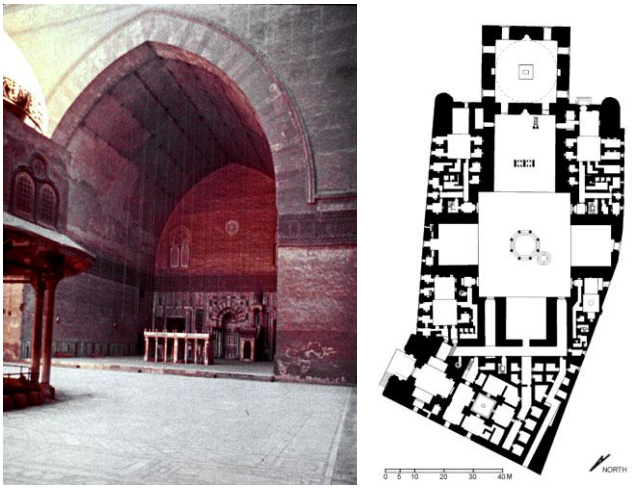

Fig. (1.8): View of the courtyard overlooking the qibla Iwan and a floor plan with four-*iwans* of mosque and madrasa of Sultan Hassan, Cairo, Egypt (1356-9 A.D.) (Source: Archnet).

1.4.4 The Triple-domed Mosque

This style can be found commonly in India, Pakistan and Bengal. However, the Indian mosque typology is more distinctive by its large courtyard space and its preference to spherical domes and arches and has characteristics of four symmetrically placed minarets, which mark the corners of spacious courtyards. The prayer hall has a prominent central portal and three polished white marble-covered high onion-shaped domes contrasting with the red- sand

stone façade and four corner minarets; these combined with extensive arcaded courtyard, featuring brickwork and terracotta decorations. The larger mosques have a raised platform, which serves both as an enclosure space used by female worshipers and could be used by the king and his entourage. This was segregated from the rest of the mosque and had a separate entrance, which could be approached directly from exterior either by a ramp or by a flight steps. One of the best examples of Mughal architectural style is Friday Mosque located in Delhi, India, Badshahi Mosque, Pakistan (1673-4 A.D.), and Friday Mosque, Fatehpur Sikri, India (1571-74 A.D.).[1] (Fig.1.9)

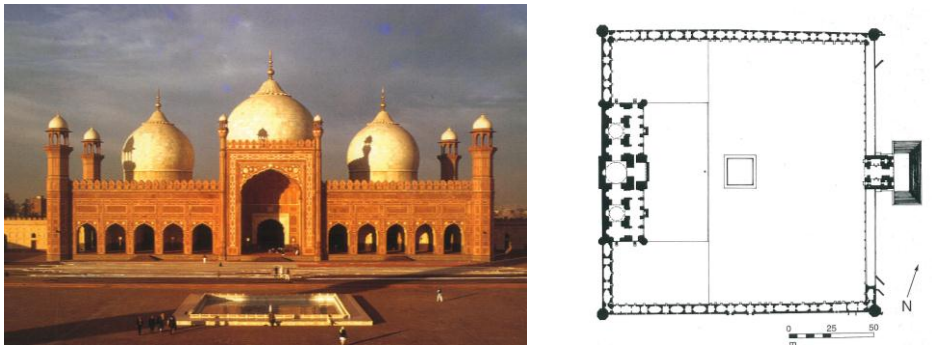

Fig. (1.9): General view and plan of the triple domed mosque of Badshahi, Lahore, Pakistan (1673-4 A.D.), showing the prayer hall with a prominent central portal (Source: The Mosque, 1994, p.168, 173)

1.4.5 The Detached Pavilions Mosque

This type has the characteristics of single axis lined with all courtyards, Pagoda Tower, Chinese pavilions, freestanding and gateway, which leads to the prayer hall. The mosque building is subdivided into a number of courtyards. It is decorated with clay brick carvings. This mosque also has characteristics of special inverted eaves. It features several layers of brackets glazed roof tiles. There are a number of wooden houses called water houses. They are the place where worshipers can perform ablution before they attend a prayer. The special

[1] Buhlfaia, Saeid A., "Historical Background of Libyan Mosque Architecture: Assessment and Criticism of Mosques in Ajdabiya City." Msc. Dissertation, Technical University of Middle East, 2006, p.17.

building is the prayer hall, featuring a combination of the Chinese traditional archway and pavilion. It is characterized by multiple stories of tilled roof, decorated with *quranic* inscriptions, which are formed in colorful decorative patterns of grass and flowers. The Chinese mosque has neither domes nor minarets, but the tower called introspection serves as a minaret, located at the center of the main courtyard. The introspection tower is the tallest structure in the whole mosque. Except for using of Arabic calligraphy combined with Chinese floral patterns, Chinese tradition in both design and its artistic outlook is dominated. The best example of this style is the Great Mosque, Xian, China (685-762 A.D.)[1], (Figs.1.10, 1.11, 1.12).

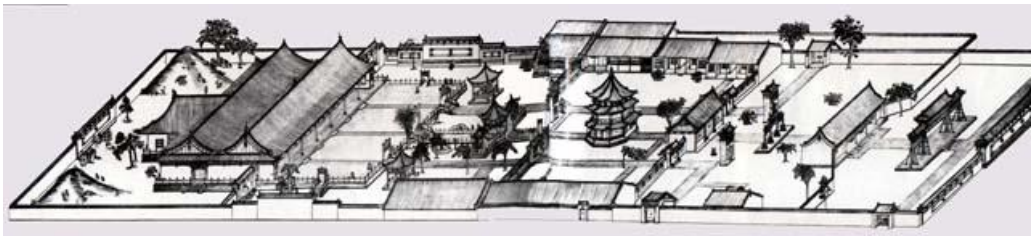

Fig. (1.10): General view of the Great Mosque, Xian, China. (Source: Archnet.org)

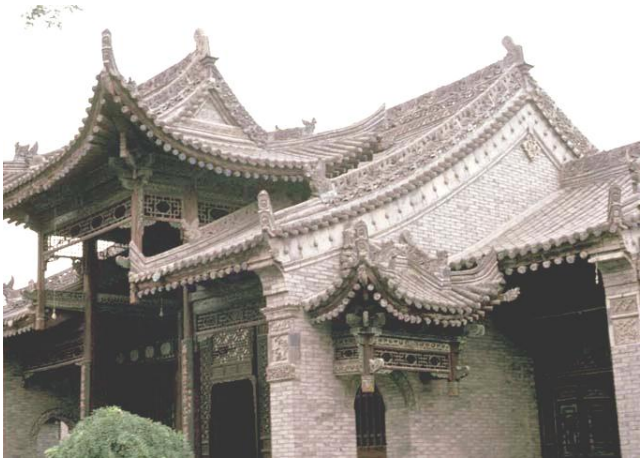

Fig. (1.11): A Detail of the upswept roof eaves at the Unmatched Pavilion of the Great Mosque, Xian, China. (Source: Archnet.org)

[1] Ibid. p.19.

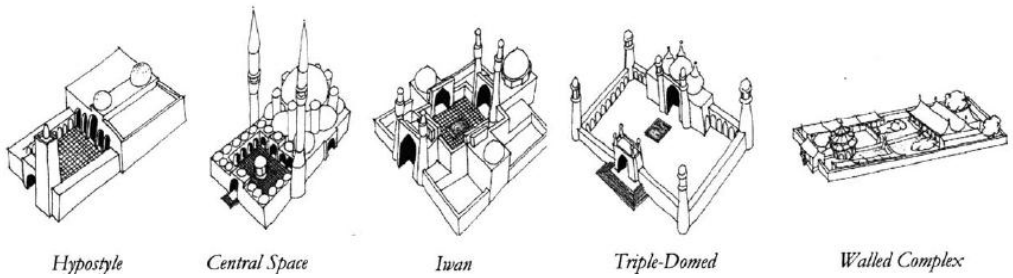

Fig. (1.12): The five basic categories of mosques typologies (Source: The Mosque, 1994)

1.5 The Inherited Values of Traditional Mosque Architecture.

1.5.1 The Functional Values

1.5.1.1 Architectural Elements

According to Kuban's classification, the form of the mosque that corresponded to all these requirements and was shaped by the development of them was and remained simple: a large sanctuary on the *qibla* side and a courtyard, to which the sanctuary opened. Arcades may appear on three sides of the *sahn*, the *minbar*, the minaret and the *maqsura* were the essential features of this simple enclosure.[1] The specific liturgy and functional requirements of the most mosques did not dictate any particular architectural and physical layout.[2] Typically, historians like Kuban, Hillenbrand and Frishman identified features that were commonly used in mosques. The most important elements was the demarcated sheltered space, the *mihrab* or prayer niche, the *minbar* or pulpit, the *maqsura* or royal terrace, the minaret, and the ablution area.

[1] Dogan, Kuban. *The mosque and its Early Development*, part I, Netherlands: Leidene E.J Brill, 1974, p.3

[2] Serageldin, Ismail & Steele, James (Eds.). *Architecture of The Contemporary Mosque*. Great Britain: Academy Editions, 1996, p.10.

1.5.1.1.1 The Demarcated Space:

The praying area is the space provided for the congregation at prayer, it is usually rectangular or square in plan. It could be partly roofed and partly open to the sky, the size of the covered prayer hall or sanctuary varies according to the area of the courtyard, which often surrounded from its three sides by colonnades or arcades, and the fourth side was left to be the access to the prayer hall.[1] The most popular plan types in the Islamic world are, the hypostyle hall with a flat roof (as found in Arabia and Africa), a large central hall covered by massive dome (as found in turkey), and a central rectangular courtyard with *iwans* placed on each side, [2] (Fig.1.13).

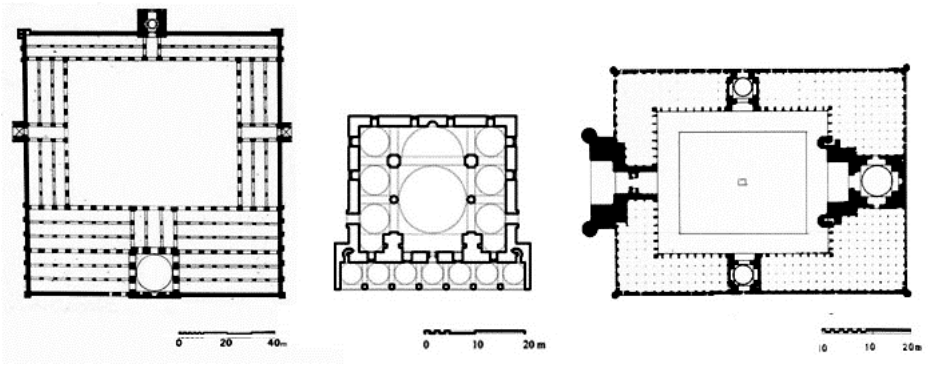

Fig. (1.13): The hypostyle hall, the large central hall, and the rectangular courtyard with 4 *Iwans*, respectively, were the common mosque types in the Islamic world. (Source: Archnet.org)

1.5.1.1.2 The Niche (Mihrab):

The word *mihrab* in the *quran* refers to a temple, and symbolically commemorates the customary place of the prophet.[3] It was first originated from the 'prototype' represented by the Torah-niche of the synagogue and the apse of Christian churches, a form that appeared early in the Coptic chapels of

[1] Frishman, Martin & khan, Hasan-uddin (Eds.). *The Mosque; History, Architectural Development and Regional Diversity.* London: Thames & Hudson, 1994, p.33.
[2] Ibid, p.12.
[3] Dogan, Kuban. *The mosque and its Early Development*, part I, Netherlands: Leidene E.J Brill, 1974, p.3.

Bawit* in Egypt. The niche, like the apse is derived from the ancient *baldachin*, the symbol of divine.[1]

The plan of the *mihrab* niche can be rectangular, polygonal or semi-circular, covered by a decorative semi-cupola. The flat *mihrab* at the Dome of the Rock (691 A.D.) was probably made during the Fatimid period, while the first recessed *mihrab* in Islamic architecture was in the form of a niche in the *qibla* wall at the Prophet's Mosque, and it was built during the Umayyad period. The second niche was in Amr Ibn Al-As Mosque within the expansions made by Qurra Ibn Shuraik**, and the *mihrab* in the mosque of Sidi Uqba at Qirawan in Tunisia is considered one of the oldest, dating to (862-863 A.D.).[2] During the Fatimid period, wooden *mihrabs* were erected in Egypt, like the *mihrab* of the Caliph Al-Amir Biahkam Allah (1125 A.D) at Al Azhar Mosque. The earliest wooden *mihrab* was found at Al Qairawan Mosque (820-836 A.D.) in Tunisia.[3] A great variety of materials were used in the decorations in the various regions and periods, such as stone, stucco, precious stone and wood.

In general, there is only one main *mihrab* in the mosque. However, several *mihrabs* were found in the *qibla* wall of some mosques. Some attribute it as to accentuate the direction of the *qibla*, others related it as a specialization of a separate *mihrab* for each sect or to dedicate a *mihrab* to a great mosque and associate one's name on it.[4] (Figs.1.14, 1.15) show the architectural styles down the centuries in various regions.

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* Bawit, a town located in Asyut in Egypt, carried out excavations that were important for the history of Coptic art.

[1] Stierlin, Henri, *Islam; early architecture from Baghdad to Cordoba, Taschen,* volume I, 2002, p.28.

** Qurra Ibn Shuraik - vizier of Egypt (710-712 A.D.) during the reign of Al-Walid Ibn Abd Al-Malik.

[2] Dogan, Kuban. *The mosque and its Early Development*, part I, Netherlands: Leidene E.J Brill, 1974, p.4.

[3] Ibrahim, Abd El Baki, and Center of Planning and Architecture Studies. *Principles of Architectural Design and Urban Planning during Different Islamic Eras*. Cairo: Organization of Islamic Capitals and Cities, 1992, pp.433-435.

[4] Dogan, Kuban. *The mosque and its Early Development*, part I, Netherlands: Leidene E.J Brill, 1974, p.4.

Fig. (1.14): The *mihrab* of Al Kairouan mosque, Tunisia (817-8 A.D.) (Source: archnet.org), the *mihrab* of the great mosque of cordoba, spain (962-6 A.D.) (Source: isalm, art and architecture, 2007, p.45), and the *mihrab* of the great mosque of tlemcen, algeria (1082-1136 A.D.) (Source: the mosque, 1994, p.26) respectively.

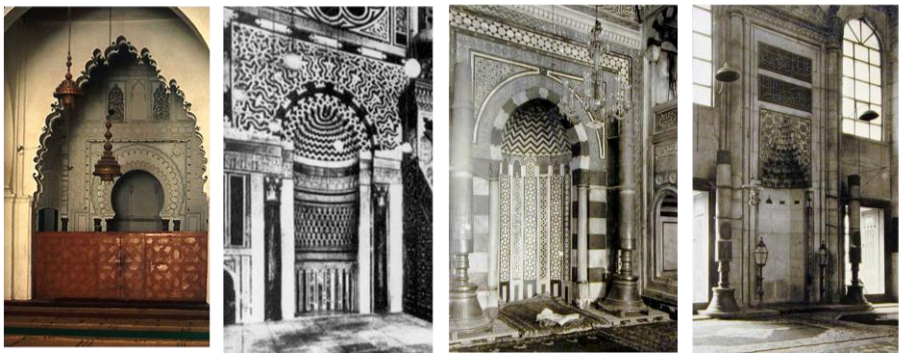

Fig. (1.15): The *mihrab* of Kutibya mosque, morocco (1147-62 A.D.) (Source: archnet.org), the *mihrab* of Al Mu'ayyad sheikh, Cairo (1415-22 A.D.) (Source: archnet.org), the *mihrab* of sinan pasha mosque, Damascus, syria (1590 A.D.) (Source: archnet.org), and The *mihrab* of sultan ahmet mosque, Istanbul, turkey (1609-17 A.D.) (Source: archnet.org) respectively.

1.5.1.1.3 The Pulpit (Minbar):

The word *minbar* is derived from the Arabic word "*nabara*" which means to elevate. According to the manuscripts, Tamim Al Dari[*] was the one who thought of building that *minbar*. When it became harder for the prophet to stand

[*] Tamim al dari, Originally a Christian priest, al-Dari lived in southern Palestine. His first contact with the prophet was in 628 A.D.

up. Historians indicated that the origins of the Madinah *minbar* were found in the Syrian Coptic architecture. The origin of the *minbar* was also found in Roman and Greek architecture, and found in agoras and parliaments. The word "ambo" used to donate the pulpit in churches is derived from the Greek work "anabainien" which means to raise or elevate, the same meaning of "*nabara*".[1]

Before the prayers, it was customary for the prophet to preach to his followers where in the beginning they only formed a small gathering, so the prophet (pbuh) spoke while leaning against one column. But when the followers grew, he used a simple chair of two steps and an additional one for sitting. The *minbar* became after that a special and common feature; served as the pulpit of the Friday ceremony. The width of the *minbar* was 50 cm, its length and height was 100 cm. The Umayyads used *minbars* equipped with wheels; the great mosque of Cordoba in Spain (784-987 A.D.) had wheels, and was kept in a room in the *qibla* wall.[2]

Minbars received much attention in the interior decorations, as they were made of wood and the sides of the pulpit were made of geometric shaped wooden panels carved with arabesque patterns in the early period then floral patterns were used in decorating wooden surfaces as those found in Fez and Marrakesh. In later Islamic architecture, from the 14th century, varied types of *minbars* appeared. Examples sheathed in tile work were erected in Iran and in Ottoman Turkey. Stone, especially marble *minbars* of great size were common. In Egypt, during the Fatimid and Ayyubid periods, the sides of the pulpit were made of geometric shaped wooden panels carved with arabesque patterns, as found in Al Salih Tala'i mosque (1160 A.D.). During the Mamluks period, especially the circassian, floral patterns were rarely used in decorating wooden surfaces, instead it was inlaid with nacre or ivory and the wooden units of the balustrade were smaller. Examples of such *minbars* are found at *madrasa* of sultan Barquq (1384-1386 A.D.), and

[1] Ibrahim, Abd El Baki, and Center of Planning and Architecture Studies. *Principles of Architectural Design and Urban Planning during Different Islamic Eras*. Cairo: Organization of Islamic Capitals and Cities, 1992, pp.435-438.

[2] Dogan, Kuban. *The mosque and its Early Development*, part I, Netherlands: Leidene E.J Brill, 1974, pp.5-6.

Qaytabi mosque (1472-73 A.D.) in cairo. Similar *minbars* were found during the Ottoman period as in sultan ahmet mosque, Istanbul, turkey (1609-17 A.D.).[1] (Figs.1.16, 1.17) show the architectural styles down the centuries in various regions.

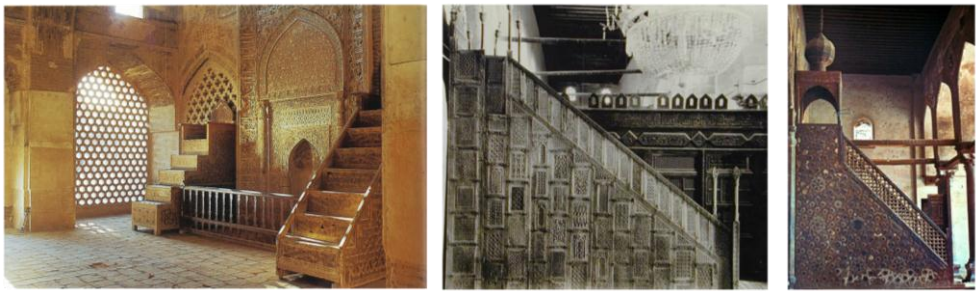

Fig. (1.16): The *minbar* of the Friday mosque of Isfahan (8th c. A.D.) (Source: The mosque, 1994, p.130), the *minbar* of the great mosque of kairouan, Tunisia (817-838 A.D.) (Source: archnet.org), and the *minbar* of Al salih talai' mosque, Cairo, Egypt (1160 A.D.) (Source: archnet.org) respectively.

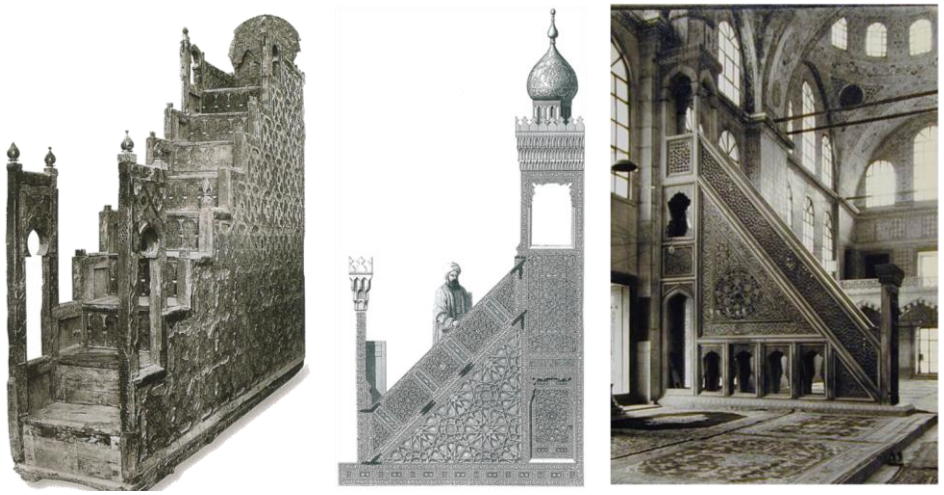

Fig. (1.17): The *minbar* of the Kutibya mosque, morocco (1120 A.D.) (Source: Islam, art and architecture, 2007, p.257), the *minbar* of the qaitbay mosque, Cairo, Egypt (1472-73 A.D.) (Source: Islam, art and architecture, 2007, p.23), and the *minbar* of sultan ahmet mosque, Istanbul, turkey (1609-17 A.D.) (Source: archnet.org), respectively.

[1] Ibrahim, abd el baki and center of planning and architecture studies, *principles of architectural design and urban planning during different Islamic eras*, organization of Islamic capitals and cities, Cairo, 1992, pp.435, 438.

1.5.1.1.4 The Minaret

The word *manarah* originally means 'an object that gives light'. This word was used in the old Arabic poetry for the oil lamp or rush light used in the cell of the Christian monk. The application of the word *manarat* to the tower of a mosque is due to the light held by the Muezzin as he recites the call to prayer at night, which gives the onlooker below the idea of a light-tower. The original purpose of this tower-like feature, apart from serving as a landmark, was to ensure that the voice of the muezzin making the *Adhan* could be heard at a maximum distance. During the lifetime of the prophet, the call to prayer was given from the roof of his house in medina by Bilal, and it was not until the fourteenth and fifteenth centuries that the building of minarets became common.[1]

The first appearance of a tower-like structure used as a minaret occurred in Damascus where one of the towers set at the corners of the Roman temons, wherein the great mosque was built. During Mu'away's reign, evidently these towers were the prototypes that were commonly built after the reign of Al-Walid[*] in the early eighth century. The governor of Egypt asked the caliph to build four minarets at the corners of Amr Ibn Al-As Mosque at Fustat (673 A.D.) that was added during the late Umayyad period. It was built with mud bricks, similar to that was the Roman temple at Damascus. Al baladhuri[**], indicated that the minaret of Al-Basra mosque was built of stone in (665 A.D.). Those minarets were believed to be low square towers built with burnt bricks, and they looked like guarding pavilions at the corners of buildings.

In the various regions of the Islamic realm, the form of the minaret was different, square towers in Syria, Palestine, North Africa and Spain, cylindrical minarets with exterior ramps, imitated ziggurats were built during the early

[1] Richard J. H. Gottheil, [Ninth century Persian historian (died in 859 A.D.)] the origin and history of the minaret, journal of the American oriental society, volume 30, no. 2, 1910, pp.132-154.

[*] Al walid, (668–715), an Umayyad caliph who ruled from 705 - 715.

[**] Al baladhuri, (died 892 A.D.) was a 9th century Persian historian.

Abbasid mosques of Mesopotamia. In the ninth century, Tulunid Egypt has introduced its own style, which combined the Syrian and Mesopotamian types; the minaret of Ibn Tulun Mosque (876-879 A.D.), is similar to that of the Samarra mosque (848 A.D.), in Iraq, it was cylindrical in the upper stages with exterior stairs and square at the lower stage. In the later architectural styles of Iran, Iraq, Central Asia and India, the minarets were cylindrical. In India polygonal minarets were built, and in Turkey minarets generally followed Persian models except in the South where the Syrian type was common. Later in the Ottoman period, slim cylindrical and polygonal shafts with conical roofs became the exclusive form for Turkish minarets, and under the Ottoman rule, this type was carried to North Africa and to all Eastern countries. All minarets were at first detached towers, even when they were incorporated into the composition of the mosque plan. Usually the towers of early mosques were placed on the side opposite to the *qibla* wall, either attached as at Qairawan or independent as at Samra'.[1] (Figs.1.18, 1.19) show the architectural styles down the centuries in various regions.

Fig. (1.18): The minaret of the great mosque of Aleppo, Syria (715 A.D.) (Source: Archnet.org), the minaret of the mosque of samara, Iraq (848 A.D.) (Source: Islam, art, and architecture, 2007, p.105), the minaret of the Friday mosque of Isfahan, Iran (8th c. A.D.) (Source: Archnet.org), the minaret of the Kutibya mosque, morocco (1120 A.D.), and the minaret of the Djinguere mosque, Timbuktu, Mali (14th c. A.D.) (Source: The mosque, 1994, p.24-25), respectively.

[1] Dogan, Kuban. *The mosque and its Early Development*, part I, Netherlands: Leidene E.J Brill, 1974, pp.6-7.

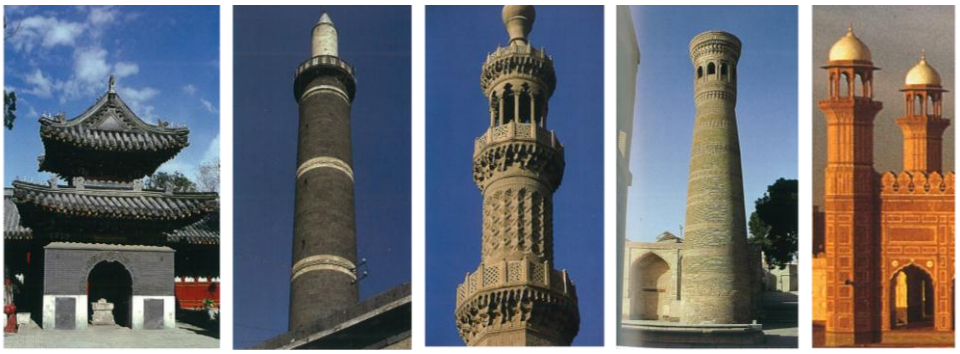

Fig. (1.19): The minaret of the Niu jie mosque, beijing, china (1362 A.D.) (Source: The mosque, 1994, p.25), the minaret of the Ayni mosque, Diyarbakir, turkey (1489 A.D.) (Source: The mosque, 1994, p.24), the minaret of the Amir Qurqumas mosque, cairo, Egypt (1506. A.D.) (Source: The mosque, 1994, p.24), the minaret of the Bukhara mosque, uzbekistan (16th c. A.D.), and the minaret of the Fatehpur sikri mosque, india (1571. A.D.) (Source: The mosque, 1994, p.25-168), respectively.

1.5.1.1.5 The Maqsura:

The *Maqsura* is an enclosure not strictly related to Muslim ritual, but originally it was the place set apart to safeguard the life of the *imam*, who was in the early centuries of Islam, the Caliph, as a protection from danger of assassination.

Ibn Khaldoun* stated that the first *maqsura* was constructed for Mu'awya or Marawan Ibn Al Hakam**, consisted of a raised platform with protective wooden screen which was marked as a feature of byzantine architecture, its earliest examples was found in Qasr Al Imara and the mosque of Abu Dulaf. It was erected next to the *qibla* wall and sometimes had a direct access to the *mihrab* area to provide maximum security, as in Ibn Tulun mosque at Fustat.

A highly developed and one of the earliest examples of the *maqsura* with wooden screens was that of the great mosque of Cordoba, built for Al Hakam II*** in (961-968 A.D.). The characteristics of Seljuk architecture in

* Ibn Khaldoun, (1332-1406 A.D.) was a muslim historiographer and historian.
** Marawan Ibn Al Hakam, (623—685), was the first caliphs of the Umayyad dynasty.
*** Al Hakam II, (915-976 A.D.) was the second Caliph of Cordoba, spain.

Iran, a domed chamber, occupy the area in front of the *mihrab*[1], which was attributed to the fact of the presence of the Caliph that demanded special accentuation architecturally. In addition, a separate enclosure for princely use was often shown, as the open *Iwans* of mosques in the Central Asia, with side rooms reserved for local rulers. Such was the Sultan's lodge (*maqsura*) in the Yesil Cami mosque (1412 A.D.), Bursa, as it usually screened off from the prayer hall with its own entrance.[2] From the eleventh century, domed chambers incorporated into the sanctuary of the mosque began to proliferate, especially in the eastern Islamic world as in the Great mosque of Isfahan, to the western Islam as in the Mosque of Al Maridani in Cairo.[3] (Fig.1.20) Shows the architectural styles down the centuries in various regions.

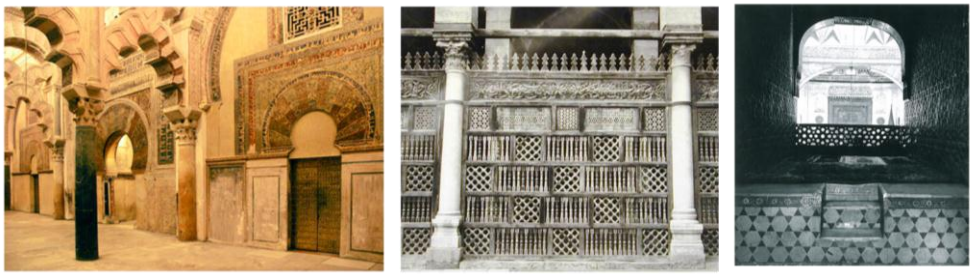

Fig. (1.20): The *maqsura* of the great mosque of Cordoba, Spain (10th c. A.D.), the wooden screens of Al Maridani mosque, Cairo, Egypt (1339-1340 A.D.), and Sultan's lodge in the yesil cami mosque, bursa, Turkey (1412-19 A.D.) (Source: Archnet.org), respectively.

1.5.1.1.6 The Raised platform (Dikket al Mobalegh):

The raised platform is a tribune of single storey height made of timber with a lower wooden balustrade, with a staircase attached. It is often located within the covered sanctuary, depending on the climate and the size of the congregation; it may be located in the open courtyard. Regardless, it is aligned with the position of

[1] Dogan, Kuban. *The mosque and its Early Development*, part I, Netherlands: Leidene E.J Brill, 1974, p.8.

[2] Frishman, Martin & khan, Hasan-uddin (Eds.). *The Mosque; History, Architectural Development and Regional Diversity.* London: Thames & Hudson, 1994, p.39.

[3] Hillenbrand, Robert. *Islamic Architecture: Form, Function and Meaning*. New York: Columbia university press, 1994, p.50.

the *mihrab*. From the raised platform, the respondent repeats the words of the *imam* during the prayer, so that the back rows could hear.[1]

Wooden platforms over marble pillars were used earlier, as in Ibn Tulun mosque (876-879 A.D.). Marble platforms were widely used during the Mamluks period, the earliest examples were found in Al-Ulmas Al-Hagib mosque (1329-1330 A.D.), and in the sultan Hassan *madrasa* (1356-1362 A.D.). Stone podiums carried on marble posts were also used, as in Shaikhu Al-Nasiri mosque (1553 A.D).

During the Ottoman period, the platform was placed on the wall opposite to the *mihrab* where a staircase parallel to that wall leads upwards, made of timber and carried on timber posts. Examples of such podiums are found in Sulayman Pasha mosque (1528 A.D.), and in Sinan Pasha mosque (1571 A.D.), Turkey. The architectural styles down the centuries in various regions are shown in (Fig.1.21).

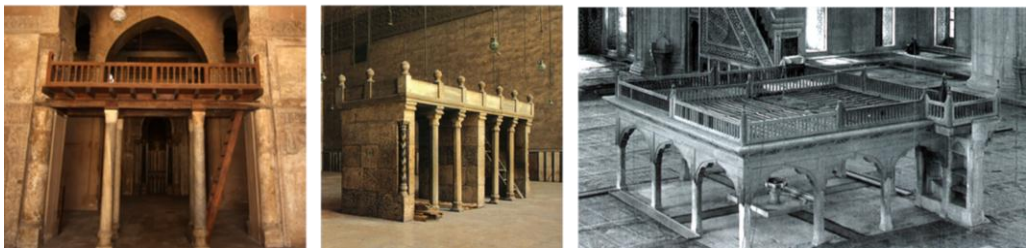

Fig. (1.21): The Wooden platforms over marble pillars of Ibn Tulun mosque, Cairo, Egypt (876-9 A.D.) (Source: The Author), the marble platform of Al Sultan Hassan mosque, Cairo, Egypt (1356-9 A.D.), and the platform beneath the central dome of the Selimiye mosque, Edrine, Turkey (1569-75 A.D.) (Source: The mosque, 1994, p.26, 39), respectively.

1.5.1.1.7 The Quran Stool (Kursi):

The *quran* stool is the lectern on which the *quran* is placed and the respondent reads and recites. It has two or three separate steps, and a V-shaped part to carry the holy *quran* book while reading and the lower part of the stool was used as a closet to keep the holy book in. The stool has a lower wooden

[1] Frishman, Martin & khan, Hasan-uddin (Eds.). *The Mosque; History, Architectural Development and Regional Diversity*. London: Thames & Hudson, 1994, p.37.

balustrade and its sides are decorated with geometric patterns, inlaid with nacre. An example is found at Al Sultan Hassan mosque (1356-1362 A.D.), (Fig.1.22).

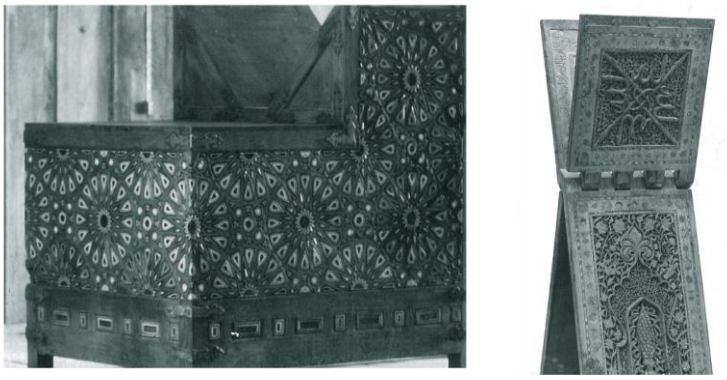

Fig. (1.22): The Wooden *kursi* of Sultan Hassan mosque, Cairo, Egypt (1356-9), and a wooden *kursi* from Iran dated to 1360 A.D. (Source: The mosque, 1994, p.37), respectively.

1.5.1.1.8 The Portal:

In the religious buildings of the early Islamic periods, portals were simple openings in the wall alignment. There was more than one portal in the same wall leading directly to the court, as in Amr Ibn Al- As Mosque (641 A.D.), and in Ibn Tulun Mosque (876-878 A.D.) both in Cairo, Egypt. Several portals were used in the Fatimid period, but not as much as in the Tulunid period. It did not exceed three portals. Each wall had one portal except the *qibla* wall; the entrance facing the *qibla* wall was treated as the main entrance, while the other portals were considered secondary entrances.

The first clear entrance in the religious architecture of Islamic periods in Egypt was the western portal at Al-Hakim Mosque (990-1013 A.D.), which was similar to the portal of Al-Mahdiyya Mosque in Tunisia (921 A.D.). In the Asanbugha Mosque (1380 A.D.) in Egypt, the profile surrounding the portal was divided into two boughs, at the foot of the arch one surrounded the three-foil arch intersecting at the key of the arch forming a circle, and the other bends

composing a rectangle inside the niche. An earlier example was also found around the courtyard arches at Al-Qairawan Mosque in Tunisia (1294 A.D.). This profile in some cases, especially at the end of the Mamluk period, intersected constituting hexagonal or circular form as in the portal of Al-Ghuri caravanserai (1504-1505 A.D.). The intersecting profile was also used in the Ottoman period. Black and white marble was used in facades, and the door was surrounded by sitting decks from both sides. Above the door portal, a circular window in most cases, as in Sultan Barquq madrasa, the window also helps in lighting and ventilating of the vestibule, surrounded by marble geometric and floral patterns, as in the portals of Al-Ghuri Madrasa (A.H. 909-910/ A.D. 1504-1505).).[1] The architectural styles down the centuries in various regions are shown in (Figs.1.23, 1.24).

Fig. (1.23): The portal of Qarawiyin mosque, fez, Morocco (859 A.D.) (Source: The mosque, 1994, p.108), the portal of the west facade of the great mosque of Cordoba, Spain (10th c. A.D.), and the portal of the great mosque of Mahdiya, Mahdia, Tunisia (921 A.D.) (Source: Archnet.org), respectively.

[1] Ibrahim, abd el baki and center of planning and architecture studies, *principles of architectural design and urban planning during different Islamic eras*, organization of Islamic capitals and cities, Cairo, 1992, p.440-446.

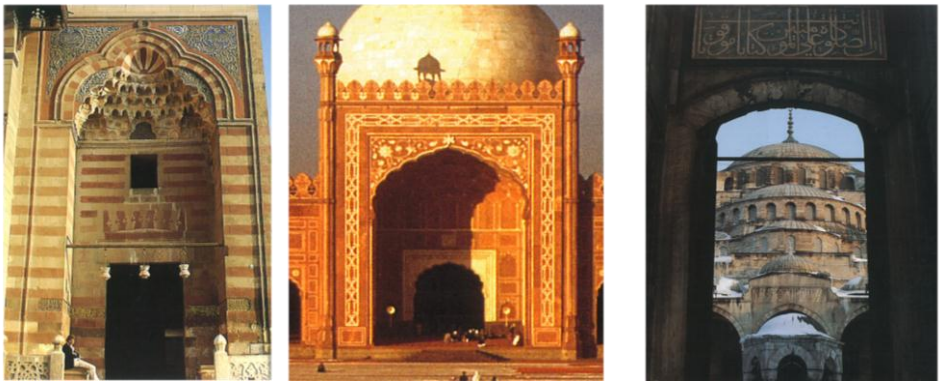

Fig. (1.24): The recessed portal of the sultan Barquq mosque, Cairo, Egypt (1398-1411 A.D.) (Source: The mosque, 1994, p.23), the portal of the Badshahi mosque, Lahore, Pakistan (1673-4 A.D.), and the portal of Sultan Ahmet mosque, Istanbul, Turkey (1607-17 A.D.) (Source: The mosque, 1994, pp.25-168), respectively.

1.5.1.1.9 The Ablution Area

Tahara, a pre-requisite for prayer, was achieved by the act of *wudu',* washing to be accommodating within the mosque. According to Tabari, it was an innovation of the Caliph Omar. Thus fountains, pools or similar installations evidently had been developed from this period onwards. Originally the water was collected in a pool located in the center of the courtyard, but the followers of Abu Hanifah[*] refused to wash with standing and impure water, and instead used a fountain with running water for both drinking and ablution purposes. It was designed to allow a number of worshippers to wash, display inventive design especially in the form of domed, small pavilion-like roofs carried by marble pillars. The most beautiful example is the Qubbat Al-Barudiyin in Marakesh (12th century A.D.) and Badshahi mosque in Lahore.

The place of ablution fountains has usually located at the center of the *sahn*, or, where there is no courtyard, on the entrance side. In larger mosques; as of the later Turkish period, they were placed on the outer facade of the *sahn* walls, and the fountains found in the courtyards were for decorative and functional purpose.[1] In Iran and India, a lot of the courtyards were taken up by

[*] Abu Hanifah, (699-767 A.D.) was the founder of the Sunni Hanafi school of fiqh (Islamic jurisprudence)

[1] Dogan, Kuban. *The mosque and its Early Development*, part I, Netherlands: Leidene E.J Brill, 1974, p.9.

a large pool, which acted also as a landscape feature.[1] (Figs.1.25) Shows the architectural styles down the centuries in various regions.

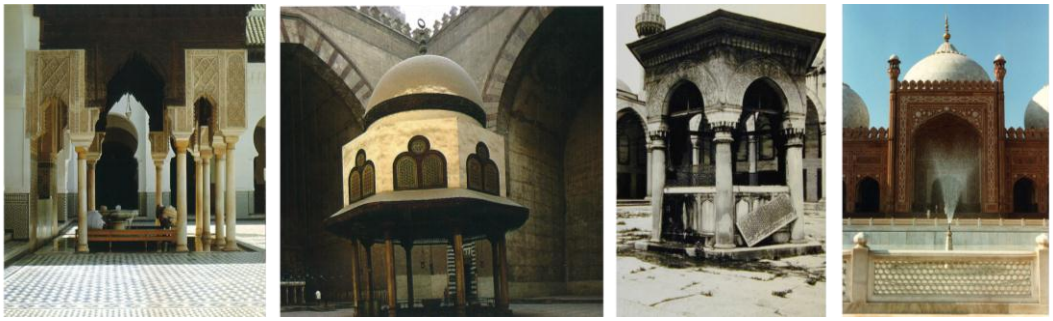

Fig. (1.25): The fountain of the Qarawiyin mosque, fez, Morocco (859 A.D.), the fountain of the sultan Hassan mosque, Cairo, Egypt (1356-9 A.D.)(Source: The mosque, 1994, p.28), the fountain of Sultan Ahmet mosque, Istanbul, turkey (1607-17 A.D.), and the fountain of the Fatehpur sikri mosque, India (1571 A.D.) (Source: Archnet.org), respectively.

1.5.1.2 Structural Elements

1.5.1.2.1 Columns and Piers

Columns and piers were used as structural elements in buildings of the Islamic periods. Marble was commonly used in columns and limestone in piers. In early Islamic periods palm trunks were used as columns as in Amr Ibn al as Mosque (641 A.D.). Old Egyptian Roman and Byzantine columns were reused, regardless of their different form. Especially in the shaft and the capital. Ibn Tulun mosque (876-879 A.D.), was the first building in which no structural elements were trans located from other building, piers with posts in the corner were built of bricks. Various forms of piers were used; octagonal pylons were used, in Aqsunqur Mosque (1348 A.D.) and in the foundations of Sultan Qaytbay. Piers with rectangular, T shaped and L shaped plans were also used as in al-Zahir Baybars Mosque (1269 A.D.).[2]

Ties between columns were used to overtake the horizontal forces resulting from the arches and to carry lanterns placed above the wooden

[1] Hillenbrand, Robert. *Islamic Architecture: Form, Function and Meaning*. New York: Columbia university press, 1994, p.56.

[2] Ibrahim, abd el baki and center of planning and architecture studies, *principles of architectural design and urban planning during different Islamic eras*, organization of Islamic capitals and cities, Cairo, 1992, p.451.

platform,[1] as in al-Aqmar Mosque. Between the column shaft and both the capital and base, melted lead was casted after placing wooden sections, the soldering place was covered by a copper profile; those columns were expected to be earthquake resistant (hinged columns).

1.5.1.2.2 Arches:

An arch is a structure that spans a space while supporting weight. Arches appeared in the second millennium BC in Mesopotamian brick architecture and their systematic use started with the Ancient Romans who were the first to apply the technique to a wide range of structures. Arches were widely used in the architecture of Islamic periods with different forms. The arch *voussoir* were made of limestone and sand stone, respectively, or colored limestone, (red and white respectively); zigzag decorations were also made on the arch facade. The face and soffit of brick arches were decorated with stucco decorations. In stone arches, a profile surrounds the arch and intersected to form a circle at the top of the arch.

The round arch was used before Islam; it was a characteristic feature of Roman architecture. It was first used in Islamic architecture in Qasr al-Hayr al-Sharqi in Syria, (729 A.D.). In Egypt, the round arch was widely used, as in the arcade overlooking the court of Sultan Qa1a'un complex (1284 A.D.). During the Ottoman period in Egypt, the round arch was used in the portal as in Muhammad Ali Mosque at the Citadel (1830-1848 A.D.).

The pointed arch appeared for the first time in Qasr Ibn Werdan (561-564 A.D.) near Homs, it was found in the Umayyad Mosque in Damascus (705-715 A.D.), and in Qasr Imra (712-715 A.D.). In Egypt, it was found in Amr Ibn Al as Mosque (827 A.D.), and Ibn Tulun Mosque (876-879 A.D.). The pointed arch was used in the *haram* aisles in Sulaiman Pasha Mosque at the Citadel (1528 A.D.), It was also used in Portals arches, and in *mihrabs*.

[1] Moanes, Hussein, *The mosques*, National culture, arts and literature community, Kuwait, 1978, p.125.

The horseshoe arch was found before Islam in Syria (359 A.D.). It was excessively used during the Islamic periods, in Spain and North Africa. One of the earliest examples is found in the niches to the right and left of Al-Mahdyya Mosque portal at Susa in Tunisia, at the beginning of the 10th century A.D. Horseshoe arches that rest on reused classical columns were used in Cordoba mosque, 8th century A.D.

The trefoil arch was used in main portals, the earliest example in Egypt was found in the portal of al-Bunduqdriyya Madrasa (1263 A.D.). And the interlocking arch was used in the aisles of the prayer hall, as in front of the *mihrab* at Cordoba mosque.[1]

1.5.1.2.3 Domes

Domes were first introduced in the ancient Middle East, India and the Mediterranean, in modest buildings and tombs. The construction of technically advanced large-scale domes appeared in the Roman architectural revolution, when they were frequently used by the Romans to shape large interior spaces of temples and public buildings, such as the Pantheon. This tradition continued unabated after the adoption of Christianity in the Byzantine (East Roman) religious and secular architecture. With the Muslim conquest of the Sassanid Empire and the Byzantine Near East, the dome also became a feature of Muslim architecture, Bulbous or pointed domes were widely used in Islamic architecture.

Domes were mainly used to cover tombs, *Hammams* and mosques, and they were also used for covering the area in front of the *mihrab*. The dome over the *mihrab* was considered the most durable and versatile aspect of medieval Islamic architecture, emphasizing the princely role of the *mihrab* and marking the location of the *qibla*. In later Ottoman period, a clear hierarchy based on gradations of size ensured that the principal domes were suitably highlighted by

[1] Ibrahim, Abd El Baki and center of planning and architecture studies, *principles of architectural design and urban planning during different Islamic eras*, organization of Islamic capitals and cities, Cairo, 1992.

the diminutive scale of the surrounding ones.[1] Domes became increasingly characteristic feature of Islamic architecture after Seljuk times. More or less over, they are difficult to be placed over the square base resulting from rectilinear planning. A safe structural transition has to be made between the square and the circle, where the simplest way was to use corner squinches, creating an octagon, which could merge easily into the circle.

In the dome of the great mosque of Damascus, built in the eighth century, the surface within the squinch is shaped into a small semi-dome, and is loaded bearing, where an octagonal drum supports the dome. By the tenth century, a developed technique was used for bridging the corners, by using tiers of superimposed arches. Eventually these arches were organized according to a complex interlocking geometry to produce a stalactite, as in the *khanqah* and mosque of sultan barquq in Cairo. An alternative of the squinch was the pendetive, a triangle of masonry filling the same space. This became the commonest solution in ottoman mosques, which adopted the standard byzantine curved pendetive.[2] (Figs.1.26, 1.27) show the architectural styles down the centuries in various regions.

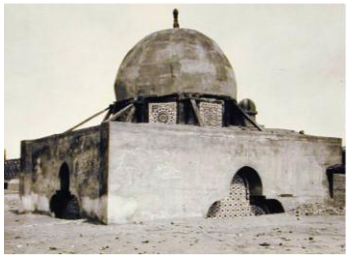

Fig. (1.26): The dome over the *mihrab* bay of Ibn Tulun mosque, Cairo, Egypt (876-879 A.D.), the squinches carrying the dome of al hakim mosque, Cairo, Egypt (990 A.D.), and the ribbed dome over the *mihrab* bay of the great mosque of Cordoba, Spain (10^{th} c. A.D.) (Source: Archnet.org), respectively.

[1] Hillenbrand, Robert. *Islamic Architecture: Form, Function and Meaning*. New York: Columbia university press, 1994, pp.53-54.

[2] Michell, George (Ed.). *Architecture of the Islamic World: Its History And Social Meaning*. London: Thames and Hudson Ltd, 1978, pp.124-125.

Fig. (1.27): The pendetives carrying the dome of the sultan barquq mosque, Cairo, Egypt (1398-1411 A.D.), the central dome of the ottoman mosques suitably highlighted by the diminutive scale of the surrounding ones of Sultan Ahmet mosque, Istanbul, turkey (1607-17 A.D.), and in Muhammed Ali mosque, Cairo, Egypt (1828-48 A.D.) (Source: Archnet.org), respectively.

1.5.1.3 Materials

Bricks had been used decoratively from early Islamic periods, laid in different planes to create effects of light and shade on the facades of buildings. An eleventh century Seljuk tomb at Qarraqan in Iran shows a variety of patterns including a band of calligraphy with specially shaped bricks.

Glazed tiles were used as veneer over brick cores, were common from Abbasid period onwards, and was commonly used in Iran and turkey during the sixteenth and seventeenth centuries.

Stone was used constructively and decoratively, as in the portal of sultan baybars mosque, Cairo (1269 A.D.), the zigzag dates back to ancient Arabia, and the circles flanking the arch were probably battle-shields in origin.

Striped masonry and paving was used in Syria and influenced Seljuk and ottomans to use, as in the great mosque of homs, Syria.

Metal has a subordinate place in Islamic architecture; much of it was mainly concentrated on and around doors. Hinges and locks were executed in a variety of metals-iron, brass, silver and gold.

Wood was an integral part of buildings, even when the structure was of other materials. In relief carvings, in marquetry and in lattice made of intricately jointed turned wood, and in ceilings. Stucco reliefs imitate the effects of stone but with complexity. The *mihrab* of the Friday mosque at Iran (1277 A.D.), contains a whole repertoire of ornamental designs deeply undercut interlacing, circular bosses, stylized foliage and a foliated band of calligraphy. Window grilles were made of stucco, a detail of the mosque of sunkur sa'di in Cairo (1315 A.D.), covered with stucco ornament,[1] as shown in (Figs.1.28, 1.29).

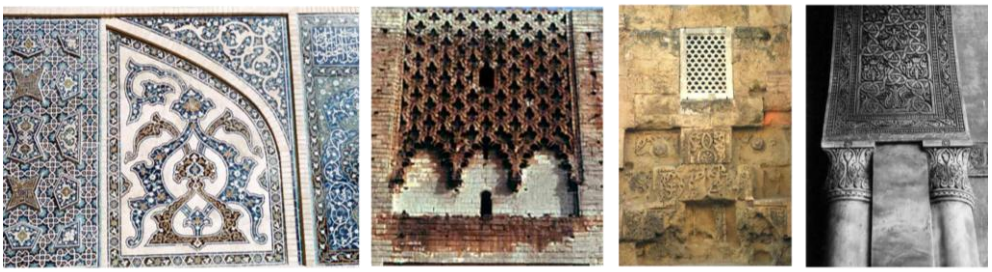

Fig. (1.28): A detail of the southern *iwan* of the Friday mosque of Isfahan, showing the glazed tile revetment with floral motifs and geometrical patterns (1366-67 A.D.), a web of intersecting lobes covers the minaret of the mosque of Hasan at Rabat, morocco (1191-99 A.D.), an exterior detail of a carved stone decoration next to the eastern portal of Cordoba mosque (10th C. A.D.), and a carved stucco intrados on the inner side of the aisles arcades of Ibn Tulun mosque, Cairo, Egypt (870-79 A.D.) (Source: Archnet.org)

Fig. (1.29): A detail view of the window grille in the southern arcade of al Zahir Baybars mosque, Cairo, Egypt (1267-9 A.D.), the wooden decorated ceiling over the sanctuary of Ibn Tulun mosque, Cairo, Egypt (870-979 A.D.), and a detail of the wooden panels of the *minbar* of kairouan mosque, Tunisia (817-838 A.D.) (Source: Archnet.org)

[1] Michell, George (Ed.). *Architecture of the Islamic World: Its History And Social Meaning*. London: Thames and Hudson Ltd, 1978, pp.116-123.

1.5.1.4 Illumination and Ventilation Principles of Mosques

Light has had a very prominent significance in Muslims beliefs throughout history. Insistence on sanctity of life originates from the religious doctrines of the pre-Islamic era, which was emphasized in the Islamic era. Light has special importance in *quranic* verses: "God is Light of heavens and earth (Noor, 35). Moreover, Prophet Mohammad (pbuh) has added a cosmological aspect to the mentioned verse: "The first creation of God was Light". Overall, in most religions, light is the symbol of Divine Wisdom and the element of all goodness and purity. Moreover, since no other sign symbolizes or is manifestation of divine unity, Islamic artists have strived to use t it in their works to make them much closer to the source of spirituality. In Islamic architecture, light plays an influential role not only in the spiritual relationship between the believers and the religion, but also between the believers and the building. Such a role is much more apparent in the mosques, taking a leading part in the creation of a spiritual or an aesthetical atmosphere. In other words, while the building's structure forms the religious environment, the light forms the religious experience.[1] In the Shaykh Lutfallah mosque in Isfahan, the reflected light, the development and multiplication of the stalactites cells beneath the domes can be understood by their function in reflecting and refracting light, and too accentuate their play of light, shining ceramic tiles were utilized. In the windows of the Suleymaniye mosque in Istanbul, light penetrating through glass or transparent screens projects patterns onto the already patterned interior surfaces and dissolves the boundaries between solid and void.[2]

1.5.2 Aesthetic Values and Mosque Architecture

Beauty is one of the attributes of the Lord, as the Prophet (pbuh) said: '***Allah is beautiful and loves beauty*'** (*narrated by Muslim*). Ornamentation is not prohibited by the Lord, to the contrary it is one of his graceful donations to his believers, as he says in Quran 7:32, ('*Say: who hath forbidden the beautiful*

[1] M. Mahdavinejad, S. Matoor, A. Doroodgar "Recognition of light-openings in Iranian mosques' domes with reference to climatic properties." *International Journal of Architectural Engineering & Urban Planning*. Vol. 21, no. 2, December 2011, pp.61-68.
[2] Ibid, p.152.

gifts of God, which He hath produced for His servants, and the things, clean and pure, (which He hath provided) for sustenance? Say: they are, in the life of this world, for those who believe, (and) purely for them on the Day of Judgment. Thus do we explain the signs in detail for those who understand').

While making statues and painting figures was prohibited in the Holy Qur'an and Prophetic *Sunnah* in order to give no chance for worship returning back to worshipping idols. Also, excessive paintings in mosques would distract the attention of prayers, and rebel to mind the places of worshipping idols. Mosques are erected only for the worship of Allah: ('*And the places of worship are for God alone: so invoke not any one along with God*'), Quran 18:72. Thus, it is clear that although Islam calls for ornamentation and beauty, in a simple, balanced and graceful manner in the framework of unity and order, without extravagancy or waste.

Aesthetic appreciation depends upon both sentimental and intellectual appreciation. *Allah is beautiful and loves beauty*, the beauty of Allah is appreciated in the beauty of His creations on earth from man, animals, plants, and substances. If we observe the Creations of God we can understand the secret of this heavenly **beauty**, which lies in the **harmony**, and integration of **forms**. Men of intellect tried to figure out constant standards for beauty through applying theories such as the colors theory, or analyzing the structural systems of natural and botanical forms. Others tried to impose **geometric theories** like the golden section or static principles like symmetry and homogeneity of forms, claiming that they could provide the basic aesthetic principles. However, each person judges beauty according to his personal taste, which differs from one person to another according to his cultural background and his emotional and psychological formation.[1]

[1] Ibrahim, Abd El Baki, and Center of Planning and Architecture Studies. *Principles of Architectural Design and Urban Planning during Different Islamic Eras*. Cairo: Organization of Islamic Capitals and Cities, 1992, pp.513-515.

1.5.2.1 The Role of Calligraphy:

Calligraphy is considered one of the greatest Islamic art forms and inscriptions used extensively in mosques, especially to glorify the name of Allah and quote verses from the quran. Calligraphy varied from simple decorations, with no extraneous ornamentation of the writing, to the indescribably ornate, an early example of simplicity was found in the great mosque of Sousse, Tunisia (850 A.D.), which had a single unornamented band of quranic, *kufic* script around the courtyard. Arabic lettering was brought to a high level of artistic sophistication and scripts can vary from the flowing cursive styles (*naskhi* and *thuluth*) to the angular *kufi*. Often different styles appear on the same building. Stone calligraphic bands, both linear and circular, proclaim the word of God on the façade of the mosque of Al Aqmar in Cairo. Such inscriptions are quranic and clarify the building function.[1]

Early mosques were restricted to the angular lettering later known as *Kufic*, since it was the only style of Arabic script in general used during the early Islamic period. During the Abbasid caliphate, with the development of round hand and the definition of calligraphic proportions leading to the canonization of the classic round scripts in the tenth and eleventh centuries, *thuluth* script became the calligraphic style for Quranic inscriptions. The angular *Kufic* was always retained, but over time it became more ornamental and less readable with the incorporation of foliation knotting into the letters. As of the classic scripts, *muhaqqaq* was rarely used in inscriptions and was generally reserved for copying large scale Qurans; *tawqi* was the script of stucco inscriptions, as in the *mihrab* of Oljaytu (1310 A.D.) in the Friday mosque, Isfahan. *taliq* and *nastaliq* were both reserved for documents, and were considered inappropriate for Quranic mosque inscriptions.[2] The different styles down the centuries in various regions are shown in (Figs.1.30, 1.31).

[1] Michell, George (Ed.). *Architecture of the Islamic World: Its History And Social Meaning*. London: Thames and Hudson Ltd, 1978, pp.150-151.

[2] Frishman, Martin & khan, Hasan-uddin (Eds.). *The Mosque; History, Architectural Development and Regional Diversity*. London: Thames & Hudson, 1994, p.47.

Fig. (1.30): The fragment of the restored tile mosaic work dating from the Umayyad period in the prayer hall of the Al Aqsa mosque, Jerusalem (750 A.D.), the ornate carved on a stucco panel on the *mihrab* of the Friday mosque, Isfahan (1310 A.D.), includes sayings of Ali, and the tile panel, proclaims the name of *Allah* in the great mosque of Fez, Morocco, respectively. (Source: The mosque, 1994, p.52, 46, 49)

Fig. (1.31): The creed decorating the portal of the Al Muayad Sheikh mosque, Cairo, Egypt (1415-22 A.D.), the Tile panel above the window in the portico of the Fatih mosque, (1463-70 A.D.) the *Kufic* inscription includes part of the 'throne verse', (Quran 2:255), and an inscription in a wall panel below one of a pair of windows in the mosque of Wazir Khan, Lahore, Pakistan (1634 A.D.), written by nastaliq script, respectively. (Source: The mosque, 1994, p.42, 50, 51)

1.5.2.2 Quranic *Verses*

Quranic verses were carefully chosen to denote the function of the architectural elements within the building. They were also used to denote the duties towards God, in the Holy *quran* and Prophetic *hadith.* It was noticed in some religious buildings dating back to the Fatimid period the use of some *quranic* verses that referred to members of the Prophet's family: Quran 33:33, ('*And stay quietly in your houses, and make not a dazzling display, like that of the former times of Ignorance and establish regular prayer, and give regular Charity, and obey God and His Apostle. And God only wishes to remove*

abomination from you, ye Members of the Family, and to make you pure and spotless'). This verse was found in al-Aqmar Mosque (1125 A.D.). Verses indicated the transfer of the *qibla* direction towards the Holy *Kaaba* instead of Al-Aqsa mosque were written around the *mihrabs*; as in Quran 2:144, ('*We see the turning of the face (for guidance) to the heavens: now shall we turn thee to a Kiblah that shall please thee. turn then thy face in the direction of the Sacred mosque. Wherever you are, turn your faces in that direction. The people of the Book know well that that is the truth from their Lord. Nor is God unmindful of what they do*').[1]

Quranic verses related to the function of the place were usually used. At the gateway into the mosque complex at Fatehpur Sikri built by the Mughal emperor Akbar (1575 A.D); carved in very low relief, the *thuluth* inscription consisting of *Suras* 39:73-75, 41:53-54 and 41:30-31. The first section includes the phrases 'And the gates thereof shall be ready set open', and across the top of the gateway, '*Here after we will show them our signs in the regions of the earth'* (41:53), all particularly appropriate for a monumental gateway built in celebration of a major military victory. On the portals and facades of mosques, Quran 9:18 ('*The mosques of God shall be visited and maintained by such as believe in God and the Last Day, establish regular prayers, and practice regular charity and fear none except God. It is they who are expected to be on true guidance'*). In the pole of the dome from which pendent oil lamps hang, the following verse is written, Quran 24:35 ('*God is the light of the heavens and the earth. The parable of His light is as if there were a Niche and within it a lamp: The lamp enclosed in Glass: the glass as it, were a brilliant star: lit from a blessed Tree, an Olive, neither of the East nor of the West, whose oil is well-nigh luminous, though fire scarce touched it: Light upon Light: God doth guide whom He will to His Light: God doth set forth Parables for men: and God doth know all things'*).[2]

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[1] Ibrahim, Abd El Baki and center of planning and architecture studies, *principles of architectural design and urban planning during different Islamic eras*, organization of Islamic capitals and cities, Cairo, 1992, pp.460-464.

[2] Frishman, Martin & Khan, Hasan-uddin (Eds.). *The Mosque; History, Architectural Development and Regional Diversity*. London: Thames & Hudson, 1994, pp.43-55.

1.5.2.3 Applications of Geometry

Geometrical forms represented an ideal combination in stemming out geometrical types with endless compositions, representing the form, composition and character in an integral balanced fabric, expressing the aesthetic values of Islamic architecture. This architecture expressed the professional skills and artistic originality that were enhanced by the integration of Muslims. The geometric patterns were built on the creative repetition of certain geometric units, of certain geometrical shapes in two and three dimension.

1.5.2.3.1 Principles of Geometry

Principles of geometry have been applied differently in various architectural traditions. The octagonal plan of the dome of the rock, Jerusalem (690-2 A.D.), was based on two identical squares sharing a common center, one rotated 45 degrees, the result was a double octagonal shape surrounding a circular arrangement of columns and piers, which reflects the influence of contemporary Byzantine church, (Fig.1.32).

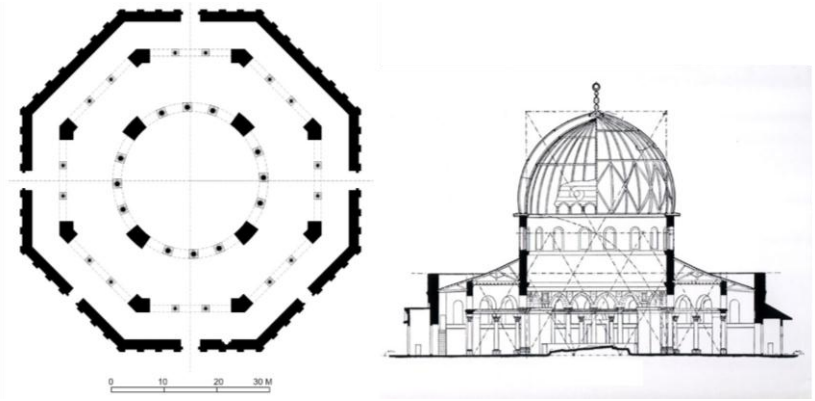

Fig. (1.32): The octagonal plan, and the symmetric section of the dome of the rock, Jerusalem (690-2 A.D.). (Source: Archnet.org).

- **The centralized plan**

The centralization of the plan was not common in the design of mosques; it was ubiquitous in the design of mausoleums. Centralized plans especially octagonal ones, can be found in funerary structures belonging to different architectural traditions including the Abbasids, Timurids, Ottomans and Mughals that were often connected to mosques or mosque-*madrasa* complexes, as the complex containing the mausoleum, mosque-*madrasa* and hospital of Sultan Qaloun in Cairo (1284-5 A.D.), where the irregular outline of the complex is distinguished by its highly regular plan, consisting of a square surrounding an octagonal arrangement of alternating piers and columns which support a dome, as shown in (Fig.1.33).

Different Geometric principle as the **modularity system** was also used instead of using elementary geometric shapes or fixed systems of proportions, which can be tracked to the early hypostyle mosques. The hypostyle mosque was planned according to the basic unit or module of a rectangular bay defined by four columns or piers in addition to the covered spaces consisting of the multiples of the basic module, where the result was usually a regular composition of covered areas placed within a rectangular outline and surrounding a rectangular court, as in the ninth century mosque of Samarra.

Fig. (1.33): The regular plan of the Sultan Qaloun complex, in Cairo (1284-5 A.D.), consisting of a square surrounding an octagonal arrangement of alternating piers and columns, which support the dome. (Source: Archnet.org)

- **The symmetry**

The **symmetry** played a prominent role in the religious architecture of the Islamic world; among many examples of mosques symmetrically planned along their longitudinal axis are the bibi khanim mosque in Samarqand (1399 A.D.), and the Friday mosque, Delhi (1644 A.D). The large open courtyard allowed the symmetrically organized facade including paired minarets and in the Selimiye mosque, Edrine, Turkey (1569-75 A.D), the symmetry reveals in the square plan and central dome through the presence of a minaret at each corner,[1] as shown in (Fig.1.34).

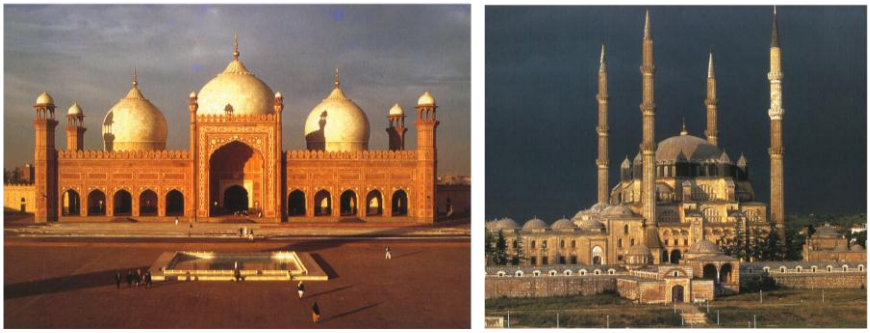

Fig. (1.34): The symmetrical façade of the Badshahi mosque, Pakistan (1673 A.D.), including the paired minarets. (Source: The mosque, 1994, p.58), and the symmetry of the selimiye mosque, Edirne (1569-75 A.D.), including the square plan and the central dome through the presence of a minaret at each corner, respectively. (Source: Islam, art and architecture, 2007, p.558).

1.5.2.4 Geometric Patterns:

The geometric patterns consist of four basic shapes, "repeated units," from which the more complicated patterns were formed, circles and interlaced circles; squares or four-sided polygons; the star pattern, ultimately derived from squares and triangles inscribed in a circle; and multisided polygons. However, the complex patterns found on many objects include a number of different shapes and arrangements allowing them to fit into more than one category.[2]

[1] Ibid, pp.55-59.
[2] Yalman, Suzan. "The Art of the Mamluk Period (1250–1517)." *In Heilbrunn Timeline of Art History*. New York: The Metropolitan Museum of Art, October 2001, Web. September 2010.

Surfaces, curved or flat, in a brick or stucco, are covered by designs that are infinitely expandable. Patterns are rendered visible from a distance by contrasts of plane, which permit the play of light and shade, as found in the curved outline of the minaret of the great mosque at Damghan, Iran. The star, six, eight, sixteen or more points, is one of the fundamental shapes of Islamic geometrical design. It can also be used equally in two or three dimensions, to transform the dome into a complex net of interlaced surfaces or to decorate timber and bronze fittings inside the buildings, such design were found on the ceiling of the tomb of hafiz at shiraz, and on the door detailing in the sultan Hasan *madrasa*,[1] as shown in (Fig.1.35).

Fig. (1.35): The window grille in the west iwan of the mosque of ibn tulun mosque, Cairo (876-9 A.D.) (Source: the mosque, 1994, p.54), the interlacing star-pattern revetment of kutibya mosque, Marrakesh, morocco (1147-1162 A.D.), The interlaced geometric motifs detail of the wooden *minbar* of qaytbay mosque, Cairo, Egypt (1472-1474 A.D.) (Source: Archnet.org), and the patterning inlay work at the bibi khanum mosque, Samarqand, Uzbekistan (1399-1404 A.D.) (Source: the mosque, 1994, p.64), respectively.

1.5.2.5 Foliation:

The classical vine and scroll motifs provided Islam with a starting point for a whole repertoire of lithe, living forms, ranging from almost scientific naturalism to the completely abstract art of the arabesque. The endless line of arabesque takes the curvilinear shapes of the vine and scroll and imposes symmetry upon it, as found in the mosque of Al Salih Talai' in Cairo. Curling tendrils leaves and flowers form the exquisite stone screen of a window in the mosque of Sidi Said, Ahmadabad, India. From the trunk of the tree grow

[1] Michell, George (Ed.). *Architecture of the Islamic World: Its History And Social Meaning*. London: Thames and Hudson Ltd, 1978, pp.148-149.

twisting curved stems, forming shapes that seem abstract but are in fact organic and asymmetric.[1]

1.5.2.6 The Stalactites (Muqarnas):

There are different types of *muqarnas* named by its origin according to its shape, the native Syrian, *Halabi*, triangular (*mutallat*), and stalactite with chevron (*bi-dallaya*).[2] The formal organization of the stalactites are closely linked to that of two-dimensional geometric patterns, and its composition can be viewed as stereo metric projection of these patterns. In plan, stalactites configurations are arranged according to rectilinear or radical grids in which the circle and its polygonal and star-shaped derivatives are basic features. Stalactites compositions can be found in numerous parts of a structure including column capitals, minaret balconies, cornices, entrances and portals associated with the transitional zone of a dome.[3]

Geometric principles were also used for the generation of various three dimensional architectural elements, many of them were associated with the dome. Ribbing system was also used as a structural device supporting the dome, with a decorative value, as it can be arranged to provide a variety of geometric patterns articulating its surface. In the great mosque of Cordoba, ribbing was used for both purposes. Each of the mosque's three *squinch* domes located in front of the *mihrab* incorporate eight intersecting ribs, which create intricate geometric patterns of eight pointed stars and polygons, including squares and octagons. Instead of using the *squinch* only to transform the square into an octagon on which the dome could be placed, the architect Sinan employed it to transform the rectangular domed prayer hall of Mehmet pasha mosque in Istanbul, 1572 A.D, into a hexagon.[4] (Figs.1.36, 1.37)

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[1] Ibid. pp.154-155.

[2] Ibrahim, abd el baki and center of planning and architecture studies, *principles of architectural design and urban planning during different Islamic eras*, organization of Islamic capitals and cities, Cairo, 1992, pp.440-442.

[3] Frishman, Martin & khan, Hasan-uddin (Eds.). *The Mosque; History, Architectural Development and Regional Diversity*. London: Thames & Hudson, 1994, pp.65-66.

[4] Ibid, pp.60-65.

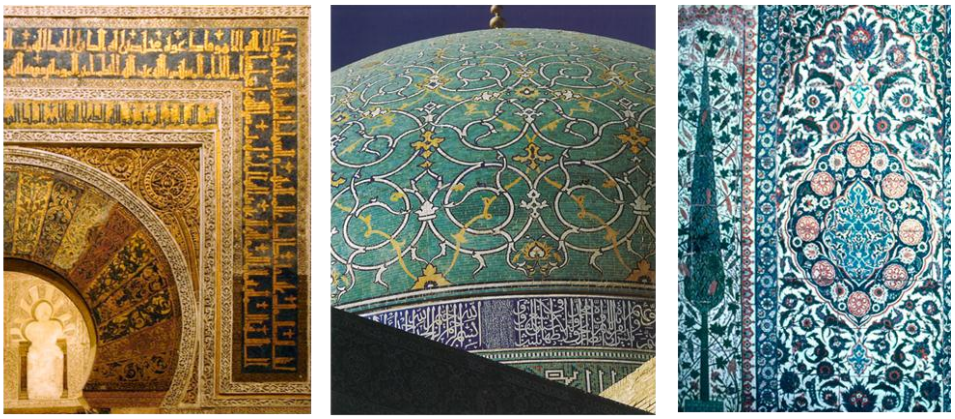


Fig. (1.36): Foliated designs used on the *mihrab* arch in the great mosque of cordoba, spain (10^{th} C. A.D.) (Source: Archnet.org), the dome of Shah mosque in Isfahan, iran (1611-30 A.D.) (Source: Architecture of the Islamic World, 1978, p.126), and the detail from the two tile panels depicting cypresses and floral arrangements in white, red, blue, turquoise and green, in sultan ahmet mosque, Istanbul, turkey (1609-17 A.D.) (Source: Archnet.org), respectively.

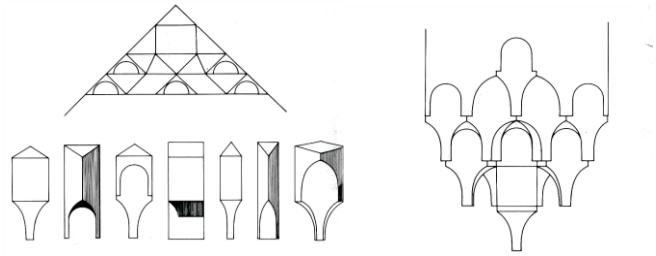


Fig. (1.37): The combinations of the seven shapes of the stalactites, which in section are rectangular or triangular (Source: the mosque, 1994, p.66).

Fig. (1.38): The complex three-dimensional stalactites in the vault of the southern *iwan* of the Friday mosque, Isfahan, Iran (1366-1367 A.D.), a detail in the stalactites in the portal of barquq mosque in Cairo, a detail in the portal and in one of the pendetives below the central dome of the suleyme mosque, Istanbul, turkey (1550-7 A.D.), and the intricately decorated stalactites vault in the entrance of the masjid-I shah, Isfahan, Iran (1611-1630) (Source: the mosque, 1994, p.21, 23, 68, 69), respectively.

1.5.3 Symbolic Values and Mosque Architecture

Traditionally the mosque has played a central role in most Muslim environments; it was also a definer of the society's identity. The powerful symbolism of the mosques' traditional architectural vocabulary is unique to the Muslim culture and is uniquely identified with it, to the extend of being almost a shorthand for designating 'Muslims'. The minaret, dome, gateway, and stalactites are the key elements of much mosque architecture. These elements speak to all Muslims and Non-Muslims with a powerful symbolism that transcends space and time. Yet today these symbols have been degraded to signs and even signals, with a concomitant loss of architectural expression. [1]

1.5.3.1 Symbolism Interpretation in Mosque Architecture

Symbolic elements in mosques - the minaret, dome, pointed arch, decorations, calligraphy, crenellations, colors and numbers, which incidentally are often used as standards to mark the particular sect to which a mosque belongs - are not absolute requirements but nevertheless offer great potential for stylistic elaboration. The associated symbols have evolved in the past and may do so in the future, but whereas in the past it took many generations for an established symbolic element to be changed, today such changes are fast and frequent.[2] Symbolism in mosques was expressed by elements, colors and numbers as explained below.

1.5.3.1.1 Symbolism in Elements

The dome is one of those symbols (*qubba*), where the word *qubba*, in Arabic, is synonym to the word *turba*, the Arabic name used in to denote the grave or tomb; as the dome, *qubba*, was widely used in the Islamic world to cover tombs. This image of the dome, which continued in the Islamic civilization, was based on what mentioned in the verses of the quran about

[1] Serageldin, Ismail & Steele, James (Eds.). *Architecture of The Contemporary Mosque*. Great Britain: Academy Editions, 1996, p.14.

[2] Fethi, Ihsan (Au.) & Cantacuzino, Sherban (Ed.). *Architecture in Continuity*: *The mosque today*. New York: Aperture, 1985, p.62.

comparing heaven to the canopy of earth. The Lord says in quran 21:32, ('And we have made the heavens as a canopy well guarded'). Symbolism appeared in other architectural elements, like the *minaret*, which rises up towards heaven as a symbol of the eternal relationship between earth and heaven.[1]

Another famous symbol in Islamic architecture is the crescent, which was used in the Islamic religious architecture above domes and minarets, parallel to the direction of the *qibla*, because the crescent was related to the Islamic timing, which depends on lunar months, the appearance of the crescent at the beginning of the lunar month lights above the earth dispersing darkness, just as the appearance of Islam dispersed *gahiliyya*.

The entrance **portal** of mosques is another area that customarily attracts more complex treatment and symbolic meaning, as a gateway flanked by splayed projecting wings, as it were welcoming worshippers inside. However, the *mihrab* is the natural focus of the religious symbolism in mosque architecture in associating the *mihrab* with the prophet and where the caliph stood to lead the Friday prayer.[2]

1.5.3.1.2 Symbolism in Colors

Spiritual and actual **lights** are inextricable linked in the Muslim world. Light is a remarkable gift of the creator and there is nothing more perfectly symbolic of divine unity than the phenomenon of light. In **colors**, Muslims also see a perfect representation of God's divine presence on earth. The diffusion of light into a spectrum of colors helped in finding the inevitable representations, where colors reflected human attributes. For instance, **white** resembles the color of pure light, which represents unity, veracity, virginity and beauty. **Black** represents the hidden aspects of the divine, grief and sorrow. The **green** color is bequeathed with the virtues of gift, charity, immortal, supreme divine

[1] Ibrahim, abd el baki and center of planning and architecture studies, *principles of architectural design and urban planning during different Islamic eras*, organization of Islamic capitals and cities, Cairo, 1992, pp.506-507.

[2] Hillenbrand, Robert. *Islamic Architecture: Form, Function and Meaning*. New York: Columbia university press, 1994, p.17.

blessing and peace. **Red** is the color of fire, energy, potency, youth and conditions of extreme excitements. The color of **blue** is the premise of satisfaction and fulfillment, fertility and pregnancy. It signifies the depth of the ocean and the blue sky of the divine knowledge**. Yellow** is associated with maturity and old age and symbolizes time.[1]

1.5.3.1.3 Symbolism in Numbers

In Islamic architecture, **numbers** were of great importance as each number used had a certain symbolic meaning referring to **number two** for instance is seen as the original essence from which the power of duality proceeds and derives its reality. The most symbolic and inclusive number is the **number nineteen** of which several *suras* in the *quran* reference, particularly that related to the significance of the nineteen angels, the first *sura* of the holy Quran consists of nineteen letters and the whole *quranic* text is structured based on this number. **Number one** represents the metaphysical state and it is the symbol of the unity of the creator. **Number three** is characterized with the state of matters and solids, as it classifies the formation of all geometrical shapes: the polygons and polyhedrons, and the form of the crystals. **Number five** represents the organic and the sensible world of animals and plants. **Number seven** is significant in cosmological sense, in the way that it symbolizes the seven heavens of the creator. **Number two** is also given the characterization of unity, as it is divisible by its own pair and its original source is one.[2]

1.5.3.2 Spirituality in Islamic Tradition

God, the angels, the cosmos and eschatological expectations are simultaneously both sources and objects of 'spiritual' contemplation, the initiators and ultimate references of the systems of values and beliefs transmitted and reproduced with devotion in each spiritual tradition. All individuals born and trained in such a tradition spontaneously share the

[1] Kazimee, Bashir A. & rahmani, Ayad B., *Place, Meaning and Form in the Architecture and Urban Structure of Eastern Islamic Cities*. The Edwin mellen press, volume II, 2003, pp.57-62.
[2] Ibid, pp.69-71.

inherited 'values' and psychological mechanisms of spiritualization, sacral, transcendent of the profane, and the modest realities of their own environments. It is crucial to make a clear distinction here between spirituality, sacredness and transcendence as substantive values used in theology and classical metaphysics, and spirituality, sacredness and transcendence as the products of the agents of social, cultural and historical activities. This difference will become clear with the following example of the 'wrong' mosque. This means that spirituality in all cultural traditions has not yet been analyzed and reinterpreted with the new conceptual tools that were elaborated in the neurosciences to map the spiritual functions of the brain. Thus, the history of spirituality has to be rewritten in light of this neuroscientific approach. Fundamentalist believers from all religions will immediately reject such a 'positivist' explanation. It is true that intellectual modernity has generated two competitive psychological postures of mind: the spiritualist attitude sticks to the mythical, metaphorical, lyrical cognitive system taught by traditional religions, the empirical scientific attitude does not negate spirituality and its various manifestations but aims to elucidate, and to differentiate between spirituality, spiritualism, phantasmagoria, subjective arbitrary representations, theosophical constructions. This critical approach to spirituality is particularly absent in Islamic contexts today; political scientists and sociologists speak of the 'return of religion', the 'awakening of Islam', and the struggle of an emotional, unthought-of spirituality opposed to 'western materialism and positivism'. Within these confusing ideological discourses, which are disguised with religious claims and vocabulary, architects are commissioned to revitalize, restore and preserve 'Islamic' cities. Whether the architects themselves do or do not have an Islamic background is not a priority issue; what matters more is the content and the functions they give to spirituality in the present cognitive, anthropological mutations that are imposed upon the human condition.

It is a well-documented fact that many leading architects who endeavor to build mosques in 'the spirit of Islam' have neither a critical historical understanding of this difficult concept, nor an anthropological approach to what is called the metamorphosis of the sacred. Are the main components of the

mosque - *mihrab, minbar,* minaret, courtyard, ablutions - intrinsically Islamic and therefore unchangeable through time and culture, or are they arbitrary forms and signs made orthodox by theological definitions, made sacred by collective ritual functions established over centuries? Islamic thought itself has not changed - intellectually, conceptually, politically, culturally - to any significant degree since the thirteenth or fourteenth centuries. On this issue, lets consider two striking verses from the Koran: And those who took a place of worship [*masjid*] out of opposition and disbelief, in order to generate dissent among the believers and to provide a place of ambush for those who warred against God and His messenger aforetime, they will surely swear: we purposed naught save good. God bears witness that they verily are liars.

Never stand there [for prayer]. A place for worship founded for piety from the first day is more worthy that you stand in it. Therein are men who love to purify themselves; God loves the purifiers, (9, 107-108). These two verses clearly show how spiritual values, sacred places and religious truths which are considered to be absolute, intangible and ultimate references, are historically contingent and dictated by a violent confrontation between social and political groups of 'believers' still struggling for survival.[1]

[1] Arkoun, Mohammed, Cynthia C. Davidson, & Serageldin, Ismail (Eds.). *Architecture Beyond Architecture: Spirituality and Architecture.* London: Academy Editions, 1995, pp.17-18.

Conclusion:

The mosque is considered the most important structure in the Islamic world; it is a building not only made for public worship, but it is also the place where Muslims may practice their political, social and educational activities. The mosque represents Islamic culture and civilization, and therefore, it imparts to cities their Islamic identification.

The specific liturgy and functional requirements of most mosques did not dictate any particular architectural and physical layout. Thus architects are bounded only by their imaginations in the designs they can propose. If some of them preferred to return back to the classical trends and spirits, this has been by choice rather than limitation.

The evolution of mosque architecture in history reveals the early innovations from the mosque of the Prophet, to the modern era mosques varying from continent to continent, from culture to culture. The reading of religious texts and the tradition exposes that Islamic teachings do not oppose beneficial innovation in mosque architecture. The used pattern in the design of mosques shows that not all mosques have the same features, not the same approach has been applied in all mosques and not all mosques have been influenced by the same factors.

Architecture of mosques in the early period of Islam was characterized by simplicity and relied fully on local building materials and domestic techniques. However, in some cases, foreign expertise was employed. The form of the mosque evolved not only to synthesize local architectural elements, but also more importantly to integrate details resulting from the availability of material and responses to climatic conditions, cultural traditions and available technologies. The monumental style of mosque developed and expanded into numerous types of mosque styles around the world.

From studying the development of mosques architecture during Islamic eras, we can conclude that the inherited values of mosques design can be defined as, Functional Values (Architectural/Structural elements, materials, and illumination and ventilation), Aesthetic Values and Symbolic Values.

REFLECTION OF TECHNOLOGY ON THE INHERITED CONCEPTUAL DESIGN OF MOSQUES

Chapter Two: The Development of Architectural Design approaches of Mosques, in Muslim and Non Muslim Societies

This Chapter aims to understand mosques' architectural approaches, by describing the range of characteristics of each approach, the relation between the traditional development and the modern technology. The chapter also identifies the contribution of new technology in developing design concepts and elements of mosques, by defining the main characteristics of high technology, using software and computer programming techniques, the use of smart materials and smart building technologies. The chapter also introduces applications of high technology architecture of the 21st century, in order to identify appropriate tools and techniques to be used in mosques.

1. Mosque Architecture between Modernism & Originality

-Westernization (1800-1900)

-Revivalism (1900-2000)

2. Mosque Design and Architectural Approaches

- Traditional/Vernacular Approach
- Conservative/Conventional Approach
- Adaptive Approach
- Contemporary/Modern Approach
- Post Modern Approach (Hi-Tech Approach)
- Eco-Green Approach
- Eco-Tech: Sustainable Architecture and High Technology Approach

3. Architecture Technologies

1. Material Technologies
- Applications on Material Technologies.

2. Intelligent Technologies
- Applications on IntelligentTechnologies.

3. Computer Aided Technologies
- Applications on Computer Aided Technologies.

Conclusion

To develop an Islamic theory in which modernism and originality are in parallel, the applied approaches should be improved, and a better understanding of the main essence of the religious and spiritual aspects should be considered. Technology directly affected architecture of the 20th and 21st centuries by material technologies, intelligent building technologies and automated control systems, and by the digital representation of using computer aided technologies.

Chapter Two
The Development of Architectural Design approaches of Mosques in Muslim and Non Muslim Societies

The Islamic world is undergoing nowadays-unprecedented transformation in its history, in search of a direction. A desire of rapid development brought to the Islamic and Arabic countries massive importation of western technology, planning, design and constructional expertise. The construction of new mosques, the issue of physical form and function easily initiates debate within Muslim and non-Muslim communities, the mosque should be based on its traditional forms or to combine with modernism.

This chapter will discuss the mosque architecture design approaches, the relation between the traditional development and the modern technology, the effect of colonization on Muslim societies and how modernism and western models have dominated design concepts in eastern societies, and the role regionalism played in diverse Muslim countries.

The chapter will focus on the concepts of hi tech architecture, and will shed some light on digital architecture, and using computer software programming techniques. Intelligent building technologies and the use of smart materials will also be mentioned, which provide both the building operator and occupant with an environment that is flexible, effective, comfortable, and secure. The chapter also will introduce the latest applications of technology architecture of the 21st century, in order to identify appropriate tools and techniques to be used in mosques.

2.1 Mosque Architecture between Modernism and Originality

In the Islamic world it was possible to see the development of a limited combination of eastern and western styles. The whole of Islamic secular architecture from the middle of the 19th century was strongly influenced by models from western colonial states. Conversely, in the early 20th century, building styles and formal elements from the Islamic world provided stimulus for architectural development in Europe and North America. Architects such as Walter Ropius and le Corbusier then discovered the attraction of applying eastern form reduction to their concept of modern architecture.

2.1.1 Westernization (1800-1900 A.D.)

The nineteenth century started with the first European military interventions in the Orient and ended with most of it under direct colonial rule. Architecture was affected by the new political realities and by the disciplinary developments in Europe, where architecture had become an academic field with its rules and parameters. European styles began shaping the outlook of oriental cities and the tastes of their inhabitants. Also European and European-trained designers became the masters of the building trades everywhere. These professionals acted as the interpreters of the architectural heritage of the countries worked in.

Consequently, hybrid styles of building and decoration were produced in both East and West that borrowed freely and sometimes indiscriminately from the varied repertoires of non-western architectures, and blended them with various European structural, constructional, functional, and stylistic modes. The end results came to be known collectively as Oriental styles and individually encounter various epithets such as the Neo-Moorish, Neo-Mamluk, and Neo-Mughal. For example, The Nusretiye Mosque, Istanbul: (1822-26 A.D.) built by Mahmut II*, one of the most extreme examples of the rococo dominance in late Ottoman architecture, (Fig. 2.1), and the

* Mahmut II, the promoter of new order, after he managed to eliminate the Janissaries, hence the name of the mosque means "victory."

Dolmabahçe Mosque, Istanbul: (1852-3 A.D.), built by Karabet*, as an adaptation of a neo-classical style,[1] (Fig. 2.2).

Figs. (2.1, 2.2): Nusretiye Mosque, Istanbul, exterior view showing the southwest façade with side arcade (Photo by, Walter B. Denny), and Dolmabahce Mosque, Istanbul, exterior view showing the southwest façade with side arcade, respectively. (Photo by, Walter B. Denny)

The Adaptation of a European building style was viewed in many Islamic countries as an opportunity to progress in a more modern direction. One typical example of this was the intention of the Egyptian khedive Ismail to Europeanize Cairo, (1863-1879 A.D.).[2] Westernization and political nationalism have helped to bring secularization in many Islamic states. The *awqaf* has lost its independence and became an official governmental organization. In most Islamic states it has acquired a large share of the real-estate market and was heavily involved in property development. As a result it didn't give proper attention to the documentation and maintenance to the historic mosques or to the new ones. The private mosques were built by local contractors with the permission of the municipal authorities and not the *awqaf*, which didn't appear to give much architectural guidance or design

* Karabet, the first of the Balian family of architects.

[1] "20-Nineteenth-CenturyReligious Architecture." Web. November 2011.

[2] Hattstein, Markus & Delius, Peter (Eds.). *Islam, art and architecture*. Cairo: American university press, 2007, pp.586-590.

quality control in most Muslim countries, where badly executed and strangely hybrid mosques were built all over the Islamic world.

The influence of some European architects has also helped to give credence to the concept of the mosque as freestanding monument. Mario Rossi*, for example, was influential in the development in Egypt of a new, but conservative style of mosques design. His mosques were an attempt to create a synthesis of the ottoman and Mamluk styles, with some innovations. Rossi's mosque designs showed a basic adherence to tradition, especially in his repeated use of the ottoman centralized dome type. The mosques of Omar Makarram in Cairo, the Abi al-Abbas al-Mursi mosque (1929-45 A.D.), the mahatat al raml mosque (1948-51 A.D.), and Mohamed Kurayyim mosque (1949-1953 A.D.) in Alexandria, were of particular interest.[1] Rossi was the leader in the introduction of the use of reinforced concrete to the construction tradition of *awqaf*.[2] (Fig. 2.3)

Fig. (2.3): Exterior views of Omar Makkram Mosque, Cairo, Egypt (Source: http://www.panoramio.com/photo/27014794)

* Mario Rossi, an Italian architect (1897-1961), He was employed as the chief architect of the ministry of the *awqaf* from 1929 to 1954.

[1] Fethi, Ihsan (Au.) & Cantacuzino, Sherban (Ed.). *Architecture in Continuity*: *The mosque today*. New York: Aperture, 1985, pp.57-59.

[2] Turchiarulo, Mariangela. "Building Styles Brought to Egypt by the Italian Community Between 1850 and 1950: The style of Marrio Rrossi." *Proceedings of the third congress on construction history*. Cottbus, Germany, May 2009, pp.381-388.

2.1.2 Revivalism (1900-2000 A.D.)

Through the admiration of European art and the influence of European companies, Islamic traditions almost came to a point of collapse and the infrastructure of older craft industries was almost annihilated by the European industrial system.[1] Most countries of the Islamic world have achieved independence only since the late 1940s as a result of rapidly changing conditions; traditional regional mosque design has been subjected to the influence of internationalism and modernism. The designs of mosques were not determined only by religious practice but also by ideological considerations. Ruptures in the continuity of adapting historical forms and practices can be detected in all regions of the Islamic world, most of which were transformed physically and culturally during a long period of colonial rule by European powers.

Representative examples of the rupture are the mosque of Muhammed Ali (1828-48 A.D.) in Cairo, Egypt and Istiqlal mosque (1955-1984 A.D.) in Jakarta, Indonesia. Muhammad Ali built a monumental mosque that appeared to be a classical ottoman style, instead of using the prevailing Mamluk vocabulary. In Istiqlal mosque, the country allowed only Indonesians to enter the competition for its design and construction. Materials used had to be long lasting and available within the country, the designer chose concrete and steel for manufacturing the building components. These examples are cited to demonstrate the process involved in the formation of the attitude adopted, which were symptomatic of the distancing and the rupture that took place, not only in all areas where Islamic cultures had taken root,[2] (Figs.2.4, 2.5).

[1] Hattstein, Markus & Delius, Peter (Eds.). *Islam, art and architecture*. Cairo: American university press, 2007, pp.586-587.

[2] Ibid, p.586.


Figs. (2.4, 2.5): Exterior views of Muhammed Ali mosque in the citadel, Cairo (photo by, Gary otte, copyrighted to Aga Khan Trust for Culture), and Istiqlal mosque, the state mosque of the republic of Indonesia, respectively. (Source: Archnet.org)

By the end of the 20th century and beginning of the 21st centuries, several architectural schools appeared in the west, focusing on the materialistic values of the industrial revolution, (L'Institut du Monde Arabe, jean nouval (1987-1988 A.D.), (Fig. 2.6). The schools called for an architectural reformation in which shapes are simplified to replace former decorations, which were based on visual excitement. Post modernism architecture breached all previous architectural concepts, and became more individual. For example, ornamentations and symmetry disappeared, and it also erased the architectural identity.

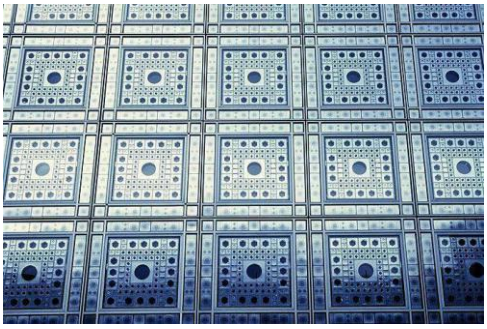


Fig. (2.6): courtyard entry and patterned facade overview of L'Institut du Monde Arabe, Paris, France (source:www.greatbuildings.com/buildings/L_Institut_du_Monde_Arabe.html)

2.2 Mosque Architectural Design Approaches

The method of building in most Muslim countries has had to keep pace with the rate of development. Hence the widespread adoption of western methodology and technology, have made for speed and efficiency, even the architecture of mosques, which tends to be conservative, has succumbed to this procedure. The Stylistic variations and the production of the hybrids arising from local architectural traditions are obviously more visible and tangible than the usually slight, subtle typological changes. The arrival of modern technology and the general liberalization in architectural design have resulted in the cause of some innovation but also of much misguided experimentation, resulting in stylistic transplants and strange hybrids. It has become more difficult, therefore, to define the typology of mosque design.

According to Ismail Serageldin and Ihsan Fethi classification of mosques design approaches, the architectural expressions have reflected a range of common approaches that can be classified into five board approaches, and two approaches were lately added and was derived from the main approaches.

2.2.1 Traditional/Vernacular Approach:

The differences between mosques from one region to another are mainly due to regional diversity of cultures and climates. Regardless using the same elements in most mosques, architectural languages vary from one region to another. Traditional movement adopts 'vernacularism' as a strategy that seeks to speak for a specific identity.[1]

Vernacular architecture is undertaken by local master builders, using local materials and techniques, which rely on long experience of local workmen in using and forming the local materials, by chosing suitable

[1] Buhlfaia, Saeid A., "Historical Background of Libyan Mosque Architecture: Assessment and Criticism of Mosques in Ajdabiya City." Msc. Dissertation, Technical University of Middle East, 2006, pp.42-43.

elements and structural forms. Hassan fathy was one of the first architects to break with modern architecture and to found a new approach based on a conception of interpreting forms and masses from the past. He encompassed the development of modern architecture and the international style from the 1930s to 1970s, as well as the formulation of the post-modern movement from the 1970s onward.[1]

The mosque at new Gourna, Luxor (1945 A.D.) reflects the expression of traditional vernacular architecture; Fathy incorporated a mud brick mosque, using traditional materials of the region and at the same time created a modern building that responds to the functional requirements of a mosque.[2] He used ancient Nubian techniques for the construction of the vaults and domes in simple way and inexpensive materials. The technique didn't require wood for framework and was therefore also viable ecologically and ethically, as well as architecturally. This style was adopted in North Africa, Middle East and area where earth was a commonly used building material. This architecture became associated with hot dry climates,[3] (Fig.2.7).

In addition to that, the mosques currently being designed by Abdul Wahed El-Wakil in Saudi Arabia show his classicism and traditionalism in using the language of the past for its emotive power and affective content, for example, Bin laden mosque in Jeddah (1988 A.D.), (Fig.2.8).[4] The approach of Al-Wakil strives to reinterpret components of seminal historical buildings and strongly opposes the widespread attempts to islamicize buildings by the superficial application. Instead, he employs the authentic technologies and

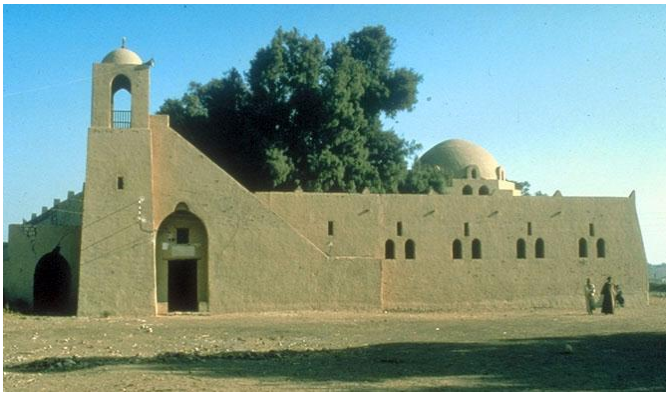
[1] El-Shorbagy, Abdel-Moniem. "Hassan Fathy: the unacknowledged conscience of the twentieth century architecture." *International Journal of Basic and Applied Sciences*, 10(2), pp.45-47.

[2] Hattstein, Markus & Delius, Peter (Eds.). *Islam, art and architecture*. Cairo: American university press, 2007, pp.588-589.

[3] Petruccioli, Attilio & Pirani, Khalil K. (Eds.). *Understanding Islamic Architecture*, London: Routledge/Curzon, 2003, p.87.

[4] Serageldin, Ismail & Steele, James (Eds.). *Architecture of the contemporary mosque*. Great Britain: Academy Editions, 1996, p.17.

building processes that are intrinsic in the historical buildings to which he looks for inspiration.[1]



Figs. (2.7, 2.8): Exterior views of the small mosque of new Gourna, Luxor (Source: Archnet.org), and Bin laden mosque, Jeddah, respectively. (Source: Archnet.org)

2.2.2 Conservative/Conventional Approach:

These mosques adhere to existing regional characteristics, using familiar and stereotyped forms, with some modern architectural materials and services. Though modern structural systems such as reinforced concrete roofs, beams and columns were largely used, the mosques were heavily dependent on local masons and craftsmen for finishing techniques, decorative work, and calligraphy. In other words, they tend to be quite modern in their structure, but conservative in their liturgical imagery. Examples reflect this approach are Abi Abbas al Mursi mosque in Alexandria (1945 A.D.), (Fig.2.9) and Habibiya mosque in Tunisia (1961 A.D.)

[1] Petruccioli, Attilio & Pirani, Khalil K. (Eds.). *Understanding Islamic Architecture*, London: Routledge/Curzon, 2003, p.93.

Fig. (2.9): Exterior view of Abi Al-Abbas Al-Mursi mosque, Alexandria (photo by, Emily & Michael Dziedzic)

2.2.3 Adaptive Approach:

The Adaptive approach tends to incorporate traditional vocabulary into a modern approach. The mosques mostly have modern structures, often incorporating sophisticated and innovative construction techniques and architectural services. In other words they are essentially modern, but an attempt has been made to make them fit with the locality by the use of the traditional vocabulary and symbolism. The designs cannot be called conservative, because they are adaptive and innovative; and cannot be called contemporary, as they clearly depart from the usual internationalist architectural idiom.[1]

Rasem Badran is one of the pioneers of this approach, where he adopts individual elements of classical Islamic architecture and transfers them into a modern form with modern materials. A certain tension between modern building forms and materials used and traditional architectural forms can be seen in his work.[2] Examples dominating this approach are, the mosque and Islamic centre in Italy (1975 A.D.) and the Grand mosque in Kuwait (1976-1984 A.D.), (Figs.2.10, 2.11).

[1] Fethi, Ihsan (Au.) & Cantacuzino, Sherban (Ed.). Architecture in Continuity: *The mosque today*. New York: Aperture, 1985, p.55.

[2] Hattstein, Markus & Delius, Peter (Eds.). *Islam, art and architecture*. Cairo: American university press, 2007, pp.587-588.

Fig. (2.10, 2.11): The prayer hall structural components of the mosque and Islamic centre in Italy, and a general view of the Grand mosque of Kuwait, respectively. (Source: The mosque, 1994, p.260, 270)

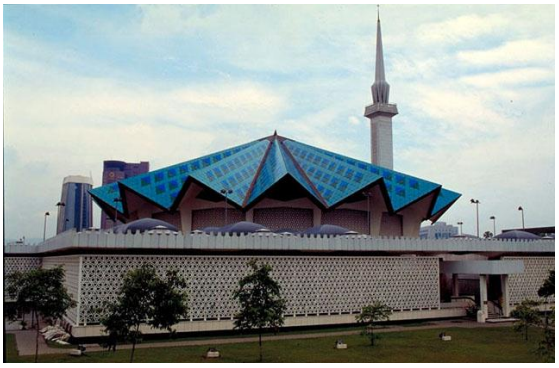
2.2.4 Contemporary/Modern Approach:

Purity and abstraction are primary principles of the International Modern Movement.[1] These Mosques follow a contemporary international style vocabulary predominated in abstracted forms and streamlined geometry using the modern structural construction techniques, services and materials. Consequently they don't necessarily attempt to attain a specific local architectural identity. The designs are more innovative and some of them show a remarkable degree of originality and simplicity.

Examples dominating this approach are, Negara Great Mosque (1965 A.D.) in Malaysia and Sherefudin White Mosque (1980 A.D.) in Bosnia [2], (Figs. 2.12, 2.13). The use of the metaphorical analogy can be seen in the Bait Al-Mukarram mosque in Dhaka (1962 A.D.), which imitates the cubic form of the black stone, (Fig.2.14).

[1] Buhlfaia, Saeid A., "Historical Background of Libyan Mosque Architecture: Assessment and Criticism of Mosques in Ajdabiya City." Msc. Dissertation, Technical University of Middle East, 2006, pp.45-46.

[2] Fethi, Ihsan (Au.) & Cantacuzino, Sherban (Ed.). Architecture in Continuity: *The mosque today*. New York: Aperture, 1985, p.56.



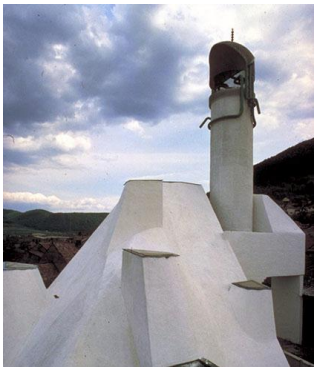


Fig. (2.12, 2.13): Exterior views of Negara Great Mosque, Malaysia, and Sherefudin White Mosque, Bosnia, respectively. (Source: The mosque, 1994, p.259, 264)

Fig. (2.14): Main entrance of Bait Al-Mukarram mosque at Dhaka, Bangladesh (Source: Aga Khan Trust for Culture)

2.2.5 Post Modern/Hi-Tech Approach:

Post-Modernism started from the 1950s, but did not become a movement until the late 1970s, and still influence present-day architecture. Postmodernism considers using well-known elements as a method to address and to connect with people and get involved in their period and environmental architecture. Post-Modernism insists on producing architecture, which can be perceived by the public, demanding exaggerated ornamentations instead of 'purity'. [1] Examples of mosques dominating this approach are The Putra Mosque (1997 A.D.) and the Malacca Straits Mosque (1996 A.D.) both in Malaysia, (Figs.2.15, 2.16).

[1] Buhlfaia, Saeid A., "Historical Background of Libyan Mosque Architecture: Assessment and Criticism of Mosques in Ajdabiya City." Msc. Dissertation, Technical University of Middle East, 2006, pp.45-46.


Figs. (2.15, 2.16): Exterior views of Putra and Malacca Straits Mosque (Source: http://en.wikipedia.org/wiki/Putra_Mosque, http://magictravelblog.com/wp-content/uploads/2011/11/Melaka-Mosque-Feature.png), respectively.

High-tech architecture is an architectural style that was emerged in the 1970s, incorporating elements of high-tech industry and technology into building design. High-tech architecture appeared as a revamped modernism, an extension of those previous ideas aided by more advances in technological achievements. This category serves as a bridge between modernism and post-modernism. In the 1980s, high-tech architecture became more difficult to distinguish from post-modern architecture. Many of its themes and ideas were absorbed into the language of the post-modern architectural schools.[1]

The characteristics of high-tech architecture included the prominent display of the buildings' technical and functional components, and use of pre-fabricated elements. Glass walls and steel frames were also immensely popular. Structural Expressionist buildings reveal their structure on the outside as well as the inside, but with visual emphasis placed on the internal steel and/or concrete skeletal structure as opposed to exterior concrete walls, and additional exposure of mechanical services. Hi-tech architecture covers information technology, space technology, new materials technology, ecological environment technology and artificial intelligence.[2]

[1] Frederic P. Miller (Au.), *High-tech Architecture.* Vdm Publishing House, 2010.

[2] "High-tech architecture." *Wikipedia.* December 2008. Web. 20 December 2011.

2.2.6 Eco-Green Approach

The concept of the sustainable approach attempts to find balance among main dimensions: quality, economy and environment. Sustainable architecture takes into account all aspects of the building that will affect and be affected by environment and users. It looks at things such as material use and embodied energy, solar access, natural passive heating and cooling, ventilation, water and energy use in order to reduce its dependence on fossil fuels and other un-renewable resources. In addition, it can utilize recycled materials to reduce their total energy requirements for construction. Sustainable architecture aims to have as little impact on the local and global environment as possible without polluting either indoor or outdoor environments, while continuing to provide adequate, comfortable and safe buildings.

Two different traditional approaches; passive cooling and material approach have been adapted as sustainable solutions for mosques architecture.

- **Energy Approach:** The use of passive cooling techniques to cool the indoor environment of the mosques as an alternative of the usage of mechanical air conditioning systems.

- **Material Approach**: The use of local materials and simple building techniques in the process of mosques construction.

In Saudi Arabia, the most common problems facing mosques are mosques capacity, accommodating people during the lectures, maintenance and energy consumption. These two different approaches were implemented in local mosques to present innovative utilizations of sustainable architecture's principles that serve and improve mosques architecture, physically and functionally without jeopardizing heritage identity.

- ***Energy Approach: Cooling Towers.***

In hot-dry climates, traditional techniques, such as wind towers and courtyards are used extensively due to their energy-efficiency and cost-effectiveness characteristics. The simplest design for a passive cooling tower is a vertically constructed duct "chimney shape" that is projected above its surroundings and has an open top window or windows to catch the outside dry hot air. The dry hot air is allowed to pass through a perforated wet media to get cool and then directed into the building spaces. This technique has been applied in Al-Ruhmaniah mosque in Saudi Arabia, (Fig.2.17).

Fig. (2.17): Wind Towers in Al-Ruhmaniah Mosque, Saudi Arabia
(Source: http://alrahmaniah.org/en/design/design.html)

- ***Material Approach: Local Components and Methods***

Local building materials used in the traditional mosques in the central region of Saudi Arabia, for example, adobe bricks made from a mixture of mud and straw that contributed in achieving high level of sustainability. In addition to being simple and economic, the bricks are thermally efficient, a characteristic that makes them harmonize with the desert harsh climate and capable of producing internal comfortable atmosphere in buildings.

This natural and passive technique that saved cooling energy cost is significantly low, compared to electromechanical air-conditioning systems, and the merit of the second approach is the creation of friendly environments

that respect the surrounding atmospheres. Mud is a good insulating material, which keeps buildings warm during the cold season and cold during the summer season.[1]

2.2.7 Eco-Tech Approach: Sustainable Architecture and High Technology Approach

Since the mid 19th century, the industrialized technology has been a factor in architectural design. In the early years of experimentation, high technology was used to express the possibilities of mass production. However, in recent years architects have moved towards using technology that responds to the environment in which the building is placed.[2] The worldwide Islamic missionary group (Tablighi Jamaat) has come up with the innovative idea to build futuristic giant mosque that features wind turbine minarets and tidal power in London, using translucent latticed roof to replace the dome.[3] In Levenshulme in Manchester UK, 2008, an eco-mosque was built with solar panels, under-floor heating, low-energy light bulbs, wood from renewable sources, and reclaimed stone.[4] (Fig.2.18)

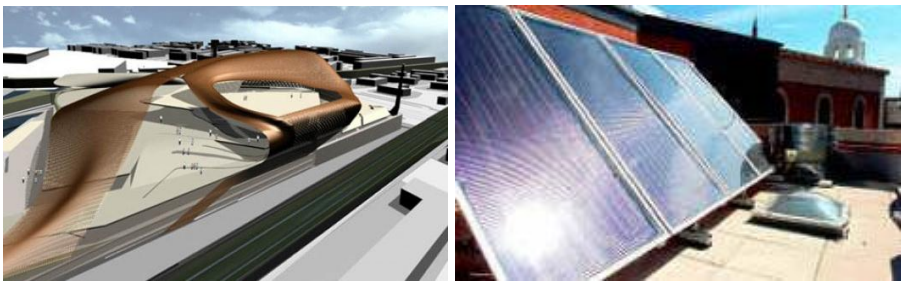


Fig. (2.18): The futuristic giant mosque that features wind turbine minarets and tidal power in London, and Manchester solar paneled eco-mosque. (Source: http://ifees.org.uk/index.php?option=com_content&task=view&id=58&Itemid=56)

[1] Al-Tassan, Abdurrahman & Bahobail, Mohammed. "Mosques and Sustainable Traditional Technique." College of Architecture and Planning, King Saud University, Saudi Arabia, pp.1-8.

[2] Slessor, Catherine. *Eco-tech: Sustainable Architecture and High Technology*. New York: Thames and Hudson, 1997, editorial reviews.

[3] Irani. "Sustainable Mosque with Wind Turbine Minarets and Latticed Roof."*Eco Friend, 26* December 2005. Web. 4 September 2010.

[4] "Is your mosque an Eco mosque?." *Islamic Foundation for Ecology and Environmental Sciences*. Web. 10 December 2010.

2.3 The Impact of Technology on Architecture of the 20th and 21st Centuries.

Throughout the nineteenth century, architecture refused to have anything to do with industry; it had been concerned solely with monumental projects glorifying the state and giant civic structures expressing the pride of its people. This however, all changed with the dawn of the twentieth century. Industrial production became an integral part of modern society and a new relationship was forged between man and machine. From the nineteen hundreds on, architecture was viewed in this new light. Modernism and the optimistic belief that architecture could change the future of society through a synthesis of science and technology was the result. It reflected a new ideal for humanity - one that linked man to a new rational culture in tune with mechanization and efficiency. The industrial revolution gave three new materials to the architect of the 20th century: reinforced concrete, steel and glass. The new materials were inexpensive, mass produced and flexible to use.[1]

2.3.1 High Technology Architecture

High-tech architecture, also known as Late Modernism or Structural Expressionism, is an architectural style that was emerged in the 1970s, incorporating elements of high-tech industry and technology into building design. High-tech architecture appeared as a revamped modernism, an extension of those previous ideas aided by more advances in technological achievements. This category serves as a bridge between modernism and post-modernism, however there remain gray areas as to where one category ends and the other begins. In the 1980s, high-tech architecture became more difficult to distinguish from post-modern architecture. Many of its themes and ideas were absorbed into the language of the post-modern architectural schools.

[1] "What impact has technology had on architecture of the 20th century." Web. 24 April 2012.

2.3.1.1 Definition

Technology is the making, usage, and knowledge of tools, machines, techniques, crafts, systems or methods of organization in order to solve a problem or perform a specific function. It can also refer to the collection of such tools, machinery, and procedures. The word *technology* comes from the Greek work (*technología),* meaning "art, skill, craft", and*(-logía),* meaning "study of-" [1] In industry, it means electronics, computers, silicon chips, robots, and in architecture it means a particular style of building.

2.3.1.2 Characteristics

The characteristics of high-tech architecture included the prominent display of the buildings' technical and functional components, and use of pre-fabricated elements. Glass walls and steel frames were also immensely popular. Structural Expressionist buildings reveal their structure on the outside as well as the inside, but with visual emphasis placed on the internal steel and/or concrete skeletal structure as opposed to exterior concrete walls, and additional exposure of mechanical services.[2]

High tech buildings are distinguished with various elements, as the muscular steel structure, smooth, impervious skin, deliberating exposed pipes and air ducts, which are often powerfully expressive of their technical function, but the form of the complete building is powerfully inexpressive of its use. The issue of space has been replaced in high tech architecture by the more technical issue of flexibility as a serviced zone. It might be external or internal, it will be perfectly clear which elements are the staircases, lifts, escalators and air ducts, the only doubt will be about the nature of the internal space being serviced by all these technical contraptions.

In buildings such as the Pompidou Centre, Paris, by Richard Rogers (1977 A.D), this idea of revealed structure was taken to the extreme, with apparently structural components serving little or no structural role. In this case, the use of "structural" steel is a stylistic or aesthetic matter. The

[1] Merriam-Webster. Retrieved 2007-02-16. (Accessed: 8 March 2011)

[2] http://en.wikipedia.org/wiki/Architectural_style. (Accessed: 20 April 2011)

ventilation ducts are all prominently shown on the outside, and the columns are water-cooled to improve the fire resistance. This was a radical design, as previous ventilation ducts would have been a component hidden on the inside of the building. The means of access to the building is also on the outside, with the large tube allowing visitors to enter the building. The design aim was to show the public how a building functions, (Fig.2.19).

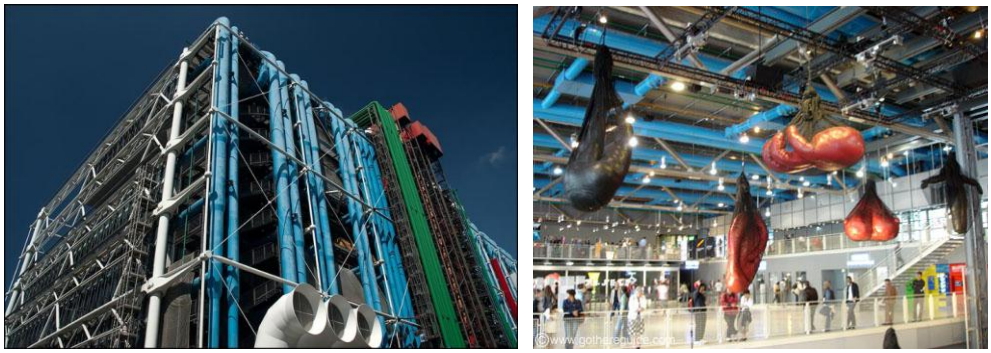


Fig. (2.19): The colour coded building functions, and the flexible interior of Pompidou centre, Paris, France (Source: www.gothereguide.com/pompidou+centre+paris-place)

2.3.1.3 Function and representation

The typical High Tech building symbolizes and represents technology rather than simply using it in the most efficient way possible, and architecture cannot be purely functional or artistic. It may be cheaper and quicker to build a load-bearing brick wall, but the High Tech architect will always prefer the steel frame and the lightweight metal panel, because this technique represent the spirit of the age. In this Endeavour, symbolism and representation have an important part to play. The motifs of High Tech - exposed steel structure, visible air conditioning ducts, plug-in service pods, and so on - are almost never the most economical solutions.

Le Corbusier described the house as a machine for living in, but he built houses that were technologically primitive and looked nothing like machines. High Tech buildings do look like machines. The machine is more than a metaphor; it is a source of technology and of imagery. Machines are usually mass-produced, either mobile or portable, and made of synthetic materials

such as metal, glass, and plastic. These characteristics have become the reference points of High Tech architecture. The buildings may not be mass-produced, or even assembled from mass-produced components, but they look mass-produced, or at least capable of repetition, (Fig.2.20).

Fig. (2.20): Exterior view of villa Savoye by Le Corbusier, Paris, 1929. (Source: http://www.archdaily.com/84524/ad-classics-villa-savoye-le-corbusier/)

2.3.1.4 The mass production problem

An architecture that tries to imitate the methods and products of manufacturing industry encounters some special problems, plus the problem of mass production. Cars are made in millions; buildings are usually one-off. It takes many years and very large sums of money to design and develop a car. Many prototypes must be made and tested. If a building is to make use of the same technology, and achieve the same level of sophistication, then there must be a similar level of investment in its design and development. It seems that the necessity for constant adaptation to different site conditions and different use requirements means that, in the end, it is usually cheaper to build in bricks and mortar. Meanwhile, the mass production of certain building components has increased steadily. Windows, doors, curtain wall mullions, raised floors and suspended ceilings are mass-produced to standard

patterns in factories and it is now commonplace for buildings to incorporate whole systems of components. Even buildings that are apparently thoroughly traditional turn out to contain many non-traditional synthetic components and materials, such as asbestos tiles, glass fiber insulation, steel joist hangers and plastic windows. Building has quietly been industrialized, the technology has changed profoundly, but the architecture has not. High Tech architects want to bring buildings back into line, not by returning to traditional building technology, but by creating an architecture that looks mass-produced and machine-like, (Fig.2.21).

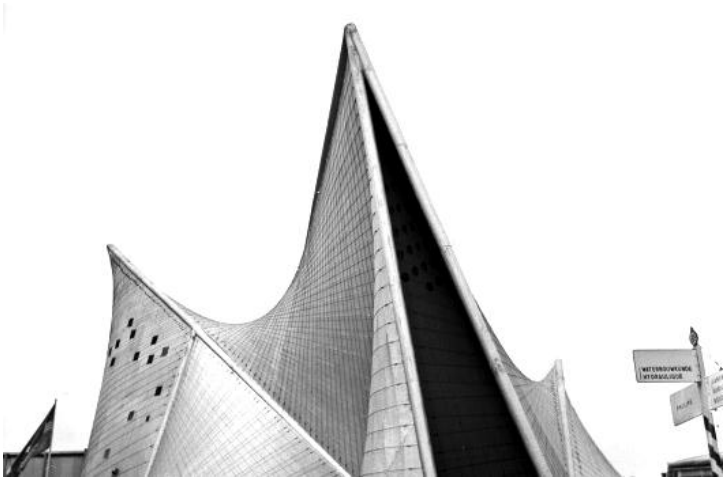


Fig. (2.21): Exterior view of philips pavilion, Le Corbusier, Brussels, 1959. (Source: http://www.archdaily.com/157658/ad-classics-expo-58-philips-pavilion-le-corbusier-and-iannis-xenakis/)

2.3.1.5 Structure and services - The glorification of technology

Exposed structure and exposed services are the two most visible distinguishing features of High Tech architecture, even though not all High Tech architects expose the structure and services of their buildings as a matter of course. Steel structures are one of the very few building materials that are strong in tension. Given High Tech architecture tendency to dramatize the technical function of building elements, it is not surprising that steel tension members should be given such prominence.

A single-storey building can expose its steel structure, but the frame of a multi-storey building must be fireproof. Traditionally, that means either using reinforced concrete or, if the frame is steel, encasing it in concrete. Neither of these is likely to meet with the approval of High Tech architects for whom dry, factory-made, bolted steel is always to be preferred to wet, messy, cast-in-place concrete. At the Centre Pompidou, the problem was solved by a combination of water-cooling for the columns, dry insulation for the trusses, and spray-on fireproofing for the joints.

2.3.1.6 Space and flexibility

The various elements of a High Tech building - the muscular steel structure, the smooth, impervious skin, the deliberately exposed pipes and air ducts - are often powerfully expressive of their technical function, but the form of the complete building is often remarkably inexpressive of its intended use. The molding of space, whether to suit particular patterns of use or simply for visual effect, has never been an issue in High Tech architecture.

The purpose of the complicated exterior is precisely to keep the internal space as simple as possible. The issue of space has been replaced in High Tech architecture by the more technical issue of flexibility. A serviced zone, it might be internal or external, the possible use of this zone are maximized by providing facilities of various kinds - air, heat, light, power, and something to fix partitions to on a regular grid. In the Centre Pompidou, there is a contrast between a simple, abstract, rectangular floor plan and a complex, technically expressive exterior. This, however, is a multi- functional building with art galleries, museum, library, theatre, concert hall, and restaurant. Still, the basic elements of the interior, including the massive long- span trusses, remain the same, whatever the function is. Space cannot be committed to a single function because the whole design is committed to the idea of flexibility.[1]

[1] Davies, Colin. *High Tech Architecture.* London: Thames and Hudson Ltd., 1988.

2.3.2 Technologies of the 20th and 21st Centuries.

Technology affected architecture of the 20th and 21st centuries by the continual transformation of material technologies and application methods, in intelligent building technologies and automated building control systems where the building has the ability to adjust and adopt according to its occupants and to climate changes, and also by the digital representation of using computer technology that liberates the design and construction process. The previously mentioned technologies are based on the following writings:

- According to Blaine Brownell book (Material Strategies: Innovative Applications in Architecture): "Architecture is the fulfilment of a spatial premise by way of material substance. Throughout history architecture has been shaped by the continual transformation of **material technologies** and application methods. Its course of development is inseparable from the shifting terrain of technology and the social effects that result. Materials are fundamental to the expression, performance and experience of buildings. In many ways architecture is an idea of space while materials are the physical expression of that idea. The advancements of materials have a tremendous impact on all the objects and spaces we come into contact with and effectually influence our lives. - Blaine Brownell." [1]

- According to Mohammad Javad, paper conference (The Function of Smart Material's behavior in architecture): "Smart materials are the answer for the 21st century technological needs. Use of smart materials in architecture moreover dramatically reduces the energy and material cost of the buildings, enables the human to design of direct and discrete environments that providing better conditions in space for human occupants. Smart materials allow even a further specificity because their properties are changeable and thus responsive to transient needs. An intelligent element is the element that without the support of infrastructure element acts as a clever system and does not stop performance of peripheral systems. Since

[1] Brownell, B., *Material Strategies: Innovative Applications in Architecture.* Princeton Architectural Press, 2011, p.8.

the architectural design always involve integrated systems and materials traditionally –making coverage of building depends on the building structural system, HVAC system of building is subject to a cover structure– then the biggest potential application of smart materials will result in to separate the specific components (The development of smart materials will be involved in a variety of components such as sensors, actuators, the shape-memory alloys and etc.), behaviors or indoor environment." [1]

- According to a web article by Anupam Jolly (Eco Tech: Architecture to Witness a revolution with the development of Smart materials): "German architect Alex Ritter thinks that the latest development in technology will yield smart materials that will revolutionize architecture forever. The materials will make buildings of tomorrow generate renewable energy for power and change their properties in reaction to heat, moisture or light. The future of these materials will be endless. Buildings will be built that can change their color or shape with input from the environment and will be able to take energy directly from natural sources, without the need for a grid connection."[2]

- According to a web article by King, Rawlson (What Are Intelligent Building Technologies?): "Intelligent technologies are defined as integrated communication and control systems that provide both the building operator and occupant with an environment that is flexible, effective, comfortable, and secure. By using such systems, building operators can control a network of disparate building automation systems, which typically comprise electronic equipment that automatically performs specific facility functions. Building automation system (BAS) includes the comprehensive automatic control of one or more major building system functions required in a facility, such as heating, ventilating, and air-conditioning systems. Automated systems

[1] Javad Sadeghi, Mohammad, J. "The Function of Smart Material's behavior in architecture." *International Conference on Intelligent Building and Management Proc. of CSIT.* Vol.5, 2011. IACSIT Press, Singapore, pp.317-322.

[2] Jolly, Anupam. "*Eco Tech: Architcteure to Witness a revolution with the development of smart materials."* 7 September 2009. Web. 24 April 2012.

include a collection of sensors that determine the condition or status of parameters to be controlled, such as temperature, relative humidity, and pressure. The smart building integrates new technologies from such areas as computer automation, new building materials, energy management and operation technology. The resulting building/space has the ability to adjust and adapt to its occupants**."** [1]

- And according to a web article (New digital technology set to revolutionize architectural practice): "The design process has also presented with the aid of computers. Structural sciences have advanced and many new structural and constructional systems that achieve long spans with less use of materials have contributed to the image of architecture. New building materials have been developed such as plastics and synthetic materials, glass fibers. Building technology has included prefabrication and automation of traditional construction methods resulting in significant saving of time and money. Simultaneously, advances and innovations have been taking place in other building services. Lighting and acoustic sciences have advanced and solar and energy-conscious systems have become available. The digital representation of physical and functional characteristics of a project –building information model (BIM) – delivers a clear picture of what is happening in a single project. Immediate benefits are more accurately estimated costs and time, a reduction in errors, detection of clashes and reduced variations, and the ability to see and analyze the project in near-real life fidelity." [2]

Therefore, we can conclude that technology affected architecture of the 20^{th} and 21^{st} centuries by **material technologies**, **intelligent building technologies** and automated control systems, and by the digital representation of using **computer aided technologies.**

[1] King, Rawlson O. "What Are Intelligent Building Technologies?" *Electronic Design.* 29 June 2006. Web. 2 February 2012.

[2] "New digital technology set to revolutionize architectural practice." *Australian Institute of Architects.* 11 April 2007. Web. 2 February 2012.

2.3.2.1 Material Technologies.

Materials are fundamental to the expression, performance and experience of buildings. In many ways architecture is an idea of space while materials are the physical expression of that idea. The advancements of materials have a tremendous impact on all the objects and spaces that come into contact with and effectually influence our lives.

- ***Composite Materials***

Composites materials in construction offer a number of potential advantages over traditional material, the ability to integrate special finishes and a very wide variety of unusual effects, simulation of traditional materials such as stone or granite, huge weight savings – Composite Domes weigh 15% of a Concrete dome, easier, faster and more economic installation, the ability to bring larger sections to site reducing assembly time and cost. Also the reduction in size and cost of supporting structure, foundation, reduced energy in transportation to site, superior durability, resistant to atmospheric degradation, reduction in maintenance requirements, faster build times, better quality control, reduction in carbon emissions and running costs, sustainability, low embedded energy, and possible use of natural fibers and resins.[1] The principle of sandwich construction consists in coating to a core on both sides two sheets, called skins. The core is made of a light material or structure, which must have good properties when submitted to transverse compression. The skins must have good properties in tension. The objective of sandwich concept is to obtain a material combining lightness and high flexural stiffness.

The sandwich skins are most frequently constituted of laminates with glass fibers, carbon fibers. Light alloy sheets are also used. In order that sandwich constructions are efficiency, it is necessary to have a good bonding between the core and the skins so that the mechanical loading can be

[1] "Premiere Composites for Architecture, Challenging the form of New Buildings." *Premiere Composite Technologies*. Web. 20 April 2012.

transmitted between core and skins. The bonding is obtained by using resin systems for skins compatible with the core materials or by interleaving particular interface layer between core and skins, (Fig. 2.22).[1]

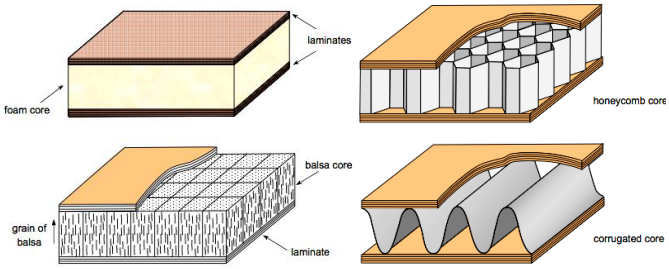


Fig (2.22): Sandwich materials with solid cores and with hollow cores. (Source: "Sandwich Composites." pp. 57-58)

- Smart Materials in Architecture

Smart materials are objects that sense environmental events, process that sensory information, and then act on the environment. Fundamental characteristics, which distinguish smart materials from most traditional materials that use in architecture, are transiency, selectivity, immediacy, self-actuation and directness. Smart materials are materials that receive, transmit, or process a stimulus and respond by producing a useful effect that may include a signal that the materials are acting upon it. The effects can be a color change, a volume change, a change in the distribution of stresses and strains, or a change in index of refraction. This ability to producing a useful effect to respond the stimulus has rendered smart materials as considerable materials to the architectural design since buildings are always confronted with changing conditions. The characteristics of smart materials directly focus on their immediate response to the environmental conditions, energy exchange capability, discrete size/location, and reversibility. [2]

[1] " Sandwich Composites." *Architecture of Composite Materials*. pp. 51-59. Web. 20 April 2012.

[2] Javad Sadeghi, Mohammad, J. "The Function of Smart Material's behavior in architecture." *International Conference on Intelligent Building and Management Proc. of CSIT.* Vol.5, 2011. IACSIT Press, Singapore, pp.317-322.

- Acoustics Materials

Public meeting places such as churches and places of worship can present interesting acoustic challenges. Creating high quality sound environments that offer excellent speech clarity throughout require proper placement of acoustic panels to control the dissipation of sound energy. There are several items to consider when evaluating materials for public speaking and live music environments. Noise Reduction Coefficient (NRC) ratings, finished appearance and building code requirements are key performance features to consider when choosing acoustic materials for public meeting places. Computer generated acoustical analysis and guidance on the choice of materials and installation methods for public meeting place are provided to increase the acoustics performance.[1]

2.3.2.2.1 Applications on Material Technologies

The past few decades have seen outstanding advances in the use of composite materials in structural applications. Composites have revolutionized traditional design concepts and made possible an unparalleled range of new and exciting possibilities as viable materials for construction. The following will show briefly examples of how these materials were used and integrated in buildings.

- Composite Façade Structures.

In the Façade of Rak gatway, Ras Al Khaimah, in Emirates, the exterior is fully structurally clad and is delivered to site in an all in one unit that is attached to the building slabs without further substructure. This process requires each exterior panel to be fully insulated and to incorporate all external structural skin and surface finishes, all components such as doors and windows and the fixing grid for the plasterboard interior fit-out.

[1] "SOFT SOUND® Acoustic Panels." *The Online Source for Soundproofing and Acoustic Products*. Web. 20 April 2012.

The prototype composite panel measures 8 x 4m with a complex bi-axial curved shape and is made from a sandwich of glass fiber and epoxy resin composites with a structural foam core and is fully insulated to reach an optimum U-value. Structural bonded glass windows are built into the facade and each panel is decorated in contemporary ceramic slabs in a repetitive geometric pattern. To construct the entire facade, the panels will be hoisted up by crane and will be connected to each other with a watertight bolted, panel-to-panel connection, allowing significant cost and time saving[1], (Fig. 2.23).

Fig. (2.23): Façade of Rak gatway, Ras Al Khaimah, Emirates. (Source: http://www.pct.ae/composite_projects.php?project=18)

- ***Composite Domes***

Composite domes are High-tech structures made from a sandwich of glass-fiber/epoxy resin composites with a thermoplastic, honeycomb core. The design and manufacturing process utilizes cutting edge technologies and precision machining to produce millimeter accuracy in tolerances. Whilst the construction and installation system permits significant time and cost savings compared to conventional construction. The manufacturing process begins with conceptual designs developed by architects and design engineers. 3-D images are generated with Computer Aided Three-Dimensional Interactive

[1] "FRP Façade For RAK Gateway." *Premiere Composite Technologies*. Web. 20 December 2011.

Application (CATIA, DELCAM and Rhino) for detailed design and structural analysis before proceeding to model and mould construction. The design elements are subdivided into large pre-fabricated panels that are laminated on CNC-milled moulds and oven-cured under vacuum.

For example, the Astelco Telescope Dome in Turkmenistan, the dome consists of 6 composite panels that all open in a particular sequence to reveal a telescope. The panels open through the use of a hydraulic system and for this reason they need to be light. The panels are therefore made from a sandwich of glass fiber and epoxy resin composite with a thermoplastic core. Each panel has the same painted finish. This material is strong, durable and extremely lightweight with as little as 10-15% of the weight of an equivalent dome built in concrete. The dome was installed in less than 3 days.[1] (Fig. 2.24).

Fig. (2.24): Exterior view of Astelco Telescope Dome in Turkmenistan. (Source: http://www.pct.ae/composite_projects.php?project=25)

- Smart Glass

The Electro-chromic glass is made by coating the inside of the outer glass pane with many layers of thin film ceramics. These ceramics are clear in their natural state, but when electricity flows through the layers, the ions

[1] "Composite domes, Astelco Dome." *Premiere Composite Technologies*. Web. 20 April 2012.

become excited and each layer becomes darker, providing light shading and solar heat protection similar to a low-e coating. As more layers are activated, the glass gets darker and provides more protection while maintaining its translucence. Conversely, the flow of electricity can be lowered so the glass becomes lighter, returning to its normal clearness. This allows building spaces to use daylight harvesting and heat gain to their benefit. Zone controls can be installed according to the needs of the occupants. Clerestory or upper windows might remain clear, even if there is direct sunlight, in order to harvest daylight. Likewise, areas with special needs, such as those set up for audio/visual displays, can use switches to override the zonal controls, (Fig. 2.25)[1]

Fig. (2.25): Example showing the electro chromic glass turned on and off. (Source: http://designbuildsource.com.au/smart-glass-700-billion-market)

2.3.2.2 Intelligent Building Technologies.

An intelligent element is the element that without the support infrastructure element acts as a clever system and does not stop performance of peripheral systems. Since the architectural design always involve

[1] Javad Sadeghi, Mohammad, J. "The Function of Smart Material's behavior in architecture." *International Conference on Intelligent Building and Management Proc. of CSIT.* Vol.5, 2011. IACSIT Press, Singapore, pp.317-322.

integrated systems and materials traditionally –making coverage of building depends on the building structural system, HVAC system of building is subject to a cover structure– then the biggest potential application of smart materials will result in to separate the specific components, behaviors or indoor environment.

Such technologies are defined as integrated communication and control systems that provide both the building operator and occupant with an environment that is flexible, effective, comfortable, and secure. By using such systems, building operators can enjoy a single interface that can control a network of disparate building **automation systems**, which typically comprise electronic equipment that automatically performs specific facility functions.

The commonly accepted definition of a **building automation system** (BAS) includes the comprehensive automatic control of one or more major building system functions required in a facility, such as heating, ventilating, and air-conditioning systems. Automated systems include a collection of sensors that determine the condition or status of parameters to be controlled, such as temperature, relative humidity, and pressure. Similarly, output devices impart electronic signals or physical action to the control devices, which may be electric relays or damper and valve actuators. The sensors and output devices are connected either to a unitary controller or to a distributed processor.

Using such advanced intelligent-building technology provides both property managers and tenants with a comprehensive access and security system that can effectively and efficiently exchange information with other building systems. Fully integrated functionality makes it possible to open doors, notify responsible staff of unwanted intrusions, and ensure that lighting, fire, and other building-management systems are informed of personnel that enter or leave the building. This information then can be used to manage the local environment and resulting energy usage.

2.3.2..2.1 Applications on Intelligent Technologies

The following will show briefly examples of how these technologies were used and integrated in buildings.

- ***Automated Solar Driven Convertible Umbrellas***

The typical form of the umbrella is characterized by a conical, double-curved membrane used in repetition, and adopting the form of a translucent, vaulted hall, covered with Teflon fiber membrane. The umbrella frame, arms and struts consist of extruded aluminum tubes of cross-sections corresponding to their respective structural demands. The connections and bearing details between all moving parts are of specially formed aluminum castings.

The integration of photovoltaic solar cells along the umbrella arms and the use of a wireless remote control make it unnecessary to lay permanent wiring, and facilitate a quick and easy installation. The energy required for the opening and the closing operations are gathered by 12 solar cell panels on the outer surfaces of the umbrella arms, stored in a battery equipped with a charge regulator, which is integrated in the foot of the umbrella. The operation is initiated by signals sent to each umbrella from a separate central high frequency transmitter equipped with time switch, daylight sensor, and wind speed monitor, where the umbrella is closed when wind speed exceeds 15m/sec[1], (Fig. 2.26).

(Fig. 2.26): Exterior view of the solar convertible umbrella (Source: http://www.sl-rasch.de/)

[1] "Umbrellas." *Sl-Rasch GMBH*. Web. 20 December 2011.

- ***Automated Convertible Textile Roofs***

The use of movable sunshades are represented in southern climates, the textile shade roofs prevent the spaces underneath from being overheated by the sun and thus allow the climate to be regulated. However the cooling effect is achieved not only by shading but also by the radiation of the heat to the sky when the shade roof is folded together at night.

For example, in the pavilion of Venezuela in Germany, the roof can be opened and closed and rests on a steel pillar that houses the elevator of the building. The symmetrical flower consists of sixteen roof wings radiating outward from the center in two overlapping layers that in the closed position form a translucent, segmented cupola, which offers protection from wind and rain. The wings are opened in good weather conditions and form a shading roof for the naturally lighted and ventilated pavilion. The roof position is fixed according to the sun position, to create the most favorite climate conditions in the pavilion, without additional artificial ventilation measures during hot climate. The individual roof wings consist of biaxial-curved stiff trusses, covered by a weather resistant pre-stressed membrane. This double curved minimal shaped membrane is supported on curved tubular sections cantilevering from the steel truss. All sixteen steel trusses are hinged to the centrally located mast top, each one being operated by an automatically controlled hydraulic cylinder. Computer control, position measuring and control of each individual cylinder guarantee the precise operation of all sixteen wings.[1] (Fig. 2.27).

[1] "Converible Textile Roofs." *Sl-Rasch GMBH*. Web. 20 December 2011.

Fig. (2.27): Exterior views of the Pavilion of Venezuela at Expo 2000 in Germany. (Source: http://www.sl-rasch.de/)

- *Automated Auto Wudu' Washers*

The Auto *Wudu*' Washers is the world's first automatic pre-prayer personal washing system introduced to enable an individual to perform the *Wudu*' ablution in conformance to *quranic* teachings. This is achieved by the use of a purpose built ear, mouth and facial washer unit, a forearm and elbow washing unit and a foot and ankle washing unit all of which are incorporated in a single system. The AWW performs all these three *Wudu*' functions hygienically, conveniently and efficiently without water spillage. The AWW incorporates state of the art technology in fluid dynamics, valve control technology and ergonomics, creating an environment that gives the user an individualized clean washing and drying experience never known and available before. The main features of the machine are clean and hygienic, no water spillage, ergonomic Stainless Steel design, user friendly, low maintenance, and Easy installation,[1] (Fig. 2.28).

Fig. (2.28): The Auto Wudu' Machine. (Source: http://www.fahad.com/pdf/AutoWudu.pdf)

[1] "Auto Wudu Washers." *AACE WORLDWIDE*. Web. 30 January 2008.

- ***Adaptive and Dynamic Façade Screens***

In recent years, there are real advancements in climate change issues, many of which have been directly related to the built environment. Leading organizations have introduced innovative models aimed at encouraging greener building design and construction. It's the next stage of green building where initial advances in the last few years of the green revolution start coming together in dynamic, intelligent systems that have far greater impact in their buildings than those of each system operating independently. It's where the individuals who occupy those buildings have a relationship with the environment around them; where parts of the building think, move, react, and adapt to real time conditions.

For example, solar motion technology, the control of solar shading and day lighting. Traditionally, these existed as fixed systems bracketed in place on a building, with dynamic, controllable systems that react to environmental conditions. The next generation of intelligent operable shading systems, ranging from exterior louver and fin systems to retractable external venetian blind systems. Operating Sun Controls were installed in 1997 over the gallery skylights of the Art Museum to provide filtered sunlight to each of the galleries and to prevent the sun's UV rays from damaging valuable artwork. Solar motion dynamic facades are almost like a living part of the building and respond to climate conditions providing optimal comfort[1], (Fig. 2.29).

[1] "Adaptive and Dynamic Buildings – The Future of Environmental Design & Architecture." *Arch Daily*. 10 August 2010. Web. 19 April 2012.

Fig (2.29): Exterior view of J. Paul Getty Art Museum Sky light. (Source: "Adaptive and Dynamic Buildings – The Future of Environmental Design & Architecture." Arch Daily. 10 August 2010. Web. 19 April 2012.)

Screens and lighting elements generally offer a change of the three dimensional perception of an immobile object. The first known interactive media surface was, however, made up of a mechanical display and was the result of the work of a team of architects, engineers, mathematicians and programmers. It is precisely this spatial change that creates different surface images, which makes the 'Aegis Hyposurface' so revolutionary. The display has been constructed using reflecting metal plates that are moved pneumatically and react in 'real-time' to electronic input. Sensors transfer impulses from the surroundings of the display and these are transmitted to a matrix of rotors to which the metal plates are attached. The movements of the spectators are transferred in 'real-time' to the display and transferred in exact detail into expressive, naturally looking flowing movements, (Fig. 2.30).

Fig (2.30): View of a Mechanical Media Surface. (Source: Fritz, Susanne. "Media Façade, A new form of art in architecture." *Archi Tonic*. Switzerland. Web. 20 April 2012.)

At Jean Nouvel's famous 'Institute du Monde Arabe' a mechanical media surface has been permanently integrated into the façade construction. The façade is made up of a constructed lattice window attached to the blinds, which imitate those of a camera. Using their reaction to the intensity of the sun, light shining into the building can be regulated. The visible mechanics and the design of the blinds come together in an ornamental pattern that changes in interaction with sunlight, (Fig. 2.31).

In contrast to mechanical media facades, where surfaces are tangible, projections form an intangible content beyond the surface onto which pictures are projected. The challenge is the interaction of the surfaces, the technology and the content of the projections. Basically there are two major categories of projections: frontal projection and reverse projection. Frontal projection can be used on a variety of surfaces; ideal of course are projections on to surfaces that are as light coloured as possible while reverse projections are made onto translucent screens that can, for example, be made of glass and acrylic glass.

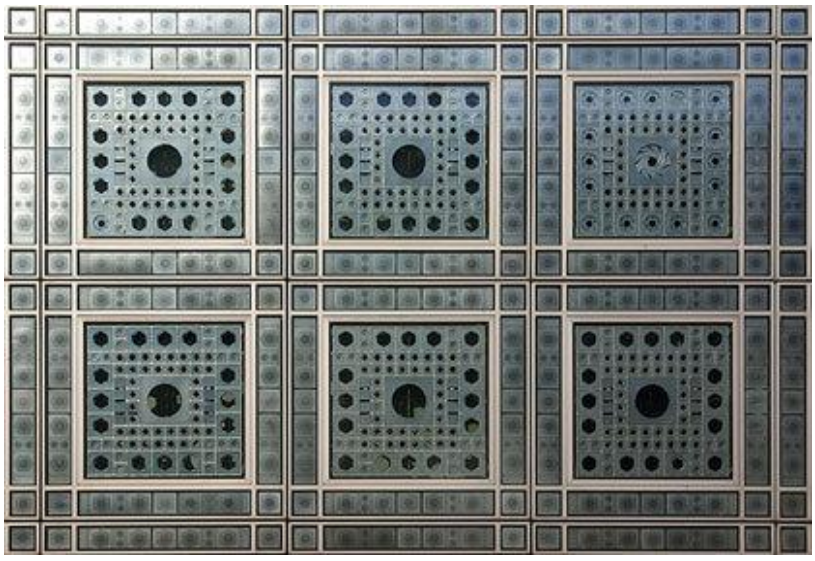


Fig (2.31): Exterior view of Institute du Monde Arabe. (Source: Fritz, Susanne. "Media Façade, A new form of art in architecture." *Archi Tonic*. Switzerland. Web. 20 April 2012.)

2.3.2.3 Computer Aided Technologies

In addition to the above mentioned, the design process has also presented with the aid of computers. Structural sciences have advanced and many new structural and constructional systems that achieve long spans with less use of materials have contributed to the image of architecture. New building materials have been developed such as plastics and synthetic materials, glass fibers and many others with unique properties. Building technology has included prefabrication and automation of traditional construction methods resulting in significant saving of time and money. Simultaneously, advances and innovations have been taking place in other building services, such as waterproofing, elevators, electrical installations, heating, ventilating and air-conditioning systems (HVAC). Lighting and acoustic sciences have advanced and solar and energy-conscious systems have become available. The modern building to a great extent has gained complexity and many specialized professionals from many related disciplines participated in the design process and realization of buildings.

These advances and developments have impacted on two aspects of architecture: The first was the creative and innovative aspect represented by the architects' thoughts and imaginations expressed with fewer constraints. This has led to new building images and types. The second was the technological aspect represented by the use of new and innovative construction methods utilizing the rapid developments in building systems and integrated services. The purpose was to ease the building realization and create a degree of comfort for its occupants. This has led to the evolution of a new concept developed in recent years in architecture called "intelligent" or "smart" buildings. The smart building integrates new technologies from such areas as computer automation, new building materials, energy management and operation technology. The resulting building/space has the ability to adjust and adapt to its occupants**.**

- Digital Architecture Technology

Architects, designers and engineers have been using computers for decades to increase productivity to solve seemingly insoluble problems and for sophisticated presentations. It is only recently, however, that computers

are being used not just as tools, but also as creative devices capable of generating startling new design, ideas and entirely unexpected forms for the built world. For the first time, a generation of technocratic architects and designers are producing buildings and structures that are redefining of the practice and understanding of architecture. By breeding ideas with form, real with virtual, they create hybrid spaces that challenge long-held conventions of space, architecture and time. The explosive growth in the field has been fuelled by a variety of new software and computer programming techniques. Whether derived from the digital animation or complex algorithms, the results of these methods are sending shockwaves around the architecture world, undoubtedly has an impact on mosques design searching for new forms.[1]

New computer technology that liberates the design and construction process, while making it more efficient and cost effective, is set to revolutionize architectural practice. Many new buildings – including Melbourne's Eureka Tower and the Sydney Opera House's opera theatre – are being created by design and construction consultants with new 3D software, leading a major technological change in the construction sector, by linking data from multiple sources into a single integrated database is now making it possible to digitally construct 3D models of a building's physical components. This transforms the current dependence on computer-aided drawing (CAD), into model based presentations that permits rich sharing and collaboration.

- BIM for Construction

The digital representation of physical and functional characteristics of a project – what we call the building information model (BIM) – delivers a clear picture of what is happening in a single project.

Immediate benefits are more accurately estimated costs and time, a reduction in errors, detection of clashes and reduced variations. BIM also helps those involved to easily understand design concepts, resulting in better teamwork and work efficiencies. Building design professionals can now work

[1] Zellner, Peter. *Hybrid Space: New Forms in Digital Architecture*. New York: Rizzoli International, 1999, editorial reviews.

concurrently to produce one virtual model that can be mined and/or manipulated by any consultant, contractor or post-construction facilities manager. The integrated process is collaborative, continuous and provides the ability to see and analyze the project in near-real life fidelity. It's envisaged that the models developed by such integrated practice will have a life beyond construction, informing a building's owners of its scope for operations and maintenance, and adapting or reusing it in the future.[1]

2.3.2.3.1 Applications on Computer Aided Technologies

The following will show briefly examples of how these Technologies were used and integrated in buildings.

- ***LED Computer Animated Media Facades***

Since media technologies are being developed at a tremendous speed, the challenge of designing media surfaces lies not only in the technical effect but is aimed at the desired innovative and artistic applications of media elements as part of the architecture and the choice of content.

Special software analyses the moving images of advertising spots on the LED* screen and generate a color reflection with reverse projection technique onto the curtains. This results in a smooth transfer from LED screen to façade 'screen'. Even though the resolution of the installation on the façade is low compared to that of the LED screen both are seen together as a complete installation, with the brain seeing the colored areas as part of the advertising film.

The trend for LED facades for purely architectural purposes, as part of a building shell, has produced a number of new products. Modern LED facades are quickly technically obsolete, but fluorescent tubes appeal to the nostalgic feeling. The facades are made up of a metal mesh that is combined with LEDs. Wherever a lower resolution is sufficient for writing, signs or

[1] Australian Institute of Architects. "New Digital Technology Set to Revolutionize Architectural Practice". April 2007. Web. June 2011.

* LED, Light Emitting Diodes.

coloured areas. The LED metal mesh comes in strips of any required length and up to 8 meters wide[1], (Fig. 2.32).

Fig (2.32): Exterior view of Museum of Modern Arts, Graz, Austria. (Source: Fritz, Susanne. "Media Façade, A new form of art in architecture." *Archi Tonic*. Switzerland. Web. 20 April 2012.)

- ***Solving speech intelligibility, enhancing acoustical performance and sound systems using modern technology***

- **Acoustical Performance**

The acoustics of a room are commonly judged by reverberation evaluated from the sound level decay curves. The first, conventional Reverberation Time (RT) is defined as the time it takes for sound to decay by 60 dB after the sound source has stopped. It is usually determined by extrapolating the slope of a straight line fitted to the first part of reverberant decay curves as a function of frequency between -5 and -25 (RT20), or -35dB (RT30). The second indicator is the Early Decay Time (EDT), which is found to be a subjectively more relevant indicator than RT and is defined as the sound decay slope of a straight line fitted to the decay observed during the first -10

[1] Fritz, Susanne. "Media Façade, A new form of art in architecture." *Archi Tonic*. Switzerland. Web. 20 April 2012.

dB. EDT values are more influenced by the details of early reflections. Both measures indicate reverberation as a function of frequency, which in turn appears to be responsible for the sensation of being in a room as well as providing a sensation of distance from the sound source, (Fig. 2.33). For optimum listening conditions for speech intelligibility reverberation time values must be in the range of about 0.5 to 1.0 second at mid-frequencies.[1]

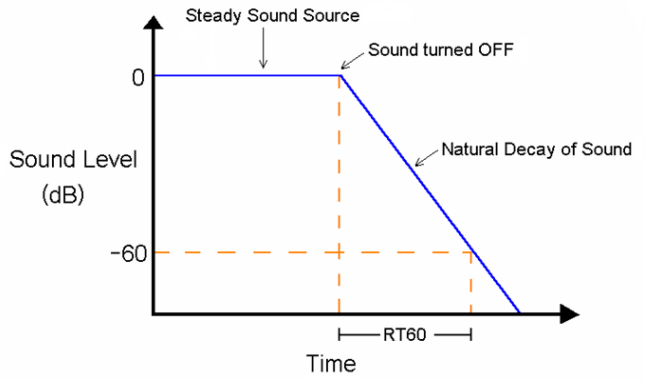


Fig. (2.33): A graph showing that the time it takes for sound to after the sound source has stopped is 60 db. (Source: http://www.sengpielaudio.com/calculator-RT60.htm)

- **Solving speech intelligibility**

Speech intelligibility is a major concern in spaces acoustical design. Acoustic modeling and simulation are beneficial and effective computer-based tools. Room-acoustics programs have typically been used for the prediction and assessment of room acoustic indicators in the early design stage of various spaces. The spatial distribution of many sound quality indicators can be visualized and assessed. It can also assist the design and installation of sound reinforcement systems in terms of number of loudspeakers required their directivity, and relevant locations to overcome insufficient sound levels or poor audibility hindering speech intelligibility.

[1] Adel A. Abdou, King Fahd University of Petroleum and Minerals, Comparison of The Acoustical Performance of Mosque Geometry Using Computer Model Studies, *Eighth International IBPSA Conference*, Eindhoven, Netherlands, August 11-14, 2003.

The speech intelligibility often happen due to lack of sound absorbing surfaces, in comparison to many sound-reflecting surfaces can create many acoustic problems, the internal structure of the building often creates sound problems, the use of old wrong and mismatched sound equipment, the extensive use of hard surfaces, marble, stone, glass etc., which often result in too long reverberation time (RT60). and lack of understanding of acoustic problems. A long reverb time will seriously affect the clearness of speech – STI (Speech Transmission Index). STI has a value between 0 and 1, and a higher value is better.

EASE Focus and Odeon are three-dimensional, acoustic simulation software used for the configuration and modeling of line array systems and of adjustable loudspeakers. Different materials, shapes and speakers can be tested in the computer model and with good accuracy.[1] For example, the Public Address and Voice Alarm systems used in Dubai Metro station, the first steps to be taken in a computer simulation are to get the drawings of the building as well as the interior's surface materials. With a model imported into Odeon, all interior surfaces have to be evaluated and given an absorption coefficient, which is corresponding to the material used. A key concept in the acoustic design was the "intelligibility" prediction, which involves a synthesis of inter-related factors. The key elements of success to the design of the PA system were achieving appropriate reverberation times, speaker coverage, sound pressure level, speech intelligibility and selection and placement of absorbing materials. Contract compliant performance values for speech intelligibility were required to be achieved throughout all areas. To reach the requirements, it was important that ceiling materials and coverage were correctly specified in order to maintain appropriate reverberation times, sound pressure levels, and consequently, speech intelligibility levels. Sound pressure level coverage was also a major consideration in the selection and locating of speakers[2], (Fig. 2.34).

[1] "Solving speech intelligibility in mosques using modern technology." *Soliflex*. Web. 10 March 2012.

[2] "PA-system at Dubai Metro Station." *Odeon Room Acoustics Software.* Web. 19 April 2012.

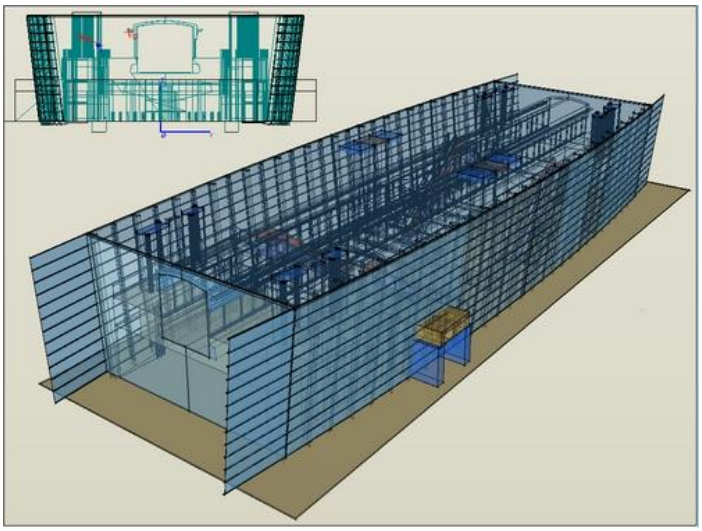


Fig. (2.34): Digital modeling and simulation of Dubai metro station for accurate PA/voice alarm system design to be integrated. (Source: http://www.odeon.dk/pa-system-dubai-metro-station)

- Building analysis software:

Building analysis softwares <virtual environment> are used in the thermal simulation and analysis of the building, in order to determine the internal and thermal comfort conditions, to optimise HVAC system performance and verify building safety. The main idea was to create a natural environment by minimising the air-conditioning requirement and taking advantage of the overall thermal mass of the structure while utilising natural ventilation whenever possible to optimise internal comfort levels. In addition, a series of occupancy safety simulations were incorporated, to examine both real time evacuation and the total egress times, with the effect of smoke build up from a simulated fire within the building. The purpose of the evacuation model was to determine how quickly occupants could escape the building. (Fig.2.35)

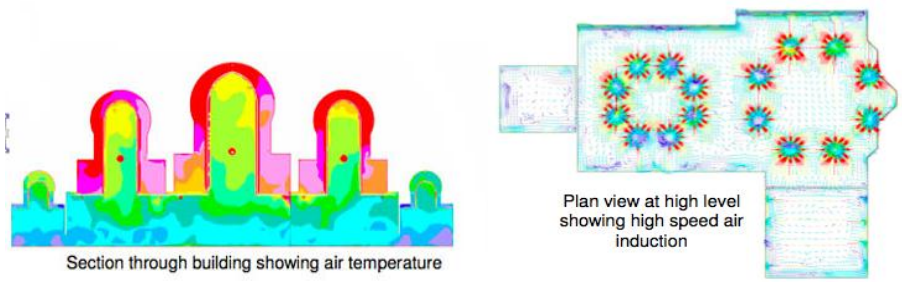


Fig. (2.35): Plan & sectional view through a building at high level, showing high speed air induction and air temperature. (Source: "Case Study IES Revit Integration". *Integrated Environmental Solutions*. 2009. Web. 20 April 2012.)

The Solar analysis, create images and movie files to visualize the sun path and solar gains. The Natural ventilation analysis, assess the performance of natural ventilation using operable windows. Results will demonstrate effectiveness of natural ventilation through a full year simulation. Additionally a detailed "snapshot" will show the complex air movement and temperature distribution using an advanced computational fluid dynamics model. HVAC systems simulation, introduce the component-based HVAC system modelling interfaces for advanced energy simulations. Thermal analysis performs several simulations to assess variations on the design, and review the results in tables, graphs, and 3D visualizations. Daylight analysis performs simulations to create a foot-candle map on the floor plan, and create photo-realistic 3D renderings.[1]

[1] "Case Study IES Revit Integration". *Integrated Environmental Solutions*. 2009. Web. 20 April 2012.

Conclusion:

This chapter discussed the mosque architecture approaches, the relation between the traditional development and the modern technology, the effects of colonization on Muslim societies and how modernism and western models have dominated design concepts in eastern societies, and the role regionalism played in diverse Muslim countries.

The twenty first century is witnessing the highest point of the High-Tech movement. The aim of creating High-Tech architecture is to produce a kind of building where social and formal effects depend very much on conspicuous technical devices. Architects use combinations of materials such as plastic and metal, and suspension building systems and structural devices, all of which had been developed during the past thirty years.

An intelligent element is the element where without the support infrastructure element acts as a clever system and does not stop performance of peripheral systems. Since the architectural design always involve integrated systems and materials traditionally –making coverage of building depends on the building structural system, HVAC system of building is subject to a cover structure– then the biggest potential application of smart materials will result in to separate the specific components (The development of smart materials will be involved in a variety of components such as sensors, actuators, the shape-memory alloys and etc.), behaviors or indoor environment.

Smart materials fulfill the 21st century technological needs, that will reduce the energy and material cost of the buildings, enabling designs of direct and discrete environments, providing better conditions in space for human occupants. Today, architects are beginning to look forward to using the developments in smart materials to bring new solutions to long-standing problems and also to exploit the potential of smart materials in developing new building functions, forms, and responses.

Digital design technologies play a significant role in assisting the designer through conceptual architectural design. Computer supported design systems can generate various images at the early design phase and can contribute to seeking alternative architectural forms. Currently, different design approaches are being employed in the formation of architectural products.

The chapter introduced applications of technology architecture of the 21st century, and showed that technology directly affected architecture of the 20th and 21st centuries by **material technologies, intelligent building technologies** and automated control systems, and by the digital representation of using **computer aided technology**. The main idea was to prove whether these technologies were introduced to mosque architecture or not and to what extend, which will be studied in the next chapter.

REFLECTION OF TECHNOLOGY ON THE INHERITED CONCEPTUAL DESIGN OF MOSQUES

Chapter Three: The Impact of New Technology on Mosques Design Elements and Trends During Late 20th and Early 21st Centuries

Analytical study of mosques built during late 20th and early 21st centuries using the design analysis framework based on the inherited conceptual design of mosques, to track the potentials of new technology and its contribution in the development of mosques design concepts and approaches, and to identify the appropriate tools and techniques used in mosques utilized for the study, to ease the building realization and create a degree of comfort for its occupants.

1. Analysis of late 20th & early 21st centuries of mosques case studies.

- Criteria of selection.
- Analysis methodology.
- Case studies Analysis.

→

2. Evaluation analysis of late 20th & early 21st centuries mosques case studies.

- Design analysis framework table
- Case studies grading Process

→

3. Results & Discussion

→

4. Summary

Conclusion

Mosques designs conform strictly to traditional constraining models with all of the usual components, mosques are celebrated in architecture with material wealth and physical comfort, rather than a concern for aesthetic emotions or the compulsion for spiritual contemplation, which are the main essence of Islam. Technology had an impact in changing, adding and developing mosques architecture, mainly focusing on the materialistic and functional values.

Chapter Three
The Impact of New Technology on Mosques Design Elements and Trends During Late 20th and Early 21st Centuries

This chapter aims to apply the design analysis framework that was previously discussed in the previous chapters on 30 mosques case studies as an analytical study. The main purpose of this investigation is to track the potentials of new technology and its contribution in the development of mosques design concepts and approaches, and to identify the appropriate tools and techniques used in mosques utilized for the study, to ease the building realization and create a degree of comfort for its occupants.

The scope of the research focuses on the contribution of new technology, and its impact in developing traditional design values and concepts. The case studies selection focuses on the mosque as a praying space rather than focusing on the secondary spaces incorporated to the mosque, and will be selected with respect to high architectural significance and a strong representation to a design approach. The analysis will be based on the framework derived from the studies in chapter one and two, and will be applied on mosques' projects constructed within the last three decades, during a time period between late 20^{th} and early 21^{st} centuries (1975s-2010^{th}), in Muslim and Non-Muslim societies.

3.1 Analysis of Late 20th and Early 21st Centuries Mosques' Projects

The analysis commences with analyzing 30 mosques case studies according to the inherited traditional values that was derived from chapter one in terms of functional, aesthetic, and symbolic values (Diagram 3.1), and then the evaluation will be proceeded by grading the case studies according to the technologies of the 21^{st} century that was derived from chapter two in terms of material technologies, intelligent and computer aided technologies (Diagram 3.2), where these technologies will be the main indicator whether technology was used and introduced to mosques case studies functional, aesthetic, symbolic and spiritual values or not, to what extend and how.

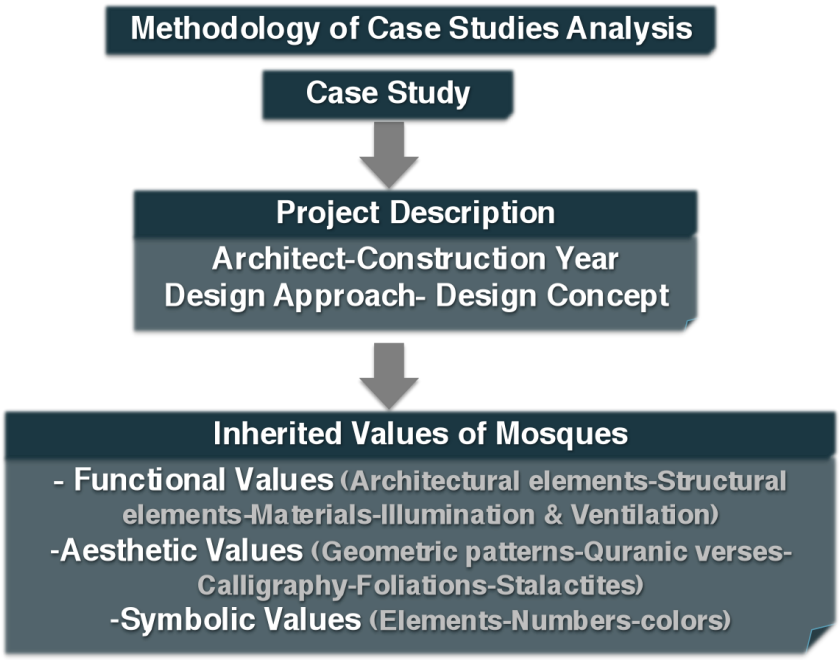


Diagram 3.1: Methodology of case studies analysis and evaluation.

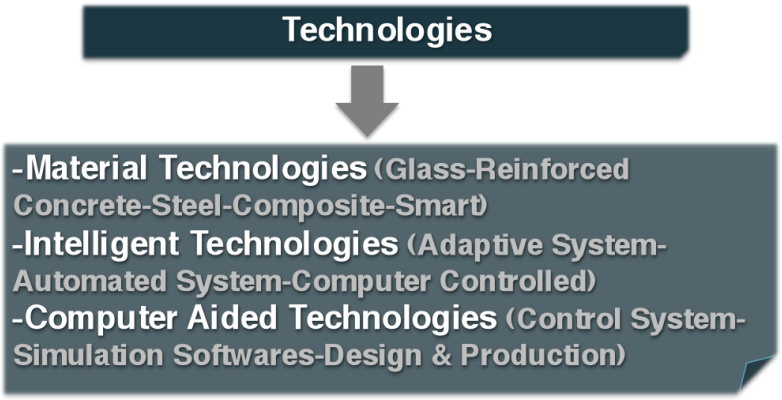


Diagram 3.2: Technologies used the analysis and grading process.

3.1.1 The Grand Mosque of Al Sheikh Zayed Al Nahyan, Abu Dhabi, United Arab of Emirates.

Architect/Construction Year: Yusef Abdelki, Syrian architect/2001-2008
Design approach: Conservative/Conventional-Eco Tech-Hi Tech Approaches

Design Concept

Description/Form:

A classical hypostyle, originally modelled from Moroccan mosques, combined with domed ottoman mosque architecture.

The mosque accommodates 40,000 worshippers, 30,000 in the courtyard and 10,000 in the praying halls, and incorporates an Islamic centre, a library, ADTA offices, a 400 underground car park and a parking area beside the mosque. (Fig. 3.1)

Fig. (3.1): Exterior view of the mosque, showing the Moroccan architecture style of the domes decorated in white marble.

Architectural Elements

The main prayer hall is rectangular in shape and opens directly onto a large **courtyard** of two aisled arcades. The central space in the main **prayer hall**, around the *mihrab* area is designed in the shape of an eight-pointed star, defined by the regular eight sides polygon carrying huge pointed horse-shoe arches, above them smaller arches intersect to transform the polygon into a circle carryings the dome.[1] (Fig. 3.2)

Low stepped wooden *minbar* lies on the right of the *mihrab*, which is made of pure gold. The **ablution area** is located at the south and north corners of the building under ground and accessible by escalators, the mosque is also surrounded by artificial lakes.[2] (Fig. 3.3)

The **portal** is influenced by the Mughal style, and the **exterior walls** are of traditional Turkish design. There are 4 corner **minarets** similar to the Mamluk's style, with public speaking systems announcing the call to prayer five times per day.

Fig. (3.2): Interior view of the main prayer hall showing the horseshoe pointed arches forming the eight-pointed star shape of the *mihrab* area.

Fig. (3.3): Interior view of the illuminated marble cladding qibla wall, showing the mihrab and minbar.

Structural Elements

Reinforced concrete was used in the main structure system of the mosque. Pointed horseshoe North African **arches** were used in the aisled arcades inside and outside the mosque. There are 82 **domes** within the mosque, the biggest covers the main entrance area, two smaller domes accompany the main dome and are all surrounded by 8 small egg-shaped cupolas each.[3]

Materials	Natural *'karara'* marble was used, to remain the place cool in the hot conditions. Huge amounts of reflective surfaces with a very few sound absorbing materials were used for acoustic treatments in the prayer halls. The Domes are covered with natural white marble. White claddings inlaid with colour marble, semi-precious stone and rich floral designs, were used in decorating the columns in the courtyard.[4]
Illumination & ventilation	Building analysis software <virtual environment> was used in the thermal simulation and analysis of the building, to determine the internal and **thermal comfort conditions,** to optimise **HVAC system** performance, utilize natural ventilation, and verify building safety.[5] (Fig. 3.4) The columns inside the praying halls also act as conduits for mechanical ventilation system, and lighting fixtures.
Aesthetic Values	There are 3 **calligraphy** styles used through out the mosque, *Naskhi*, *Thuluth* and *Kufic*. The 99 names of Allah are featured on the marble cladding of the ***qibla* wall in kufic script,** and are back illuminated using fibre lighting. Floral, botanical patterns carved into the marble were used in decorations and floor tiling.[6] The portal lies in the centre of the wall, revealing text from the Holy Quran. The repetition of domes, columns, arches, and the symmetry were used excessively.
Symbolic values	The concept of the **lighting system** of the **mosque exteriors** represents symbolically the lunar cycle of the moon. The 360-degree lighting scheme starts from the full white colour on a full moon, to deep blue as the moon disappears.[7] Projectors are fixed on twenty-two exterior towers, capable of projection and animation, located around the building. (Fig. 3.5)

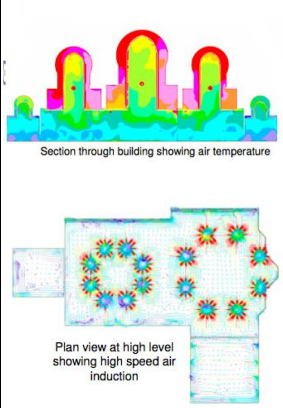


Fig. (3.4): Plan & sectional view through the building at high level, showing high speed air induction and air temperature.

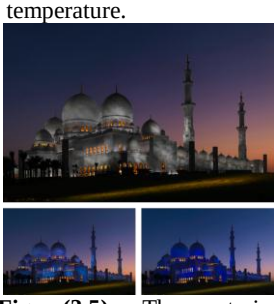


Fig. (3.5): The exterior lighting concept based on the image of a full moon building changes subtly from white to deep blue as the lunar cycle progresses.(Source: http://www.speirsandmajor.com/work/architecture/sheikh_zayed_mosque/)

[1] Saoud, Rabah. "Sheikh Zayed great Mosque in Abu Dhabi: Islamic architecture in the 21st century." *World Muslims Intellectuals Forum*. 10 April 2008, web. 22 July 2009.

[2] Trabelsi, Habib. "Sumptuous Abu Dhabi mosque attracts tourists." *The Brunei Times*. 5 March 2008, web. October 2010.

[3] "Sheikh Zayed Grand Mosque Tour Information." *Abu Dhabi Tourism Authority*. 2009-2010, web. 7 October 2010.

[4] Mankani, Zain. "Sheikh Zayed Mosque, white pearl of the Arabian gulf."*ARCHI TIMES*. ISSN No. 2073-9001. Web. October 2010.

[5] "Sheikh Zayed Grand Mosque, IES consulting case study." *Integrated Environmental Solutions*. 2009. Web. July 2010.

[6] "Sheikh Zayed Grand Mosque Tour Information." *Abu Dhabi Tourism Authority*. 2009-2010, web. 7 October 2010.

[7] " Sheikh Zayed Bin Sultan Al Nahyan Mosque, Abu Dhabi, UAE." *Speirs+Major associates*. 2009-2010, Web. October 2010.

3.1.2 Sakirin Mosque, Istanbul, Turkey.

Architect/Construction Year: Hüsrev Tayla, Turkish architect/2009.
Design approach: Adaptive Approach

Design Concept

Description/Form:

A typical Turkish style mosque, influenced by the suleymaniye mosque.

The mosque **accommodates** up to 1,200 worshippers 250 in the main prayer hall, 150 on the specially designed balcony reserved for women, and 600 more in the courtyard. The mosque is built over a parking garage and also includes an exhibition area. (Fig. 3.6)

Fig. (3.6): Exterior view of sakarin mosque, showing the influence to the suleymaniye mosque.(Source: http://travel.ezinemark.com/istanbul-a-combination-of-modern-and-tradition-in-turkey-77365c1b4878.html)

Architectural Elements

The main **prayer hall** is surrounded by glass walls designed as pages from the Quran with gilded verses inscribed.[1]

The ***minbar*** is made of acrylic with leaf patterns with 12-steps, and coloured in lighter yellow. The *mihrab* is designed like a golden eye with a turquoise lid. (Fig. 3.7)

The outer walls are a combination of glass and iron mesh, which allows sunlight to wash the beautiful gilded interiors of the mosque.

There is a fountain with a metal sphere in the courtyard.[2] (Fig. 3.8)

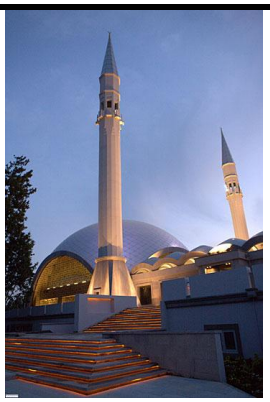
The mosque has two slim, pencil-shape **minarets** with no balcony, as azan will spread by loudspeaker. (Fig. 3.9)

Fig. (3.7): Interior view of the central prayer hall, showing the golden eye turquoise *mihrab* and the yellow acrylic *minbar.* (source: http://www.a212.com/2009/05/architect-sakirin-mosque-istanbul-)*by.html)*

Structural Elements

Stones were used in the construction of the mosque. The mosque has one metal shell dome dominating the entrance.[3]

[1] Watson, Ivan. "In Turkey, Mosque Gets a Woman's Touch." *NPR News.* 21 October 2008, web. 25 October 2010.
[2] "A Small, Modern and Pioneer work of art: Sakirin mosque." *Istanbul.com.* 12 March 2010, 28 September 2010.
[3] Jones, Dorian. "Istanbul skyline gets woman's touch." *BBC News*, Istanbul. 29 September 2008, 26 October 2010.

Materials	The **facades** are decorated with combination of glass and wrought iron grilles and mesh. Aluminium composite panels were used in the dome cladding. Wood was used in the door of the main entrance, and gilded inscriptions were used in decorating the portal frame.	 **Fig. (3.8):** The two slim minarets of sakarin mosque. (Source: http://www.npr.org/templates/story/story.php?storyId=95940942)
Illumination & ventilation	In the prayer hall, dozens of blown-glass raindrops form an asymmetrical bronze and Plexiglas chandelier.[1] (Fig. 3.10) Air-conditioning and heating system, projector are used. The design provides dome to wrap a blue image at night with ultramodern light effects.	
Aesthetic Values	The glass etching contains different layers of gilding from verses of the quran. The main **prayer hall** is surrounded by glass walls designed as pages from the Quran with gilded verses inscribed. Decorative motifs are derived from Seljuk art.	 **Fig. (3.9):** Courtyard view, showing the aluminium composite coated dome, and the metal sphere in the fountain. (Source: http://www.levantinecenter.org)
Symbolic values	The chandelier, with its dripping blown-glass globules, symbolically reflects a saying that, Allah's light should fall on worshipers like rain while praying.	 **Fig. (3.10):** The Blown-glass raindrops used in the prayer hall. (Source: http://www.a212.com/2009/05/architect-sakirin-mosque-istanbul-by.html)

[1] Watson, Ivan. "In Turkey, Mosque Gets a Woman's Touch." *NPR News.* 21 October 2008, web. 25 October 2010.

3.1.3 Al-Irsyad Mosque / Urbane, Indonesia.

Architect/Construction Year: PT. Urbane Indonesia/2010.
Design approach: Contemporary/Modern Approach

Design Concept

Description/Form:

A single storey mosque that covers an area of 970 m^2, and incorporates a prayer hall for 1000 worshippers, cultural gallery, separate ablution area, parking spaces beside the mosque. (Fig. 3.11)

The square form of the mosque resembles the ka'ba, and the idea of landscape forms circular lines surrounding the mosque; inspired by the concept that surrounds "The Tawaf". (Fig. 3.12)

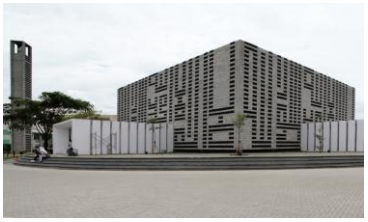


Fig. (3.11): Al-Irsyad Mosque-Ornamental Calligraphy on Exterior Wall Design (Source: http://www.archdaily.com/87587/al-irsyad-mosque-urbane/12-75/)

Architectural Elements

The primary shape of the mosque takes the form of a square, with two separate entrances for men and women. The ablution lies in a separate space next to the mosque.

The Square plan minaret stands separately, indicating the mosque location. The field of view directed conical box directly to the *mihrab*, where the transparent *qibla* wall view to the natural site. (Fig. 3.13)

Fig. (3.12): Site Plan Al-Irshad Mosque Building Design (Source: http://www.archdaily.com/87587/al-irsyad-mosque-urbane/floor-plan-220/)

Structural Elements

The structural columns are arranged that the facade seems like it is not supported by any frame, and a pitched wooden roof covers the prayer hall.

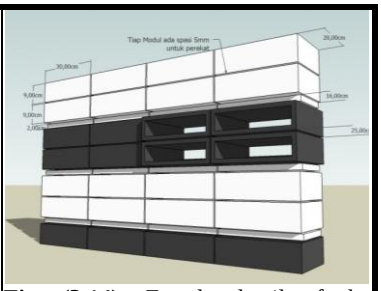
The mosque has no Dome.

Materials

Stacked stones were used in the main facade and the minaret.

Wood, Concrete and steel sections were used in the columns and the roof of the mosque. (Fig. 3.14)

Fig. (3.13): Interior view of the prayer area. (Source: http://www.archdaily.com/87587/al-irsyad-mosque-urbane/9-74/)

Illumination & ventilation	The mosque is designed to 'blend in' with nature. The stacked stones allow for natural ventilation without the need for air-conditioning. Surrounded by water, the ambient temperature around the mosque will be lower during the hot season, and to reflect natural light inside The 99 lamps in interior design that reads the sacred 99 names of Allah. (Fig. 3.15)	 **Fig. (3.14):** Facade detail of the module stone stacks. Showing the solid and void pattern on the wall as well that allow natural light inside. (Source: http://www.archdaily.com/87587/al-irsyad-mosque-urbane/facade-detail-01-3/)
Aesthetic Values	A Module of Stacked stones were used on the main façade to create tectonic effect. Islamic text/calligraphy was embedded on the facade as a graphic element and reminder prayer. With the design of exterior wall or cube-shaped leather design of writing Arabic calligraphy of the word "*Shahadat*"	
Symbolic values	The minaret has become an iconic feature of mosques, to simply indicate its location, rising up towards heaven as a symbol of the eternal relationship between earth and heaven. One minaret represents the metaphysical state and it is the symbol of the unity of the creator. The cubic shape of the mosque symbolically alludes to Ka'bah.[1]	 **Fig. (3.15):** Interior view of the prayer hall showing the natural light contrast of the qibla wall and The 99 lamps in interior design that reads the sacred 99 names of Allah. (Source: http://www.archdaily.com/87587/al-irsyad-mosque-urbane/8-74/)

[1] Saieh, Nico. "Al-Irsyad Mosque / Urbane." *Archdaily.* 10 November 2010. Web. 20 October 2010.

3.1.4 The Glass Mosque, Pennsburg, Germany.

Architect/Construction Year: Alen Jasarevic, Bosnian-born architect/2005.
Design approach: Contemporary/Modern Appproach

Design Concept

Description/Form:

An L-shaped ground plan, single storey building, incorporates two prayer halls, library, educational and administrative areas. The mosque accommodates 400 worshippers.

Architectural Elements

The Prayer hall is a free rectangular space with a second floor for women. The *mihrab* is a folded steel plate carved with *quranic* verses. The *minbar* consists of an open riser timber tread, with a transparent metal plate side, decorated with Islamic geometric patterns. The **entrance** features two concrete slabs that swing out of the wall like open gates. The mosque has one minaret. (Figs. 3.16, 3.17)

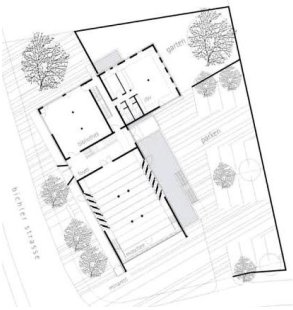


Fig. (3.16): L-shaped plan of the ground floor.

Structural Elements

The structure system of the mosque is of reinforced concrete skeleton system. The mosque has no **dome**.

Materials

Pale stone cladding and full-height decorative blue glass were used in the exteriors. The minaret, *minba*r and *mihrab* are made out of steel plates.

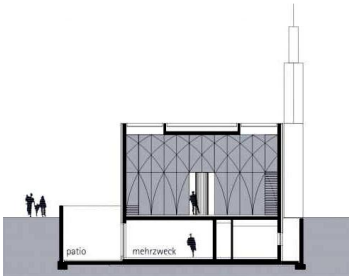


Fig. (3.17): A longitudinal section in the prayer hall, showing the second floor gallery reserved for women.

Illumination & ventilation

The transparent glass walls allow natural light to enter the prayer hall from three sides. (Fig. 3.18)

Aesthetic Values

The abstract star motifs on the ***qibla* wall** contain the 99 names of Allah.[1] Islamic geometric patterns were used on the walls and sides of the *minbar*. The *qibla* wall exterior is framed with gilded verse from the *quran*.

Fig. (3.18): The minaret decorated with Arabic words calling the faithful to prayer.

Symbolic values

The clarity and colorful streams of light symbolizes unity. The **minaret** symbolically acts as a silent call to prayer as its calligraphic representation of the words of the call to prayer. The entrance features two concrete slabs that swings out of the wall as if welcoming worshippers. [2]

[1] "Pennsburg Mosque Gather Architectural Awards." *World Arab, Architecture, Art and Design*. 18 November 2010, web. 25 October 2010.
[2] Zecher, Francisca "The Transparent Penzberg Mosque: No Longer in the Backyard." *Deutsche Welle / Qantara.de 2008*, web. October 2010.

3.1.5 Assyafah mosque, Sembawang, Singapore.

Architect/Construction Year: Tan Kok Hiang and Forum Architects/2004.
Design approach: Contemporary/Modern Approach

Design Concept

Description/Form:

A four storeys mosque accommodates 20,000 worshippers, and incorporates a main prayer hall, prayer gallery for women, ablution area, classrooms, administration area, multi purpose hall, extended prayer spaces, and cars parking in the basement. Blending modern and traditional design. (Figs. 3.19, 3.20)

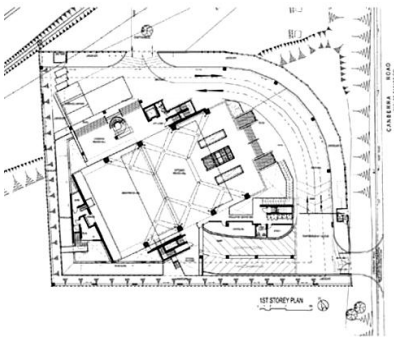


Fig. (3.19): The ground floor plan showing the orientation of the mosque. (Source: http://www.ArchitectureWeek.com/2005/0803/design_1-2.html)

Architectural Elements

The first floor is elevated from the ground level to allow natural ventilation in both ground and basement floors, by 2 skylights.

The worshippers perform the ablution in the basement floor, to a transitional space of concrete arched fore court before entering the **prayer hall** on the first floor, which is reserved for men, while the gallery on the second floor is reserved for women.[1]

The *mihrab* is decorated with Islamic calligraphy cutout, blending modern and traditional design. The *minbar* is a simple platform with a microphone that can be accessed from the back.

The ***qibla* wall** is inclined to create an imposing and domineering space, made of smooth marble surface with skylight above.[2]

The **minaret** takes the form of a tapered ten-segmented telescopic tower. (Fig. 3.21)

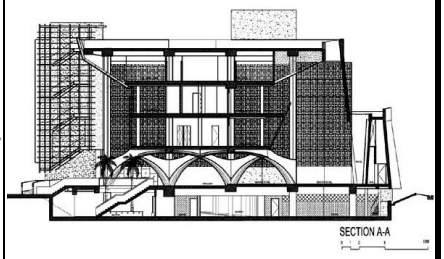


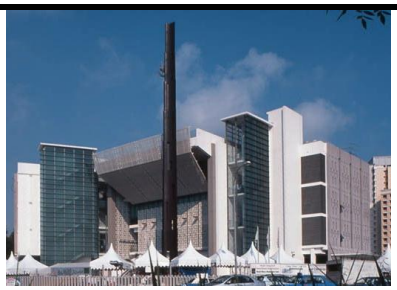
Fig. (3.20): A Longitudinal section along the main axis, with the inclined *mihrab* wall on the right. (Source: http://www.ArchitectureWeek.com/2005/0803/design_1-2.html)

Structural Elements

Cast concrete ribbed arches serve the purpose of transferring the structural loads of the upper three storeys and provide a column free span in the lower prayer space.[3]

The mosque has no **dome**, and is translated into a serious of cast concrete ribbed arched ways, using new ply forms, V-shaped plastic grooves, and steel tie-rods .[4] (Fig. 3.22)

[1] Such, Robert." Modern Mosque." *Architecture Week*. 3 August 2005, web. 10 July 2009.
[2] Forum architects. "Assyafaah Mosque, Singapore." *Architecture-Page.* 17 October 2006, 18 October 2010.
[3] "Assyafaah Mosque in Singapore." *Architecture Design News.* 18 March 2008, web. 18 October 2010.
[4] Such, Robert." Modern Mosque." *Architecture Week*. 3 August 2005, web. 10 July 2009.

Materials	The **minaret** is built from rusted steel plates coated with colourless polyurethane. Marble clad, fair-faced concrete, glass, white aluminium panels and wood were used in the prayer hall.	 **Fig. (3.21):** Exterior view of the mosque, showing the tapered minaret. (Source: http://www.ArchitectureWeek.com/2005/0803/design_1-2.html)
Illumination & ventilation	The prayer hall **sidewalls** are made of arabesque screens to allow daylight, shadow and cross ventilation inside the mosque. **Water elements** were used in the landscape around the mosque, to reflect the mosque on its surface. The main prayer hall as well as the women's gallery is naturally ventilated. (Fig. 3.23) The basement is designed with 25% natural ventilation that exempts it from mechanical means of ventilation as well a sprinkler system.	 **Fig. (3.22):** The cast concrete ribbed arches used in the prayer hall.
Aesthetic Values	The use of the positive double layer arabesque, to make the notions of overlapping geometries more explicit and negative arabesques are seamlessly incorporated in the design of this mosque.[1]	
Symbolic values	The **minaret** tapers skywards with an abstract design based on the ***alif***, first letters of Arabic alphabet, a crescent and a star are mounted on the minaret. The arabesque patterns symbolize the five important attributes of the quran; complete, infinite, clear, multi centred, and awe-inspiring, and emphasizes on the unity of god.[2] The concept of achieving transparency, simplicity and airiness, which creates a spiritual atmosphere inside the praying halls, was maintained by using aluminum screens.	 **Fig. (3.23):** The four-storey canted *mihrab* wall.

[1] "Assyafaah Mosque in Singapore." *Architecture Design News.* 18 March 2008, web. 18 October 2010.
[2] Such, Robert." Modern Mosque." *Architecture Week.* 3 August 2005, web. 10 July 2009.

3.1.6 Cologne Mosque, Germany.

Architect/Construction Year: Paul & Gottfried Böhm/2008-2010.
Design approach: Adaptive Approach.

Design Concept

Description/Form:

The mosque is designed in Ottoman architecture style, and incorporates a prayer hall for 2,000 to 4,000 worshipper, bazaar and entrance on the ground floor, lecture halls in the basement, extra prayer spaces on the upper floor and include a Muslim library. (Fig. 3.24)

Fig. (3.24): Exterior view of the mosque, showing the shell-like form.
(Source:http://en.wikipedia.org/wiki/File:Ditib-Zentralmoschee_Köln_-_April_2011_(3561-63).jpg)

Architectural / Structural Elements

The square prayer hall is dominated by a concrete glass dome. The mosque consists of flat-like wall screens, which form a dome in the centre.

In the centre, a fountain is provided, which connects the two main levels. The mosque has two detached minarets.[1]

The mosque is dominated by the area of the prayer room that consists of several shell- like wall panels that form a dominant dome in the centre.

Materials

Concrete was used in constructing the mosque, and glass was used in the dome and the walls.

Illumination & ventilation

A well is intended to be placed in the centre for natural ventilation and allow natural light inside the mosque. (Fig. 3.25)

Fig. (3.25): Aerial view, showing the centred well for ventilation and natural light. .
(Source:http://en.wikipedia.org/wiki/File:Ditib-Zentralmoschee_Köln_-_April_2011_(3561-63).jpg)

Aesthetic Values

The mosque doesn't have any inscriptions, decorations or quranic verses.

Symbolic values

The dome, which is made of three leaves and looks like clasping hands, symbolically reflects this openness. And tends to create a place where religions could meet.[2]

[1] "Cologne Central Mosque." *Wikipedia.* Web. June 2011.
[2] Quetteville, Harry. "Go-Ahead for Germany's Biggest Mosque." *The Telegraph.* 29 August 2008. Web. July 2011.

3.1.7 Chandgaon Mosque, Chittagong, Bangladesh.

Architect/Construction Year: Kashef Mahboob Chowdhury/2007.
Design approach: Contemporary/Modern Approach.

Design Concept

Description/Form:

A single storey mosque, divided into two white blocks, a gathering space and a praying area. The mosque covers an area of 1,048 m^2. (Fig. 3.26)

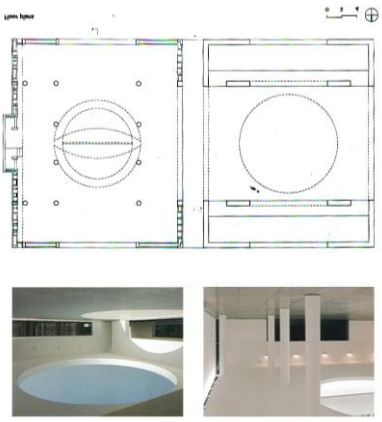


Fig. (3.26): Floor plan and interior views of the two volumes of the mosque. (Source: http://howtobecomeanarchitect.files.wordpress.com/2010/01/49.jpg)

Architectural / Structural Elements

The prayer hall and the courtyard are square in shape. The mosque is pared down to two identical cuboids structures. The first is the frontcourt, covered with heavy masonry walls punctuated with low, wide openings onto the surrounding landscape, with a large eyelike opening above.[1]

In the second volume, the subtle, naturally lit *mihrab* wall is balanced by an iconic, cut dome. Three marble steps are used as a *minbar*. The mosque has no minaret. The *mihrab* wall contains small niches to keep the holy Quran in.

The prayer hall consists of five aisles; the round columns are supporting the ceiling. Masonry blocks were used in the exteriors walls and columns.

Materials

White paint coatings and glass walls were used in the mosque; marble tiles are used to cover the floors.

Illumination & ventilation

The prayer hall is naturally lit and ventiled by an iconic dome. Indirect lighting is used at night.[2] (Fig. 3.27)

Fig. (3.27): The Naturally lit prayer hall by the iconic dome. (Source: http://www.archdaily.com/81700/chandgaon-mosque-kashef-mahboob-chowdhury/07_chandgaon/)

Aesthetic Values

The mosque doesn't have any decorations so as not to drag any attentions. Pure geometrical shapes were used, as the square in the prayer hall, and the two mosque volumes are of cuboids structures. The courtyard opening forms a circle.

Symbolic values

None.

[1] Saieh, Nico. "Chandgaon Mosque / Kashef Mahboob Chowdhury." *Archdaily*. 5 October 2010. Web. 20 October 2010.
[2] "Chandgaon Mosque." *Aga Khan Award for Architecture*. Web. 15 October 2010.

3.1.8 Dogramacizade Sami Ali Pasa Mosque, Turkey.

	Architect/Construction Year: SFMM/2007-2008 **Design approach:** Adaptive Approach.
Design Concept	**Description/Form:** The design maintains religious tradition building components in a controlled way and achieve a distinctive, unique, contemporary reinterpretation of traditional symbols. The mosque consists of 3 storeys, covers an area of 6000 m2, and incorporates prayer halls for men and women, multi-functional spaces, seminar rooms, toilets/ablutions and parking spaces. (Fig. 3.28)
Architectural / Structural Elements	The prayer halls are polygonal in shape; dominant to ottoman style a central domed space, and the main prayer hall is accessed from a rectangular courtyard. The mosque has one dome and one chamfered minaret. The octagonal prayer hall is tapered upwards forming a smaller polygon supporting the stained glass dome, using pendetives.
Materials	Glass and lightweight steel were used in the construction of the dome shape. Multi-layered, multi-colour, semi-transparent materials were used to imaging dome of the sky and the cosmos. Stone claddings were used in both exterior and interior walls.
Illumination & ventilation	The light emitted through the glass dome design creates colourful lighting, is always changing patterns of spatial experiences that emphasize the interior of the building. (Fig. 3.29)
Aesthetic Values	Blue, white and golden colors were used in the mosque. Polygons were used in forming the central prayer hall. Simple inscription bands and medalions were used all over the mosque, written in golden letters from the Quran.[1]
Symbolic values	None.

Fig. (3.28): Exterior View of the mosque. (Source: http://www.worldbuildingsdirectory.com/project.cfm?id=1469)

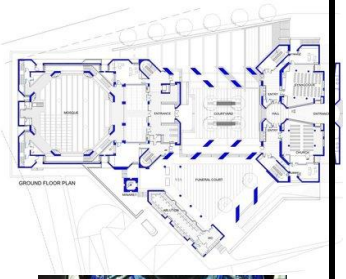


Fig. (3.29): Octagonal Floor plan and an Interior view of the prayer hall, showing the Stained Glass Dome (Source: http://www.worldbuildingsdirectory.com/project.cfm?id=1469)

[1] "Project in Detail, DOGRAMACIZADE ALI PASA MOSQUE." *World Buildings Directory.* Web. January 2011.

3.1.9 Sulatn Qaboos Mosque, Muscat.

	Architect/Construction Year: SFMM/2001-2006. **Design approach:** Conservative/Conventional Approach.
Design Concept	**Description/Form:** The Sultan Qaboos Grand Mosque covers an area of 40,000 square meters. The main prayer hall can take up to 6,600 worshippers, and the courtyard can carry up to 8,000 worshippers. The mosque incorporates a library, and seminar rooms. (Fig. 3.30)
Architectural / Structural Elements	The Main prayer hall is square; the courtyard is surrounded by *riwaqs*. The mosque has 5 minarets, each two at the end of the *riwaqs* and one in the middle of south *riwaq.* The Sultan Qaboos Grand Mosque is constructed from 300,000 tons of Indian sandstone. The central dome rises to a height of fifty meters above the floor. (Fig. 3.31)
Materials	The wall of the main hall prayer is made of gray and white marble, wooden ceiling. The smooth finishing and the different colures between white and reddish, cream Arabescato and Tajliac sandstone was chosen carefully and imported from India, and cut, dressed and carved in Muscat. There are 9 chandeliers in women prayer hall made of gold plated of Ottoman design, which was made of Turkish crystal.[1]
Illumination & ventilation	There are 35 chandeliers made ofexpensive Swarovsky crystal and gold plated metal work and the biggest is in the middle of the dome, which has 1,122 lamps containing inside it.
Aesthetic Values	The central medallion is inspired by the interior of the Shaykh Lutfallah Dome in Isfahan, Iran. [2]
Symbolic values	The mosque has 5 minarets; symbolically represent the five pillars of Islam.

Fig. (3.30): Exterior view of the mosque, showing the dome, minaret and entrance. (Source:) http://www.tripadvisor.com/LocationPhotos-g294007-d321349-w3-Sultan_Qaboos_Grand_Mosque-Governorate_of_Muscat.html#25194712)

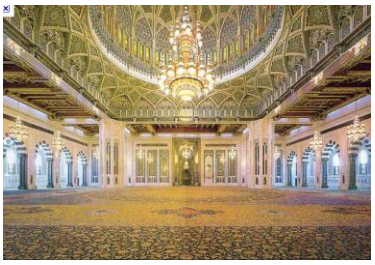
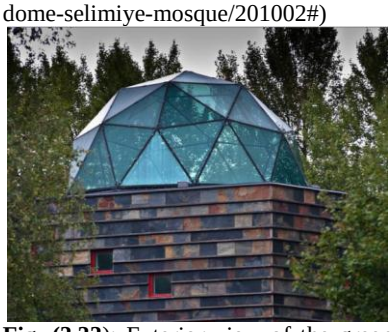


Fig. (3.31): Interior view of the prayer hall. (Source: http://religiousarchitecture.files.wordpress.com)

[1] "The Sultan Qaboos Grand Mosque, Mascat, Oman." *Blog*. 23 January 2011. Web. March 2011.
[2] "The Sultan Qaboos Grand Mosque." *Ministry of Information Sultanate of Oman.* Web. March 2011.

3.1.10 Glass Dome Selimiye mosque, Netherlands.

	Architect/Construction Year: De Architectenkamer /2006. **Design approach:** Adaptive Approach.	
Design Concept	**Description/Form:** The appearance of the mosque is modern, but the underlying principles of the design still historical references to geometry, symbolism and decoration. The mosque covers an area of 100 m2.	 **Fig. (3.32):** Interior view, showing the octagonal shape supporting the dome. . (Source: http://www.archello.com/project/glass-dome-selimiye-mosque/201002#)
Architectural / Structural Elements	The rectangular prayer hall is dominated by a glass dome. The mosque has no minarets. The dome consists of 40 triangular glass panels; the number 40 in Islam is a common reference. It is the first self-supporting glass dome structure without a visible steel structure. The pentagonal rosettes fix the vertices of the glass panels and are connected to tie rods in the joints so that the overall construction is pre-stressed. The dome is constructed on a solid ring profile above the prayer room. The pentagonal shape supports the dome. (Fig. 3.32)	
Materials	Glass and metal fixtures were used in the dome. The panels are green tinted laminated insulated glass. (Fig. 3.33)	
Illumination & ventilation	The glass dome allows natural sunlight to enter the prayer hall.	 **Fig. (3.33)**: Exterior view of the green glass dome and the triangular panels. (Source: http://www.archello.com/project/glass-dome-selimiye-mosque/201002#)
Aesthetic Values	The mosque doesn't have any inscriptions, decorations or quranic verses. The most typical example is the glass dome on the roof, what with its whimsical design language and green color is citing to an emerald. The glass panels are triangular in shape.[1]	
Symbolic values	The green color of the glass dome is referring to an emerald.	

[1] Glass dome Selimiye Mosque." *Archello.* Haarlem, Netherlands. 24 February 2011. Web. 10 March 2011.

3.1.11 The Prophet's Holy Mosque Expansion, Madinah, Saudi Arabia.

Architect/Construction Year: Group/ Renovation Phase 1985-present
Design approach: Adaptive-Eco Tech-Hi Tech Approach.

Design Concept

Description/Form:

The mosque has been extended along three of the four sides of the original building, including the two courtyards, and the expansion phase of the mosque shows a remarkable series of environmental control system. The mosque accommodates over a million worshippers. (Fig. 3.34)

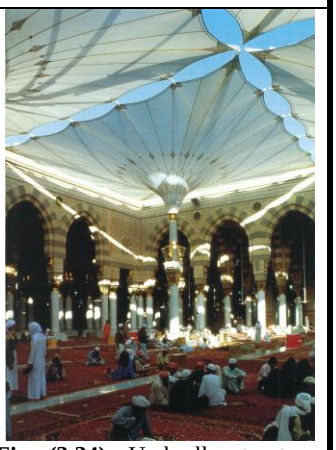


Fig. (3.34): Umbrella structures that protect the two courtyards of the prophet's mosque, Medinah. (Source: Architecture of the contemporary mosque, 2006, p.24)

Architectural Elements

It started with twelve enormous mechanically operated Teflon umbrellas, six in each court of the Mosque, to help pilgrims withstand the high temperatures.

These umbrellas work in conjunction with mechanical cooling and are connected to a computerized climatic control system of the mosque.[1]

The Prophet's Mosque has also benefited from the building of six further minarets, crowned with a gold-plated crescent.[2] (Fig. 3.35)

Structural Elements

The building extensions have been fitted out with escalators, to facilitate pilgrims' flow. Sliding Domes were incorporated in the mosque to cover the internal courtyards for natural light and ventilation.

The domes provide mobile roof that counteract the extreme temperature changes, and control and support the air-conditioned environment of the mosque. (Fig. 3.36)

Fig. (3.35): A Detail of the Mechanically operated umbrella. (Source: Architecture of the contemporary mosque, 2006, p.31)

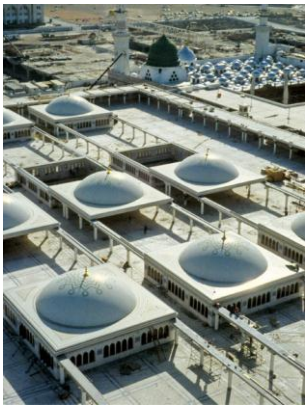
Materials

The outer cladding panels are of carbon-glass fiber epoxy laminate with ceramic tiles bonded integrally to the outer surface. The internal cladding is of wood-epoxy laminate, with maple-veneer facing

The umbrellas frames are of welded steel, and carbon fiber flaps form a protective sheath covering the translucent membrane fabric of the umbrella.

[1] Serageldin, Ismail & Steele, James (Eds.). *Architecture of the contemporary mosque*. Great Britain: Academy Editions, 1996, p.25, 28, 35.

[2] "Prophet's Holy Mosque in Madinah: 27 Sliding Domes for the Prophet's Holy Mosque in Medina." *Premiere: Composite Technologies llc*, Web. 4 December 2010

Illumination & ventilation	Lighting the square courtyard of the mosque, by spot decomposition using faceted mirror systems depending on an aluminium primary reflector unit that directs the light from a spotlight source onto a secondary reflector and illuminates a defined surrounding area. The Mosque is fully air-conditioned, where Cool air is pumped through ducts made of galvanized iron sheets, where the air is released through subsidiary, individual pipes to the air-cooling units located on the ground floor. This system features the ability to control the temperature by controlling the air and by directing the cooled air at prescribed angles. The air-conditioning system is related to the movable domes, the steel frame supporting the dome can be moved either electronically or manually. Within the frame of mechanical work, the ventilation system capable of controlling air pollution, developed according to an integrated safety, warning and fire protection system. This system is capable of fighting smoke and fire by means of hoses that automatically pump water from special stations located for this purpose. [1]	 **Fig. (3.36):** Exterior view of the retractable domes in the courtyard (Source: Architecture of the contemporary mosque, 1996, p.34)
Aesthetic Values	The plazas have been paved in decorative geometrically patterned marble tiles. Geometrical and floral patterns were used in the internal decorations of the opening and closing process of the domes. Inner dome surfaces are richly decorated in Moroccan hand-carved ornaments with gold leaf highlights and studded with turquoise colored Amazonite stones set in gilded bezels. Each dome is capped by a gold-plated finial.[2] (Fig. 3.37)	 **Fig. (3.37):** A Detail of the decorations inside and outside the domes. (Source: http://www.pct.ae/gallery_images/project9_img51.jpg)
Symbolic values	None.	

[1] "Sliding Domes, Medinah." *Dk composites.* Web. 25 June 2011.

3.1.12 King Faisal Mosque, Islamabad, Pakistan.

Architect/Construction Year: Vedat Dalokay / 1986.
Design approach: Adaptive Approach.

Design Concept

Description/Form:

The design quoted the classical forms, but is rendered by modern techniques and in modern forms, influenced by the ottoman style; a central space, courtyard, and detached minarets. The mosque accommodates 74,000 worshippers. (Fig. 3.38)

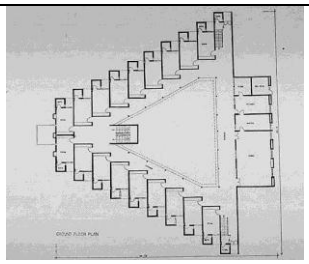


Fig. (3.38): The Triangular plan of the prayer hall. (Source: Archnet.org)

Architectural Elements

The main prayer hall is triangular in shape and is an eight faceted concrete shell, representative of a desert tent, and the cubic *Ka'ba* in Mecca. The shell is supported on four giant concrete girders. The mosque is framed by four slender pointed minarets.

The entrance is from the east and is preceded by a main courtyard with porticoes. (Fig. 3.39)

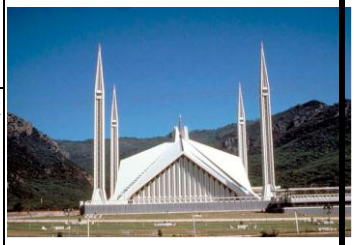


Fig. (3.39): Exterior view of King Faisal Mosque, Islamabad. (Source: Archnet.org)

Structural Elements

The dome was turned into a tent-like folded roof that spans the wide prayer hall. The structures of the exterior are of exposed concrete with the surfaces decorated with textured concrete. (Fig. 3.40)

Materials

Gypsum, wood and white marble decorated inside with mosaics were used on the surfaces.
The *qibla* wall is decorated with multi-glazed tiles, and the courtyard is paved with granite.

Illumination & ventilation

The sidewalls allow natural light to enter the prayer hall.

Fig. (3.40): Interior view of the prayer hall, showing the *qibla* wall and minbar. (Source: Archnet.org)

Aesthetic Values

The prayer hall walls are decorated with mosaics and calligraphy. The mosaic pattern adorns the west wall, and has the *kalimah* written in *Kufic* script, repeated in mirror image pattern.[1]

Symbolic values

The form symbolizes the desert tent, the dome was turned into a tent like folded roof, with eight concrete shells, supported on 4 concrete girders.

[1] "Faisal Mosque." *ArchNet.* Web. November 2010.

3.1.13 King Hassan II Mosque, Casablanca, Morocco.

Architect/Construction Year: Michel pinseau / 1986-1993.
Design approach: Conservative/Conventional –Hi Tech Approach.

Design Concept

Description/Form:

The mosque quoted the classical elements of North African mosque buildings, and is placed at the waters' edge along the Atlantic Ocean, inspired by a verse from the Koran that the throne of God was built over water. The mosque accommodates 25,000 worshippers in the main hall and 80,000 in the courtyard. (Fig.3.41)

Fig. (3.41): Minaret view of the Hassan II mosque in Casablanca.
(Source: Islam, art and architecture, 2007, p.589)

Architectural Elements

The rectangular hypostyle prayer hall has the particularity of a transparent crystal ground that allows worshippers to see through the depths of the ocean.

The minaret followed the Moroccan traditional style, and the *qibla* is indicated with a laser beam. The mosque was built to withstand earthquakes and has a heated floor, electric doors, a sliding roof, and lasers, which shine at night from the top of the minaret toward Mecca. (Figs. 3.42, 3.43)

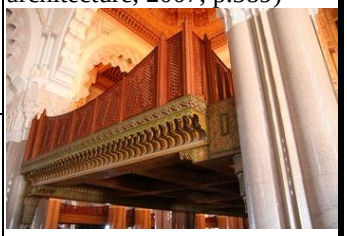


Fig. (3.42): The wooden screens of the women's gallery.
(Source: http://www.sacred-destinations.com/morocco/casablanca-hassan-ii-mosque)

Structural Elements

The structure is of reinforced concrete covered with Moroccan travertine. Horseshoe arches prevail both outside and in, and the walls and columns of the interior are delicately carved in a variety of intricate patterns. The mosque has gold-plated domes.

Materials

The interior is rich with traditional Moroccan decorations using zellig, wooden carvings and colored glass.[1] Stone and marble were used in floors and columns, sculpted plaster moldings, and carved painted wood ceilings.

Fig. (3.43): Intricately carved ceiling above the women's gallery.
(Source: http://www.sacred-destinations.com/morocco/casablanca-hassan-ii-mosque

Illumination & ventilation

The roof of the prayer hall, a triangular trussed construction, is an automated sliding roof opens for natural ventilation and illumination inside the prayer hall.

Aesthetic Values

Excessive use of Moroccan decorations and ornaments.

Symbolic values

None.

[1] Serageldin, Ismail & Steele, James (Eds.). *Architecture of the contemporary mosque*. Great Britain: Academy Editions, 1996, p.96, 97.

3.1.14 Qasr al hukm mosque, Riyadah, Saudi Arabia.

	Architect/Construction Year: Rasem Badran/1992. **Design approach:** Traditional-Adaptive-Eco Approaches
Design Concept	**Description/Form:** The mosque incorporates grand prayer hall for 10,000 worshippers. The mosque renovations seek a balance between inherited values and changing contemporary needs. (Figs. 3.44, 3.45)
Architectural Elements	The rectangular prayer space is organized with a geometrical system that allowed columns and arcades to be repeated. The mosque has two minarets framing Mecca direction.
Structural Elements	The hypostyle structural system of the prayer hall was used and the columns act as conduits for the mechanical ventilation system, so that the prayer hall can remain open. The columns are of prefabricated concrete. The mosque has no dome. [1] (Fig. 3.46)
Materials	The walls are made of local sandstone and mudstone. Marble floorings and wooden screens. Bearing walls, pre-fabricated colmns, beams, arches and double T-beamsprecast exposed concrete, concrete block walls with plaster and paint, marble and ceramic tiles. Gypsum boards were used in the ceilings.
Illumination & ventilation	Mudstone walls, with triangular slits were used to allow natural ventilation into the interiors. Walls were also layered to keep an inner one, which acts as a second layer of protection form the heat. Natural lighting and ventilation are supplied through a series of towers that correspond with the columns, eliminating the need for horizontal ductwork and unsightly suspended ceilings.[2]
Aesthetic Values	Subtle triangular bands decorate the interior and the exterior of the mosque. The minarets were used to frame the *qibla* direction. Geometric patterns were used in the wooden screens inside the mosque.[3]
Symbolic values	The minarets have a symbolic tradition role, whether there is a change in its original functions.

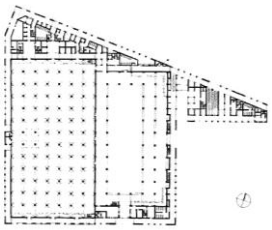


Fig. (3.44): A plan and an interior view of the hypostyle prayer hall. (Source: Archnet.org)

Fig. (3.45): Exterior view of the mosque. (Source: Archnet.org)

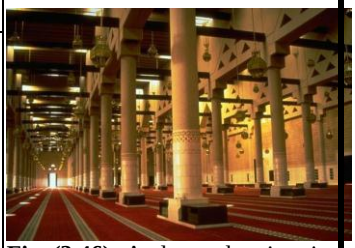


Fig. (3.46): A plan and an interior view of the hypostyle prayer hall, showing the triangular openings used for natural illumination and ventilation. (Source: Archnet.org)

[1] Serageldin, Ismail & Steele, James (Eds.). *Architecture of the contemporary mosque*. Great Britain: Academy Editions, 1996, p42-43.
[2] Steele, James & Badran, Rasem (Eds.). *The Architecture of Rasem Badran: Narratives on People and and Place.* New York: Thames and Hudson, 2005, p. 98-105.
[3] "Great Mosque of Riyadh and the Old City Center Redevelopment." *ArchNet.* Web. November 2010.

3.1.15 The Parliament mosque, Ankara, Turkey.

Architect/Construction Year: Behruz & Can Cinici/1989.
Design approach: Contemporary/Modern Approach

Design Concept

Description/Form:

The mosque has a stepped pyramidal roof, and a fully glazed qibla wall, and accommodates 450 worshippers.

By means of the design strategies of the mosque acknowledges its secular environment while enhancing the acts of prayer and devotion that are essential to Islam. (Fig.3.47)

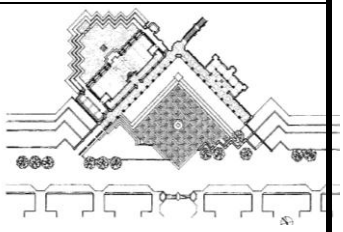


Fig. (3.47): Plan of the prayer hall of the parliament mosque, connected through an open arcade to the library. (Source: Archnet.org)

Architectural Elements

The mosque complex consists of three major parts. The first is a triangular forecourt, which precedes the prayer hall; the second is the rectangular prayer hall, and the third is the garden located in front of the prayer hall and takes the shape of a stepping triangle.

The prayer hall consists of two levels; the higher one is designated as women's prayer area. The *qibla* side with its *mihrab* contains large glazed areas opening to the sunken cascading garden located in front of the prayer hall. [1]

On top of the corner where the two porticos meet, the balconies of the minaret are placed but without its shaft and cap. These balconies barely rise above the ground, a tree is placed close to the minaret balconies as a substitute for the vertical orientation of the traditional minaret.

Other consciously incomplete references to the past include the truncated minaret, and the stepped pyramidal roof in place of the expected dome.

The customary orientation of the *qibla* wall and *mihrab* toward Mecca is maintained, but by conceiving these elements in glass. (Fig.3.48)

A wooden *minbar* is located to the right of the *mihrab*. Its design shows an abstraction of traditional *minbars.* [2]

Fig. (3.48): courtyard façade of the mosque, displays the transparent qibla wall overlooking the reflecting pond. (Source: Archnet.org)

Structural Elements

The space of the prayer hall is dominated from the top by a stepping pyramid form. The central part of the pyramid steps up higher than the other components.

The corners of this central part are articulated by abstracted stalactites. (Fig.3.49)

Large beams articulate the ceiling of the prayer hall.

[1] Serageldin, Ismail & Steele, James (Eds.). *Architecture of the contemporary mosque*. Great Britain: Academy Editions, 1996, p.105-106.
[2] "Grand National Assembly Mosque." ArchNet. Web. November 2010.

Materials	Reinforced pre-cast and cast-in-place were used in the construction. Exposed concrete is the dominant finishing material in the mosque. Marble is used in the door frames, windows and floors, stone is used for exterior floors. Ceramic panels are used for the prayer hall inscriptions. Wood is used for the shelves.	 **Fig. (3.49)**: The abstracted stalactites carrying the central pyramid space. (Source: Archnet.org)
Illumination & ventilation	The prayer hall is served by both direct and indirect light. Direct light is provided from the large windows located along the qibla wall. Indirect lighting enters the prayer hall from openings located within the steps of the pyramid covering it. (Fig.3.50)	
Aesthetic Values	The two shorter sides of the interior are articulated by large ceramic inscriptions containing words'Allah", "Muhammad", and the names of the four caliphs, written in ceramics panels using the geometric *kufic* script. A frieze of quranic inscriptions is located on each of the two sides, above these inscriptions.	 **Fig. (3.50)**: Interior view of the main prayer hall showing natural light penetrating through openings in the stepped pyramid roof. (Source: Archnet.org)
Symbolic values	The main approach to the mosque is through the triangular forecourt, where a tree and double balconies symbolise the minaret.[1] The concept to achieve transparency, simplicity and airiness, creating spiritual atmosphere inside the praying halls, was maintained by using glass *qibla* wall and *mihrab.*	

[1] Serageldin, Ismail & Steele, James (Eds.). *Architecture of the contemporary mosque*. Great Britain: Academy Editions, 1996, pp.105-106.

3.1.16 King Saud Mosque, Jeddah, Saudi Arabia.

Architect/Construction Year: Abdul Wahid al Wakil / 1989.
Design approach: Traditional Approach.

Design Concept

Description/Form:

The mosque follows the lead of the Mamluk style of the sultan Hassan mosque in Cairo, and accommodates up to five thousands worshippers. (Fig.3.51)

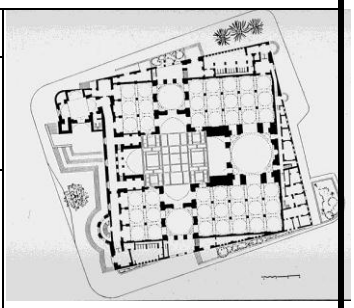


Fig. (3.51): Ground floor plan of the mosque. (Source: archnet.org)

Architectural Elements

The mosque is almost square with four iwans and a rectangular court built to the west. The north and south iwans are in front of a domed hall that separate four pillared halls to the east and west. The east halls have three naves with five bays and eight pillars each. The mosque has one Mamluk style minaret, a decorated *mihrab* and a traditional wooden *minbar*. (Fig.3.52)

Structural Elements

Clay bricks were used in the construction of the mosque. The main dome was built in masonry. The four barrel-vaulted *iwans*, consist of a large dome, two smaller symmetrical domes, and a series of smaller domes covering the remaining bays of the prayer hall. The structure systems are of load bearing brick walls, vaults and domes. The footbridge of the dome is of fenestrated triangles, and a row of windows in the drum area. (Fig.3.53)

Fig. (3.52): Exterior view of the eastern façade. (Source: Archnet.org)

Materials

The mosque is mainly build of red clay brick, covered with white plaster.

Illumination & ventilation

Chandeliers were used for illuminating the prayer hall, and side gypsum windows were used for natural illumination and ventilation during the day.

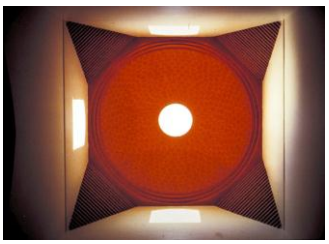


Fig. (3.53): Interior view of the smaller dome in the prayer hall. (Source: Archnet.org)

Aesthetic Values

The stalactites were used in the portals. Subtle decorations and moldings were used. The four *iwan* prayer hall are symmetrically composed around an east-west axis.[1]

Symbolic values

None.

[1] Serageldin, Ismail & Steele, James (Eds.). *Architecture of the contemporary mosque*. Great Britain: Academy Editions, 1996, pp.55-58.

3.1.17 Dar Al-Islam mosque, Abiquiu, New Mexico.

Architect/Construction Year: Hassan Fathy/1980.
Design approach: Traditional Approach.

Design Concept

Description/Form:

The mosque is designed to achieve seperation of the sexes required in all religious buildings. The mosque is dominated by a large dome, which is built over its main prayer area.

Architectural Elements

The mosque is based on a nearly square plan that provides a forward prayer space for men and a screened area for women in a very efficient way. The *mihrab* is just a subtle recess in the wall. The mosque has no minaret. (Figs.3.54)

Structural Elements

Constructed entirely with mud brick, the mosque has loadbearing walls that carry arches and domes, which cover the prayer hall, divided into single domed units.

In the construction of the domes, the corners where the arches meet to form the spring of the dome are first levelled off and then bridged with half-domes to form squinches. These squinches in turn create an octagonal base on which the structure sits. (Fig.3.55)

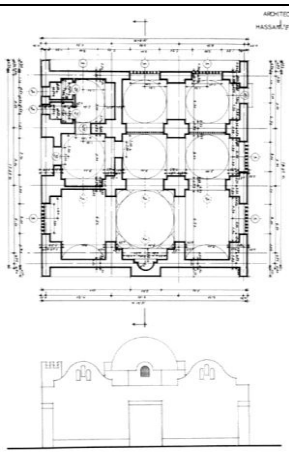


Fig. (3.54): Ground floor plan and main elevation of the mosque. (Source: archnet.org)

Materials

Mud bricks were used in the construction of the mosque with limestone and fibres additions to cope with thermal expansion.

Judging from both the technical and economic complexities involved in using adobe here, however, it would seem that the intentional choice of this material and style was made for iconographic, rather than environmental or cultural reasons."

Fig. (3.55): Interior view of the dome, showing the pendetives forming the octagonal shape supporting the dome. (Source: Archnet.org)

Illumination & ventilation

Triangular openings for natural ventilialtion and illumination. (Fig.3.56)

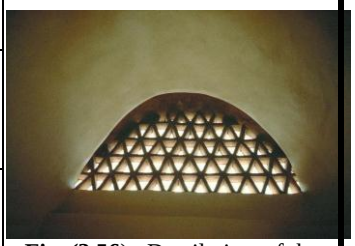


Fig. (3.56): Detail view of the triangular openings for illumination and ventilation (Source: Archnet.org)

Aesthetic Values

No decorations or inscriptions were used in the mosque except for the nubian triangular band on the exteriors.[1]

Symbolic values

None.

[1] Serageldin, Ismail & Steele, James (Eds.). *Architecture of the contemporary mosque*. Great Britain: Academy Editions, 1996, pp.154-155.

3.1.18 Al Ghadir Mosque, Tehran, Iran.

	Architect/Construction Year: Jahangir Mazlum Yazdi/1980. **Design approach:** Conservative/Conventional-Adaptive Approach.
Design Concept	**Description/Form:** The building exemplifies the symbiosis possible between traditional and contemporary architectural with Iranian architectural tradition.
Architectural Elements	The main prayer hall is based on rotated square forms. The tall dodecagonal prayer hall, dressed with ochre-coloured brickwork and blue ceramic tiles. The *mihrab* projects on the outside of one of the twelve sides. The mosque has no minaret. (Fig.3.57)
Structural Elements	The mosque has a steel reinforced concrete structure supported on reinforced concrete foundations with brickwork covering on external and internal walls. The dome covering the prayer hall steps up from its dodecagonal perimeter, its number of sides ultimately reducing from 12, 8, 4 to smaller 4, which was a technique traditionally used to make the transition from a square to a circle, although the roof is flat not spherical. (Fig.3.58)
Materials	Reinforced concrete covered with copper sheeting, brick and tiles. Granite floors, ceramic tiles, cut brick and thick sound-proof crystal glazing for the slit openings in the side walls and dome.
Illumination & ventilation	The sequence of rotated square forms of the prayer hall allows natural light to filter down from slit openings over the vertical sides and from above by way of slots located in the outer shell. The artificial lighting system produces indirect light via the same slots.
Aesthetic Values	Patterns are created through modulated hollow spaces within flat areas and is either protruding or recessed motifs combining bricks and tiles. Compositions are derived from kufic calligraphic shapes. The *mihrab* is covered with golden surfaces based on a 6 mm module, its entirely covered with a repetitive composition of the word 'Allah'.[1]
Symbolic values	The dome covering the prayer hall steps up from its dodecagonal perimeter, 12 sides symbolise the twelve Shia' imams. (Fig.3.59)

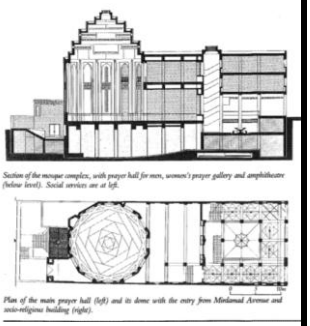


Fig. (3.57): Ground floor plan and section of the mosque. (Source: http://dcl.umn.edu/search/search_results?search_string=Islamic&per_page=60&&&page=101)

Fig. (3.58): Exterior view of the mosque (Source: Archnet.org)

Fig. (3.59): Detail of ceiling mosaic. (Source: Archnet.org)

[1] Serageldin, Ismail & Steele, James (Eds.). *Architecture of the contemporary mosque*. Great Britain: Academy Editions, 1996, p.128.

3.1.19 Istiqlal Mosque, Jakarta, Indonesia.

Architect/Construction Year: Frederich Silaban/1978.
Design approach: Contemporary/Modern Approach.

Design Concept

Description/Form:

The national mosque of Indonesia was built to commemorate Indonesian independence, as nation's gratitude for Islam's blessings. Therefore the national mosque of Indonesia was named "*Istiqlal*". The mosque accommodates up to 120,000 worshippers.

Fig. (3.60): Exterior view of the mosque. (Source: http://en.wikipedia.org/wiki/Istiqlal_Mosque)

Architectural Elements

The rectangular main prayer hall is covered by a central spherical dome, and is reached through an entrance covered by a dome. On the main wall on *qibla* there is a *mihrab* and *minbar* in the center. The latter structure is directly connected to the arcades, which run around the large courtyard. The mosque has one minaret dotted with speakers to broadcast the call to prayer. The courtyards on the south and east sides of the mosque provide additional space for 40,000 worshippers. (Fig.3.60)

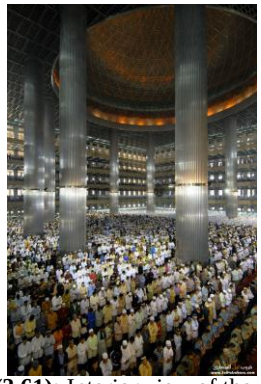


Fig. (3.61): Interior view of the prayer hall. (Source: Archnet.org)

Structural Elements

The dome is supported by twelve round columns, and the prayer hall is surrounded by rectangular piers carrying four levels of balcony.

Materials

Marble clad. The 12 columns are concrete covered with aluminium plates. (Fig.3.61)

Illumination & ventilation

The mosque remains cool by high ceilings, wide-open hallways, and open courtyards effectively dissipate the heat in the building.

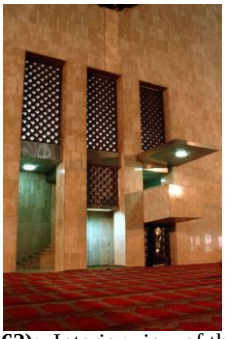


Fig. (3.62): Interior view of the *qibla* wall. (Source: Archnet.org)

Aesthetic Values

The interior design is minimalist, simple and clean cut, with minimal adornment of aluminium geometric ornaments. On the main wall, there is large metalwork of Arabic calligraphy spelling the name of Allah on the right side and Muhammad on the left side, and also the calligraphy of Surah Thaha 14th verse in the center. (Fig.3.62)

Symbolic values

The alignment of the mosque's courtyard to the National Monument adds symbolic weight to the former's position and marks it as the National Mosque.[1]

[1] "Istiqlal Mosque." *ArchNet.* Web. November 2010.

3.1.20 The New Mosque and Islamic Center of Rome, Italy.

Architect/Construction Year: Paolo Portoghesi, Sami Mousawi, Vittorio Gigliotti./ 1992-1995.
Design approach: Adaptive Approach.

Design Concept

Description/Form:

The mosque incorporates prayer hall that accommodates 2000 worshippers, a smaller prayer hall accommodates 150 worshippers, an educational section containing library, classrooms, a conference auditorium for 400 people, an exhibition area, and two residential sections, one for the Imam of the Mosque and the other for visitors. The massing of the complex seems to follow a traditional approach to the architecture of mosques, (Fig.3.63).

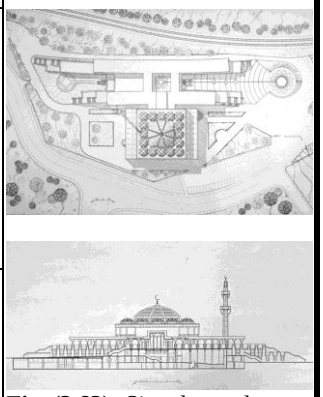


Fig. (3.63): Site plan and section of the mosque. (Source: Archnet.org)

Architectural Elements

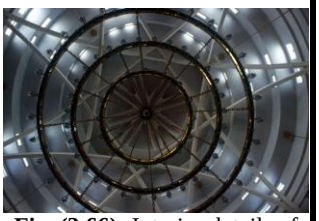
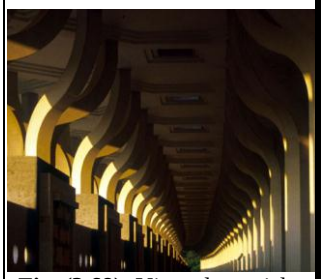
The complex consists of two masses. The first is a rectangular prayer hall measuring about 60 x 40 m with the longer sides facing the southeast, the *qibla* wall. The second part approximates the shape of H and accommodates the remaining functions of the complex except for the ablution facilities that are located beneath the prayer hall. A water channel runs along the longitudinal axis of the H shaped mass and connects two pools, one located in the centre of the mass and another to the northeast. The minaret is located southwest of the prayer hall, close to where the H shaped mass and the prayer hall meet. The treatment of the facades and exterior walls includes panels combining travertine marble and slender, and yellow Roman bricks, (Figs.3.64, 3.65).

Fig. (3.64): Exterior view of the mosque (Source: Archnet.org)

Structural Elements

The prayer hall is articulated by a large central dome with a diameter of 21.60 m. 16 smaller domes surrounding the large central one. Another important feature is the columns forming the colonnade/riwaq areas. A modular structural system was established; the modular system of the riwaq is 3.60 x 3.60 m while for the main prayer hall is 7.20 x 7.20 m, and resulting in a span for the dome of 21.60 m. The most striking aspect of the structural system is the clustered four branch columns and the ribs springing from them. These columns are composed of case-in-situ elements, and the upper web-like ribs contain both pre cast and cast-in-situ elements. The four branches of each column hold a raised octagonal stub column and all the octagonal columns support the domes. However, the web-like ribs springing from the four branched columns are purely decorative, (Fig.3.66).

Fig. (3.65): Interior view of the praying hall. (Source: Archnet.org)

Materials	The concrete employed for all the structural elements of the columns and arches consisted of a special composition of materials; white *karrara* marble aggregates mixed with white cement. The unconventional use of chromium-plated zinc coated reinforcement bars was required to avoid corrosion and concomitant staining of the white concrete. The columns of the *riwaq* are made of concrete; the curving parts of the minaret are carved out of marble.	 **Fig. (3.66):** Interior details of the ribbed dome. (Source: Archnet.org)
Illumination & ventilation	In terms of lighting, natural light enters the interior through window openings in the wall and through a series small windows located within the stepped structure of the dome.	 **Fig. (3.67):** Interior view in the prayer hall, the structural components also act as decorative elements. (Source: Archnet.org)
Aesthetic Values	A veneer of traditional Moroccan decoration was applied to the interior walls of the prayer hall. This consists of geometrical patterns made of ceramic mosaics that cover the lower part of the prayer hall's walls, the *mihrab*, and the lower parts of the columns. A painted band of calligraphic inscriptions is applied at the top of the geometrical patterns. However, the calligraphic inscriptions applied on the columns are carved in stucco.	
Symbolic values	The Columns symbolize the tree, 4 clustered branches form the arches web, made of prefabricated concrete to form a lamp, which symbolically referring to the Verse 'God is the Light of the heavens and the earth.[1] (Figs. 3.67, 3.68)	 **Fig. (3.68):** View along aisle. (Source: Archnet.org)

[1] Serageldin, Ismail & Steele, James (Eds.). *Architecture of the contemporary mosque*. Great Britain: Academy Editions, 1996, pp.151-153.

3.1.21 King Khaled Airport Mosque, Riyadh, Saudi Arabia.

	Architect/Construction Year: Hellmuth, Obata & Kassabaum/1983. **Design approach:** Adaptive Approach.
Design Concept	**Description/Form:** The mosque accommodates 5,000 worshipers inside and another 5,000 in the plaza outside. The mosque incorporates a *quranic* library, private offices and lavatories are located along the southeast on southwest walls, (Fig.3.69).
Architectural Elements	The triangular form was used as the design paradigm. Triangular trusses were chosen as an appropriate way to reflect plan forms. In the northeast corner of the mosque plaza, a minaret rises 39 meters above the plaza level. A spiral stairway inside the minaret provides access to loudspeakers that broadcast the daily five times call prayers, (Fig.3.70).
Structural Elements	The dome is 33 metres in diameter and in the northeast corner of the mosque plaza, a minaret rises 39 metres above the plaza level. A geodesic metal cage has been used in the domes, held up by steel columns and trusses braced by the lower roof. Escalators were used to reach the plaza level.
Materials	The dome and lower roof are clad with buff-colored triangular ceramic tiles, attached to steel beams. Inside, 1008 bronze panels are fitted into the dome, held up by steel columns and trusses, [1] (Fig.3.71).
Illumination & ventilation	Shafts of sunlight filter through tinted glass and illuminate the interior with a soft amber and blue light that spread tranquillity. A chandelier is suspended from the centre of the dome. Ninety-six tinted glass light cones are fitted to a bronze hoop 13 meters in diameter to bathe the prayer area in soft light after darkness falls.
Aesthetic Values	The carved marble bonds, stained glass windows and skylights, intricate ceramic tile patterns, and carved wooden doors and size make it a showplace of traditional Islamic art forms. A ring of decorative mosaic tiles inscribed with passages from the *quran* is located all around the dome. [2]
Symbolic values	None.

Fig. (3.69): Exterior view of the mosque.(Source: http://www.airport-technology.com/projects/king-khaled/)

Fig. (3.70): Interior view of the prayer hall. (Source: www.cksu.com)

Fig. (3.71): Exterior view of the minaret and the central dome of the mosque. (Source: http://en.wikipedia.org/wiki/File:King_Khalid_Airport_Moque.jpg)

[1] Serageldin, Ismail & Steele, James (Eds.). *Architecture of the contemporary mosque*. Great Britain: Academy Editions, 1996, p.39.

[2] < http://www.kkiairport.8k.com/> accessed 15 February 2013.

3.1.22 Mosque and Islamic centre of Regent's park, London, England.

Architect/Construction Year: Frederick Gibberd/1978.
Design approach: Adaptive Approach.

Design Concept

Description/Form:

The mosque has a prominent golden dome. The main hall can hold over five thousand worshippers, with women praying on a balcony overlooking the hall. The mosque incorporates a library, offices, a conference room, and events hall. (Fig.3.72).

Fig. (3.72): A view of the mosque dome and minaret from the courtyard.(Source: http://samotalis.blogspot.com/2012/08/grand-mosques-in-united-kingdom.html)

Architectural Elements

The main prayer hall features lush red carpets, a vast dome decorated with mosaics, and a huge central chandelier, (Fig.3.73). The mosque has one **minaret,** and a courtyard.

Structural Elements

The main prayer hall is covered with a flat concrete slab with a large circular hole in the center, from the edge of which rises a reinforced concrete ring-beam carrying the precast lightweight concrete drum segments. The dome is light metal structure, consists of eight tubular steel lattice frames rising from the drum to the apex. The whole structure is braced against wind pressure by the surrounding wall units and parapet beam.[1]

Fig. (3.73): Interior view of the prayer hall. (Source: http://en.wikipedia.org/wiki/File:Inside_london_central_mosque.jpg)

Materials

The roof is made of pre-stressed beam construction, with in site concrete round the minaret. The dome is clad on outside with copper alloy sheeting, gold in color, fixed to double diagonal boarding.

Illumination & ventilation

Mechanical services of air conditioning, ventilation, a low pressure hot water heating system and fire protection are housed unobtrusively so as not to detract from the architectural features of the mosque.

Aesthetic Values

Decorative screens, *mihrab, minbar* and chandelier were used in the prayer hall, decorative glazed tiles for the dome and a frieze above the main arches of the exterior,[2] (Fig.3.74).

Fig. (3.74): Interior view of the inscription band and the chandelier dome in the prayer hall. (Source: www.flickr.com)

Symbolic values

None.

[1] <http://www.sacred-destinations.com/england/london-regents-park-mosque> accessed 15 February 2013.
[2] Serageldin, Ismail & Steele, James (Eds.). *Architecture of the contemporary mosque*. Great Britain: Academy Editions, 1996, pp.165-166.

3.1.23 Tuanku Mizan Zainalabdin Mosque, Putrajaya, Malaysia.

	Architect/Construction Year: Nik Arshad Nik Mohammed /2009. **Design approach:** Contemporary Modern Approach.
Design Concept	**Description/Form:** The mosque accommodates 20,000 worshipers, and was designed to achieve simplicity, airiness and transparency, and to reflect the architectural style of the region through modern materials and techniques, by using stainless steel spiral mesh. (Fig.3.75).
Architectural Elements	The *mihrab* wall is made of 13 meter-high glass panel inscribed with 2 verses from *Sura* Al-Baqarah on the right-hand side and *Sura* Ibrahim on the left. The mihrab wall is designed so that no light will be reflected, creating an illusion that the verses are floating on air, (Fig.3.76).
Structural Elements	A filigree façade made from over 14,000-square-feet of stainless steel spiral mesh visually connects the rectangular openings of the meandering structure. Each mesh element is 25-feet-wide and up to 27-feet-long.
Materials	The main entrance is reinforced with Glass Reinforced Concrete to increase the integrity of the structure and uses fine glass to create an illusion of a white mosque from afar, (Fig.3.77). The mosque is 70 percent steel. Stainless steel was used in the mesh. The fabric mantle has a semi-transparent/opaque or a metallic appearance.
Illumination & ventilation	A unique cooling system was created using stainless steel mesh, eliminating the need for air-conditioning or fans, the mesh skin is acting as a protective membrane instead of using glass windows to achieve natural air conditioning. At night purposefully staged lighting illuminates the building, and together with the soft glow of daylight, underlines the meditative qualities desired for the building.
Aesthetic Values	The interior is decorated with 99 names of Allah calligraphy of the Thuluth variation. The entrance to the main prayer hall is adorned with verse 80 of Sura Al-Isra from the Quran. [1]
Symbolic values	None.

Fig. (3.75): Exterior view of the mosque. (Source: http://www.designandbuildwithmetal.com/SubmittedProjects/Projects/tuanku_mizan_zainal_abidin_mosque_gkd_steel_mesh.aspx)

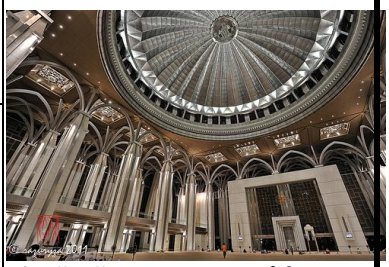


Fig. (3.76): Interior view of the prayer hall. (Source: copyrighted razuryza)

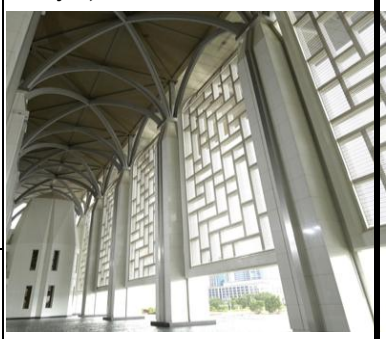


Fig. (3.77): Exterior view of the steel mesh and fountain around the mosque. (Source: http://www.designandbuildwithmetal.com/SubmittedProjects/Projects/tuanku_mizan_zainal_abidin_mosque_gkd_steel_mesh.aspx)

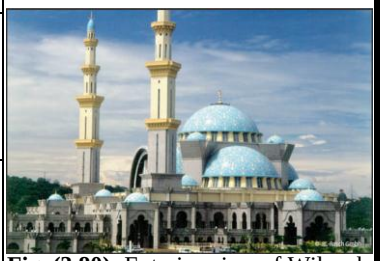
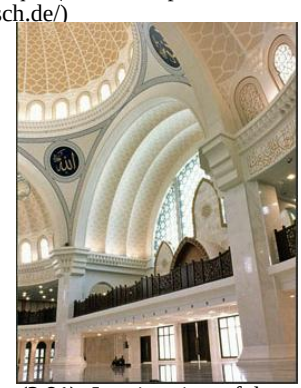
[1] http://www.designandbuildwithmetal.com/SubmittedProjects/Projects/tuanku_mizan_zainal_abidin_mosque_gkd_steel_mesh.aspx accessed 16 February 2013.

3.1.24 Putra Mosque, Putrajaya, Malaysia.

	Architect/Construction Year: NA/1999 **Design approach:** Post-modern/ Hi tech Approach.	
Design Concept	**Description/Form:** The mosque combines Middle Eastern and traditional Malay design elements in its architecture. The mosque accommodates 15,000 worshippers (up to 8000 male worshippers at the ground level while the 1st floor can hold 2000 female worshippers) and the mosque also has other functional areas including library, lecture hall, auditorium, dining hall and corpse management, (Fig.3.78).	 **Fig. (3.78):** Exterior view of putra mosque (Source: http://commons.wikimedia.org/wiki/File:Putrajaya_mosque_at_dusk.jpg)
Architectural Elements	The Main Prayer Hall is designed without internal partitions and only 12 columns supporting the prayer hall and 36-metre diameter main dome stands above. The prayer hall, ringed by special craft of wooden doors, windows and panels works. The mosque has one minaret, (Fig.3.79).	
Structural Elements	The main dome and smaller domes are made from pink granite. The domes shell panels are made of lightweight composite structures. The structure of mosque is based on the model of Persian Islamic architecture of the Safavid period with elements derived from some other Islamic countries. [1]	 **Fig. (3.79):** Interior view of the prayer hall. (Source: http://en.wikipedia.org/wiki/File:Putra_Mosque_95164719_02daf597ec.jpg)
Materials	The outer cladding is completed in a pink colored mosaic ceramics with floral design while the inner cladding consists of simple ornaments hand painted in cream and pink color.	
Illumination & ventilation	Natural and artificial illumination and ventilation wee used in the mosque.	
Aesthetic Values	The main entrance to the mosque is patterned after gates to public buildings in Persia. The building was constructed mainly with rose—tinted granite, juxtapose by brown-stained woodwork to enhance the decorative features of the doors, windows and panels. [2]	
Symbolic values	None.	

[1] http://www.malaysia-traveller.com/putra-mosque.html.(Accessed 22 February 2013)
[2] http://www.riseap.org/2010/09/07/putra-mosque-kuala-lumpur/(Accessed 22 February 2013)

3.1.25 Wilayah Mosque, Kuala Lumpur, Malaysia.

	Architect/Construction Year: NA/2000. **Design approach:** Post-modern/ Hi tech Approach.	
Design Concept	**Description/Form:** The mosques' design is a blend of Ottoman and Malay architectural styles, heavily influenced by the Blue Mosque in Istanbul, Turkey. The mosque accommodates 17,000 worshippers, and incorporates a library, dining hall, and auditorium, (Fig.3.80).	 **Fig. (3.80):** Exterior view of Wilayah mosque (Source: http://www.sl-rasch.de/)
Architectural Elements	The mosque has 2 *minarets*, the *qibla* wall is decorated with *thuluth* calligraphy and floral motifs. The hemispherical 31.2m wide main dome with arched windows at its base, has half domes beneath it and a vault joining it to a monumental portal arch facing the courtyard, [1] (Fig.3.81).	 **Fig. (3.81):** Interior view of the prayer hall. (Source: http://www.sl-rasch.de/)
Structural Elements	Reinforced concrete was used in the structure system of the mosque. It has 22 domes made from a composite material of glass fibre fabric mixed with epoxy resin to make it durable and light.	
Materials	The outer cladding is completed in a turquoise colored mosaic ceramics with floral design while the inner cladding consists of simple ornaments hand painted in cream and sand color. A scalloped form with ornamental motif raised in relief decorates the inner shell of the main dome. Muqarnas, fabricated in the same composite materials, are used extensively. [2]	
Illumination & ventilation	The prayer hall lighting system technique was based on the use of daylight, by an opening in the apex of the dome, equipped with redirection system to collect sunlight by heliostat mirrors, and beam it down to a grand chandelier. At night, lamps are installed instead. This automated lighting system utilizes integrated daylight and artificial light that complement and balance each other, (Fig.3.82).	 **Fig. (3.82):** Interior view of the prayer hall showing the lighting system. (Source: http://www.sl-rasch.de/)
Aesthetic Values	Computerized pixel technique was used in the outer cladding ornamentation. Pendentives between the half domes have monumental Arabic calligraphy with real gold finish and painted arabesque borders. Floral motifs, *muqarnas* and *quranic* verses were used in the portal decorations. [3]	
Symbolic values	None.	

[1] http://www.pct.ae/composites_projects.php?project=6 (Accessed: 22 February 2013)
[2] http://www.sl-rasch.de/ (Accessed: 22 February 2013)
[3] http://www.dkdomes.com/p3_wilayah%20main.htm (Accessed: 23 February 2013)

3.1.26 Al Mukminin Mosque, Singapore.

Architect/Construction Year: Forum Architects/2006.
Design approach: Contemporary/Modern Approach.

Design Concept

Description/Form:

The mosque was designed in contemporary colors and with traditional Islamic influence, accommodates 4,500 worshippers, and incorporates conference rooms, and offices (Fig.3.83).

Fig. (3.83): Exterior view of Al Mukminin mosque (Source: http://islamicprojects.wordpress.com/2011/07/29/al-mukminin-mosque-forum-architects/)

Architectural Elements

The prayer hall has its prominent fan-shaped roof. The intricate composition of turquoise, yellow and blue - dominant colours in Islamic buildings - convey a sense of depth and animation to a flat surface, also visible through the skylight gap between the old and new block, [1] (Fig.3.84).

Fig. (3.84): Interior view of the prayer hall. (Source: http://islamicprojects.wordpress.com/2011/07/29/al-mukminin-mosque-forum-architects/)

Structural Elements

A crescent-shaped rooftop and star-like dome covers the prayer hall. Each of its façades is treated in a different manner, the "head" section, a semi-cylindrical form; the long façade fronting the Mass Transit line, blank except for 5% of the windows.

Materials

A new screen behind the prayer hall is made from panels of Alucobond. The juxtaposition of colors and shadows on the aluminium blinds is designed to create a mottled effect of facade dematerialization. [2]

Illumination & ventilation

The louvers screen off the harsh afternoon sun whilst allowing ventilation and illumination into the corridor behind and not allow monsoonal rains to beat in, (Fig.3.85).

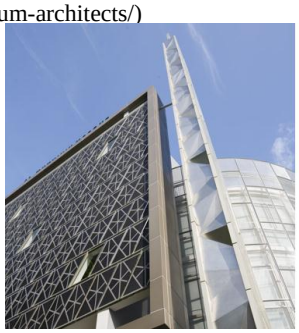


Fig. (3.85): Detail view of the façade screens.
(Source: http://islamicprojects.wordpress.com/2011/07/29/al-mukminin-mosque-forum-architects/)

Aesthetic Values

The screen design mimics an Islamic arabesque, a complex overlay of two or more geometric patterns to form a third pattern. The intricate composition of turquoise, yellow and blue - dominant colours in Islamic buildings - convey a sense of depth and animation to a flat surface, also visible through the skylight gap between the old and new block. [3]

Symbolic values

None.

[1] http://islamicprojects.wordpress.com/2011/07/29/al-mukminin-mosque-forum-architects/ (Accessed: 19 February 2013)
[2] http://www.skyscrapercity.com/showthread.php?t=969698 (Accessed: 23 February 2013)
[3] http://trendsideas.com/Article8182/TheGulfAndAsia (Accessed: 23 February 2013)

3.1.27 Baitunur Mosque, Alberta, Canada.

Architect/Construction Year: Manu Chugh Architects/2008.
Design approach: Contemporary/Modern Approach.

Design Concept

Description/Form:

The mosque design is a mixture of very traditional architectural styles and ultra-modern technology. The mosque accommodates 1500 worshippers, and incorporates classrooms, office space, a children's area, a kitchen, praying spaces for men and women, and a community centre, (Fig.3.86).

Fig. (3.86): Exterior view of Baitunur Mosque (Source: http://islamicspots.blogspot.com/2012/04/baitun-nur-calgary-canada.html)

Architectural Elements

The prayer hall is rectangular in shape divided equally between men and women, the mosque consists of 2 floors, the *mihrab* is recessed and framed with an arch. The mosque has one tall steel capped minaret tower, (Fig.3.87). The portal is framed with a huge pointed arch, decorated with a *quranic* verse from above.

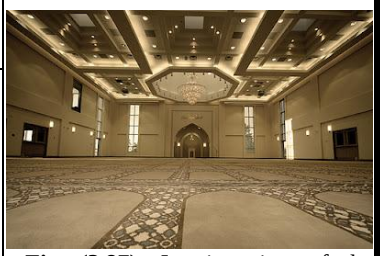


Fig. (3.87): Interior view of the prayer hall. (Source: http://islamicspots.blogspot.com/2012/04/baitun-nur-calgary-canada.html)

Structural Elements

Steel frames structure and reinforced concrete was used in the main structure system of the mosque. The large steel dome is the most noticeably externally visibly feature of the mosque, which is transformed from octagonal shape to circle to carry the dome.

Materials

Reinforced concrete, steel frames and cladding, and glass were used all over the mosque.

Illumination & ventilation

Natural and artificial illumination and ventilation wee used in the mosque, windows are placed all around the dome drum to lighten the prayer hall.

Fig. (3.88): Detail view of the Calligraphy façade. (Source: http://calgarydailyphoto.blogspot.com/2011/07/baitun-nur-mosque.html)

Aesthetic Values

Simple decorations were used in the mosque, the mosque's exterior is ringed with 99 gleaming Arabic words, each one highlighting an attribute of Allah's character as outlined in the Quran, [1] (Fig.3.88).

Symbolic values

None.

[1] <http://en.wikipedia.org/wiki/Baitun_Nur> accessed 16 February 2013

3.1.28 Goktepe Mosque, Turkmenistan.

Architect/Construction Year: NA/1991.
Design approach: Postmodern/Hi-Tech Approach.

Design Concept

Description/Form:

The mosque design is a blend of Ottoman style, (Fig.3.89).

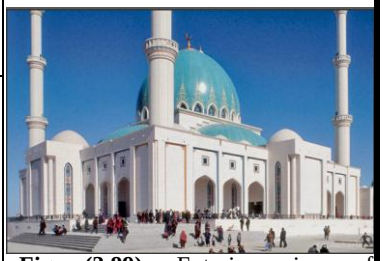


Fig. (3.89): Exterior view of Goktepe mosque (Source: http://www.sl-rasch.de/)

Architectural Elements

The prayer hall is centralized under the dome, and consists of 4 arched *iwans*. The mosque has 4 *minarets*, the *qibla* wall is decorated with *thuluth* calligraphy and floral motifs. The hemispherical main dome with arched windows at its base, has half domes beneath it and a vault joining it to a monumental portal arch facing the courtyard, (Fig.3.90).

Structural Elements

Reinforced concrete was used in the structure system of the mosque. The domes are made from a composite material of glass fibre fabric mixed with epoxy resin to make it durable and light, supported on steel shells, (Fig.3.91).

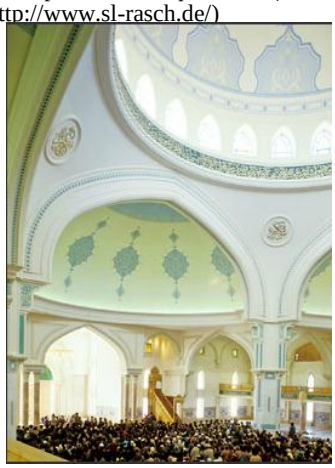


Fig. (3.90): Interior view of the prayer hall. (Source: http://www.sl-rasch.de/)

Materials

The outer cladding is completed in a green colored mosaic ceramics with floral design while the inner cladding consists of simple ornaments hand painted in white and green colors.

Illumination & ventilation

Natural and artificial illumination and ventilation were used in the mosque.

Aesthetic Values

Green mosaic ceramics with floral design was used on the outer cladding, while the inner cladding consists of simple ornaments. Pendentives between the half domes have monumental Arabic calligraphy with real gold finish and painted arabesque borders.[1]

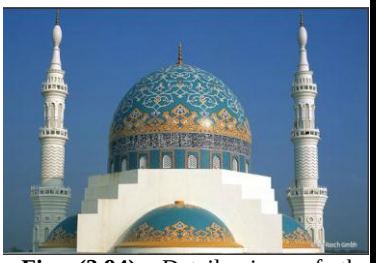
Fig. (3.91): Detail view of the Dome construction. (Source: http://www.sl-rasch.de/)

Symbolic values

None.

[1] http://www.sl-rasch.de/ (Accessed: 26 February 2013)

3.1.29 Bokhary Mosque, Kuala Lampur, Malaysia.

	Architect/Construction Year: NA/NA **Design approach:** Postmodern/Hi-Tech Approach.	
Design Concept	**Description/Form:** The mosques' design is a blend of traditional style of Isfahan, (Fig.3.92).	 **Fig. (3.92):** Exterior view of Bokhary mosque (Source: http://wikimapia.org/2883259/Masjid-Al-Bukhary)
Architectural Elements	The main prayer hall is rectangular in shape, the column in the central space in the main **prayer hall**, around the *mihrab* area is designed that the columns will form trefoil arches carrying the stalactites that transform the shape into a circle to carry the dome. The mosque has a wooden *minbar*, and 2 *minarets* guard the smaller half domes positioned below the main dome, (Fig.3.93).	 **Fig. (3.93):** Interior view of the prayer hall. (Source: http://www.sl-rasch.de/)
Structural Elements	Reinforced concrete was used in the structure system of the mosque. The mosque is crowned with twenty-three composite domes supported on steel shell. Stalactites were used to convert the octagonal to circle that supports the dome.	
Materials	The domes are made from a composite material of glass fibre fabric mixed with epoxy resin to make it durable and light, supported on steel shell. The domes exterior has a mosaic tile finish with arabesque motifs in the same style as the main dome.	
Illumination & ventilation	Natural and artificial illumination and ventilation were used in the mosque. Beneath the dome, there is a drum of window arches with decorative grilles.	 **Fig. (3.94):** Detail view of the Dome tiles decorations. (Source: http://www.sl-rasch.de/)
Aesthetic Values	The inner shell of the main dome has a decorative treatment with ribs raised in relief, tracing out an intricate geometric pattern, surrounding calligraphic inscriptions. The medium-sized domes and small domes also have geometric motifs and hand painted calligraphy, all designed with reference to historical examples of Islamic architecture from Iran and central Asia, [1] (Fig.3.94).	
Symbolic values	None.	

[1] http://www.dkdomes.com/p3_albukhary%20main.htm (Accessed: 26 February 2013)

3.1.30 Palm Jumeirah-Abdulrahman Sadik Mosque, Dubai, Emirates.

Architect/Construction Year: Yaghmour Architects /2012
Design approach: Adaptive Approach.

Design Concept

Description/Form:

The mosque design maintained the idea of centralized domed mosque; the idea was to provide worshippers with space that connects them more with the religious practice rather than more details, using abstracted elements. It has capacity for 1,000 worshippers; 800 for men and 200 for women, (Fig.3.95).

Architectural Elements

The prayer hall is rectangular in shape and the mosque has one abstracted minaret, the transparent glass *qibla* wall provides indirect light that filters through the wall following the facade's orientation to the *qibla* in Mecca. There are two praying halls with courts tied to each, two ablution areas.

Structural Elements

Reinforced concrete is used as the structure system of the mosque. The dome is made of steel and glass. The treatment of the façade that faces the Qibla in Makkah; with its layers of rough stone and patterned glass, it appears that the building skin has been sliced. The glass has a double skin all the way to the ground, with an insert of aluminium sheet, (Fig.3.96).

Materials

The mosque was built using marble, concrete, glass, steel and aluminium instead of stone and ornaments. The dome is made of steel and glass and parts of its walls are transparent to make visitors feel closer to God. The façade is covered with metal mesh.

Illumination & ventilation

Natural and artificial illumination and ventilation were used in the mosque; in terms of chandeliers, windows, and metal mesh screens.

Aesthetic Values

Circular shapes were used in the screen mesh patterns used in the façade. Quranic verse was carved on the minaret stone cladding. Simple and abstracted ornaments were used in the mosque.

Symbolic values

The concept to achieve transparency, simplicity and airiness, creating spiritual atmosphere inside the praying halls, was maintained by using metal mesh, transparent glass walls, to make worshippers feel closer to God. [1]

Fig. (3.95): Exterior view Abdulrahman Sadik mosque (Source: http://www.momentaryawe.com/blog/?p=3433)

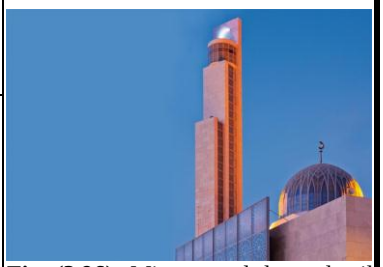


Fig. (3.96): Minaret and dome detail view of Palm Jumeirah mosque (Source: http://www.constructionweekonline.com/article-16665-spine-mosque/#.UVM7z80gsh8)

[1] http://www.thenational.ae/news/uae-news/palm-jumeirah-mosque-has-unique-design (Accessed: 27 March 2013)

3.1 Evaluation Analysis of Late 20th and Early 21st Centuries Mosques' Projects

The evaluation will be proceeded by using the design analysis framework to evaluate the case studies, technology used in each value will be graded as one point summed and will be expressed in the form of percentage as an indicator of the weight of the technology used in this item between the selected 30 mosques case studies. The analysis table will then be followed by a detailed explanation and clarification of each technology, how it was used and integrated in the mosque, (Table 3.1).

Table (3.1): A detailed analysis of the mosques projects, designed between 1975-2010 A.D, illustrating the different design approaches of mosques, and the new technology used. (Source: Author)

	Items/Projects	1.Sheikh Zayed Grand Mosque	2.Irsyad Mosque	3.Glass Mosque	4.Sakirin Mosque	5.Cologne Mosque	6.Chandgaon Mosque	7.Assyafah Mosque	8.Sami Ali Pasha Mosque	9.Glass Dome Mosque	10.Sultan Qaboos Mosque	11.Prophet's Mosque Expansion	12.King Faisal Mosque	13. Hassan II Mosque	14.King Saud Mosque	15.Parliament Mosque	16. Dar al Islam Mosque	17.Al Ghadir Mosque	18.Istiqlal Mosque	19. Qasr al Hukm Mosque	20.Wilayah Mosque	21.Göktepe Mosque	22.Putra Mosque	23.Bokhary Mosque	24.Abdulrahman Sadik Mosque	25.Tuanku Mizan Zainalabdin Mosque	26.Islamic center & Mosque of Rome	27.King Khaled Mosque	28.Mosque & Islamic center of Regen	29.Al Mukminin Mosque	30.Baitunur Mosque	Percentage
Approaches	**Design approach**																															
	Traditional/Vernacular Approach														●		●			●												10%
	Conservative/Conventional Approach										●			●																		7%
	Adaptive Appraoch				●	●			●	●		●	●					●							●		●	●	●			37%
	Contemporary/Modern Approach		●	●			●	●								●			●							●				●	●	30%
	Post Modern/Hi Tech Approach	●																			●	●	●	●								17%
	Eco Green Approach																			●												3%
	Eco Tech Approach	●										●																				7%
	More than One Approach	●																														7%
Functional Values	**Architetcural Elements**	●		●	●		●	●	●					●		●										●		●	●		●	40%
	1.Prayer Space																															0%
	2.Mihrab			●	●											●												●				13%
	3.Minbar				●																											3%
	4.Minaret			●	●			●	●					●												●		●	●	●	●	30%
	5.Portal	●		●			●	●						●																		17%
	6.Ablution							●																								0%
	Structural Elements	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●		●	●		●	●	●	●	●	●	●	●	●	●	●	93%
	1.Domes	●			●	●	●		●	●	●	●						●	●		●	●	●	●	●	●	●	●	●		●	67%
	2.Arches											●		●							●		●	●		●	●					23%
	3.Vaults																				●		●	●		●						3%
	4.Roofs		●									●	●	●	●	●		●												●		27%
	5.Stairs	●										●														●						10%
	6.Columns	●	●	●	●		●	●						●		●		●	●		●		●	●		●	●			●	●	57%
	Materials																															
	1.Brick Work/Mud Brick													●	●		●	●									●					17%
	2.Stone/semi precious stone	●	●	●	●				●		●			●		●		●		●				●	●							40%
	3.Marble	●					●				●	●	●	●		●			●	●				●			●	●				40%
	4.Wood Work/Timber	●	●		●						●	●	●	●	●	●	●		●	●	●	●	●	●	●			●				60%
	5.Metal Work/Metal Grilles				●									●					●		●			●	●							20%
	6.Tiles/Glazed Tiles/Mosaics/ceramic												●	●		●		●			●	●	●	●				●				30%
	7.Gypsum/plastering/Stucco												●	●	●			●		●	●			●			●	●				30%
	Illumination & Ventilation	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●	●	97%
	1.Lighting System	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	97%
	2.Ventilation System	●						●				●		●				●								●				●		77%
Tech. in	Functional Values	●	●	●	●	●	●	●	●	●	●	●	●	●		●		●	●	●	●	●	●	●	●	●	●	●	●	●	●	93%
	Aesthetic Values			●	●			●				●														●						17%
	Symbolic Values	●	●	●	●	●		●					●			●		●								●	●					37%
Tehcnologies	**Material Technologies**	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●			●		●	●	●	●	●	●	●	●	●	●	●	90%
	1.Glass	●		●	●	●	●	●	●	●		●		●		●					●	●	●	●	●	●			●	●	●	67%
	2.Reinforced Concrete	●		●	●	●	●	●	●		●		●	●		●			●		●	●	●	●		●	●	●		●	●	70%
	3.Steel/Metal	●	●	●	●			●		●		●		●	●	●			●		●	●	●	●	●	●		●	●	●	●	70%
	4.Fabrics											●	●		●	●																10%
	5.Composites	●			●							●									●	●	●	●								23%
	6.Smart Materials																															0%
	Intelligent Technologies	●										●		●																		10%
	1.Adaptive System	●										●																				7%
	2.Automated System	●										●		●																		10%
	3.Computer Controlled	●										●																				7%
	Computer Aided Technologies	●										●									●		●	●								20%
	1.Control System	●										●									●		●	●								7%
	2.Simulation Softwares	●																			●		●	●								7%
	3.Design & Production																				●		●	●								20%
	Technology Used in Case Studies	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●		●	●		●	●	●	●	●	●	●	●	●	●	●	93%

3.3 Results & Discussions

The previous analysis (table 3.1), determined that 93% of the case studies used technology, (Table 3.2), which varied between 90% of the case studies used material technologies, 10 % used intelligent technologies, and 20% used computer aided technologies, (Table 3.3 & 3.4).

Technology Used in Mosques Case Studies:	
Case Studies used technology	93%
Case Studies didnt use technology	7%

Table 3.2: The percentage of technology used in mosques case studies.

Technology types Used:	
Material Technologies	90%
Intelligent Technologies	10%
Computer Aided Technologies	20%

Table 3.3: The percentage of technology types used in mosques case studies.

Technology Used in Inherited Values:	
Functional Values	93%
Symbolic Values	37%
Aesthetic Values	17%

Table 3.4: The percentage of technology used in the Inherited Values.

The following will show how material, intelligent and computer aided technologies were integrated and affected the inherited values of mosques case studies; functional, aesthetic, spiritual and symbolic values.

- Material Technologies used in the Functional Values.

- Lightweight composite domes fixed on steel structures were used to cover the prayer halls, and Teflon fabrics were used to cover the steel umbrellas used in shading the courtyards, in Prophet's Mosque Expansion. Metal sphere dome coated in Aluminium composite panels were used to cover the prayer hall of Sakirin Mosque, (Fig. 3. 97).

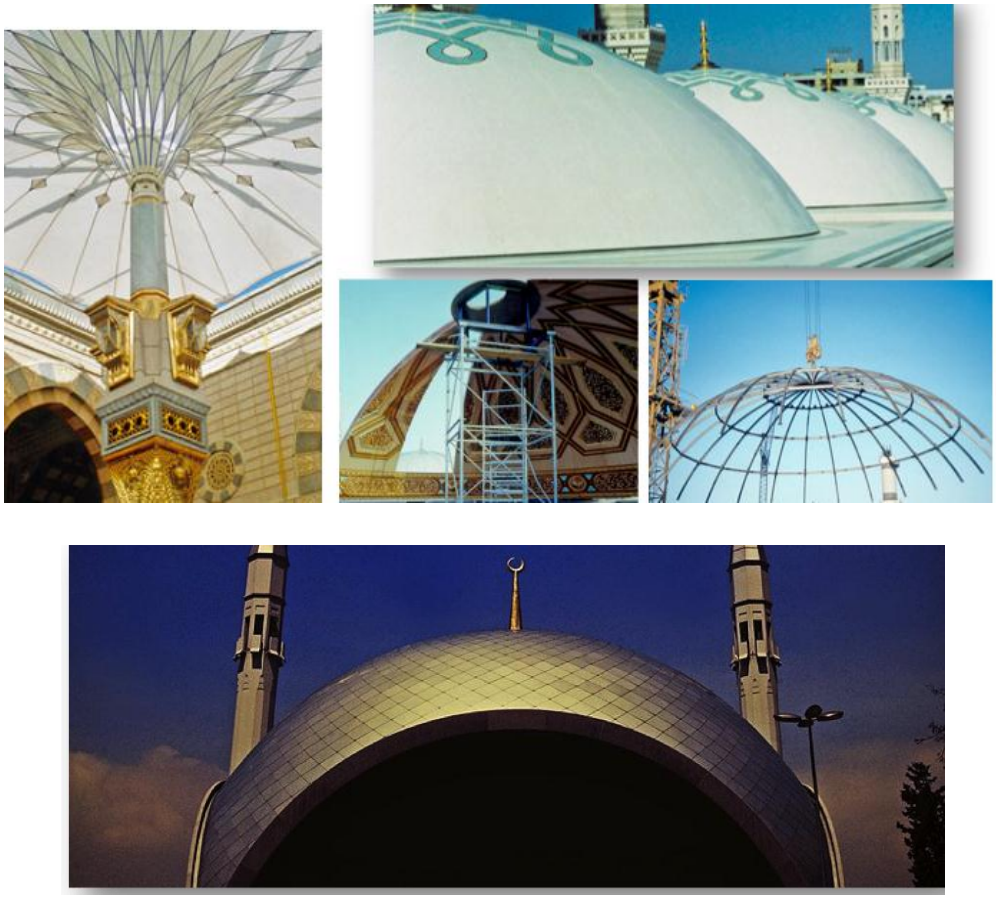


Fig. (3.97): Steel frames, teflon umbrellas, composites materials, and aluminum composite panels used in Prophet's, and Sakirin Mosques, respectively.

- Cast concrete ribbed arches structure were used to offer a large span prayer hall in Assyafah mosque. Stainless steel fixed system was used to support

the natural stone of the facades and domes of Sheikh Zayed mosque. Tinted insulated glass dome with metal fixtures was used to cover the prayer hall of Glass Dome mosque, and ribbed steel dome with blue tinted glass was used in Sami Ali Pasa mosque, (Fig. 3. 98)

Fig. (3.98): Cast concrete, stainless steel structures, ribbed steel dome, materials used in Assyafah, sheikh zayed, glass dome mosque and sami ali pasha mosques, respectively.

- Stainless Steel structures were used for the columns, domes, arches and vaults in most of the spaces in Zainal abdin Mosque. The dome is made of steel and glass; the façade is covered with metal mesh, in Emirates Glass Mosque, (Fig. 3.99)

Fig. (3.99): Stainless Steel structures, and steel and glass façade of zainalabidin and emirates glass mosque, respectively.

- Illuminators of fiber optics were used to decorate the *qibla* wall in Sheikh Zayed mosque. The *qibla* wall is subtly decorated so as not to distract the worshippers, and is lit by 250 EFO illuminators of Fibre optics. The 99 names of Allah are featured on the marble cladding of the *qibla* wall and are back illuminated using fibre lighting. The cable is fixed behind the marble and throws light onto white reflector behind, making the design glows, (Fig. 3.100)

Fig. (3.100): LED Fibre Optic Projector used in illuminating the *qibla* wall, the three versions can be used in end emitting as well as side emitting fiber.

- Materials used to express the spiritual & symbolic values.

- The lighting system concept in sheikh zayed mosque represents symbolically the moon lunar cycle, which is based on the image of a full moon with wisps of cloud moving across its face. Projectors fixed around the mosque are capable of projecting 360 lighting scheme, computerized to change with the full white colour on a full moon, then for 14 days the colour changes from white to cool white to pal blue to mid blue and then all way to deep blue as the moon disappears. Then for the other 14 days as a new moon slowly transforms to a full moon, the illumination reserves all the way back to white. The lighting-control systems automatically retrieve the required sequences; the effect of moving clouds was also animated on the exterior and the clouds direction are drifted from Mecca, (Figs. 3.101, 3.102).

Fig. (3.101): The exterior lighting concept of sheikh zayed mosque.

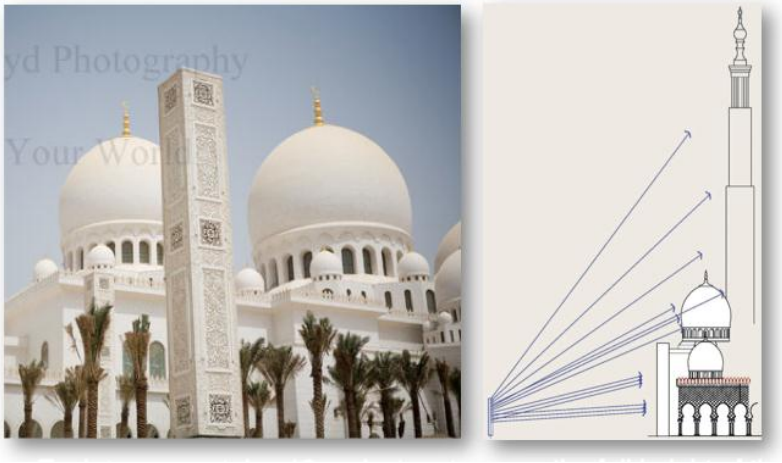


Fig. (3.102): Exterior view of the mosque, showing the projectors towers located around the building.

- The minaret symbolically acts as a silent call to prayer in Glass mosque; its calligraphy represents the words used to call prayer, made of steel plates. Tinted Glass wall was used in the exteriors, in order to reflect transparency and openness. The entrance features two concrete slabs that swing out of the wall like open gates, to welcome the worshippers, (Fig. 3.103)

Fig. (3.103): Exterior view of the mosque, showing steel calligraphy used in the minaret, glass wall, and entrance concrete slabs of glass mosque.

- The concept to achieve transparency, simplicity and airiness, creating spiritual atmosphere inside the praying halls, was maintained by using aluminium screens, glass *qibla* wall and *mihrab,* and stainless steel mesh, in Parlimant, sakirin, assyafah and zainalabidin Mosques, respectively, (Fig. 3.104)

Fig. (3.104): Exterior views showing the materials used in parlimant, sakirin, and al assyafah mosque, respectively.

- The cubic shape of Irsyad mosque symbolically resembles the *Kaaba,* concrete and steel columns were arranged that the façade and the prayer hall seem like they are not supported by any frames, like the *Kaaba.* The form symbolizes the desert tent in Islamabad mosque, the dome was turned into a tent like folded roof, with eight concrete shells, supported on 4 concrete girders, (Fig. 3.105)

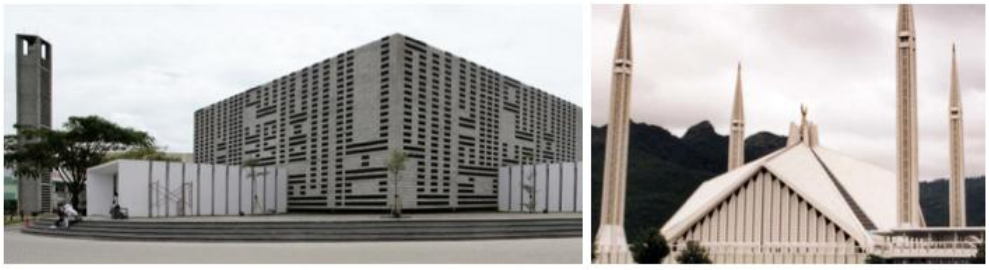


Fig. (3.105): Exterior views showing the forms of Irsyad and Islamabad mosques.

- In cologne mosque, the dome is made of three concrete leaves like as if clasping hands where symbolically religions could meet. In Rome Mosque, columns symbolize the tree, four clustered branches form the arches web, made of prefabricated concrete to form a lamp, which symbolically referring to the verse 'God is the Light of the heavens and the earth, (Fig. 3.106).

Fig. (3.106): Exterior view of cologne mosque, and interior view of the arches and ribs inside the prayer hall of Rome mosque, respectively.

- Intelligent Building Technologies used in the case studies.

- 10 % of the case studies used intelligent technologies, 7% used IT in adaptive systems, 10 % used automated systems, and 7% used IT in computer controlled systems, (Table 3.5), as follows:

Intelligent Technologies Used:	
Adaptive System	7%
Automated System	10%
Computer Controlled	7%

Table 3.5: The percentage of intelligent technologies used in mosques case studies.

- Sliding Domes were incorporated in the courtyard to control AC environment in Prophet's mosque expansion. The domes provide mobile roof that counteract the extreme temperature changes, and control and support the air-conditioned environment of the mosque. Resting on a steel framework on four-wheel carriages, the domes are designed to move on high-grade stainless steel tracks. The non-corrosive wheels have a direct-drive mechanism powered by electric motors that are digitally controlled by the main computer. The domes are made from glass fibre and epoxy resin composite with a thermoplastic foam core. Automated sliding roof opens for natural ventilation and illumination were used in the prayer hall of Hassan II mosque, (Fig. 3.107).

Fig. (3.107): Sliding domes in the courtyard of prophet's mosque, and an interior view of the automated roof in the prayer hall of Hassan II mosque.

- Escalators were incorporated to facilitate the worshippers flow in Sheikh Zayed, Zainal Abdin, and Prophet's Mosques, (Fig. 3.108).

Fig. (3.108): Sliding domes in the courtyard of prophet's mosque, and an interior view of the automated roof in the prayer hall of Hassan II mosque.

- Climate Control Umbrellas were used in the two courtyards of prophet's mosque to control solar radiation absorbed, in summer and minimize heat loss in winter, to protect worshippers while praying. The roof is divided along the middle of the court with each half retracing into a recess above the parallel arcades that run alongside it, which is supported by steel cables, permanently stretched across the opening. The support consists of a tubular truss construction running along both of the longitudinal sides of the courtyard. The hinged bearings of the trusses allow the necessary deflection under the wind loading with counterweights providing the required pre-tensioning. The arms are driver by hydraulic cylinder incorporated into the umbrella mast, making an easily opening in less than a minute; the drive unit automatically shuts off. These umbrellas intended to work in conjunction with mechanical cooling and are connected to a computerized climatic control system of the mosque. Air-conditioning outlets are integrated into each umbrella column, along with the lighting. The translucent, conical forms are made of woven Teflon fabrics. The umbrellas are computerized to close when wind speed exceed 15m/s., (Fig. 3.109).

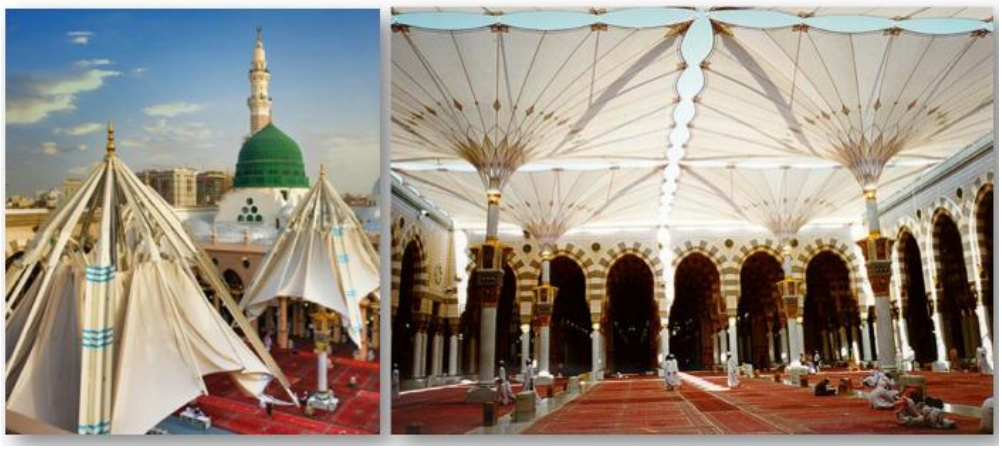


Fig. (3.109): Mechanically operated Teflon umbrellas used in the inner courtyard of the Prophet's Mosque.

- Computer Aided Technologies used in the case studies.

- 20% of the case studies used computer aided technologies, 7% used control systems, 10 % used simulation softwares, and 20% used CA technologies in the design and production, (Table 3.6), as follows:

Computer Aided Tech. Used:	
Control System	7%
Simulation Softwares	7%
Design & Production	20%

Table 3.6: The percentage of Computer Aided technologies used in mosques case studies.

- The composite domes manufacturing process used in Putra, Wilayah, and Prophet's mosque, begins with 3d images of the designs, generated with computer aided three dimensional interactive application for detailed structural analysis before proceeding to model and mould construction. The CAD-CAM approach to design and manufacture enables design data to be fed directly into the production equipment,

increasing reliability and saving time. Composite cladding elements are produced from computer numeric control machined moulds. Five-axis CNC milling machine can precisely generate complex 3-dimensional forms, making it possible to produce curved dome surfaces in two directions as well as complicated architectural elements, like *muqarnas*, (Figure 3.110).

Fig. (3.110): Shots showing the Five-axis CNC milling machine and the manufacturing process of curved dome surfaces.

- The dome installation process of Goktepe mosque, the dome shell is subdivided into large prefabricated panels with trussed steel structures, ready to be installed in site, saving time and cost and high degree of quality control, (Fig. 3.111).

Fig. (3.111): Shots showing the installation process of goktepe mosque dome.

- Building analysis software was used in sheikh zayed mosque in the thermal simulation and analysis of the building, to determine thermal comfort conditions, and optimize HVAC performance and verify building safety. The main idea was to create a natural environment by minimising the air-conditioning requirement and taking advantage of the overall thermal mass of the structure while utilising natural ventilation whenever possible to optimise internal comfort levels. In addition, a series of occupancy safety simulations were incorporated, to examine both real time evacuation and the total egress times, with the effect of smoke build up from a simulated fire within the building. The purpose of the **evacuation** model was to determine how quickly occupants could escape the building, (Fig. 3.112).

Fig. (3.112): Plan & sectional view through the building at high level, showing high speed air induction and air temperature.

- Computer controlled Sound system was used in the prayer hall of sheikh zayed mosque. Sound system of column speakers, high mounted, directional loudspeakers, computer controlled in directivity to minimize sound reflections, different patterns are stored on a memory to allow the system automatically adjust the units according to the numbers of worshippers in the space, even whether they are standing or kneeing, (Fig. 3.113).

Fig. (3.113): The loudspeakers located inside the prayer hall of al sheikh zayed mosque.

- In Wilayah mosque, the fully automated lighting system in the prayer hall utilizes integrated daylight and artificial light that complement and balance each other. An interesting feature is the chandelier suspended below the main dome. Constructed from curved glass, prismatic foils and bi-convex lenses, the 9m chandelier is a unique source of illumination. Through multiple reflections sunlight from the cupola is focused on to the chandelier via a pyramid mirror, to provide diffused and brilliant light that gives depth and three-dimensionality to the space. Natural daylight is also reflected into the upper areas by re-directional lamellae located at the dome windows. Made of highly reflective material, the lamellae automatically rotate along the longitudinal axis to track the sun's position at different times of the day. A computerized control system receives information on weather conditions from external solar sensors, translates that data to determine how much artificial light is required, then relays instructions to the remote terminal unit that controls the appropriate light components and appliances inside the mosque, (Fig.3.114).

Fig. (3.114): The lighting system in the prayer hall of wilayah mosque.

- 17 % used Computer Aided Technologies in Aesthetic Values

- Ornamentation designs in prophet's mosque and glass mosque, were made by using computer aided software, which helps in establishing the geometric order of patterns and verses to be generated. The design data can fed directly into the production machine, exploited in a wide variety of different architectural applications, as laser-cut wood marquetry, water-jet cut stone, and 5-axis CNC milling, (Fig. 3.115).

Fig. (3.115): Different ornamentation designs used in mosques, cut by 5-axis CNC milling system.

- Design Approaches used in case studies.

- 37 % of the case studies used adaptive approach, 30 % used contemporary/Modern approach, and 17% of the case studies used post-modern/hi tech approach, (Table 3.7).

Design Approach :	
Traditional/Vernacular Approach	10%
Conservative/Conventional Approach	7%
Adaptive Appraoch	37%
Contemporary/Modern Approach	30%
Post Modern/Hi Tech Approach	17%
Eco Green Approach	3%
Eco Tech Approach	7%

Table 3.7: The percentage of design approaches used in mosques case studies.

3.4 Summary

- This chapter Analyzed thirty mosques case studies based on the inherited values of the traditional mosque and the technologies of the 20th and 21st centuries.

- The study realized that mosques designs conform strictly to traditional constraining models with all of the usual components; mosques are celebrated in architecture with material wealth and physical comfort, rather than a concern for aesthetic emotions or the compulsion for spiritual contemplation, which are the main essence of Islam. Technology had an impact in changing, adding and developing mosques architecture, mainly focusing on the materialistic and functional values.

Chapter Four

4.1 Conclusions

– The study realized that mosques designs conform strictly to traditional constraining models with all of the usual components, mosques are celebrated in architecture with **material** wealth and physical comfort, rather than a concern for aesthetic emotions or the compulsion for **spiritual contemplation**, which are the main essence of Islam.

– Technology affected architecture of the 20^{th} and 21^{st} centuries by **material technologies**, **intelligent building technologies** and automated control systems, and by the digital representation of using **computer aided technologies.** Technology had an impact in changing, adding and developing mosques architecture, mainly focusing on the materialistic and functional values, which can be classified as follows:

- **Material Technologies.**

  - Lightweight composite domes fixed on steel structures, teflon fabrics, metal sphere dome coated in aluminium composite panels, cast concrete ribbed arches structure, and ribbed steel dome, were used to cover the prayer halls.

  - Green tinted insulated glass was used in dome structures with metal fixtures, aluminum screens built from modules hung on steel frames, prefabricated concrete, and stainless steel fixations for stone facade and dome, were used in mosques.

  - Illuminators of fiber optics illuminators were also used in the decorations inside the mosque.

– Materials were also used to express the spiritual and symbolic values inside the mosque. The concept to achieve transparency, simplicity and airiness, creating spiritual atmosphere inside the praying halls, was maintained by using aluminium screens, glass *qibla* wall and *mihrab,* and stainless steel mesh.

- Intelligent Building Technologies used in the Inherited Values.

- Sliding Domes were incorporated in the courtyard to control AC environment. The domes provide mobile roof that counteract the extreme temperature changes, and control and support the air-conditioned environment of the mosque. Automated sliding roof opens for natural ventilation and illumination.

- Climate control umbrellas were used also in the courtyards to control solar radiation absorbed, in summer and minimize heat loss in winter, to protect worshippers while praying. The umbrellas are computerized to close when wind speed exceed 15m/s.

- Columns act as conduits for mechanical ventilation system, and lighting fixtures.

- Escalators were incorporated to facilitate the worshippers flow.

- Computer Aided Technologies used in the Inherited Values.

- The composite domes manufacturing process begins with 3d images of the designs, generated with Computer aided three dimensional interactive application for detailed structural analysis before proceeding to model and mould construction. The CAD-CAM approach to design and manufacture enables design data to be fed directly into the production equipment, increasing reliability and saving time.

- Building analysis software was used in the thermal simulation and analysis of the building, to determine thermal comfort conditions, and optimize HVAC performance and verify building safety.

- Computer controlled sound system was used in the prayer halls, sound system of column speakers, high mounted, directional loudspeakers, computer controlled in directivity to minimize sound reflections, the system automatically adjust the units according to the numbers of worshippers in the space, even whether they are standing or kneeing.

- A computerized control system receives information on weather conditions from external solar sensors, translates that data to determine how much artificial light is required, then relays instructions to the remote terminal unit that controls the appropriate light components and appliances inside the mosque.

- Ornamentation designs in some mosques, were made by using computer aided software, which helps in establishing the geometric order of patterns and verses to be generated.

- Design Approaches used in case studies.

– 37 % of the case studies used adaptive approach, 30 % used contemporary/Modern approach, and 17% of the case studies used post-modern/hi tech approach.

- Studying and identifying mosques' key concepts and principles derived from *quran* and *hadith*, and the historical development of mosques concluded that:

- Islamic Values are assumed to be intellectual base of Islamic art and architecture, but they are not dominating the scene in the Islamic world. The values of privacy, simplicity, the use of abstraction and others are not driving the design decisions. Architects/Designers rather copy some

forms with old functions, as domes, minarets, stalactites, and arches, with no need for such functions. What became symbols of Islamic Architecture are not genuinely Islamic.

- The specific liturgy and functional requirements derived from quran and hadith did not dictate any particular architectural and physical layout. Thus architects are bounded only by their imaginations in the designs they can propose. If some of them preferred to return back to the classical trends, this has been by choice rather than limitation. The conceptual features of the mosque that could serve as design principles can be sorted to:

  1. **Cleanness of space**; The space defining the mosque has to be suitable for prayer – clean as one prostrates with his face in this surface.

  2. **Directionality**; The only required visual engagement for praying is to be oriented towards the *qibla*.

  3. **Rows of prayer**; The Prophet (pbuh) said, "Straighten your rows as the straightening of rows is essential for a perfect and correct prayer"

  4. **Prayer space**; Wherever you pray, that place is a mosque," and, "I have been given the whole earth as a sanctuary" raise a question about how the mosque should look like, and remains an intriguing phenomenon that is at once simple and complex.

  5. **Multiuse of space;** The idea of the mosque is not only about a building meant for a single ritual worship act, but more of a kind of social centre.

- The inherited values of mosques design can be classified as: Functional Values (Architectural/Structural elements, materials, and illumination and ventilation), Aesthetic Values and Symbolic Values.

4.2 Recommendations

- To develop a modern theory of mosques architecture, functional, aesthetic, and symbolic values need to be balanced, as they are equally important, in order to create sacred qualities.

- An adaptive and contemporary/modern approaches should take into account the needs and aspirations of the worshippers. The choice of technology, to be appropriate, must depend on the conditions of a particular region and culture, rather than imitating past styles.

- Understanding mosques' architecture, the Islamic values, meanings and limitations annotated from the *quran* and the *hadith* will definitely facilitate and frame the final design.

- A detailed analysis focusing technically on the new materials and construction techniques used in mosques should be provided in comparison to the traditional ones.

- Attention should be driven towards an appropriate architectural documentation of mosques.

- **Special Recommendation for Future Studies:** The projection mapping and the new art of illusion, could lead to the concept of a virtual mosque. This idea was used in sheikh zayed mosque; ornaments were projected on plain white stone cladding, creating changeable & moving decorations that illuminate the façade, (Fig. 4.1).

Fig (4.1): Exterior view of Sheikh Zayed mosque, Abu Dhabi, Emirates. (Source: http://www.barrythrew.com/projects/shiekh-zayed-grand-mosque-architectural-projection-mapping/. Web. 8 March 2012.)

Reference List

Books:

Abu Seif, Doris. *Islamic Architecture in Cairo*. Netherlands: Leidene E.J Brill, 1992.

Allievi, Stefano, *Conflicts over Mosques in Europe: Policy issues and trends.* United Kingdom: Alliance publishing trust, 2009.

Arkoun, Mohammed, Cynthia C. Davidson, & Serageldin, Ismail (Eds.). *Architecture Beyond Architecture: Spirituality and Architecture.* London: Academy Editions, 1995.

Brown, P., *Indian Architecture: Islamic Period.* Fifth Edition, Bombay: Taraporevala, 1968.

Brownell, B., *Material Strategies: Innovative Applications in Architecture.* Princeton Architectural Press, 2011.

Creswell, Keppel A., *EMA I: Early Muslim Architecture*. Oxford: Clarendon Press, Volume I, 1932.

Davies, Colin. *High Tech Architecture.* London: Thames and Hudson Ltd., 1988.

Dogan, Kuban. *The mosque and its Early Development,* part I, Netherlands: Leidene E.J Brill, 1974.

Dogan, Kuban. *The mosque and its Early Development*, part II, Netherlands: Leidene E.J Brill, 1985.

Fethi, Ihsan (Au.) & Cantacuzino, Sherban (Ed.). *Architecture in Continuity*: *The mosque today*. New York: Aperture, 1985.

Frishman, Martin & khan, Hasan-uddin (Eds.). *The mosque; history, architectural development and regional diversit.*, London: Thames & Hudson, 1994.

Hattstein, Markus & Delius, Peter (Eds.). *Islam, Art and Architecture*. Cairo: American university press, 2007.

Hillenbrand, Robert. *Islamic Architecture: Form, Function and Meaning*. New York: Columbia university press, 1994.

Hoag John D., *History of World Architecture: Islamic Architecture*, Academy Editions Ltd, 1979.

Hoag John D., *Western Islamic Architecture*. New York: George Braziller, 1963.

Holod, Renata & khan, Hasan-Uddin. *The Contemporary Mosque: architects, clients and designs since 1950s.* New York: Rizzoli International Publications, 1997.

Ibrahim, Abd El Baki, and Center of Planning and Architecture Studies. *Principles of Architectural Design and Urban Planning during Different Islamic Eras*. Cairo: Organization of Islamic Capitals and Cities, 1992.

Kazimee, Bashir A., & Rahmani, Ayad B., *Place, Meaning and Form in the Architecture and Urban Structure of Eastern Islamic Cities*, Volume II, New York: Edwin Mellen Press, 2003.

Kurdi, Obaid allah A. *The Holy Ka'bah and the Holy Mosques: Construction and History*. Saudi Arabia: The Saudi Bin Ladin Group, 2002.

Michell, George (Ed.). *Architecture of the Islamic World: Its History And Social Meaning*. London: Thames and Hudson Ltd, 1978.

Moanes, Hussein. *The mosques.* Kuwait: National Culture, Arts and Literature Community, 1978.

Petruccioli, Attilio & Pirani, Khalil K. (Eds.). *Understanding Islamic Architecture*, London: Routledge/Curzon, 2003.

Piotrovosky, Mikhail B., *Art of Islam: Heavenly Art Earth Beauty*. Amsterdam: Lund Humphries, 2000.

Prochazka, Amjad B., *Introduction to Islamic Architecture.* Zurich: MARP Publications, 1986.

Serageldin, Ismail & Steele, James (Eds.). *Architecture of the contemporary mosque*. Great Britain: Academy Editions, 1996.

Slessor, Catherine. *Eco-tech: Sustainable Architecture and High Technology*. New York: Thames and Hudson, 1997.

Steele, James & Badran, Rasem (Eds.). *The Architecture of Rasem Badran: Narratives on People and Place.* New York: Thames and Hudson, 2005.

Stierlin, Henri. *Islam: Early Architecture from Baghdad to Cordoba*. Volume I, Italy: Taschen, 1996.

Stierlin, Henri. *Encyclopedia of World Architecture*. London: Macmillan Press, 1983.

Yeomans, Richard. *The Story of Islamic Architecture.* Garnet Publishing Ltd, 1999.

Zellner, Peter. *Hybrid Space: New Forms in Digital Architecture*. New York: Rizzoli International, 1999.

Thesis & Dissertations

Buhlfaia, Saeid A., "Historical Background of Libyan Mosque Architecture: Assessment and Criticism of Mosques in Ajdabiya City." Msc. Dissertation, Technical University of Middle East, 2006.

Chinchilla, Najahyia L., "Converging Identities: Islamic Architecture in Detroit." Msc. Dissertation, University of Maryland, College Park, 2007.

Khachan, Lucie G., "Form and Function of Northeast Ohio Mosques." Msc. Dissertation, University of Akron, 2008.

Urey, Ozgur. "Use of Traditional Elements in Contemporary Mosque Architecture in Turkey." Msc. Dissertation, Technical University of Middle East, 2010.

Shyqeriu, Banush. "Synergic Spaces – Mosque." Msc. Dissertation, Anhalt University of Applied Science, Germany, 2009. 17 April 2009. Web. August 2011.

Conference & Symposium Proceedings

Abdou, Adel A. "The Impact of Cyberspace and Globalization on the Future of Architecture." *The 6th Saudi Engineering Conference, Dhahran*, vol.1, 2002.

Turchiarulo, Mariangela. "Building Styles Brought to Egypt by the Italian Community Between 1850 and 1950: The style of Marrio Rrossi." *Proceedings of the third congress on construction history*. Cottbus, Germany, May 2009.

Javad Sadeghi, Mohammad, J. "The Function of Smart Material's behavior in architecture." *International Conference on Intelligent Building and Management Proc. of CSIT*. Vol.5, 2011. IACSIT Press, Singapore, pp.317-322.

Papers

Al-Tassan, Abdurrahman & Bahobail, Mohammed. "Mosques and Sustainable Traditional Technique." College of Architecture and Planning, King Saud University, Saudi Arabia.

Journals

El-Demery, Ibrahim M., "Globalization Challenges in Architecture." *Journal of Architectural and Planning*, 26:4 (Winter, 2009), pp.343-355.

El-Shorbagy, Abdel-Moniem. "Hassan Fathy: the unacknowledged conscience of the twentieth century architecture." *International Journal of Basic and Applied Sciences,* 10(2).

Gottheil, Richard J. H., "The Origin and History of the Minaret." *Journal of the American oriental society.* Volume 30, no. 2, Published by: American Oriental Society, 1910, pp.132-154.

Itewi, Mahmoud. "Towards a modern theory of Islamic architecture." *Australian journal of basic and applied sciences, 1(2),* 2007.

Khan, Hasan-Uddin. "Contemporary mosque architecture." *Space and Architecture,* Review 21, 2008.

Mahdavinejad M., Matoor, S. & Doroodgar, A., "Recognition of light-openings in Iranian mosques' domes with reference to climatic properties." *International Journal of Architectural Engineering & Urban Planning*. Vol. 21, no. 2, December 2011, pp.61-68.

Rasdi, Mohamad T., "Muslim architecture in Malaysia: Classification of Styles and Possible Influence." *Journal Alam Bina*, volume 9 (3), faculty of built environment, University Teknologi, Malaysia, 2007, pp. 1-37.

Online Documents

AACE Worldwide Pty. Ltd. "Auto Wudu Washers: Islamic pre-prayer ablution system." *AACE Technologies*, 2006. Web. December 2009 <http://www.aace.com.my/wuduwasher.htm>.

"Adaptive and Dynamic Buildings – The Future of Environmental Design & Architecture." *Arch Daily*. 10 August 2010. Web. 19 April 2012. < http://www.archdaily.com/71450/adaptive-and-dynamic-buildings-–-the-future-of-environmental-design-architecture/>

Antonie Robertson. "Entries in Abdul Rahman Siddik Mosque on Palm Jumeirah Island." *The Culturist.* 16 August 2011. Web. 27 March 2013. < http://www.theculturist.com/home/tag/abdul-rahman-siddik-mosque-on-palm-jumei>

"Architecture Design, Assyafaah Mosque in Singapore." *Nikiomahe.* 18 March 2008. Web. 18 October 2010. <http://www.nikiomahe.com/architecture-design/assyafaah-mosque-singapore/>

"Auto Wudu Washers." *AACE WORLDWIDE*. Web. 30 January 2008. <http://aace.com.my/wuduwasher.htm>

Australian Institute of Architects. "New Digital Technology Set to Revolutionize Architectural Practice". April 2007. Web. June 2011. <http://www.architecture.com.au/i-cms?page=9281>

"Assyafaah Mosque in Singapore." *Architecture Design News.*

"A Small, Modern and Pioneer work of art: Sakirin mosque." *Istanbul.com.* 12 March 2010, 28 September 2010 <http://www.istanbul.com/inistanbul>

Barbara A. Nadel. "21st Century Building Envelope Systems: Merging Innovation with Technology, Sustainability, and Function." *Continuing Education Center*. August 2006. Web. 17 April 2012. < http://continuingeducation.construction.com/article.php?L=38&C=235 &P=2>

"Case Study IES Revit Integration". *Integrated Environmental Solutions*. 2009. Web. 20 April 2012. <http://www.iesve.com/case_ studies/pdf/ies_case_study_grand_mosque__single_pages_.pdf>

Caline Malek. "Palm Jumeirah mosque has unique design." *The National.* 24 July 2012. Web. 27 March 2013. < http://www.thenational.ae/news/uae-news/palm-jumeirah-mosque-has-unique-design>

Catheon, S. "Green design will save the world, Green Mosque Wins Best Religious Structure Award." *Inhabitat*, 11 October 2010. Web. 15November 2010, Copyright © 2010 Faith in Place. <http://inhabitat.com/2010/11/11/green-mosque-wins-best-religious-structure-award/>.

"Chandgaon Mosque." *Aga Khan Award for Architecture*. Web. 15 October 2010. < http://www.akdn.org/architecture/project.asp?id=3503>

Cilantro, Karen. "Mosque Proposal/studioZ." *Arch Daily*, 16 April 2010. Web. 4 September 2010 < http://www.archdaily.com/56689/mosque-proposal-studioz/>.

"Cologne Central Mosque." *Wikipedia.* Web. June 2011.<http://en.wikipedia.org /wiki/Cologne_Central_Mosque>

"Composite domes, Astelco Dome." *Premiere Composite Technologies*. Web. 20 April 2012. <http://www.pct.ae/composite_projects.php?project=25>

"Converible Textile Roofs." *Sl-Rasch GMBH*. Web. 20 December 2011. <http://www.sl-rasch.de/ >

"Eco mosque." *EMEL Magazine*, issue 57, June 2009. Web. August 2010 < http://www.emel.com/article?id=58&a_id=1383>.

"Faisal Mosque." *ArchNet.* Web. November 2010. <http://archnet.org/library /sites/one-site.jsp?site_id=864>

Forum architects. "Assyafaah Mosque, Singapore." *Architecture-Page.* 17 October 2006, 18 October 2010 < http://www.architecture-page.com/go/projects/assyafaah-mosque-singapore>.

Fritz, Susanne. "Media Façade, A new form of art in architecture." *Archi Tonic*. Switzerland. Web. 20 April 2012. < http://www.architonic.com /ntsht/media-faade/7000408>

"FRP Façade For RAK Gateway." *Premiere Composite Technologies*. Web. 20 December 2011. <http://www.pct.ae/composite_projects.php?project=18>

Glancey, Jonathan. "Building with Light:Speirs and Major's architectural approach to lighting goes beyond fixtures and foot-candles." *Metropolis magazine.* 16 December 2009, web. September 2010 <http://www.metropolismag.com/story/20091216/building-with-light>

"Glass Dome Selimiye Mosque." *Archello.* Haarlem, Netherlands. 24 February 2011. Web. 10 March 2011. <http://www.archello.com/en/ project/glass-dome-selimiye-mosque/201002>

"Grand National Assembly Mosque." ArchNet. Web. November 2010. < http://archnet.org/library/sites/one-site.jsp?site_id=1028>

Graph Paper Press. "Ray of Light Mosque." *ZEST architecture*, content © 2010 by zest architecture. Web. November 2010. <http://zestarchitecture.com/ray-of-light-mosque4>

"Great Mosque of Riyadh and the Old City Center Redevelopment." *ArchNet.* Web. November 2010. <http://archnet.org/library/sites/one-site.jsp?site_id=3303>

Gwodzik, David. "The Glass Mosque – A Landmark for Future Generations." January 2007, web. June 2010 < http://www.global-expat-counseling.com/pdf/p20.pdf>

Hadid, Zaha architects. "Contemporary Islamic projects, Strasbourg Mosque." *Victoria and Albert Museum*, Web. February 2009 < http://www.vam.ac.uk/collections/architecture/architecture_features/alternating_currents/contemporary/mosque/index.html>.

"High-tech architecture." *Wikipedia.* December 2008. Web. 20 December 2011. < http://en.wikipedia.org/wiki/High-tech_architecture>

Irani. "Sustainable Mosque with Wind Turbine Minarets and Latticed Roof."*Eco Friend, 26* December 2005. Web. 4 September 2010 < http://www.ecofriend.org/entry/sustainable-mosque-with-wind-turbine-minarets-and-latticed-roof/>.

"Istiqlal Mosque." *ArchNet.* Web. November 2010. < http://archnet.org/library/sites/one-site.jsp?site_id=975>

"Is your mosque an Eco mosque?." *Islamic Foundation for Ecology and Environmental Sciences*. Web. 10 December 2010 <http://ifees.org.uk/index.php?option=com_content&task=view&id=58&Itemid=56>.

Jolly, Anupam. "*Eco Tech: Architcteure to Witness a revolution with the development of smart materials."* 7 September 2009. Web. 24 April 2012. <http://www.ecofriend.com/entry/eco-tech-architecture-to-witness-a-revolution-with-the-development-of-smart-materials/>

Jones, Dorian. "Istanbul skyline gets woman's touch." *BBC News*, Istanbul. 29 September 2008, 26 October 2010 <http://news.bbc.co.uk/2/hi/7636142.stm>

"*Kaaba Stairs, Al Haram Mosque in Mecca, Saudi Arabia*." *Sl-Rasch GMBH*. Web. 20 December 2012. <http://www.sl-rasch.de/ >

Kamarul, Nurfadhilla. " Singapore's first eco-friendly mosque." *Channel News Asia*. 14 May 2009, web. 20 September 2010 <http://www.channelnewsasia.com/stories/singaporelocalnews/view/429210/1/.html>

Kash, Cheong. "Singapore Mosques get Modern to keep up with times." *Thomson Reuters*. 18 Feb 18 2009, web. 20 September 2010 <http://in.reuters.com/article/idINIndia-38074320090218>

King, Rawlson O. "What Are Intelligent Building Technologies?" *Electronic Design.* 29 June 2006. Web. 2 February 2012. <http://electronicdesign.com/article/communications/what-are-intelligent-building-technologies-12853>

Mankani, Zain. "Sheikh Zayed Mosque, white pearl of the Arabian gulf."*ARCHI TIMES*. ISSN No. 2073-9001. Web. October 2010 < http://www.archpresspk.com/Aplusi19_Mosque.htm>

"Martin: Grand Mosque." *The Reference*. 24 August 2009, Web. 4 September 2010 < http://www.thereference-online.com/martin-grand-mosque>

Meinhold, Bridgette. "Ground Zero Mosque to be first LEED-Certified Mosque." *Inhabitat*, 23 August 2010. Web. 17 October 2010 < http://inhabitat.com/2010/08/23/ground-zero-mosque-set-to-be-1st-leed-certified-mosque-in-country/>.

Mok, Kimberley. "Cambridge Uk Site of Europe's First Eco-mosque*." Tree Hugger*, Montreal, Canada, 12 July 2010. Web. 23 July 2010 < www.treehugger.com/files/2010/07/cambridge-uk-europe-first-eco-mosque>.

"New digital technology set to revolutionize architectural practice." *Australian Institute of Architects.* 11 April 2007. Web. 2 February 2012. <http://www.architecture.com.au/i-cms?page=9281>

Oliver Ephgrave. "Spine Mosque." *Constructionweekonline.com.* 28 April 2012. Web. 27 March 2013. < http://www.constructionweekonline.com/article-16665-spine-mosque/#.UVM7z80gsh8>

"PA-system at Dubai Metro Station." *Odeon Room Acoustics Software*. Web. 19 April 2012. <http://www.odeon.dk/pa-system-dubai-metro-station#>

"Pennsburg Mosque Gather Architectural Awards." *World Arab, Architecture, Art and Design*. 18 November 2010, web. 25 October 2010. < http://www.worldarab.net/content/penzberg-mosque-gather-architectural-awards>

"Premiere Composites for Architecture, Challenging the form of New Buildings." *Premiere Composite Technologies*. Web. 20 April 2012. <http://www.pct.ae/architectural_composites.php?section=27>

"Project in Detail, DOGRAMACIZADE ALI PASA MOSQUE." *World Buildings Directory*. Web. January 2011. <http://www.worldbuildingsdirectory.com/project.cfm?id=1469>

"Prophet's Holy Mosque in Madinah: 27 Sliding Domes for the Prophet's Holy Mosque in Medina." *Premiere: Composite Technologies llc*, Web. 4 December 2010. <http://www.pct.ae/composite_projects.php?project=9>

Quetteville, Harry. "Go-Ahead for Germany's Biggest Mosque." *The Telegraph*. 29 August 2008. Web. July 2011. <http://www.telegraph.co.uk/news/worldnews/europe/germany/2645403/Controversial-mosque-gets-go-ahead-in-Germany.html >

Saieh, Nico, "Al-Irsyad Mosque / Urbane." *Arch Daily*.10 October 2010. Web. 20 November 2010. <http://www.archdaily.com/87587/al-irsyad-mosque-urbane/>.

Saieh, Nico. "Chandgaon Mosque / Kashef Mahboob Chowdhury." *Archdaily*. 5 October 2010. Web. 20 October 2010. <http://www.archdaily.com/81700/chandgaon-mosque-kashef-mahboob-chowdhury/>

Saoud, Rabah. "Sheikh Zayed great Mosque in Abu Dhabi: Islamic architecture in the 21st century." *World Muslims Intellectuals Forum*. 10 April 2008, web. 22 July 2009 <http://www.wmif.org/islamic%20civilization_36.htm>

Saieh, Nico. "Dubai Mosque competition: The Mosque Category for Design as Reform Competition in Dubai", *ArchDaily*, 16 July 2010. Web. 22 November 2010 < http://www.archdaily.com/68953/mantle-daniel-andersson-christiane-flugel/>.

"Sandwich Composites." *Architecture of Composite Materials*. pp. 51-59. Web. 20 April 2012. <http://www.compomechasia.com/IMG/pdf/BehaviourChapter_03-2007.pdf>

"Sheikh Zayed Grand Mosque Tour Information." *Abu Dhabi Tourism Authority*. 2009-2010, web. 7 October 2010 <http://www.abudhabitourism.ae/en/portal/main.navigationen/portal/eservices/zayed.mosque.aspx>

"Sheikh Zayed Grand Mosque, IES consulting case study." *Integrated*

Environmental Solutions. 2009. Web. July 2010. <http://www.iesve.com/consultancy/showcase/1943/Grand+Mosque>

"Sheikh Zayed Bin Sultan Al Nahyan Mosque, Abu Dhabi, UAE." *Speirs+ Major associates.* 2009-2010, Web. October 2010 <http://www.speirsandmajor.com/>

"Sliding Domes, Medinah." *Dk composites.* Web. 5 December 2010. <http://www.dkdomes.com/p3_medina%20main.htm>

"SOFT SOUND® Acoustic Panels." *The Online Source for Soundproofing and Acoustic Products*. Web. 20 April 2012. <http://www.soundprooffoam.com/soft-sound-acoustic-panels.html>

"Solving speech intelligibility in mosques using modern technology" *Soliflex.* Web. 10 March 2012. <http://soliflex.se/wp-content/uploads/2010/03/mosquesound_white-paper.pdf>

Teo, Angie. "Muslim washing rite goes hi-tech with *wudu* machine." *Reuters.* 31 January 2010, web. 25 November 2010 <http://www.reuters.com/article/idUSTRE6100FM20100201>

"The Sultan Qaboos Grand Mosque." *Ministry of Information Sultanate of Oman.* Web. March 2011. http://www.omanet.om/english/Relegious/grandmosq.asp

"The Sultan Qaboos Grand Mosque, Mascat, Oman." *Blog*. 23 January 2011. Web. March 2011. <http://everythingspossible.wordpress.com/2011/01/23/the-sultan-qaboos-grand-mosque-muscat%C2%A0oman/>

Trabelsi, Habib. "Sumptuous Abu Dhabi mosque attracts tourists." *TheBruneiTimes*. 5 March 2008, web. October 2010 <http://www.bt.com.bn/focus/2008/03/05/sumptuous_abu_dhabi_mosque_attracts_tourists>

"Umbrellas." *Sl-Rasch GMBH*. Web. 20 December 2011. <http://www.sl-rasch.de/ >

Watson, Ivan. "In Turkey, Mosque Gets a Woman's Touch." *NPR News.* 21

October 2008, web. 25 October 2010 <http://www.npr.org/templates/story/story.php?storyId=95940942>

Yalman, Suzan. "The Art of the Mamluk Period (1250–1517)." *In Heilbrunn Timeline of Art History*. New York: The Metropolitan Museum of Art, October 2001, Web. September 2010 <http://www.metmuseum.org/toah/hd/maml/hd_maml.htm>

Zecher, Francisca. "The Transparent Penzberg Mosque: No Longer in the Backyard." *Deutsche Welle / Qantara.de 2008*, web. October 2010. <http://www.qantara.de/webcom/show_article.php/_c-478/_nr-763/i.html>

"20- Nineteenth-Century Religious Architecture." Web. November 2011. <http://web.mit.edu/4.614/www/h20.html>.

الخلاصة

يخلص البحث الى مجموعه من النتائج و التوصيات اهمها ما يلى:

لقد اظهرت الدراسه النظريه و التحليليه للمساجد ما يلى:

- ادركت الدراسه ان نماذج المساجد تميل الي الطابع التقليدي مع استخدام احدث المواد والتقنيات لتحقيق الراحه للمصلين، وعدم الاهتمام بالقيم الجماليه، والقيم الرمزيه والروحيه، التي تعبر عن جوهر الاسلام.
- ساهمت التكنولوجيا الحديثه فى ادخال بعض العناصر والمفردات والتقنيات الحديثه لعماره المسجد، وذلك باستخدام تكنولوجيا المواد، التكنولوجيا الذكيه، والتكنولوجيا الرقميه.
- القيم الموروثه لتصميم المسجد تتلخص في القيم الوظيفيه، القيم الجماليه، والقيم الرمزيه والروحيه.
- ٩٣% من المساجد استخدمت التكنولوجيا فى مواد بناء و انشائيه حديثه، ١٠% من المساجد استخدم فيها التكنولوجيا الذكيه و٢٠% من المساجد استخدمت التكنولوجيا الرقميه سواء فى انظمة تحكم داخل المسجد او خلال عمليه التصميم و التنفيذ.

التوصيات :

- لتطوير النظريه الحديثه لعماره المسجد يجب الاخذ في الاعتبار المحددات الوظيفيه، الجماليه والروحيه بشكل متوازن، ويجب على المعمارى فهم القيم الاساسيه لتصميم المسجد بدلا من النسخ.
- يجب الاستفاده من التكنولوجيا الحديثه فى البناء للحصول على حلول معماريه مبتكره تخدم الفكره التصميميه و تحقق راحه للمستخدمين.
- جاءت هذه الدراسه كبدايه رصد لتأثير التكنولوجيا على قيم و مفردات المسجد و تطور الاتجاهات التصميميه و لذلك فانه من الضروره استكمال مزيد من الدراسات و ايضا يجب الاهتمام بعمل توثيق معمارى للمساجد.
- تفتح الرسالة مجال البحث في دراسه تفصيليه على مواد البناء و الانظمه الانشائيه التى ادخلت علي عماره المسجد فى ظل عصر التكنولوجيا.

الباب الثانى: تطور الاتجاهات التصميميه و تكنولوجيا عمارة المسجد فى المجتماعات الاسلاميه والغير اسلاميه

يعرض هذا الباب خصائص و تطور مناهج تصميم المسجد واثر النماذج الغربيه على مفاهيم التصميم فى المجتمعات الشرقيه. و يركز هذا الباب على خصائص و مفاهيم التكنولوجيا الحديثه وعمارة المسجد وسوف يلقى بعض الضوء على تقنيات العماره الرقميه بالاضافه الى اهم التطبيقات الحديثه فى القرن الواحد و العشرين الملائمه للاستخدام فى تصميم المسجد.

الباب الثالث: دراسه تحليليه لنماذج مساجد القرن العشرين و الواحد و العشرين

يقدم هذا الباب دراسه تحليليه لنماذج مساجد نفذت فى نهاية القرن العشرين وبداية القرن الواحد والعشرين من حيث الفكر والاتجاه التصميمى والمفردات ولبقيم الوظيفيه والجمالبه والرمزيه من أجل توضيح الثوابت والمتغيرات وتخيل صورة مستقبلية لعمارة المساجد.

الباب الرابع : النتائج والتوصيات

يعرض هذا الباب النتائج التي تم استنباطها من الدراسه النظرية والتحليلية السابقه كما يقترح بعض التوصيات للابحاث المستقبليه في هذا المجال.

مجال ومحددات البحث :

يناقش البحث دور وتأثير التكنولوجيا الحديثه في تطوير أساليب ومفاهيم تصميم المسجد. يركز البحث على دراسة المسجد كفراغ للصلاه، وسيتم اختيار مساجد ذات أهمية معمارية وتمثيل قوي لنهج من مناهج التصميم. وسوف يستند هذا التحليل على الإطار/ المعايير التي تم مناقشاتها في الفصل الأول، وسيتم تطبيقها على المساجد التي بنيت في غضون العقود الثلاثة الماضية، وذلك خلال الفترة الزمنية بين أواخر القرن العشرين وبداية القرن الواحد والعشرين، في المجتمعات الاسلاميه والغير اسلاميه.

منهجية البحث :

يطبق البحث المنهجيات النظرية والتحليلية لتحقيق الأهداف التي سبق ذكرها.

- سيتم تطبيق المنهجية النظرية على الأهداف ١ و٢، لمعرفة أصول نشأة والتطور التاريخي لعمارة المساجد خلال العصور الإسلامية، فضلا عن القيم التقليديه الموروثة لتصميم المسجد، وايضا تحديد المفاهيم الاساسيه والمبادئ المستمدة من القرآن والحديث، و ذلك في الباب الأول.
- كما سيتم تطبيق المنهجية النظرية على الهدف ٣، لفهم المناهج المستخدمه لتصميم المساجد ، مع وصف خصائص كل اتجاه، سيتم تطبيقها على الأهداف ٤ و ٥ و ٦، لعرض أحدث تطبيقات التكنولوجيا في القرن الواحد و العشرين، و ذلك في الباب الثاني.
- سيتم تطبيق المنهجية التحليلية على الهدف ٧، حيث سيتم تقييم و تحليل المساجد التي بنيت خلال اواخر القرن العشرين و بداية القرن الواحد و العشرين، وذلك باستخدام معايير التصميم المستنتجه من الدراسه النظريه لمعرفة التغيرات التى ادخلتها التكنولوجيا على عمارة المسجد و ذلك في الباب الثالث.

هيكل البحث :

<u>الباب الاول: دراسة الخلفيه التاريخيه لعمارة المسجد</u>

يعرض هذا الباب مفهوم ووظيفة و نشأة تطور المسجد بدايه من المسجد النبوى حتى مساجد العصر العثمانى. سيتم ايضا دراسة الاحكام الشرعيه المتعلقه بعمارة المسجد المستمده من القران والحديث بالاضافه الي دراسة التطور التاريخى لتصميم المسجد فضلا عن القيم الموروثه لتصميم المسجد مع عرض سريع للانماط التقليديه. وتركز الدراسه على تطور عناصر و مفردات تصميم المسجد وتصنيفها الى: قيم وظيفيه و جماليه و رمزيه.

مشكلة البحث:

ان المشكله الرئيسيه للبحث هو عدم وجود إطار تصميم نقدى لتوثيق و تحليل و تقييم نماذج المساجد من اجل معرفه مدخلات التكنولوجيا على عمارة المسجد مع الاخذ فى الاعتبار تحديات التصميم.

فرضية البحث :

تتلخص فرضيه البحث فى ان تحليل نماذج المساجد باستخدام الاطار التصميمى المستنتج من القيم الموروثه لتصميم المسجد سيؤدى الى معرفة التطورات التى طرأت على عمارة المسجد وايضا معرفه اذا كانت التكنولوجيا لها دور او تأثير فى هذا التطور ام لا.

هدف البحث :

الهدف الرئيسي من البحث هو وضع إطار تصميمى لتحليل و تقييم المساجد، استنادا إلى المفاهيم والقيم التقليدية التي كانت تستخدم خلال العصور الإسلامية في تصميم المساجد. وذلك من أجل التعرف على إمكانات التكنولوجيا الحديثه ومساهمتها في تطوير مفاهيم ومناهج تصميم المساجد.

من أجل تحقيق هدف البحث الرئيسى، لا بد من تحقيق الأهداف الفرعيه التالية:

١. دراسة مفهوم و نشأة تطور المسجد فى العصور الاسلاميه.

٢. دراسة الاحكام الشرعيه المتعلقه بعمارة المسجد المستمده من القران و الحديث بالاضافه الي دراسة التطور التاريخى لتصميم المسجد.

٣. التعرف على أساليب تصميم المساجد ووصف خصائص كل منهج.

٤. التعرف على إمكانيات التكنولوجيا الجديدة ومساهمتها في تطوير المفاهيم ومناهج تصميم المساجد.

٥. التعرف على إمكانيات العمارة الرقمية، و اكتشاف أحدث تطبيقات التكنولوجيا الحديثه في القرن الحادي والعشرين، التي يمكن استخدامها في المساجد.

٦. دراسة امكانيه استخدام تكنولوجيا تحافظ على البيئة، كمنهج يستخدم فى تصميم مساجد موفره للطاقة.

٧. تحليل نماذج مساجد بنيت خلال القرنين العشرين و الواحد و العشرين، وذلك باستخدام معايير التصميم المستنتجه من الدراسه النظريه.

مقدمة البحث:

احتلت عمارة المسجد عبر مختلف العصور الإسلامية موقع الصدارة والاهتمام بين سائر عمائر وتعبيرات البنيان الإسلامي، وإن فن العمارة الإسلامية نشأ مع ظهور الإسلام، وبالتحديد مع بناء أول مسجد في المدينة المنورة حيث بلغ قمة ازدهاره وعظمته في القرنين السابع والثامن الهجري. وبجانب الوظيفه الاساسيه للمسجد فلقد وفر المسجد ايضا اماكن للتعليم واستراحه للمسافرين واماكن لتوزيع الطعام على الفقراء. شهد تاريخ المسجد تطور تدريجى خلال العصور الاسلاميه من حيث البساطه فى التكوين و تحقيق متطلبات وظيفيه الى منشات اكثر تعقيدا.

تأثرت عمارة المسجد فى القرن التاسع عشر بعمارة الغرب عن طريق التقليد للنماذج الغربية او المزج بين الطراز الشرقي والغربي. وعلى العكس، في القرن العشرين، ظهرت عدة مدارس معمارية في الغرب تركز على القيم المادية للثورة الصناعية، ودعت الى تبسيط الاشكال بدلا من استخدام الزخارف. في الوقت الحاضر، فإن القرن الحادي والعشرين يشهد أعلى حركة فى مرحلة استخدام التكنولوجيا، وإدخال مواد بناء وانشائيه جديدة، وتقنيات البناء، التي تم تطويرها خلال السنوات الثلاثين الماضية. تقنيات التصميم الرقمي تلعب دورا مهما في مساعدة المعماريين من خلال التصميم المعماري وتصور المبنى في مرحلة مبكره. وقد أدى هذا إلى تطور مفهوم جديد للمباني "الذكية" التي تدمج تقنيات حديثه و التحكم فى عناصر المبنى و مراحل التشغيل عن طريق الحاسب الالى، وذلك لتحقيق الراحه للمستخدمين.

ولذلك فالهدف الرئيسى من البحث هو وضع اطار تصميمى لتحليل وتقييم المساجد استنادا على المفاهيم و القيم المستخدمه خلال العصور الاسلاميه. ولذلك فقد تم دراسه نشأة و تطور المسجد مع دراسة الاحكام التشريعيه المستمده من القران والحديث بالاضافه الى دراسة التطور التاريخى للقيم الموروثه لتصميم المسجد خلال العصور الاسلاميه. تم ايضا شرح اتجاهات تصميم المسجد مع وصف خصائص كل اتجاه و التعرف على امكانيات التكنولوجيا الحديثه ومساهمتها فى تطوير مفاهيم ومناهج التصميم. واخيرا تم تحليل نماذج مساجد خلال فتره زمنيه بين اواخر القرن العشرين واوائل القرن الواحد والعشرين باستخدام الاطار التصميمى المستخلص من دراسه السابق. وقد تم تحديد العناصر التى اثرت عليها التكنولوجيا.

الكلمات المفتاحيه: القيم الموروثة لعمارة المسجد التقليديه، الروحانيه وعمارة المسجد، الاتجاهات التصميميه للمسجد، عمارة المسجد و التكنولوجيا الحديثه.

كلية الهندسة
جامعة عين شمس
قسم الهندسة المعمارية

مستخلص الرسالة

عنوان البحث: تأثير التقنيات الحديثه على القيم الموروثه لتصميم المسجد

دراسه مقدمة لكلية الهندسة – جامعة عين شمس لنيل درجة الماجستير في الهندسة المعمارية

بحث مقدم من / رضوى احمد عمر ابو السعود

يناقش البحث دور وتأثير التكنولوجيا الحديثة في تطوير أساليب ومفاهيم تصميم المسجد، والهدف الرئيسي من البحث هو وضع إطار تصميمى لتحليل و تقييم المساجد، استناداً إلى المفاهيم والقيم التقليدية التي كانت تستخدم خلال العصور الإسلامية في تصميم المساجد. ولذلك فقد تم دراسة نشأة وتطور المسجد مع دراسة الأحكام التشريعية المستمدة من القرآن والحديث بالإضافة إلى دراسة التطور التاريخي للقيم الموروثة لتصميم المسجد خلال العصور الإسلامية. تم أيضاً شرح اتجاهات تصميم المسجد مع وصف خصائص كل اتجاه والتعرف على امكانيات التكنولوجيا الحديثة ومساهمتها فى تطوير مفاهيم ومناهج التصميم. وذلك من أجل التعرف على إمكانات التكنولوجيا الحديثة من مواد بناء وإنشائية جديدة وتقنيات حديثة والتحكم فى عناصر المبنى ومراحل التشغيل عن طريق الحاسب الآلي، وذلك لتحقيق الراحة للمستخدمين. وقد تم تحليل نماذج مساجد خلال فترة زمنية بين أواخر القرن العشرين وأوائل القرن الواحد والعشرين باستخدام الإطار التصميمي المستخلص من دراسة السابق. وقد ساهمت التكنولوجيا الحديثة فى إدخال بعض العناصر والمفردات والتقنيات الحديثة لعمارة المسجد، وذلك باستخدام تكنولوجيا المواد، والتكنولوجيا الذكية، والتكنولوجيا الرقمية. وادركت الدراسة ان نماذج المساجد تميل إلى الطابع التقليدي مع استخدام أحدث المواد والتقنيات لتحقيق الراحه للمستخدمين، عن الاهتمام بالقيم الجمالية، والقيم الرمزية والروحية، التي تعبر عن جوهر الإسلام.

الكلمات المفتاحية: القيم الموروثة لعمارة المسجد التقليدية، الروحانية وعمارة المسجد، الإتجاهات التصميمية للمسجد، عمارة المسجد والتكنولوجيا الحديثة.

إقـــرار

هذا البحث مقدم الي جامعة عين شمس للحصول علي درجة الماجستير في الهندسه، و قد تم انجاز هذا البحث بقسم الهندسه المعماريه كليه الهندسه- جامعه عين شمس، من عام 2006 الي 2013، هذا و لم يتم تقديم اي جز من هذا البحث لنيل اي درجه علميه لاي معهد علمي اخر.

و هذا اقرار مني بذلك ،،،،

التوقيع :

الاسم :

التاريخ :

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جامعة عين شمس
قسم الهندسة المعمارية

اسم الباحث : رضوى احمد عمر ابو السعود

عنوان الرسالة : تأثير التقنيات الحديثة على القيم الموروثة لتصميم المسجد

الدرجة العلمية : رسالة ماجستير

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تاريخ البحث: / /

الدراسات العليا:

ختم الاجازة : أجيزت الرسالة بتاريخ : / /

موافقة مجلس الكلية : موافقة مجلس الجامعة

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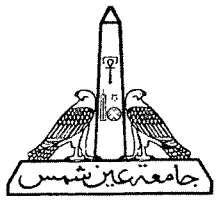

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تأثير التقنيات الحديثة على القيم الموروثة لتصميم المسجد

دراسة مقدمة لكلية الهندسة - جامعة عين شمس لنيل درجة الماجستير
فى الهندسة المعمارية

بحث مقدم من

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