



Islamic Architecture and Arch

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ABSTRACT

The arch, an essential architectural element since the early civilizations, permitted the construction of lighter walls and vaults, often covering a large span. Visually it was an important decorative feature that was transmitted from architectural decoration to other forms of art worldwide. In early Islamic period, Muslims were receiving from many civilizations, which they improved and re-introduced to bring about the Renaissance. Arches appeared in Mesopotamia, Indus, Egyptian, Babylonian, Greek and Assyrian civilizations; but the Romans applied the technique to a wide range of structures. The Muslims mastered the use and design of the arch, employed for structural and functional purposes, progressively meeting decorative and symbolic purposes. Islamic architecture is characterized by arches employed in all types of buildings; most common uses being in arcades. This paper discusses the process of assimilation and charts how they contributed to other civilizations.

1. Introduction

Islamic architecture encompasses a wide range of styles, influencing the design and construction of both secular and religious buildings in the Islamic societies. Arches characterize buildings from houses to mosques, commonly in arcades lining courtyards. The earliest form of arch was semi-circular, borrowed from Roman and Byzantine sources. However, soon the Muslims began to develop new types of arches with both structural and aesthetic advantages, which attained a level of excellence in Andalusia. The early Islamic architecture was taking from existing styles and patterns of other contemporary styles, improving and varying those, and contributing them to world architecture and to non-Islamic structures in a way that changed the entire European Architecture for centuries.

This paper discusses the process of assimilation and synthesis of various forms of architecture and elements in the early Islamic religious buildings, and charts how a more refined Islamic architecture and its elements, a distinct form and rich style fully developed by the Muslims, especially the arch, contributed into the world architecture, being borrowed by the Europeans and used in structures including churches.

2. Early Islamic Development

There were not many Islamic buildings in the first three generations after the Prophet's death. In 630 AD, an Abyssinian carpenter was engaged to rebuild the *Ka'aba*; he did this first major work of Islamic architecture in his native style. Consolidation and expansion of Islam began in the 650s. Muslim armies conquered a huge expanse of land, and progressed mainly westward. Grabar (1964) opined that little was changed in the cities conquered by the Muslims; with no building tradition, they rather relied on local or imported craftsmen till the Eighth Century, directing them to work in a different manner within new principles and an iconic decoration (Draper, 2005). Ettinghausen and Others (2001) identified only exception in adopting older sanctuaries as mosques. The buildings drew on a wide range of craft and expertise from different parts of the Muslim world. Islam was the unifying

force that shaped their urban environment - the shared cultural and religious codes that molded the daily chores and worldview of the believers (Grabar, 1964).

The Muslims put up unadorned buildings, and incorporated a simple mosque layout in new or converted buildings (Freshman & Khan, 1994). For example, a Baptistery was modified to build the Great Mosque of Damascus (706-716); it was completed with pillars, columns and arcades (Ali, 1999). The aisles facing the altar with a higher nave were reoriented, separated by arches on reused Roman columns in the large hall. Over them, a second row of columns and arches were added to raise the ceiling without affecting the spatial quality (Grabar, 1996). The hall opened onto the courtyard with unimpeded daylight; it was a novel relation derived from the Prophet's mosque. The Umayyads used Roman *temenos* as the basis and developed the religious structure within the mould created by classical antiquity. They re-enacted the unity of the classical Roman ensemble that was abandoned by the intervening Christians as smaller edifices were unable to achieve the classical scale (Grabar, 1964).

Thus a distinguished Islamic architectural style emerged, developing from localized Egyptian, Byzantine, and Sasanian models, and adapted to specific religious needs of space and order. The Dome of the Rock (691) was the first monumental statement of the new faith in the Christian heartland. It featured vaulted spaces, a circular dome, mosaic decoration, marble panels and repeated use of stylized decorative patterns, built by Christian craftsmen (Hillenbrand, 1994; Grabar, 1996). The 17-aisle Great Mosque of *Samarra* (Iraq, 848-851), built by the Abbasid, used the hypostyle architecture. The walls had glass mosaics; stucco carvings in floral and geometric designs represent early Islamic decoration. After capturing Istanbul, the Ottomans converted the Basilica to *Hagia Sophia* mosque and incorporated Byzantine elements, e.g. dome, into their own work with profound influence.

Islamic architecture was characterized by ordered repetition, radiating structures, and rhythmic, metric patterns (Saoud, 2002). Clevenot and

DeGeorge (2001) identified a good use of fractal geometry, especially in mosques and palaces. Other significant features included columns, piers and arches, organized and interwoven with alternating sequences of niches and colonnades (Ettinghausen & others, 2001). The role of domes in Islamic architecture has been considerable over centuries; this was incorporated into Western architecture till the Nineteenth Century (Ettinghausen & others, 2001), and as far as the USA (Curiel, 2004).

2.1 Confronting Byzantium

Arabia and Byzantium were powerful bastions of two independent cultures. During the early Islamic classicism, the two synthesized with the socio-political and religious entities elaborated by the Prophet and his successors. Considerable Byzantine influence is seen in the early Islamic monuments like the Dome or the *Qasayr 'Amrah* baths. Thus Byzantium played the role of one of many parents who brought a new Islamic art to life (Grabar, 1964). Artistic contacts for centuries flowed in both directions. While the Byzantines acquired a taste for Islamic objects and orientalized to their royal court and churches, the Muslims continued to seek or feel the impact of their art. Such social contacts, reliance on Greek science, and a Mediterranean orientation in the Middle Ages made the Arabs rely on Byzantine themes.

The Muslims borrowed, modified and adapted from Byzantium according to the circumstances, e.g. for iconography, making it essential in its formation. Though the Byzantines patronized art and possessed artists and treasure, the Muslims used not the *art* but the *theme*, and avoided using any stylistic representation that could not be retained for new symbol. For example, as Islamic doctrines forbade the use of humans and animals in design, these were avoided in architecture (Clevenot & DeGeorge, 2001). Geometry is as important as vegetation, often working in counterpoint, either deployed on adjacent surfaces or natural patterns finding their way into decoration (Clevenot & DeGeorge, 2001). Byzantine art provided the Muslims with a vocabulary and a grammar for their emerging language.

The first generation could not acquire the sophistication of imagery; it explored alternatives, and adopted the Byzantine techniques without its formulas (Grabar, 1964). The Fatimid ceremonies were closely related to that of the Byzantines, imitating their artistic techniques, e.g. cloisonné enamel. There are many features related to Byzantium in the Seljuk or Ottoman Anatolia monuments or the Persian miniatures of 14C. After the 13C, the rule of Turks or Kurds and the taste of Iran introduced a non-Arab component in Islamic culture and art. The Syrians inherited a complete and complex entity with well-known physical, human, economic, and artistic characteristics. The same is true of North Africa, though examples are rare. Byzantine elements are less in defining the Mamluk art of Egypt or the late Mediaeval art of Morocco and Andalusia.

Byzantine and Arab architects and workers accomplished the Dome's artistic feat (Clevenot & DeGeorge, 2001), learnt and interpreted the old style in the philosophy of the new faith mixing Greek traditions with Arab taste. The columns, internal and exterior surfaces of the dome and the drum engaged Byzantine artists with skill and ingenuity in the sophisticated art of glass mosaics. The piers and beams were covered with vegetal motifs and forms instead of human figures as an early Islamic decoration, inspired by Christian forms. The Umayyads paid equal attention to decoration and architecture (Ettinghausen & Others, 2001). With its lavish decoration, balanced architecture and excellent workmanship, it made up a grand Islamic edifice (Ali, 1999).

However, the use of mosaics by Muslims goes back to 684 when the *Ka'aba* was restored, and glass mosaics were brought from a Yemeni church to cover its walls. Byzantium Emperor sent workers and material to rebuild the Prophet's mosque, and craftsmen for the Dome and Great

Damascus mosque. The money and employment available in Umayyad commissions lured the Byzantines (Gibb, 1958). For the Muslims, it was partly a way of learning the ropes and partly a way to impress as the Caliph was anxious to acquire imperial features (like sponsoring superb monuments for the subject). Moreover, it symbolized the subservience of the Byzantine emperor to the Muslims, who believed that the Byzantines had excellent workers (Grabar, 1964).

The Dome, a calculated response to *Holy Sepulchre*, conformed to key measurements; Ali (1999) found a similarity of the octagonal plan to that of the Byzantine Churches of the *Ascention*, Olives Mount and *San Vitale*, Ravenna (527). The architectonic of the arcades are determined by a simple and subtle layout, perfected from a rigorous application of geometric harmony. This, to be the focus of considerable architectural and ornamental development in the Islamic world, originated in Byzantine tradition, itself heir to Rome and Greece (Clevenot & DeGeorge, 2001). There and in the Damascus mosque, crown suspended around a sanctuary and of an idyllic landscape created an imagery expressing the victory of Islam over the Christian and Sasanian antagonists and power of an ideal Muslim world (Ettinghausen & others, 2001).

The Dome proclaimed an Islamic message as it lacked any figural representation in decorative work, using calligraphy for the first time. It also used pointed arches in the inner arcade, a manifest difference from the Christian neighbor. It was as much pragmatic (to achieve height equal to outer semicircular arch with larger span and keeping the ceiling flat) as symbolic. Seminal position and distinguishing features of the dome express a cultural identity for the new religion. Its aesthetic value too was acceptable if not actively desired. The Dome and *al-Aqsa* mosque demonstrate Christian art characters in the construction techniques and part decoration. However, according to Grabar (1959), the Muslim for political and historical, and especially for ideological reasons, gave a new holiness to the most ancient sacred spot in the Holy City.

For sometime the Muslims replaced the imagery of power with iconoclastic monumental symbols. Byzantine artists in Cordoba mosque shredded traces of Byzantine and Sasanian influences, and Kufic script gave birth to an everlasting geometric figure based Muslim decorative style used in abstract arabesque decoration. Much of the Arab architecture continued for long to depend on the arch and column rather than on vaults; the clearly organized vegetal form as in North Africa or Andalusia, the modified Damascus mosque, remained Muslims as neutralized by the *Umayyads*. Techniques and motifs in the early-Islamic edifices, not the Byzantine art, had a lasting effect on hitherto primitive and simple Islamic art and architecture. Grabar (1964) attributed an identifiable art of the Muslims after their emergence to the setting which they inherited from Byzantium, transformed in ways and for reasons peculiar to them.

2.2 Further Assimilations

From the Seventh to the Fifteenth centuries, Islamic art and culture went through a relentless process of assimilation, growth, re-initiation, and renewal of existing traditions while creating new styles and techniques. This suited the spiritual, aesthetics and physical requirements of its patrons and creators. The Arab Muslims in general and the Umayyads in particular showed their respect towards other cultures. They came in contact with Greco-Roman, Christian, Buddhist and Chinese civilizations, and met indigenous artistic traditions of the Berbers, Africans, Slavs, Turks, Goths, etc. But they chose what suited their beliefs, doctrine and taste, and built on it to generate an international civilization (Ali, 1999). The process respected regional variety integrating and uniting within the Islamic civilization, used churches for prayers, and re-used many finish and structural elements. After architecture became matured and distinguished,

the exchange continued with no deleterious effect on Islamic aesthetics. The dissimilar cultural encounters synthesized in Muslim consciousness left their mark on its architecture and created a distinguishing trait: "unity within diversity" or "diversity within unity" (Ettinghausen & Others, 2001).

With the spread of *Abbasid* (750-1285) power, commercial activities multiplied between Baghdad and India, China, Middle Asia, Northern and Central Europe and Africa. The commercial prosperity aided in communicating art and culture from one remote region to the other, exchanging artists and artisans. Due to intense commerce and travel, a new artistic style spread to most parts of the Empire. Ceramic ware, inlaying metalwork, Samarra beveled style and the arabesque were transmitted to Central Asia, Persia, Egypt, Syria, North Africa and al-Andalus (Saoud, 2002). Meanwhile, the fusion of Arab, Mediterranean, Berber and Visigoth traditions developed a unique Islamic architecture and civilization; a distinctive Andalusian style that spread to countries of North Africa, followed by the Mudejar style, and traveled further north.

Like Byzantium, Sasanian had a formative influence on Islamic Art, giving legacies like the *iwan* (one-side open bay) and *chahartaqs* (domed kiosks) (Hillenbrand, 2003). Seljuk Persia diffused ideas and forms (Edwards & Edwards, 1999); the architectural virtuosity and technical expertise characterizing this are often compared to the achievements of the Goths. The invading Mongols got absorbed in the society embracing Islam, which manifested itself not only in socio-political but in artistic terms. A united Mongol empire in the Thirteenth Century opened a safe route for the merchants, eastward explorers and missionaries, resulting in moving ideas, design and artistic influences through mosques, *madrasas* and shrines throughout Persia and India.



Figure 1: Interior of Masjid al-Aqsa

(Source: http://www.atlastours.net/holyland/al_aqsa_mosque_dome.jpg).



Figure 2: A sectional view of the Dome of the Rock, the first Islamic Monument

(Source: http://images.google.com.my/imgres?imgurl=http://www.atlastours.net/holyland/dome_of_the_rock_inside.jpg&imgrefurl/)



Figure 3: Mosaic decoration outside the Mihrab.

(Source: <http://images.google.com.my/imgres?imgurl=http://web.duke.edu/religion/umayyad.jpg&imgrefurl=>



Figure 4: Mihrab, dome and the arcade overlooking a very large courtyard.

(Source: <http://web.duke.edu/religion/graphic/umayyad.html&usg=>)



Figure 5: Two levels of horseshoe arches with alternate color blocks inside La Mezquita - the Great Mosque of Cordoba.

(Source: <http://images.google.com.my/imgres?imgurl=http://www.islamicity.com/culture/mosques/Europe/TMp105b.jpg&imgrefurl=>



Figure 6: Pointed arches in 9C Ibn Tulun Mosque in Cairo
 (Source: <http://www.sacred-destinations.com/egypt/images/cairo/ibn-tulun-mosque/from-above-cc-romsrini.jpg>)

3. Innovation and Evolution of Arch

The arch was known to all major ancient civilizations; yet lintels were more in use, confining arch to underground structures e.g. drains and tunnels that could diminish the lateral thrust. The Romans learned the technique from the Etruscans, and applied it systematically. They refined arch, and were the first to tap its potential for a wide range of above-ground buildings (Robertson, 1943). The Roman engineers used arch in bridges, aqueducts, palaces, amphitheatres, and gateways. Vaults based on the same concept began to be used for roofing large interior spaces, such as halls and temples; domed structures from the First Century BC started to meet similar functional and structural requirements.

Brick Arches first appeared in the Second Millennium BC in Mesopotamia; later the Romans and the Byzantines found the semi-circular arch for transmitting from architectural decoration to other forms of art. The Muslims mastered the form, reminding the mystic meaning derived from the spherical universe and the divinity of the dome strongly related to arch, connecting to the heaven above (Saoud, 2002). The Muslims' knowledge of geometry and static allowed them to improve various types of arch, first employed for structural and functional reasons, progressively meeting decorative and symbolic purposes.

The first arches were semicircular, simple to build, but not the strongest as the sides had to be restrained. It could be flattened to an elliptical shape. The strong parabolic arches, introduced by Gaudi, an admirer of the Gothic structures, carry all horizontal thrust to the foundation and so do



Figure 7: Interior of 10C Church of St. Miguel de Escalada
 (Source: http://en.wikipedia.org/wiki/File:SMdE_interior.jpg)



Figure 8: Interior piers, cross vaults and ceiling of Montecassino Abbey
 (Source: http://en.wikipedia.org/wiki/File:Monte_Cassino_Fasada_Kosciol.JPG)

not need abutments. The semicircular arch was widely used until the Muslim started to expand the horizon of arch making. Architects and builders in no other civilization ever tried and improved upon so many variations of one building or structural element. This paved the way for beautiful buildings all over Europe, and dominated the world architecture in next several centuries. Below is a discussion of some of such areas of Muslim contributions.

3.1 The Horseshoe Arch

The horseshoe arch, allowing more height than the semi-circular arch as well as better aesthetic and decorative use, originated from the semicircular arch. The first examples known were rock-carved in First Century AD in India; the first known built horseshoe arches are found in Ethiopia from around the Third–Fourth Century. At the same time, other examples in Syria were recorded in the *Mar Ya'qub* Baptistery. These suggest an origin in pre-historically linked Ethiopia or Syria (Stuart, 1991). Horseshoe arch is found in Fifth Century Armenian churches, Sixth Century *Taq-i-Kisra Sasanian* in Iraq, and Visigoth Church of *Santa Maria de Melque*. It was used in Visigoth, Islamic and Mudéjar architectures, and Moorish buildings abundantly, for decoration rather than for strength (Saoud, 2002).

The Muslims modified and adapted arch by inventing the horseshoe type in the Damascus Mosque (Briggs, 1933) that had only a few pointed arches in conspicuous positions. They used this to develop the famous ultra-semicircular arch, around which the whole of their late architecture evolved. Among the first architectural features to develop in Andalusia, the horseshoe arch reached its zenith in function and design there, taking many capitals from classical ruins. In Tunisia the horseshoe arches of the mosques of *Qayrawan* and *Muhammad ibn Khairun* have a mildly pointed form. *Qayrawan* was an important center for Islamic learning, and an administrative and commercial center under the *Fatimids* and *Zirids*. It contains this marvelous architecture originally built in the 7C, with a 35m high square minaret (724-728) –the world's oldest standing. A striking feature is the formal emphasis on a T-axis punctuated by two domes, one over the oldest preserved ceramic-covered *mihrab*. However, Jairazbhoy's (1973) suggestion that this was derived from the use of the horseshoe to protect against evil could not have a basis the as the Muslims reject such superstition.

With introduction of horseshoe arch in Cordoba and a large number of Moorish edifices from Syria through Egypt and Tunisia, this improved arch found the way for its transmission to Europe, to form the backbone of golden periods of Gothic and Renaissance architecture. The travel started with the Mozarab artists, scholars, builders and architects migrating to the

Christian areas of Northern Spain, who learnt methods of building and architectural forms and motifs from the Muslims (Trend, 1931). The *St Miguel de Escalada* near Leon (913) used melon shaped domes and the horseshoe arches of Islamic architecture. The Mozarabs used the form to illuminate manuscripts too. The church of *St Cebrian de Mazote* (921), founded by Mozarab Cordovan monks, had similar planning, structural and decorative elements, horseshoe arches, tripartite choir and horseshoe shaped apse on a Basilica plan (Dodds, 1994).

3.3 The Pointed Arch

According to Fletcher (1948), the pointed arch appeared in Babylonian Khorsabad, and in cut masonry in the ruins of the First Century AD *Baal at Dura Europus* Temple. White (1971) claimed that the Second Century pointed arch in India was transmitted to Persia, Syria and Egypt. It was carved out of rocks in Seventh Century temples (Rivoira, 1914), and in the niches of Bud-dhist temple at *Bodhgaya* (Havell, 1913; Rowland, 1977). Pointed arch in the Muslim architecture of India appeared in the filigree screens of the *Quwwatul Islam* Mosque (1199), the first to be erected after Delhi's conquest by the Muslims, and the *Arhai-din-ka-Jhopra* Mosque (1205), Ajmer. According to Hasan (1989), Hindu craftsmen, apt in corbelling but ignorant of true arches, built the form symbolizing the new domination. She mentions that the form and technology of the true arch were known in Bengal too in pre-Islamic times, widely used after the Muslim conquest. Luce (1969) found the use of pointed brick arches and vaults with radiating *voussoirs* in the Eleventh Century *Nagayon* Temple at Pagan.

Indian artists had worked for Caliph Harun-ar-Rashid in Baghdad, and Indian merchandise was sent to Egypt and Syria. As there were exchanges of men, goods and ideas, the arch could have traveled to and from any direction. Hill (1993) dismissed the idea of Indian origin of the pointed arch and its passage to the Muslims through *Sasania*. He believed in the Muslim origin of the pointed arch, tracing it to the *Al-Aqsa* Mosque (780), the *Ukhaidir* Palace (Iraq, 778), the *Ramlah* Cistern (759) and the *Jussaql Al-Khaqani* Palace (*Samarra*, 836). The *Al-Aqsa* had gone through numerous rebuilding and renovations and changes of use since Caliph Umar first built a small prayer hall (632). The Fatimid Caliph Ali *az-Zahir* built the current mosque in 1035; others later added dome, facade, *minbar*, minarets, etc. The Crusaders used it as a palace and church. Afterwards more renovations, repairs and additions were made by the Ayyubids, Mamluks, the Supreme Muslim Council, and Jordan.

Pointed arch was used in the Umayyad buildings of Syria, and the *Tarik Khana* at Damghan, Persia (Hasan, 1989). Thus in course of the Eighth-Ninth centuries, the pointed arch became well established in the Islamic world. Its trend towards a Gothic type of construction is evident in balanced thrust of the arches concentrated on piers and the typical Sasanian ellipsoidal arch approaching a pointed shape, destined to play a decisive role in Islamic architecture, and later European Gothic.

The semicircular arch was followed in Europe by the stronger pointed arch (the centerline closely following the compression) from Andalusia. Despite the association, it was not Muslim invention. Creswell (1989) listed 17 pre-Tenth Century examples. An unintentionally mild pointed profile progressing to horseshoe shape was used in *St. Apollinare* (549) or *Qasr ibn Wardan* Church (561-4) in Northern Syria. Hence Draper (2005) suggested that this arch could have originated in Syria under the Byzantines, or even in the earlier elliptical or parabolic arches used in Mesopotamia in the Second Millennium BC. *Cicernakavank Basilica* in Armenia with pointed arches and barrel vaults is dated to the Sixth/Seventh Century. These suggest independent developments of certain features from a common background, differentiated by materials and

construction— cut stone in Armenia and Syria or mud brick in the south and east. The Samanids, Karakhanids, Seljuqs, and later dynasties also adopted it (Creswell, 1989).

At around the same time pointed arch is found across North Africa (Draper, 2005), for example in *Qayrawan*. Known in Egypt, these used the pitched brick vaulting construction suitable in lands with no wood. The *Ibn Tulun* Mosque (Egypt, 876-9), the first large scale building inspired from *Samarra*, was the last in Creswell's list. This used piers, stucco ornaments and pointed arch constructively and systematically. Ahmad ibn Tulun, the Abbasid governor, built this oldest and the largest Fusat mosque (876-879) surviving in its original form. It was built on a small hill claimed to be where Noah's Ark ended (Gayer-Anderson, 2001). This focus of capital *al-Qatta'I* with a courtyard and covered halls on all sides survived early-10C razing of the city. The Fatimid *wazir* Badr al-Jamali restored the mosque (1177) and inscribed the Shii version of the *shahada*. Sultan Lajin restored it (1296), and built the current minaret with a helical outer staircase (Behrens-Abouseif, 1989).

The pointed arch concentrating the thrust of the vault on a narrow vertical line supported by flying buttresses became a major Gothic feature. This reduced the lateral thrust on the foundations, and lightened the walls and buttresses, which were massive before supporting semi-circular arches. It also resolved the difficulty of achieving level crowns in the arches of the vault, matching it to any ground plan. To tackle the height problem, Muslims employed a variety of techniques, in addition to the pointed arch. In *Qayrawan* Mosque (836), the masons raised the slightly pointed arcade of narrow areas above the arcade of wider areas to gain equal height. Its *Mihrab* surrounded by decorative Baghdad tiles had a pointed profile linked with the Abbasid. A more impressive method consisting of intersecting arches and the construction of a second arcade on top of another was introduced in the Cordoba Mosque. Examples show the genius and the rational thinking in addressing various architectural problems.

Manipulated pointed arch played a dominant role in Western European architecture during the high and late Middle Ages, transforming Romanesque to Gothic. Western patrons and craftsmen encountered it in the late Eleventh and early Twelfth Century, and considered aspects they were ready to take up and ignored others. Its use marks a clear and conspicuous break with the tenacious retention of semi-circular arch in the classical tradition, forming a vital part of the emergence of distinctively new sets of conventions, to the extent that by the Eleventh Century it became a distinguished feature of much Islamic architecture (Draper, 2005).



Figure 9: Main nave of *St. Denis Cathedral*, the first Gothic church
(Source: http://en.wikipedia.org/wiki/File:St_denis_nave.jpg)



Figure 10: Rebuilt façade of the Church of Cluny

(Source: http://www.flickr.com/photos/fotos_van_maupsmits/2626972063/)

3.3.1 Transmission of the Pointed Arch

Mesopotamian and Syrian Muslim motifs were transmitted via Egypt and Persia to Twelfth Century Gothic Europe. This followed two routes: the *Amalfitan* merchants trading with Egypt and Tunisia (Howard, 1991; Draper, 2005), and/or Andalusia (Briggs, 1933), though with some gaps in the sequence. Creswell (1979) made a chronological chart of the development of style with no conceptual or intellectual framework. He claimed that such a clear consistent progression gradually became steep due to varying distance between the centers. But development for two centuries over a wide geographic location could not be as neat and consistent, except covering a variety of forms and elements.

Use by the *Montecassino* Abbey (1071) vindicates Muslim contribution over the claim that the pointed arch was invented by Gothic architects to overcome the static problems in Romanesque vaulting. Great Mosque of Cordoba was an achievement of Hispano-Islamic tradition (Clevenot & DeGeorge, 2000), where the local traditions and innovations absorbed the Syrian influence. Baghdad's influences crossed to *al-Andalus* through *Qayrawān*, as a major source (Conant, 1954; White, 1971), brought to Morocco by the *Almohads* and *Almoravids* (Ali, 1999). In the Tenth Century, the style mixed with Syrian and Andalusian features like the painted wooden ceilings which are also seen in Persia.

The third *Church of Cluny* (1088-1095) in Southern France used features like pointed arches in the aisles, catenary vaulting, poly-foil cusps framing the *triforium* arches, and the rectangular frame enclosing the gate arch (1109-1115) (Conant, 1954, 1968). An early example of association between Islamic and classic elements, it also used fluted pilasters and Corinthian capitals, and provided a seminal building that could account for the rapid uptake of pointed arch from the Twelfth Century, not necessarily the main source (Draper, 2005). In seminal early Gothic buildings classicizing features like columns and Corinthian capitals were easily combined with pointed arches. A parallel use can be found in many earlier and contemporary Islamic buildings, for example at Diyarbakr.

Conant (1968) saw the oriental influence in the decorative use of horseshoe lobes on the *triforium* arches, and suggested *Montecassino* as possible route. Heer (1974) discussed how the adoption of pointed arch and other Islamic architectural forms in the three most influential churches in Europe (Cluny, Montecassino, St. Denise) rapidly spread such elements across southern France, later to Germany in the mid-Twelfth Century, and eventually to all Europe.

3.4 Other types

Shouldered arch, an exaggerated tri-lobed arch reducing the span with corbels, limits the maximum bending moment to a permissible level for the materials used, and permits to augment suitable materials. The tri-lobed *squinch* displays the beginnings of a compendium of arch forms. A consistent use of shouldered arch can be traced in Islamic architecture in transitional zones of domes and minaret bases, on portals (to articulate axis or as part of stalactite corbelling), and in openings and niches. The Mongols systematically exploited the decorative potential of shouldered arch, using it to demonstrate their desire to unify the interior and exterior of a building. The development of regional idiom is also seen in its use in Anatolia and Egypt. Stilted keeled arch on the façade of Cairo's *Al-Aqmar* mosque (1125), as a Fatimid feature, continued for four centuries as a distinct tradition.

Two methods basing circular dome on a square or rectangle had evolved simultaneously during the first two centuries AD: Romans and Byzantines developed a spherical surface of the *pendentive* (Mainstone, 1973), while a simple arch across the angle of two walls (*squinch*) was used in Sasanian palace of *Firuzabad*, or the early Islamic structure at Sarvistan (Creswell, 1979). The *Samanids* Tomb in Bukhara (pre-943) used *squinch* to articulate the progressive transition from the square base to the dome beyond the Parthian-Sasanian solution, resting on an octagon of arch ribs carrying the thrust downwards. This was part of the varied repertoire of architectural forms used to achieve a structurally satisfactory and aesthetically pleasant junction between domes and supports (Edwards & Edwards, 1999). While exploiting the options by opening up the wall surface and increasing dome size and height, the transition zone was decorated to animate and articulate a harmony and balance. This developed into *muqarnas*, a bridging element of multiple honeycomb or stalactite vaulting (Hillenbrand, 1994).

The Muslims use of the transverse arch for the first time in the Palace of *Ukhaidir* (720-800) set precedent for its universal use. 120 miles south of Baghdad, the limestone wall of the Palace is composed of arched recesses framed by semi-circular towers, with round towers buttressing its corners. All but north facade that has the entrance leading to the palace have gates contained by quarter-round towers. Its mosque includes a rectangular *mihrab* featuring a half-domed cover that extends onto horizontal brackets which alludes to Persian-Mesopotamian influence. Vaulted rooms are organized around a blind-arcaded court. To its south is one of the earliest examples of the Persian *pishmaq* (rectangular encased *liwan*) surrounded by *Diwan-i-Aam* and *Diwan-i-Khaas*, and *hazarbaf* (geometrically organized brick patterns) (Bell, 1994).

As pier was adopted to replace the classical column, Europe embraced this arch three centuries later, which was thrown from each pier of the arcade to the wall of the aisle. Though in Europe it was the first step in revolutionizing the church building, there is not much evidence on how and when the technique was transmitted. The use of the transverse arch over the nave not only provided greater safety and durability but also gave the final shape of the nave, especially in terms of height and roof. This step in the development of Gothic style led to the adoption of ribbed vaulting to cover the nave and evolving the compound, and made churches and spires taller, and the ceiling and facade more attractive.

The most advanced arch form developed in the early Islamic period is the four-center arch, composed of four curved sections, with steep curves lower down and flattened point at the apex. The earliest occurrence of such arch is at Samarran *Qubbat al-Sulaybiyya*. Cusped arch first appeared at Samarra in the external decoration of the *Qasr al-Ashiq*; this became one of the favorite decorative arch forms used throughout the Islamic world from Spain to India. The form of Fifteenth and Sixteenth century 'Tudor' arch, peculiar in Britain, is matched by mosques in Tenth Century Cairo,

and earlier Persian buildings.

4. Discussion

Harvey (1968) and Edwards (1999) cited Seljuk as the original source to European architecture. Twelfth Century Isfahan mosque shows aisle with pointed arches, which could be imagined as part of a French Gothic cathedral. Briggs (1933) argued that Eight Century Persia, excelling in brick architecture, could have started the pointed arch, large domes, the ogee vault, ribbed vault, external buttresses, and the ingenious *squinch* before the European Gothic. It gave rise to ribs from the ogee vault resting on piers with merely shelled inter-spaces. Some vaults followed similar construction in Romanesque domes in Spain and Italy, an Eastern derivation important in the evolution of European architecture. Brick vaults of the Isfahan mosque, adjacent *souq*, and Ardistan *Jumah* mosque, displayed skills that appeared a century later in Europe. However, the strength depended more on the mortar while in Europe it was the material (stone). The vault using rudimentary buttresses were developed in Syria and Rome centuries before it appeared in Gothic.

There were complicated and perplexing cross-currents between East and West regarding the construction of dome (Briggs, 1933). The link of architectural ideas between Persia and Europe was not frequent as the two dome types followed different lines on same principles. In southern Europe many intermediate type *squinch-pendantive* domes are found, e.g. in Le Puy. Yet the routes and means of its transmission and reasons for adoption are contested. Sicily and Venice were the possible conduits for transmission in Italy and beyond, though the survived examples are from later periods (Howard, 1991).

Venice a major port for the crusaders' voyages has an oriental aura. Competing militarily and economically with the Muslims, the Republic acquired their many characteristics (Howard, 1991). Islamic architectural features grew out of the heritage with Byzantine influence. After the Fourth Crusade, as a large part of Byzantium was colonized and Constantinople became an oriental trading post, the Venetians entered into trading pacts with the Mamluks, and resisted Papal pressure on trading with the 'infidels'. According to Ruskin (1851), these were not the 18C's *chinoiserie*, but invented orientalism in an exquisite refinement of Islamic architecture in a period overseeing the fastest growth in Venice's trading. Howard (1991) found the Venetian nobles, dressed in lavish oriental textile, speaking their own dialect, built palaces that expressed an easily recognized orientalism with Islamic characteristics.

The raised domes of *San Marco* resembles that of Ibn Tūlūn with a comparable function. The terracotta decoration in the *Santa Fasca* Church resemblances the ornamentation of Seljuk tombs. Its ambulatory added during the crusade refers to the Dome of the Rock that was then in the charge of the Templar, who built many churches across Europe modeled on the Dome that was wrongly believed to be the Solomon's Temple. The 14C Doge's Palace is infused with oriental references: the two-dimensionality and openness of the façades, the Lozenge pattern on the upper wall, the roofline crenellations matched by Umayyad palaces, and the delicate traceries. The inlaid marble diaper pattern, reminiscence of lozenge pattern in Seljuk monochromatic brickwork, was transformed into colored glazed tile work all over Persia in later centuries. The elegant ogee arches were closer to oriental model. The double-curved pointed arch, a major Venetian motif, was from the Aleppo Mosque, evoking a characteristic of the Islamic townscape (Briggs, 1933).

Though local craftsmen were employed in Spain and Southern Italy, their involvement in northern Europe is debated. For example Le Puy used many Islamic features and motifs, e.g. colored coursing in ashlar and

voussoir, pattern work masonry panels, pointed arches, decorative cusped arches and wooden doors. It engaged a Saracen craftsman, later to become the Chief Architect of Henry I (Harvey, 1968). Briggs (1933) too mentioned of medieval records showing visits of church architects to the East. The Prior of a monastery on the Loire stayed in 12C Baghdad. Constantine, a Tunisian scholar with knowledge of Muslim building techniques and forms, and his Arab assistant advised on the construction of *Montecassino*; (Meyerhof, 1931). In 1083, Abbot St. Hugh visited this before building *Cluny III* (1088-1095). The *St Miguel* built by Cordovan monks shows elements of Islamic architecture (Dodds, 1994). Magins, the artist of *Beatus of Lebana*, an illuminated manuscript, worked at the *St Miguel* monastery. Abbot Suger visited Cluny in 1130, and built *Cathédrale Royale de Saint-Denis* in 1135-44, using innovative structural and decorative features drawn from many sources in the first truly Gothic building. The basilica provided an architectural model for cathedrals and abbeys of northern France, England and other countries in *Rayonnant* Gothic style.

Eleventh and Twelfth century North European builders were not ready to use such sophisticated ornamental vocabulary (Draper, 2005); it was more than two centuries before anything comparable was used in the tracery of Gothic architecture. The period when the borrowing took place coincides with the Crusades when many features of civil and military architecture passed from the Near East to Europe. Perceived as exotic borrowings from rival culture, there was no barrier, e.g. the reservation by Fifteenth Century Renaissance about the propriety of pagan precedents borrowed for Christian monuments. Once a motif spread in Western Europe, its eastern origin was forgotten.

The consistent use of integrated elements, especially the strong combination of vaults and columns, distinguishes the exploitation of pointed arch in Western Europe. It facilitated vault construction in the aisles of Cluny III, and facilitated an easy construction of a thinner groin vault with a scientific profile (Conant, 1968). It was the first appearance of the arch in a proper Romanesque context, important for not only use as arch but for barrel vault reducing the lateral thrusts. This was why it was rapidly diffused in Romanesque Europe. Stalley (1999) too supported the above, and (re)asserted its borrowing from the Islamic world, linked to the scale and structural advantages when used for bearing load. Appreciating the structural flexibility, its use in openings indicates a new mannerism different from the Romanesque, and contributed to its rapid spread (Draper, 2005).

Western medieval architecture frequently refers to the Islamic culture and the adoption of arches, though the Islamic medieval architecture had little reference to the West (Draper, 2005). It became a recognizable feature across the Islamic world, with many distinct regional variations depending on the available materials and building traditions of each region. Visigothic or Armenian arches predate the first extensive use of horseshoe arch in Islamic architecture. Thus both a connexion between Gothic and Islamic building traditions or independent regional development from a late-Roman origin was possible. Indeed Hellenic-Roman legacy endowed the region's visual culture with a common repertoire of decorative motifs and building types (Howard, 1991).

The distinctive new language of architecture for the new religion that went beyond new types of buildings included a rich array of decorative motifs and the handling of constructional features in a decorative manner. An *arcuated* corbel supporting a shoulder arch constitutes a basis for distinctive Islamic form of structural decoration. That arch was used for functional reason, but increasingly obscured, was truer for the muqarnas; its decorative effects belied the structural origin that was explored for aesthetic and symbolic reasons (Ettinghausen & others, 2001). By mid-Twelfth Century, it had achieved a high degree of sophistication, exhibiting a dazzling visual effect of shimmering weightlessness, a

metaphor aligned with the meaning of the dome itself, in a mature demonstration of the handling of this novel kind.

By the time western European patrons saw many Islamic buildings, Muslims have matured a range of arch forms: horseshoe, ogee, shouldered, four-centered, etc., where the shape and decoration undermined any structural appearance. It was however the combination of pointed arch with stone vaults that transformed an alternative form of arch into an essential component of buildings in new manner (Draper, 2005). The aesthetic and structural purposes are not mutually exclusive, and there were greater consistency of motivation. The characteristics subversion of architectonics can be traced back to the separation of decoration and structure through the application of stucco ornamentation in Sasanian buildings; this was achieved particularly through the complex shapes. The arrival of refined and advanced arches in the West was opportune but not entirely fortuitous. By the late Eleventh Century, Romanesque architecture had reached an elaboration that needed a new range of decorative features. As an exotic motif, pointed arch was aesthetically appealing, with apparent technical advantages. This allowed to adjust height and maintain homogeneity during a boom of more complex and articulated buildings.

Elements of Islamic architecture that evolved for a structural reason were transformed into decorative features with the passage of time and refinement of the forms, and non-structural embellishments or modifications of the forms began to appear. Islam's specific propensity has been to draw upon precedents, and develop them into its own idiom (Edwards & Edwards, 1999). Whether certain form was fully decorative, purely architectonic, or a mixture of both, is often ambiguous. Consideration of the use of pointed arch between the Seventh and Twelfth centuries raises questions on the relationship between the architectural vocabulary and structural reasons, transfer and translation of motifs, and the changing meanings of individual features when employed in different contexts. Classical Roman background of both Western and Islamic architecture could explain the ways medieval architecture in both traditions was conditioned. The Romans' structural innovations and imaginative planning never challenged the use of hemispherical arch; they found alternative forms for utilitarian purposes, rarely displayed in public buildings, except perhaps in Pantheon entrance.

The horseshoe arch developed alongside the pointed arch, occasionally as a decorative feature in Byzantine context in *Rabbula Gospels* (586), and in a set of carved wooden panels in the *Al-Aqsa* mosque, where the form was only an insignificant motif demoting the arch to a decorative element (Hillenbrand, 2003). Subsequent popularity of the profile may owe to its development for purely decorative purpose. Replacing the semicircular arch, also indicated the progressive separation of Umayyad art and architecture from [classical and Byzantine] roots. The horseshoe arch structurally is a disconcerting form when used for bearing load, as in Cordoba where pointed arch was only sparingly used. A dominant feature of the interior, addition of cusps to make multi-foil arches undermined the structural role. Such subversive use is explored more in North African *Almoravid* architecture and in Saragossa displaying full panoply of the decorative form.

5. Conclusions

This paper shows how early Islamic architecture assimilated elements from various civilizations they contacted, improved upon those, to be used by the rest of the world, for example the way the arch was adopted in European architecture to provide solutions to many practical and intellectual problems. The Islamic arch has never slept due to its structural and decorative functions as well as its universal adaptability (Saoud, 2002). Architecture between Malaya and Morocco, Europe and both the

American continents would show widespread use of semi-circular, horseshoe, pointed, ogee, cusped or multi-foil arch – a Muslim contribution to the world of architecture (Curiel, 2004).

The golden age of the Muslims (900-1200) matched with their rule in Spain. This flourished in many urban centers e.g. Baghdad, Damascus, *Qayrawan*, Cordoba, Seville and Cairo, in liberal societies with intellectual atmosphere independent of the religious authorities. The Muslims passing through stagnancy at the onset of Renaissance did not try to catch up with Reform, Enlightenment, or the Industrial Revolution (Ali, 1999). Mansfield (1992) identified other factors like the Central Asian invaders, the deterioration in agriculture in the Middle-East and North Africa, and the discovery of the maritime route around the Cape that caused rise of Europe and affected the Muslims.

Al-Andalus, Sicily and the Crusades linked the Islamic World and the West to bring Renaissance, including in artistic persuasions and thought process (Draper, 2005; Howard, 1991). Yet Judeo-Christian focused western civilization avoids this reference. The arabesque, the genuine epitome of Islamic design with an aesthetic value and spiritual connotations, exemplifies the influence of Islamic art on Europe. This was adopted and adapted in illuminated manuscripts and on walls, furniture, metalwork and china. Origin of arch did not interest the scholars of Islamic architecture until the badgering of Western search for Gothic's roots (Draper, 2005). A misguided focus of the Gothic literature from the Seventeenth to Nineteenth Century was largely subsumed within a greater interest in the origin of rib vaulting, which shaped current view on medieval architecture. Search for the origin of pointed arch, fundamental to the Gothic style, had a nationalistic concern underlying the revival of interest in Gothic during the Eighteenth and early Nineteenth centuries. Draper (2005) in fact sensed a rivalry among European scholars rejecting external influence in order to establish the roots in their own lands.

The arch was one among a number of forms found in Islamic architecture; the experiments suggest active search for its variations. Often argued in the early Nineteenth Century that pointed arch was accidentally discovered as an intersecting arcade, the fact of its import into Western Europe from Islamic architecture was eventually accepted (Draper, 2005). With progress of Gothic Revival, polarized viewpoints with powerful overtones saw the pointed arch as a Northern European contribution in an antithesis of classical tradition. Historians attempted to disentangle from a thicket of prejudice and conjecture about the main thread of architectural growth described as the Dark Ages: Ruskin's dogmatic, moralizing, Christian standpoint did not prevent him from admiring the positive qualities of eastern architecture and the spiritual sincerity of its tradition. Ruskin (1851) recognized the debt to Islam while opening European eyes by stating that its architecture was colored and perfected from the East: while the northern burghers were living in dark streets and grisly oak castles, the Venetian merchants were covering their palaces with porphyry and gold. He identified the Muslim influence to about 1180, as the Byzantine-Roman style was succeeded by a distinctly Islamic transition in more slender shafts and consistently pointed arches.

Foisting Western concern onto Islamic culture distorts historical perspective and understanding of origin and interrelations of various elements (Hillenbrand, 2003). Studies on Renaissance onwards assumed the superiority of classical semi-circular arch, more pleasing and considered stronger than pointed arch that destroyed the former. It was an aberration from correct form, showing the intrinsic decadence of the Gothic manner of building (Draper, 2005). Wren asserted that rather than naming after the Goths who were destroyers not builders, to call it *Saracenic* would have been reasonable. Since the westerners lost both art and learning, they borrowed out of the Arabic books diligently translated from Greek. Wren recognized the vital role of the Muslims in the

transmission of the classical tradition. Fenelon, archbishop of Cambria, recognized that: "This architecture we call Gothic came down to us from the Arabs; lively and unrestrained by rules or culture, could not do otherwise than plunge into false subtleties" (Frankl, 1960).

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