Sources of Influence on Gothic Architecture

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SOURCES OF INFLUENCE ON GOTHIC ARCHITECTURE

by

FRANK MILLS LESCHER

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HE擠 HEAD OF DEPARTMENT OF ARCHITECTURE
PREFACE.

In the beginning, I wish to apologize to the readers who may in the future look over this effort. Some may think that an undergraduate thesis upon such a subject is presumptuous. I realize myself, now that it is too late, that I might better have employed my time upon the usual thesis in design which falls to the candidate for graduation in architecture. At the same time, however, I have obtained a great deal of pleasure from the study necessitated by this work, and if, in the future, some graduate student in architecture or archeology should find herein even one small item that may set him upon a line of thought that will lead to the discovery of new facts in those sciences, I shall feel amply repaid for what labor I have expended.

I wish to state also, that in many cases I have quoted almost bodily from some of the authors whose works I have studied in preparing for this thesis. Wherever that has been done, I have endeavored to give full credit for such quotations, and if credit has not been given, it is an oversight on my part. A complete list of those works is given at the end of this thesis.

I wish also to express my thanks to Professor F. M. Mann, the head of the Department of Architecture, for the aid he has given me, and the suggestions he has made as my official thesis adviser. I wish also to thank Professor N. C. Ricker for the loan of books from his private library, and for suggestions he has made.

June 1, 1911.

F. M. L.
## CONTENTS

The **Definition** and Origin of Gothic Architecture. .................. Page 1.

Social, Political, Religious, and Commercial Influences. .............. 17.

Gothic Constructive Principles. ....................................... 27.

Ribbed Vaulting. ....................................................... 27.

The Pointed Arch. ..................................................... 54.

The Clustered Pier. .................................................... 67.

The Flying Buttress. ................................................... 67.

The Chevet. ............................................................ 74.

Portals, Windows, and Tracery. ........................................ 81.

The Spire. ............................................................. 83.

Moldings, Ornament, Sculpture, Painting, and Stained Glass. ........... 91.

General Conclusions. .................................................. 104.

Bibliography. .......................................................... 109.
SOURCES OF INFLUENCE ON GOTHIC ARCHITECTURE.
CHAPTER I

The Definition and Origin of Gothic Architecture

In attempting to define Gothic architecture, it is well to look first into the origin of the term "Gothic" as applied to the style of architecture that reached its highest development in France in the thirteenth century.

Reinach, in his "Apollo," says, "The expression Gothic Art is inaccurate, for the art which succeeded to Romanesque art was neither created nor propagated by the Goths. The term is said to have been first used by Raphael, in a report he addressed to Leo X, dealing with the works projected in Rome, Gothic being used at that period as a synonym for barbarous, as opposed to Roman. The use of the expression still survives in the term Goth, denoting an uncouth and mannerless person. The use of the epithet Gothic was popularised by the historian of Italian art, Vasari (1574), and still persists."

Corroyer, too, in his "Architecture Gothique," holds much the same opinion regarding the use of the term. In his opinion, the use of the term is purely conventional, and had its origin in an ironical use of the word to denote that the style for which it stands was barbarous, and could have been conceived by no one
save savages. He feels that it is particularly the case, since the Gothics and Visigoths, conquered by Clovis in the sixth century, left hardly any monuments to commemorate the fact that they had once occupied Gaul. He says further, that the term is as incorrect as the later term, "Architecture ogivale," accepted by authors who believe that the "arc-brise", improperly called "ogive" is the distinguishing characteristic of the style of architecture called Gothic.

Simpson, in his "History of Architectural Development," holds much the same opinion, saying that the word Gothic conveys nothing as to the origin of the style, and is meaningless, being first used by the Renaissance purists of the seventeenth and eighteenth centuries as a term of reproach, directed toward an architecture that they had ceased to appreciate or to understand. Sir Christopher Wren, writing from the Continent of Europe, speaks of the "barbarous Gothic" erections that he had viewed in his travels.

A quotation from Addison and Steele, in the "Spectator" of May twelfth, 1711, shows the general feeling of that time toward the Gothic style. It is as follows, "...a monstrous Fabrick, built after the Gothick manner, and covered with innumerable Devices in that barbarous kind of Sculpture." Nothing could show more clearly the origin of the term, expressed thus in a paper which had for that day a wide circulation.

Having thus seen the origin of the term Gothic, it is well, in order to have a firm basis from which to work, to construct a definition for Gothic architecture--one that will enable the writer to determine the essential elements that go to make up
the style in its entirety. Moore says, in his "Gothic Architecture," that the style differs from arched Roman and Romanesque far more fundamentally than by the use of pointed arches in place of round arches, or the substitution of one type of ornament for another, although at the same time Romanesque elements are proper to Gothic, which is an art not only developed from Romanesque, but which is Romanesque completely developed. Nearly every constructive member of a Gothic building exists in a rudimentary form in a vaulted Romanesque structure. The principles that are later to become those of Gothic are not entirely worked out in the Romanesque type. The author says that the so-called "French Gothic" of the eleventh and twelfth centuries is the only true Gothic. It is, indeed, the most perfect Gothic, both in constructive features and in the beauty arising from those constructive features, but other countries, notably England and Spain, following closely the pace set by France, built Gothic structures that were as true to type as anything that France produced, although they perhaps lacked the daring originality and exquisite finish of the French structures.

Reinach gives as a definition of Gothic architecture, the use of the "ribbed vault, the flying buttress, and a decoration introducing natural forms, the plants and fruits of the region around the building." In addition to this, he speaks elsewhere of the distinction between the Romanesque and Gothic styles as lying in the use of the round arch for the former, and the pointed arch for the latter. As Moore indicates, no greater mis-
take can be made than to suppose that a hard and fast line separates Romanesque and Gothic architecture. Reinach has to a certain extent made this mistake, in laying too much weight on the pointed arch as the dividing principle between the two styles.

Simpson says, "by Gothic is meant pointed arches, ribbed vaulting, and flying buttresses, combined with a new system of moldings, and a fresh feeling in carvings." This agrees rather closely with Reinach, and also with the principles that Fergusson has enunciated as being peculiar to the Gothic style.

Ruskin changes his view somewhat, in that he believes that the principal distinction between styles of architecture depends on their methods of roofing or covering any space; that is, the character of Gothic architecture depends on its roofing spaces with pointed arches or gables—a distinction that ignores almost entirely the vital element of Gothic—its principle of construction.

In formulating a definition for Gothic architecture, the fact must be kept in mind that this style is essentially a constructive one, and that a definition which does not bring that fact prominently to the fore, does not do justice to the leading characteristic of the style. Keeping this in mind, I would formulate a definition as follows: "The Gothic style includes those edifices which employ the principles of the pointed arch, and of opposing forces neutralizing each other so that equilibrium is attained, together with a fresh system of moldings, and a system of ornament derived from the forms of Nature." This may not cover the principles of Gothic as well as might be, but it does...
the essential points in as few words as possible.

Turning now to the origin of the Gothic style in general, we find that the Gothic system was immediately evolved from the Romanesque of Northern France, (Moore) which began to assume its characteristic forms in the eleventh century, and reached its most complete type in the nave of the Church of St. Etienne of Beauvais, about 1110. The principles and elements of this Romanesque architecture were, however, partly derived in their turn from more ancient sources, and from various localities.

In fact, the evolution of the architecture of the Middle Ages begins with the earliest departures from the principles and constructive forms of the art of imperial Rome, and culminated in the Gothic art of the twelfth and thirteenth centuries. The new Romanesque movement first found its full expression, as Romanesque, on the plains of Lombardy, from whence it spread through Germany, where the seed had already been sown in the time of Charlemagne, leaving behind it, on the shores of the Rhine, some of the finest monuments of the period, and westward through Southern France, where it had to contend at first with other traditions of an earlier art. Soon Normandy was reached, almost virgin soil, and then the style leaped across to England.

The various types of Christian Roman and Romanesque buildings which survive to the present day are but so many phases of a transitional art, except those which are manifestly survivals of old forms devoid of progressive character.
With few exceptions, this fact has hardly been recognized by writers on medieval architecture. It was practically implied, however, when Quicherat, forty years ago, have his excellent definition of Romanesque, which is as follows, "Romanesque architecture is that which has ceased to be Roman, although it retains much of the Roman quality, and which has not yet become Gothic, although possessing many Gothic traits." This definition removes the beginning of Romanesque to a period far before the eleventh century, when that of Northwestern Europe first takes form. Other authorities, most of them in fact, agree with this. If that architecture is Romanesque which has ceased to be Roman, while yet attaining to the qualities and elements of Gothic, without becoming Gothic, then we must look for the beginnings of Romanesque in those architectural systems which exhibit the earliest innovations on the principles of Roman design. Those systems arose in the Eastern Countries, chiefly in Byzantium, where conditions became favorable for a fresh impulse in creative art after the decline of the older civilization of Rome. The search for the origin of and sources of Gothic must begin with these countries of the East, where lies the nascent Romanesque.

The architecture of Rome was incapable of any change for the better without material changes in principles and forms. The cross vaults, with their elliptical and wavy groin lines, were incapable of further development without an entire change. Walls and piers that sustained the vaulting covered altogether too much area. The orders as applied to the Roman buildings served no con-
structive purpose whatever, but were entirely superficial. The Palace of Diocletian at Spalatro, dating from about 300, shows however, a change that was later to be an important element of the Byzantine style. This was the springing of arches directly from the tops of the columns. Reber ("Ancient Art") thinks that the Roman private basilicas, for a century or so before Diocletian's time, had side arcades in this same style, but Diocletian's villa is the first prominent instance of the change. Fergusson, Lubke, and Spiers and Anderson all agree that the origin of the change was about a century earlier than the instance at Spalatro.

The earliest departures from Roman forms were for the most part in the cities of Central Syria, although the early Coptic churches of Egypt showed some rather marked changes, and were no less accessible on account of Moslem occupation during the early part of the Middle Ages. These constructions attained to structural features which, in the fifth and sixth centuries, gave them a strikingly Romanesque appearance.

In these constructions of Central Syria, arches always spring from heads of piers or columns, no pieces of entablature are interposed, and there is none of the Roman framing in of arches by means of columns and entablatures. It is not certain whether these constructions are simultaneous with like features in Rome, or whether they were adopted from Roman models. De Vogue ("Syrie Centrale") shows that the Pretoire de Mousmieh, at the village of that name, was built under Marcus Aurelius, about 160-169, while
Rome and its dependencies were yet pagan. This structure shows the arches on each side of a square plan to be sprung from the heads of Corinthian columns. The Basilica of Chaqoa (of the second or third century), shows arcades sprung from piers, and the Basilica of Qennaouat, of the fourth century, shows arches sprung from the heads of Doric columns, in much the manner of Diocletian's villa. It is reasonable to suppose that these constructions might have started independent of Roman models. Where arches are sprung across the nave, dividing it into bays, additional supports are inserted, which are grouped with the piers of the longitudinal arches in a way that presages the later grouping of supports in the Romanesque and Gothic systems. Vaulting is rare, and is of the simple barrel or cross type where it does occur. Short shafts are sometimes used, resting on corbels against the clerestory walls, and supporting the timber roofs. This arrangement was later used in the Romanesque of Southern France.

A building that one might say foreshadows the Gothic western front is seen in the basilica of Tourmanin, in Syria. Here we see a small portico, formed by a round arch, and flanked on each side by a low tower, rising to the height of the nave, and connected above the first story by a colonnaded gallery, which partly masks the front of the nave.

In the Byzantine Empire, the great change from the Roman system was in the use of the pendentive dome, or cupola. The cupola was known to the Assyrians, and was adopted by the Persians from them. From Persia the tradition had spread into Syria, so
that the Byzantines must have had a direct Asiatic influence directing them in the use of this feature of the dome. The Byzantines, too, must have had some aid from Syria in the practice of placing the arches directly on the heads of the columns, although the impost block that we see used is probably the remains of the bit of entablature remaining from Roman practice.

The Gothic plan is, in general, the old Roman basilican plan, modified by the requirements of the Christian Church, and by the exigencies of the new system of construction. In Early Christian times, the private basilicas of Rome, not the public edifices, were used for Christian worship, as these were more private, and consequently gave less opportunity for interference than if services were held in the forensic basilicas. These latter were used, it is true, but not until after the Christian faith had become the state faith of Rome, at which time some of them were converted to the service of the church. A circular plan was not uncommon in the Roman period, and such constructions doubtless furnished the model for some of the circular churches of the early days, in some cases being used themselves, like the basilicas. When the Romanesque style began to take organic form as such, an innovation was introduced, in making the plan of the shape of the Latin cross, thus giving rise to the transepts. The cross shaped plan was not a novelty peculiar to the Romanesque, as the Byzantines used a plan based upon the Greek cross—a feature that is noticeable in most byzantine structures of any size. When we come to Gothic times, however, the system of construction determines the plan to a con-
siderable extent. In these churches and cathedrals, it was necessary to take care of a large number of people. As the breadth of the church was largely determined by the builders' ability to spring his vaults across a space, the extra space for worshippers must be obtained by additional length, covered by similar bays of vaulting. Transepts also gave additional space for attendants upon the services. The side aisles gave space for worship, and also furnished a route for the passage of the processions. The apsidal aisle was developed in order to give more freedom of movement to these processions.

Here and there through France there are isolated examples of deviations from the general trend of the Romanesque work. The Church of St. Philibert of Tournous (Saone-et-Loire), dating from the first quarter of the eleventh century, is an example of this. This church shows a nave covered with a succession of barrel vaults whose axes are perpendicular to the long axis of the building. They are carried on transverse arches springing from short shafts which rest on great cylindrical columns that support the main arcades and divide the nave from the aisles. The aisles are covered with groined vaults on transverse ribs. The nave vaulting exerts no thrust laterally, and there may be openings in the ends of the vaults like those of a clerestory. This is a very ponderous and inelegant arrangement, and one that had no further important application. It resembles some of the Persian and Syrian types that are shown by Dieulafoy in "L'Art Antique de la Perse."

Another unusual type, showing the strength of the
Byzantine influence, is the Church of St. Front at Perigeux, and a group of similar buildings in Acquitaine. St. Front is a Byzantine structure vaulted with a dome on pendentives. The pointed arch was used in the support of these domes, but Moore inclines to the belief that it had no structural significance. It might, however, have furnished a model for the use of the pointed arch at a time when need was felt for some expedient to make vaulting less difficult.

In the North of France the groined vault had been used almost exclusively, while in the South, the barrel vault had been almost equally used. In parts of Burgundy and Auvergne, however, these influences of the North and South meet, so that buildings exhibit the characteristic qualities of both—that is, barrel vault and groined vault are used conjointly. This scheme was carried out in the Abbey Church of Cluny. In this case and others like it, there was a barrel over the nave, and groined vaults over the aisles, the latter being low enough for a clerestory. This arrangement is illogical and weak, although heavy walls and vigorous buttressing permitted the building to stand until it was destroyed during the Reign of Terror.

In Sicily and Southern Italy there was a peculiar combination of architectural principles. The Greeks had originally colonized the territory, and left many architectural monuments there. Then the Romans had entered into possession, and left their traces, followed by the Byzantines. These in their were driven out by the Moors at the time they over-ran Europe, but these again were
conquered by the Normans, who invaded the territory in the eleventh century. Thus we have a peculiar pointed architecture in Sicily and Southern Italy, but one in which the pointed arch has no relation to the vaulting save in a few isolated instances, as in the apsidal vaulting of the Cathedral of Naples. The great churches of Polermo, Monreale and Cefalu, are basilican structures modified and embellished with elements derived from Byzantine and other Eastern sources, but without any Gothic features. This region, in spite of its accessibility, and the strong combination of architectural motives, had very little effect upon the architecture of Western Europe.
CHAPTER II.

Social, Political, Religious, and Commercial Influences.

Gothic architecture is, first of all, Christian architecture. Without the influence of Christianity, one may feel safe in stating that Gothic architecture would have been much delayed in its development, if it had come into being at all. For this reason, it is hardly necessary to go back of the Christian era in the search for general influences on the Gothic style.

The Christian era, as far as architecture is concerned, may be said to begin with the edict of Constantine, promulgated from Milan in A. D. 313, which accorded to Christianity equal rights with all other religions. This edict relieved the Christians from the necessity of worshipping in secret places, and encouraged them in the preparation of places for worship—either remodeling Roman edifices, or building to suit the needs of the church. In A. D. 323, Constantine announced his conversion to the Christian faith, which then became the established faith of the Roman Empire.

Another very vital source of influence lay in the removal in A. D. 324, of the seat of the Roman government to Constantinople, where Constantine reigned until his death in A. D. 337. This date marks the end of the old Roman political system, and
with it, the sharpest decline in the power of Rome that had yet been seen. From this time forward, the power of Western Rome declined, and the Empire of the East, or Byzantium, became the ruling power, as is shown by the fact that Gregory the Great (590-604), when besieged by the Lombards at Rome, employed the imperial army of Constantinople in the defense of Rome. In Italy, Theodoric the Goth reigned from 493 to 526, a period of great peace and prosperity, during which Byzantine art exerted great influence on Early Christian art, by way of Ravenna, which was the seat of the Gothic dynasty, and was, in 539, important as the seat of the Exarch of the Byzantine Emperors, a position retained by the city until 752.

After this period, kings of separate states were elected in Italy, Spain, Gaul, and Northern Africa, Odoacer, the new King of Italy, recognizing the supremacy of the one Roman emperor at Constantinople. The emancipation of the West from direct imperial control aided greatly the development of Romano-German civilization, which made possible the growth of new states and nationalities, consolidated and enlarged the power of the Christian Church, and caused the Roman language to separate into dialects, these later developing into what are called the Romance languages.

During the reign of Gregory the Great, mentioned above, the Latin language and Early Christian architecture, both the heritage and outgrowth of Roman civilization, ceased to exist, and for the next two centuries architecture was practically at a standstill in Europe, until the beginning of the Carolingian epoch.
During this time, however, there had been, in Central Syria and in Egypt, a form of Christian architecture built up, which, had it not been for the rise of the Moslem hordes, might have developed into a distinct style, based on the architectural remains left by the Romans in those districts. This was particularly the case in Syria, which was a possible source of influence on Romanesque architecture, and thus on the Gothic style of Europe.

Byzantium, as has been noted, did not become of importance until the removal of the seat of Roman government to Constantinople. This city occupies an important commercial site, standing as it does at the intersection of the two great highways of trade, the water road from the Black Sea into the Mediterranean, and the land route from Asia into Europe. Owing to this strong commercial position, we find that the Byzantine art influences were carried westward by traders, and we find them strongly marked in Venice, Ravenna, and the South of France, and in the southern part of Italy and the island of Sicily.

Byzantium was originally a Greek colony, a fact which has much to do with the character of the art that carries its name. When the Roman was first removed to the East, the Roman style of building was carried with it, the old Roman traditions still dominating all architecture; but toward the end of the fifth century, the Greek artistic feeling, the influence of which through the centuries of Roman domination had been considerable, found at Constantinople under the Eastern emperors, opportunities for free expression greater by far than it had previously enjoyed. The re-
result was a real revival of art, which culminated in the sixth century in the building of St. Sophia, and in the consolidation of existing methods of construction and ornamentation into what was practically a new style, possessing strongly marked characteristics. The traits of this style quickly spread through all the towns and districts which were under Eastern rule. Greek workmen, coming from Byzantium, exercised great influence in Early Christian art, and their influence is to be seen in many of the specimens of that art yet extant, especially in mosaic and wall-painting.

A series of struggles that meant much to Western art were those in connection with the ascetic heresy of the image-breakers, called iconoclasts, who gained the upper hand for a time, and during the ninth century, not only destroyed many of the works of art in Constantinople and other parts of the Empire, but drove the Byzantine sculptors and mosaic workers from their native land, many of them taking refuge at the court of Charlemagne, at Aix-la-Chapelle, where they again took up their work, influencing greatly the minor arts of the period and country.

The principal motive of Byzantine architecture is the dome raised upon pendentives, a feature that had no hitherto existed in any land, although we find a forerunner of it in the domes of the Sassanides, raised as they were upon squinch arches in the corners of the square apartment over which the dome was placed. In connection with this domed covering is seen the square of cruciform plan that was later to be prominent feature of Medieval architecture, almost equal in importance to the basilican plan of the
Gothic period.

Leaving the East, we turn again to Western Europe, the art of which had fallen into decay—had even disappeared almost entirely from view. The transition from Early Christian to Medieval architecture is formed by the Carolingian period, that of Charlemagne (768-814), and of his successors of the ninth century. This ruler was the true founder of Medieval customs and culture—a broad-minded genius, who lived for the accomplishment of his chief desire, the restoration of the old Roman empire, with its civilization and its arts upon the soil of Germany. Under his, Roman, Byzantine, and to a small and somewhat indefinite extent Mohammedan culture influences combined with German character.

The character of the people of the Holy Roman Empire was a curious admixture of different national elements. Primarily Christian, the Carolingian was then German-Roman, with a strong tincture of the Byzantine Greek, opposed by the wilder influences of the North, which had but lately come under the influence of Christianity. The architecture of the period was influenced by all of these elements, unified by some study of Vitruvius, (Ricker's Translation of Redtenbacher's "Medieval Architecture.") so that in general the style was a sort of Proto-Renaissance, perhaps modified by Mohammedan elements, for Charlemagne had conquered a part of Spain in 778, when Moorish art was at its best, and had later contracted a sort of alliance with the rulers of the Abbasides dynasty, which had its capital at Bagdad.

After the death of Charlemagne in 814, his domain fell into the hands of his grandsons, Lothair, Louis, and Charles, who
however, were much weaker than he had been, and destroyed his work of union by the treaty of Verdun, which gave rise to the three national groups, Gallic, Germanic, and Lombardic. After the fall of this dynasty, there were civil dissensions brought on by the constantly changing government, as well as invasions by the barbarous tribes from the North, and the Huns and Slavs from the east. This time, too, marks the beginnings of the feudal order, due to the perilous and uncertain character of the times. The great nobles inclined more and more to build their strongholds on steep heights, that they might be more easily defended, while the lower classes inclined toward uniting their forces in walled towns. The period was one of general stress and peril, and there was no time for the development of the arts save in the monasteries which were being built up at the time, as the time of the people was taken up almost wholly in the defense of life and what little property there was.

The most strongly predominant influence existing at the close of the Carlovingian period was undoubtedly that of the religious organizations. From the Carlovingians to the Crusades is the consolidation of the three great western kingdoms, under the Capets, who ruled in France from 987 to 1328. After Charlemagne and his dynasty, two powers controlled Italy, the Roman-German Empire till 1056, and the Papacy soon afterwards. Under Charlemagne, the Pope was merely the first Bishop of France. The secular authority of the Pope was established under Gregory VII (died 1085) by the subjugation of Henry IV at Canossa. The period from 1085
till 1254 is that of the contest between Papacy and Kingdom. In 1076, the city of Jerusalem fell into the hands of the Seljukian Turks, whose ill-treatment of the Christian pilgrims who had been going to that city in hordes aroused the wrath of Peter the Helmit, and caused the first Crusade, which went forth under the direction of Urban II, who, with his successors, carried out that and the succeeding Crusades. The prediction that the world was to come to an end in the year 1000 had much discouraged enterprise of all kinds, and especially building, but after that time had passed, and the fear of the end seen to be unfounded, a new love of life was aroused, with a spirit of willing sacrifice in favor of the church. The ruinous ancient churches were rebuilt, and numerous churches and monasteries were founded.

The foundation of the monastic orders had much to do with the architectural development of Europe. These orders—the first of which was that of the Benedictines, founded in the sixth century, in Italy—were communities of monks, where the arts and industries, as far as they were at that time known, were practised in great perfection. These were the universities of the period—the schools of art and science, of enlightenment in general—and exercised an enormous influence in the growth and development of the civilized world at that time. Down to the thirteenth century, architecture was practised only by the clergy, and came to be regarded as a sacred science. The monasteries were so completely supplied with all the necessities of life that a really isolated life could take place in them; all necessary trades and art in-
dustries were carried on there; architects, sculptors, painters, masons, stonecutters, cabinet makers, and locksmiths wrought there as well as workmen employed for other material needs of life.

The first steps in the development from Romanesque to Gothic occurred in the monastic churches, before the great cathedral movement set in. The monastic orders of the north were much less given to seclusion, contemplation and inaction than those of the south, so that they soon became energetic builders. There was much mutual intercourse and interchange of ideas, together with a development of the spirit of invention. The monasteries had been free from pillage, so that they had accumulated considerable wealth and they were thus enabled to enter upon building operations much more extensive than those of the impoverished secular communities. As already stated, monks were largely the architects of the period, and where this was not the case, the architects had been trained in the monastic schools, so that Gothic, when it finally developed, was primarily the architecture of churches, and was applied to secular buildings only so far as its principles could be made to serve the needs of these latter.

The commerce of the period had much to do with the spread of new architectural ideas. As has already been noted, Byzantium had its capital upon the junction of the great land and water routes over which came the travel and trade between Europe and Asia. This naturally caused more or less influence from the East to be exerted on the architecture of the Byzantine Empire, which was probably in its turn passed on to the architecture of Western
Europe. Venice was the intermediary of Byzantine commerce, and consequently to a great extent of the commerce with Asia, and had in addition, large manufacturies of her own. Byzantine and Venetian workmen were in demand throughout Europe, for the quality and taste of their designs and workmanship, and undoubtedly aided much in disseminating art principles throughout the West, even though that art had become quite decadent. Byzantine influence was especially strong in Western France—markedly so in Acquitania—due to the fact that all communication between Venice, as the intermediary of all commerce with the East, and Northern France, passed along the main route through Western France to avoid the long voyage around Spain, and the passing of the Straits of Gibraltar, at that time made unsafe by Arab pirates. The maritime traffic with the East found safe port at Marseilles and Narbonne, whence goods were carried beyond Limoges, the seat of an ancient Venetian colony, to Nantes or Rochelle, and even to Brittany, Normandy and England. The arrival of the Venetians at Limoges in 988 or 989 decided the coloring of the entire civilization of Western France; from thence the merchants sent their goods in all directions. The important Abbey of Perigeux was founded shortly before by Venetians, and served as a model for many churches in Western France.

The Lombard workmen, who had done so much to advance architecture in their own province, had migrated into Gaul before the eleventh century, and undoubtedly had much influence there in shaping the architectural destiny of the province.
The people of the South of France were of a different race from those of the North. Burgundy, at the beginning of the eleventh century, was part of the German Empire; the Dukes of Normandy and Brittany were to all intents and purposes their own masters; and in both North and South were other dukes and counts who practically ruled as they pleased their large domains. They acknowledged the King at Paris as their suzerain, but suzerainty in feudal days were a very doubtful quantity. In the latter half of the twelfth century, more than half of France belonged to the King of England, or was dependent on him; and although the beginning of the thirteenth century saw a vast extension of the French King's territory and influence, a large portion of the country still remained semi-independent. Many of the Bishops and Abbots of the Church were temporal lords as well, holding vast estates under the feudal tenure.

Notwithstanding the slow and tedious methods of transportation of the Middle Ages, travel was surprisingly frequent and extensive. In addition to the pilgrimages which were at all times being made to the Holy Land, and the other sacred places of the East, there was considerable travel on business and pleasure, guarded somewhat against the attacks of the robber barons, but nevertheless much freer than one would suppose could be the case. All of this had its effect on the interchange of ideas, and had its part in the building up from the heterogeneous fragments of the past art of many countries the style that we of today call Gothic.
CHAPTER III

Gothic Constructive Principles.

As we have already noted, the great underlying principle of the Gothic constructive system is in the action of forces which are opposed to and neutralize each other. The real beginning, then of this constructive system is in the development of ribbed vaulting, which is able to take the thrust of the entire vault and transfer it to a support. This is first met with in the Lombard churches of Northern Italy, dating from the eleventh century.

A brief resume of the constructive steps in the evolution of Gothic would be about as follows; An arch exerting side thrust was first employed. There are two ways of meeting such a thrust—by means of external abutments, and by downward pressure on the walls or piers against which the thrust operates. The development of the buttress to meet the thrust began in the Romanesque style, when the hitherto ornamental pilaster strip became a true buttress. At Caen, in the Abbaye-aux-Hommes, and in the Abbaye-aux-Dames, half barrel vaults were used to counteract the nave thrust, being in effect concealed flying buttresses. The next step was the discovery that the pointed arch exerted a much less powerful side thrust, and that its use also obviated many of the difficulties of vaulting irregularly shaped compartments, due to the facility with which its crown could be brought to any practical height without increasing the span of the arch.
Since the vaulting had come to rest upon a framework of ribs, there had been an attempt to carry the ribs down to the ground, in order to form a support that would thus member organically with them. This was carried out consistently, and gave rise to the form of column that was characteristic of the Gothic style. Finally the entire construction becomes a frankly confessed framework, or skeleton, to which is applied the roof and the glass of the windows.

Moore gives a very excellent outline of the Gothic constructive system, which I shall quote entire. He says, "The distinctive characteristic is that the whole scheme is determined by, and its whole strength made to reside in, a finely organized and frankly confessed framework rather than in walls. This framework, made up of piers, arches, and buttresses, is freed from every unnecessary encumbrance of wall, and is made as light in all its parts as is compatible with strength--the stability of the fabric depending not upon inert messiveness, (except in the outermost abutments), but upon a logical adjustment of active parts whose opposing forces neutralize each other and produce a perfect equilibrium. It is a system of balanced thrusts in contradistinction to the ancient system of inert stability. Gothic architecture is such a system carried out in a finely artistic spirit."

Simpson gives a brief summing-up of the principle of thrust and counterpoise in his "History of Architectural Development," which might be of value and interest.
may be necessary to state that the "tas-de-charge" is made up of several horizontal courses of stone, which form a base or skewback from which to start the vaulting ribs, and which have the ribs carved upon their faces.

The tas-de-charge itself offers resistance to thrust, and consolidates them at given points.

The tas-de-charge itself offers resistance to thrust, and also decreases the amount of thrusts, inasmuch as the live portion of the vault is decreased by the amount of the tas-de-charge.

A high wall above the point of pressure tends to divert a lateral thrust into a vertical.

Pinnacles act in the same way.

Flying buttresses transmit thrusts to abutments.

Abutments that are weighted by pinnacles can be built somewhat smaller than when not so weighted.

In the Gothic constructive system, as has been noted before, the pointed arch has its greatest reason for being in the fact that its thrusts are very much weaker than those of the round arch, and can consequently be more easily neutralized. Furthermore, if the pointed arch is used to any extent at all, it must be used practically throughout the structure, in order to secure architectural harmony. In some places, however, the round arch, stilted, is to be preferred, notably in the case of the wall, or longitudinal rib, for the reason that the stilting enables the builder to concentrate the thrusts of the transverse
and diagonal ribs much more nearly in a point than would otherwise be the case, and gathers the vault strains upon the compact pier, which is effectively stiffened by the flying buttresses. Uniformity of parts and symmetry are thus seen to be ruthlessly abandoned when they are not demanded by structural exigencies.

Ruskin, in his "Seven Lamps of Architecture," write as though though there had been an impression in his time that Gothic architecture was not purely a constructive style, but instead derived its inspiration from the forms of vegetable life; that the columns were the trunks of trees, translated into stone, and the arched and branching ribs of the vaulting were the spreading branches of those same trunks: the whole symbolic at once of nature, and of the upward yearnings of the human spirit, compared to the turning of the tree toward the sun-filled sky. Such an origin for a consistently constructive style like Gothic is of course only the creation of a poet's brain.
CHAPTER IV.

Ribbed Vaulting.

The most characteristic trait of Medieval architecture is vaulting, and yet it is by no means universal, either in Romanesque or Gothic work, although the true Gothic cannot be said to be such unless it has ribbed vaulting. This lack of universality was due more to the difficulty of vaulting large spans than to any other reason, as we see in some of the earlier buildings, where a timber-roofed nave is flanked by vaulted aisles.

The vault was no invention of the Middle Ages. Of the two basic forms, the barrel vault and the intersecting or cross-vault, the former was well known to the Egyptians and Assyrians, and both were used extensively by the Romans. The seven sanctuaries of the Temple at Abydos are roofed with vaults made in horizontal course, and rounded off afterward with the chisel, although this is not a true vault, but rather a sort of lintel. The Egyptians, however, used a true vault, which is described by Professor Flinders Petrie as being composed of three rings of crude brick, of about the date of the fourth or fifth dynasty (B.C. 3600.) Mariette says that he found a semi-circular arched vault at Abydos of the sixth dynasty with brick voussoirs and limestone keystones.

The Assyrians employed the arch and vault, even pointed vaults, which were used to cover drains as well as rooms, and
were built with voussoirs, and not in horizontal courses, thus being true vaults. At Lycia, in Asia Minor, rock-cut tombs are seen in the tomb of Atreus, at Mycenae, which is circular in plan, and covered with a pointed dome, laid up in horizontal courses.

The Cloaca Maxima, in Rome, which dates from the time of the early Etruscan kings, about the sixth century B.C., is covered by a stone vault with radiating voussoirs, and is probably the oldest true arch or vault in Europe. The Greeks possibly used vaults or arches in their domestic work, but as none of this has survived to the present day, we have no sure way of proving that this was the case, although there is no reason to think that they did not use such a form if older and more primitive civilizations had made use of it.

The Romans were the first people to use vaults consistently and regularly. These Roman vaults are nearly always of concrete, especially the larger ones, and are so constructed as to form a homogeneous mass, which, after it has once set, exercises no lateral thrust, except by reason of the elasticity of the concrete. If they have been built of brick or stone in the same manner as those of the Middle Ages, their construction would have been almost impossible, owing to the enormous thrust that they would have exerted. The two kinds of vaults that were most popular with the Romans were the barrel vault, and the cross-vault, made by intersecting two barrel vaults at right angles. The smaller vaults built by the Romans were, however, constructed with voussoirs, in the same manner as arches.
The architecture of the Romans followed the eagles of the legions throughout the countries conquered by them. All through Southern France we find the monuments of the Empire scattered over the country, and preserved to become examples to the builders of a later generation. The building that goes by the name of the Baths of Diana, at Nîmes, is such a monument, and might have served as a model in the use of rib centering and infilling. The barrel vault that covers this building is of stone, with ribs, which were built first, and used as a centering for the remainder of the vault, which is made up of stone lintels, spanning the space between the ribs, and thus covering the space beneath.

Syria was settled as a Roman colony, and thus started with the Roman ideas of building. During the latter days of the Western Empire of Rome, Roman architects introduced many modifications, and dispensed altogether with piers and attached columns, placing the arches direct on the tops of ordinary columns. This was a distinct step in advance, and one that was followed by the Byzantine and later builders. The entablature was still retained, but it became merely a decorative string-course above the tops of the arches. We see this same feature in Syrian work. In the church at Roueiha, there is a basilican plan, in which the arcades consist of three arches on each side, which spring from stumpy T-shaped piers, from which transverse arches are also sprung. The Church at Calb-Louzeh has no transverse arches, but does have detached shafts between the clerestory windows, which rest on carbels, and support the beams of the roof. Similar
short shafts were afterward used to support vaulting ribs in the Romanesque. Some of the churches in the southern part of Syria are vaulted with stone. The secular basilica of Chaqqa, which is of the third or fourth century, shows vaulting much like that of the Baths of Diana at Nimes.

The Sassanian architects used the vault to a considerable extent. In the Palace at Ctesiphon, built by the Sassanian king Chosroes I, who reigned from 531 to 579, is seen a great barrel vault, which is elliptical in section, and is of brick, placed edgewise in four or five rings. In the architecture of the Sassanians we see another expedient beginning to come into use. This is the principle of the pendantive. In none of the Sassanian palace is the true pendantive to be found, although many of them were covered with a round dome placed on a square plan. At Piruz-Abad, according to Reber, the Palace, erected 460-488, has barrel vaults and cupolas of parabolic section, and shows a hall covered by a dome resting on a series of squinches instead of pendentives. This is also seen at Serbistan, and might have been used much earlier than this, giving the idea which was brought to its highest development in the Byzantine style.

As already noticed in the chapter on the pointed arch, the Coptic churches in Egypt, some of which are known to date from the sixth century, and which may be older, use the pointed barrel vault extensively for covering the nave space. It is not known whether there was direct communication with these people or not, but with the pilgrimages that were going on at all times, and
the missionaries who were being sent out from all the monasteries, there must have been some communication with these communities. Like those in Syria, however, they were shut off from the world about the seventh century by the invading hordes of Moslems, who captured Egypt and Syria.

The Byzantines, although they cannot claim to have invented the pendentive dome, did perfect it, and brought it into a general use worthy of its value. There are several buildings of earlier date than they Byzantine Empire, in which it had been used, but these were all small. One example, at Kusr-en-Nureijis, in Palestine, is of the second century, and others may be as old. In a few cases, especially in later work, after Moslem influence had commenced to be felt, the domes are not hemispheres, but are four-centered, and the top is pointed, as in the majority of later Moorish domes. No moldings or ribs ever broke the surface of Byzantine domes.

The Byzantines, however, were responsible for one very important innovation in vaulting, according to Simpson— one which was the first type that was distinctly different from Roman vaulting. This innovation was the domical groined vault, with which small square and oblong compartments in the aisles and narthex of St. Sophia were covered. This scheme was far more flexible than the Roman groined vault, which consists of two half cylinders of equal diameter intersecting at right angles. This can cover only an area that is approximately square. The Byzantine architects conceived a form in which the groins, as
well as the side arches, should be semi-circular. This raised the crowns of the groin arches above the level of the crowns of the side arches, and produced peculiar vaulting surfaces that were nowhere perfectly spherical, but were somewhat domical.

Here we have, in these two new forms, the germ of much that was to influence the architecture of the Middle Ages. Without this form of the domical groined vault, in which the diagonals are semi-circular in shape, the Lombardic builders might not have given their quota to the upbuilding of the Gothic style.

The theory and practice of vaulting had been continued throughout Germany without interruption since the period of the Roman occupation. There were many classic remains still standing in the country, the ruins of which gave an insight into methods of construction from all sides. Charlemagne, in his attempt to revive the architectural glories of imperial Rome, must have made use of these ruins as examples for his architects. In the Minister of Aix-la-Chapelle the three most important systems of vaulting employed by the Romans—dome or cupola, barrel and cross vaults—were reproduced with remarkable fidelity, and the apses and crypts of the basilicas had not allowed the practice to become forgotten.

The Romanesque of Southern Gaul shows much of Roman artistic tradition in its character. The larger churches show a modified basilican plan with a barrel vault of either round or pointed section over the nave, and with smaller vaults, or half-
vaults, of the same form over the aisles. The aisles are in many cases so high as to preclude a clerestory, and thus their vaults act as abutments to the central vaults. Many of these barrel-vaulted churches of Southern France are described by M. Revoil, in "Architecture Romane du Midi de la France." Some of these Medieval Barrel Vaults, like Roman ones, are solid; and the outer covering, generally tile, is bedded on top of the vault itself. In the majority of cases, however, they are only a foot or so thick, and are covered by a protecting timber roof, in much the same manner as the intersecting vaults are covered and protected. One practical disadvantage of a barrel vault over an aisled church, is that it presses alike on voids and solids. In the words of Sir G. C. Scott, it entails "an illogical arrangement of divided substructure and continuous superstructure." This, insofar as it affects appearances, is overcome in many of the twelfth century churches of Burgundy and Auvergne, by placing transverse arches above the piers, as in Autun Cathedral. These, however, are not of use structurally, as the vault is not carried on them as in the Baths of Diana, at Nimes, although one church, that of St. Pierre, Reddes (near Bedarieux), of the tenth century, is modeled after the Roman building, and like it, is covered with a barrel vault, and has attached columns lining the interior. Where pointed barrel vaults are used, it is probable that their advantage of diminished thrust was realized, and that they were used for that reason.
Coming now to the ribbed vault itself, we find that there are two theories as to its origin—the one, that it had its origin and inception in the minds of the builders of Lombardy, at the beginning of the eleventh century—the other, that the ribbed, or ogival vault was the outgrowth of the domed architecture of Acquitania. Both theories are equally plausible and ingenious, both seem to be equally borne out by examples—sometimes the same examples—but the former has behind it the weight of such authorities as Rebor, Moore, Viollet-le-Duc, Simpson, Porter, and Lubke, while the latter has only the authority of Corroyer, who, however, is as well qualified to judge as any of the other archeologists quoted.

We will consider first, the Lombardic theory, giving at the beginning some attention to cross vaulting from the time of the Romans.

The earliest Romanesque intersecting vaults, like Roman ones, are continuous—that is, there are no arches dividing the bays of the vaulting one from another. An example of this is seen in the nave aisles of the Abbey-aux-Hames, at Caen. The first modification of the ancient form that was made by the eleventh century builders was to divide the vault into bays by transverse and longitudinal arches, the latter becoming wall ribs when the vault is enclosed on two of its sides by walls. These arches spring from pilasters or attached columns projecting in front of the wall or pier, and as their span is less than that of the vault enclosed by them, they show below it. The infilling
of each bay now rests on these arches, removing to a great extent the weight of the vault from the voids below, and concentrating it over the piers, a result which had been attained to some extent when the intersecting vault was substituted for the barrel vault.

The next development carried the system one step further. This was the introduction of diagonal ribs below the lines of intersection, or groin lines, of the vault. The vault now becomes a ribbed vault, in contradistinction to a groined or intersecting vault, and each severy consists of two distinct parts, (1) the constructional part, consisting of transverse arches, longitudinal arches or ribs, and diagonal arches or ribs; and (2) the infilling or web, which rests on the frame. This latter needs to be only a few inches thick; and no part of it rests on the walls. The principle of a concentration of thrusts is now complete, and this concentration facilitated their neutralization by the use of flying buttresses.

There is some question in the mind of Simpson as to whether the Romanesque builders did actually originate the diagonal ribs. It is entirely possible that they merely re-introduced them in a modified form. In Roman intersecting vaults there are diagonal ribs of brickwork, (Choisy's "Art of Building among the Romans") which, even though they do not project below the surface, and are imbedded in the concrete of the vault, served much the same purpose—that of permanent centers to carry the infilling—that diagonal ribs serve in Romanesque work. It is quite possible
that by the eleventh century, the work of the early builders had been forgotten, but even so, the builders of the Middle Ages, in Simpson's opinion, can hardly be credited with an entirely new invention.

Keber says that SS. Pietro e Paolo in Bologna seems to have been originally designed with reference to the introduction of cross vaulting. Although not susceptible of definite proof, it is probable that the regular alternation of the supports, together with the vaulting, dates to the year 1014, and consequently, that the priority of this most important constructive advance is to be ascribed to Italy. The date of a vault is always difficult to fix, partly because it is the last part of a church to be built. The commencement of a church may be known almost exactly. Besides, builders were inexperienced, and many of the first vaults undoubtedly fell down and were rebuilt. Then, too, there were many fires, and fires almost always caused the vaulting to suffer more than any other part of the church.

Compared with the tentative and uncertain system of SS. Pietro e Paolo, the nave of S. Michele in Pavia, slowly built after 1024, exhibits a high degree of experience and ability. It was designed with a regular alternation of piers of difference strength, and evidently with the intention of introducing a vaulted system similar to that of the former church, but during the construction, this plan was evidently changed so that every support was employed as the impost for a separate bay of the nave as well as of the side aisles. S. Michele and St. Ambrogio of Milan
are both of the eleventh century, and are the first that are vaulted throughout. St. Ambrogio is the earlier of the two. Nave, aisles, and triforium have groined vaulting in square or nearly square compartments, and as the nave is double the width of the aisles, its compartments embrace two of the aisle compartments. These vaults are on the domical Byzantine order, thus showing the Byzantine influence at work. These Lombard builders were probably led to use this style of vaulting from seeing it employed in the porch and east side of St. Vitale at Ravenna. In the vaulting of St. Sophia, at Constantinople, an arch is sprung over each of the four sides of each compartment. Similar arches are found in the vaults which cover the aisles and triforium galleries of St. Ambrogio. This is entirely a Byzantine feature. In the vaulting of the nave, however, an advance is seen, in the use of strongly salient ribs, following and strengthening the groins. These groin ribs, with the bounding arches, formed a complete skeleton, so that the ceiling which it supported could be made much lighter.

Two types of groin-vaulted buildings occur in Northwestern Europe during the Middle Ages, which may be called respectively the alternate and uniform systems. St. Ambrogio represents the alternate type, with each nave compartment embracing two aisle compartments, while the uniform system has one nave compartment being square or approximately so, while the nave compartment is oblong, the length being about one-half the width. The alternate systems, as we have seen, probably originated in the Lombard Romanesque, while the uniform system seems to have originated or
to have been developed in Northern France. In some cases both types occur in one building. In the Northern Romanesque and Gothic schools, both types occur with equal frequency.

The question of the priority for Italy is considered by Simpson to be somewhat doubtful, as the entire building of St. Ambrogio was rebuilt after the fall of the vaulting in 1196. However, there are angle shafts that are certainly intended to carry more than a groin line. The original date is a question of whether the original ribs were of the same date as the tower, which is known to have been built in 1129, or whether they preceded it some forty or fifty years. There are angle shafts in England, but they are so small as to have carried no more than groin lines. The small vaults over the aisles of the choir and transept of Durham Cathedral are ribbed vaults, which John Bilson places as early as 1093-1096. This is exceedingly doubtful, however. It is natural that this question of the priority of diagonal ribs should arouse controversy, as they went a long way toward solving the problem of the vaulting of large spaces. The question will be taken up again before the close of the chapter.

In France, ribbed vaults appeared simultaneously in different parts at the beginning of the twelfth century: at Poitiers and Bordeaux in the South, at Quimperle (Brittany) in the North, round Beauvais, and in the valleys of the Seine, Marne Oise, etc. At Morienval (Oise), a narrow ambulatory around the eastern apse is covered by ribbed vaults, the date of which is said to be 1120. In the district around Beauvais and Soissons many
churches of about this date have aisles vaulted with diagonal ribs. In the Abbey-aux-Hommes, dating from 1064, there is an incomplete rib system. The builder, in common with most of the Norman builders, had not as yet freed his mind from the idea of the Roman groined vault, but felt the advantage of the rib system. This, with the sexpartite vaulting which had its origin here, caused some peculiar effects, particularly in the lateral cell which mark a far-reaching step toward Gothic vaulting. The choir of the Abbey Church of St.-Germain-des-Pres of Paris (dating from 1163), is another monument of the highest interest in connection with Gothic development, because of the excessively domical vaults, which betray much more of the Byzantine influence than those in any other part of France.

The oblong quadripartite ribbed vault was the earliest, as well as the most prevalent form of Gothic vault. The belief that the sexpartite form was the first to be developed, and that it was superseded by the quadripartite, is not believed by Moore to be correct, although Viollet-le-Duc, in "construction," refers to the sexpartite vault as being the first Gothic method of constructing vaults. St. Evremonde, St. Germer, and St. Etienne have oblong quadripartite vaults, while the later structures, as Noyon and Senlis, and originally sexpartite vaulting. In the Abbey Church of St. Leu d'Esserent, the two forms occur side by side, and are contemporaneous.

We come now to the work of Northern France, and the Ile-de-France, where Gothic, as such, was first developed. The
most of the material that follows was obtained from Moore's "Gothic Architecture," which goes very fully into the early development of the Gothic style.

The Northern types of Romanesque that were the immediate precursors of Gothic are mainly confined to the provinces of Burgundy, and the Ile-de-France. Here the Lombard system reappears, and is carried out with various modifications and progressive charges. The type characteristic of Burgundy is magnificently developed in the nave of the Abbey Church of Vezelay, dating from the commencement of the twelfth century. Here is seen a uniform system with quadripartite vaulting in oblong compartments over the nave, and square vaults of the same kind over the aisles. The system is perfectly organic as far as it is developed, but while vigorous transverse ribs of two orders separate the vaulting compartments one from another, and longitudinal ribs span their narrow ends, no groin ribs occur. The absence of the groin rib, and the omission of triforium openings, which here, as in some other Romanesque buildings of the North of France, do not occur, show a somewhat backward character, and would seem to indicate a Rhenish influence, although the Church of Laach, which Vezelay most resembles, is of later date. The vaulting is again of the domical or Byzantine type, which adjusts itself as easily to the oblong as to the square plan. The pier has a broad, pilaster-like member rising from the pavement and supporting the first order of the transverse rib, while an engaged round shaft carries the sub-order of the same. The longitudinal
rib springs from a short rectangular support which rests on the triforium ledge. The ground-story archivolts, and the transverse ribs of the aisles, which, like those of the nave, are of two orders, are carried by supports like those of the corresponding members of the nave. The principles of the Lombard system are thus here applied to a building of the uniform type by substitution for the square vault of the nave of an oblong one, and although, from the omission of the groin rib, the design, is not so completely organic as that of a typical Lombard edifice, it is carried out with hitherto unprecedented precision and elegance.

The general proportions and adjustments of the parts mark a distinct advance on Lombard achievement, especially in the greater elevation of the vaults, affording space for a well-developed clerestory. St. Ambrogio of Milan has no clerestory, while that of San Michele of Paris, in the original form of the building was insignificant. But at Vezelay the clerestory is of ample dimensions, and greatly enhances the general effect of the interior, which in most Romanesque churches was too dark. The exterior of this nave was changed in appearance within a century after it was built by the addition of flying buttresses, as the salient pilaster buttresses which were used at first were found to be insufficient for stability.

Nowhere in Europe was building more active during the eleventh century than in Normandy. The early Norman Romanesque is of the plainest type, with the basilican characteristics persisting, Massive rectangular piers, with few subordinate members,
heavy archivolts, a low triorium, if any, and a thick-walled clerestory with small round-headed openings characterize this type. (Ruprich-Roberts, "L' Architecture Normande.") The Church of St. Gervais of Falaise, which dates from about 1050, illustrates a more advanced type, in which the nave is divided more completely into bays. St. Gervais has an engaged shaft in each pier, rising from the pavement at the top of the nave wall. Such a shaft has no function in an unvaulted structure, though it may be used to carry the trusses of a timber roof. Such shafts are common in the Norman Romanesque of the eleventh century, and seem to be an unintelligent copying of Lombard piers organically composed to carry vaulting. The Normans did not perceive the significance of parts in the architectural system from which they seem to have derived their first notions of organic building. This seems to be further shown by their not uncommon practice of inserting an engaged shaft on the aisle side of the pier, in unvaulted aisles, and prolonging this shaft to the lean-to aisle roof, as seen in the Church of Notre-Dame-sur-l'Eau, Domfront. In designs like the foregoing, the piers are uniform in size and composition, and the great shafts dividing the nave into oblong bays became very common in Normandy, though there was as yet no vaulting save in the aisles.

But while the naves of the Norman churches remained unvaulted before the twelfth century, there are earlier instances of vaulting over the choir. The choir being short, rarely more than two bays, afforded, in the great piers of the crossing, and
and the heavy walls of the east end, secure abutments to the thrust of vaulting. The early Norman builders were consequently less timid about about erecting vaults here than they appear to have been in the nave. Among extant Norman choirs that were thus vaulted during the second half of the eleventh century are those of the Abbaye-aux-Dames, and the Church of St. Nicholas at Caen and that of St. George at Boucherville. In none of these vaults do groin ribs occur, though strong transverse ribs are employed in all of them. In the Abbaye-aux-dames, the compartments of these choir vaults are nearly square in plan, and the vaults are built on the Roman model, with elliptical groins and level crowns. In St. Nicholas the compartments are oblong, and the cross cells have an approximately elliptical section. In St. George, also, the compartments are oblong, and here the vaulting is domical in shape.

The Normans seem to have made no use of groin ribs until they began to vault their naves in the early part of the twelfth century, sometime after such ribs had been in use in the neighboring province of the Ile-de-France. The first vaulted nave was in the Abbaye-aux-Hommes at Caen, which had a timber roof as first constructed early in the second half of the eleventh century. The date of this vaulting has not been ascertained with precision, but its character indicates that it can hardly be later than the first quarter of the twelfth century. It has a form that we have not heretofore met with, which seems to have been suggested by the alternate system here employed. This alternate system, by
the way, does not appear to have been in use north of the Alps before the second half of the eleventh century. Then, in the Abbey Church of Jumieges, dating from about 1050, and here, in the Abbaye-aux-Hommes, dating from 1064, it occurs, and became frequently in subsequent Norman buildings. There can be little question that this system was introduced into Normandy through a direct influence from Lombardy. This has been questioned. Ruprich-Robert ('Architecture Normande') maintains the affirmative, basing his work on that of Dartein ('Etude sur l'Architecture Lombarde') whose dates for the churches of St. Ambrogio of Milan, and San Michele of Pavia have been disputed. Lefevre-Pontalis ('L'Architecture Religieuse dans l'Ancien Diocèse de Soissons') rejects Ruprich-Robert's theory on the ground that Dartein's dates are untrustworthy, and maintains that the nave of St. Ambrogio is a work of the twelfth century, and hence could not have furnished the model, as supposed, for the Norman structures considered. Sig. Cattaneo throws new light on the origin of the Lombard Romanesque, and especially on these two leading monuments and their dates. He shows ('L'Architettura in Italia dal Secolo VI al Mille Circa') that Dartein has erred, and seems to exhaust the subject of the dates of the various portions of St. Ambrogio.

Supposing that the nave of St. Ambrogio dates from the early part of the second half of the eleventh century, we may accept Ruprich-Robert's view that the alternate system of the Abbaye-aux-Hommes was directly due to influence from Lombardy,
though not perhaps from San Michele of Pavia, which he supposed to be the model. This latter is thought by Cattaneo to be principally a work of the beginning of the twelfth century.

Ruprich-Robert finds a ground for his belief in the fact that Lanfranc, abbot to the house in Caen when the church was building, had come from Pavia. This theory is not weakened by the generally accepted (though questionable) theory that the nave of San Michele is a work of the twelfth century. St. Ambrogio is close to Pavia, and must have been known to Lanfranc. Lombard derivation of the alternate system of the Abbaye-aux-Hommes may be considered as pretty well established.

The builders of the Île-de-France seem to have experimented with the groin rib from the beginning of the eleventh century, if not before, but confined their experiments to small vaults. It is uncertain whether any naves in this province had been covered with ribbed vaulting before they Norman works, but apparently no nave as large as that of the Abbaye-aux-Hommes had been vaulted before in this manner. This was rather a bold undertaking, and the Norman builders may have felt the need of caution. As the substructure is practically like that of the Lombard models, it may be supposed that they intended to vault it in the same manner as the Lombard buildings, that is; by square compartments, each embracing two compartments of the aisles. In the original work of 1064, the shaft of the intermediate pier, which, in the Lombard prototypes had not risen above the triforium, was carried up, like those of the main piers, to the top of the
wall. To prepare for the vaulting, these shafts had now to be cut down to a lower level; and the presence of the intermediate shaft may have suggested the expediency, in view of the great height and width of the nave, of springing an intermediate transverse rib from it as a measure of precaution. Such a rib was accordingly inserted, and this rib, by dividing each of the lateral triangular spaces of what would otherwise have been a square quadripartite vault into two smaller ones produced the sexpartite type of vault, subsequently an important one in the Gothic system. This vaulting is curiously formed, and rudely constructed. Those portions which have their axes in the direction of the long axis of the nave have level crowns, but the groin arches are segments of less than half-circles. This somewhat distorts the vault surfaces, while at the springing the segmental groins form angles with their vertical supports. The lateral cells describe elliptical circles against the clerestory walls, and their axes are necessarily oblique. No longitudinal ribs occur in this vaulting, but for the transverse ribs and the groin ribs the piers as originally designed provide the requisite supports. The sexpartite vault this brought into existence appears to have been the only important innovation made by the Norman builders.

As already mentioned, the buildings of the Ile-de-France at the end of the eleventh century, while many, were small and of simple design. Even over the aisles, vaulting was rare until the end of the century. In the church at Morienval,
the aisle vaults are not groin-ribbed, but are domical. Transverse ribs divide the compartments, and the piers have four wide pilasters with an engaged shaft on each. After this, development in the Ile-de-France became more rapid, so that the final development of the Romanesque was reached by the end of the eleventh century. The final condition may be best shown in the Church of St. Etienne of Beauvais. Although remodeled, the character of the original still remains. This, and St. Louis of Poissy are the only structures of the period in France that are unmistakably designed for ribbed groined vaulting over both nave and aisle. The system in use in the former is uniform, and the vault compartments in both nave and aisles are oblong. The original vaulting of the nave was destroyed in 1180 by a fire, but the composition of the piers, and the existing vaulting of the aisles show the character of the vaulting. Each pier has pilasters with central engaged shaft on the faces, and smaller shafts on either side. These members rise from the pavement, and show that they belong to the original design by the homogeneous character of the bases on which they rest, and to which they are perfectly adjusted, and by their correspondence to the unaltered work on the aisle side. It is further shown by the high vaulting capitals that are still in place in the unaltered eastern bay. Those capitals are like those of the primitive aisle vaulting and are of less advanced type than those which belong to the early remodeled portions of the edifice. That the small shaft on each side of the pilaster was designed to carry a groin rib is made clear by the
fact that its capital is set diagonally to conform with the
direction of such a rib.

Thus we have in St. Etienne of Beauvais, applied to a
uniform vaulting system, the most complete carrying out of the
Lombard idea that had yet been reached in Northern Europe, and
one in which all the forms are improved, and even reach some
degree of elegance. The original vaulting of the nave probably
had no longitudinal rib. Such a rib was hardly used in the north
at this time (although Vezelay had one without a groin rib) and
the pier inclines no member for its support. The use of the
longitudinal rib became general before the second quarter of the
twelfth century. The groin rib at St. Etienne is of a primitive
type, of rectangular section with a beveled edge. The capitals
and bases of the shafts that sustain the groins are, like those
of the nave, set diagonally to conform to the direction of the
ribs. The remaining compartments in the aisles have the same
general character, except that the groin ribs are lighter, and
have a round section, with caps of a more advanced design. The
last aisle compartments are of later design—the result either of
a pause in the work, or a very early reconstruction.

Diagonal ribs were a great advance, but they caused one
difficulty which had not existed before. In a square vault without
ribs, and with semi-circular arches, the groin lines are semi-elliptical,
and therefore weak in form. This weakness matters little
in a plain groin vault, as the groins are there, so to speak,
simply accidental. But when diagonal ribs are added, these can-
not be built on the same lines, as they have to carry a large portion of the weight of the in-filling. The Romanesque builders tried making these ribs segmental, and also semi-circular. The latter form was strong, but when the other arches of the vault were semi-circular, the result was practically a dome, and should have been built as such. (See Corroyer's theory, following.) The domical form was avoided in some cases by stilting the transverse and longitudinal arches, so that their crowns should be on a level with the apex of the diagonal ribs. A better expedient was followed at Ouistreham Church, near Caen, where the arches are semi-elliptical. Most early ribbed vaults were of short span, and the builders could consequently "fake" the curves without doing much harm. These rough devices were all right for aisles, but when it was a question of wide spans, something better was required. In searching for a remedy, the builders must have noticed the pointed arch, which had already been used to some advantage for the barrel vault. The solution was found; there was no longer any need for stilting arches, or for weak diagonal ribs, although wall ribs continued to be stilted, in order to bring the thrust of the vault nearer to a bearing on a vertical line. So too, there ceased to be any reason for the domical form of vault, although this persisted, especially in Southern France, for many years, even where the arches used were all pointed.

In France, the pointed arch was employed in vaults almost as early as the diagonal rib. Many small churches around Amiens, Beauvais, Soissons, etc., have pointed ribbed vaults which
are attributed to 1120-1130. The earliest of these is perhaps Morienval, said to date from 1120. The awkward forms of the ribs and vault surfaces, as shown in this church, seem to prove that the pointed arch was used solely to get over constructive difficulties of vaulting a curved oblong area, and not from esthetic motives, after which the artistic value was soon perceived. (Moore, "Gothic Architecture.") The interest of the vault of Morienval lies chiefly in this experimental embodying of new principles as yet imperfectly understood. The idea of the pointed arch, in connection with an independent system of ribs as a framework for vaulting, was here taking form in the minds of the builders. Incomplete and awkward as is the scheme thus worked out, we have in it a type of construction as yet unknown; a type that already contains some of the most important principles of Gothic vaulting. The apse of Morienval may therefore be regarded as the first step known to us of the distinctly gothic development of France. Another form of the pointed arch, apparently earlier than Morienval, is seen in the Romanesque church, of Chatel-Gensoir. This vaulting, while it has no groin ribs, affords an approximation to the form of the pointed arch.

The first large church with vaults of this description the date of which is known, is St. Denis, near Paris. The narthex was finished 1140, the choir 1144. St. Maclou of Fontoise, which is believed to be earlier than the apse of St. Denis, shows an innovation in the forms of the diagonal ribs, which are straight in plan, rather than curved as in Morienval and Germer. Thus all
survival of vaulting by the interpenetration of geometrical surfaces has disappeared, and the skeleton of ribs wholly determines the shape of the vault. In St. Maurice, Angers, the vault of about fifty-four feet span is pointed throughout, and cannot be later than 1150-1153.

Here we have the entire history of the development of Gothic vaulting, according to a logical line of growth, and one that has been thoroughly traced to its beginnings by men of authority upon all matters of archaeology—men who have made a study, not only of the monuments of the past, but its human aspect as well.

We come now to Corroyer's theory regarding the origin of ribbed vaulting. This archaeologist drew his conclusions, after careful study and research, to the effect that the ogival, or ribbed vault was developed from the domed buildings of Aquitaine, which all other archaeologists believe to have been built by Byzantine workmen, or under the direction of a Byzantine architect, since they are so strongly Byzantine in their appearance and method of construction. Corroyer says that it is not possible to find the germ of the ribbed vault in the Romanesque groined vault with ribs following the groin, because the vault itself is built of masonry, and the groin lines are simple the lines of the intersection of the two barrel vaults forming the groin vault. The ribbed vault being essentially an active one, cannot be derived from such a passive construction.
The cupola or dome of St. Front at Perigeux, constructed of cut and fitted stone toward the middle of the eleventh century, has in its pendentives the true origin of the ribbed vault. This dome is set upon four heavy arches of pointed form which in their turn rest upon four piers, which form a square in plan. The arches spring immediately from these piers, and their voussoirs interlock with the horizontal courses of the pendentives in such a manner that the weight of the hemispherical dome above is carried down through the pillars to the ground. The first five or six courses of the pendentive are set horizontally, and form a "tas-de-charge," to receive the remainder of the pendentive. The construction of the churches of Angouleme and Fontevraud, in the first years of the twelfth century, was along the same line. The church of Saint-Avit-Senieur furnishes an example of the apparent development along this course. The vaulting of this edifice is really that of a dome, although ribs are used—these latter serving only the purpose of stiffening the dome, which can thus be made lighter. The Church of St. Pierre, at Saumur, marked still more progress in the development of the ribbed vault from the dome. Finally, the architects of Anjou and of Maine perfected the vaulting and made the final step which resulted in the changing of the Byzantine pendentive of St. Front to the diagonal rib of the perfected ribbed vault. No other archaeologist supports Corroyer in this theory, but Heber thinks that the Lombard idea might have influenced the dome to the extent that it was placed directly upon the supporting arches, without the interposition of
the cornice that is seen in all the true Byzantine models.

In summing up, it does not seem necessary to pay any serious attention to this theory of Corroyer's. As for the theory of the Lombard origin of the ribbed vault, it is so consistent in itself, and so well supported by the most competent authority, that it would seem that there is nothing to do but accept the fact that it was an outgrowth of the constructional needs of vaulting in stone, the first step in which was taken by the builders of Lombardy, as far as it is now known, although the step might have been taken in England, in Durham Cathedral, or, according to Reinach, in Ricardy, for he says that very ancient ogival vaults have been discovered there, but gives no authority for his statement. The Lombardic theory has the weight of authority.
CHAPTER V.

The Pointed Arch.

The arch has been known to man ever since there has been building done by him. The pyramids of Egypt show a sort of arch, formed by leaning two flat stones against each other to form a relieving arch over the burial chamber hollowed out within the depths of the tomb. The roofs of the "Grotto" tombs at Beni-Hasan, which date from about 2400 B.C., are in many cases curved in a segmental form, which might indicate that the Egyptians had a knowledge of the arch or vault. This is strengthened by the words of Simpson, who says that drains or passages have been found, which are covered with barrel vaults, of a markedly pointed section. These are made of brick, and laid up much the same as similar arches of the present time. The same authority is responsible for saying that arches of stone, of a somewhat rounded shape, have also been found, also covered drains or irrigating channels.

In Assyria, the use of the arch was common, although there are no instances of the pointed arch coming down to the present time, nor even any knowledge that the pointed arch was ever used in that part of the world prior to the occupation by the Moslems. However, among the Persians, the pointed arch was used to some extent, being sprung in some cases directly from the heads of the columns on which it rested. The Sassanians, the sun-worshipping successors of the Persians, also used the pointed arch
was used to some extent, being sprung in some cases directly from the heads of the columns on which it rested. The Sassanians, the sun-worshipping successors of the Persians, also used the pointed arch to a limited extent, as well as a form of arch peculiar to themselves, which has an extreme diameter greater than the distance between the impost. This form is believed by Reber to have been the forerunner of the horse-shoe arch, used so extensively among the Arabs. A marked instance of this form is seen in the monuments at Takht-i-^ero, on Mount Zagros, which is probably not later than the fifth century after Christ.

It is probably from this region that the Arabs obtained many of their architectural ideas, as has already been noted. The archivolts present a novel appearance to western eyes, used to the semi-circular arch, as they are either pointed or horse-shoe-shaped. These forms of the arch did not originate with the Moslems nor were they brought with them from their Arabian home, but both are to be traced, according to Reber, during the ages preceding the invasion of the Moslems, in the countries first occupied by them—in Mesopotamia and Persia; the pointed arch appearing during the Assyrian epoch, the horse-shoe during the Sassanian period. The development of the latter has already been stated, and the fact shown that it was not determined by static considerations. The pointed arch was of greater constructive importance, but the use of it by the Moslems was probably due more to its lighter and more graceful proportions, as contrasted with the round arch, than to any appreciation of its material advantages,
especially as the arch was used only for openings, and not for vaulting. It may be that both forms of arches may have been adopted from their fancied resemblance to the looped-up curtains of the tent of nomadic days. The arches of the mosque of Ibn-Tulun, 879, are of horseshoe shape, slightly curved inward, and sharply pointed at the summit. The fame of the newly arisen architecture of Bagdad penetrated beyond Mohammedan lands: Theophilus, Emperor of Byzantium, 829-842, built his summer palace in imitation of a structure on the banks of the Tigris. It is entirely possible that this may have been the source of the pointed arches that are seen in the later Byzantine work, especially that in Asia Minor.

Returning now to Egypt, we find there a Christian sect, called the Copts, who built a considerably number of churches and monasteries, a few of which have survived to the present day. Most of these Coptic churches, according to Simpson and Porter, are either domed, or else covered with barrel vaults; most of these latter, except in the earliest examples, are pointed in section. Many of the arches between the columns are also pointed, showing that this form was employed by the Copts in their churches long before it appeared in the West.

The monastic Church of Dair-as-Suriani, in the desert, was founded by Greeks from Syria, in the sixth century, who, there is every reason to believe, built in the church which is now in existence. The arches of the arcades are pointed, and so is the barrel vault which covers the nave. In the Church of Dair-Baramous,
the pointed arch is also used throughout for the nave arches and vaults, the latter being strengthened by transverse ribs thrown across from pier to pier. The principal dome over the clergy spance is carried on stalactite, pendentives, such as were afterwards common in Mohammedan work. Mons. A. Gayet, in his "l'Arte Copte," States that it was from the Coptic churches that the Saracens took the idea of the pointed arch and the stalactite vaults, or rather that, as they compelled the Coptic workmen to build for them, these men naturally followed in the mosques the methods to which they had been accustomed in the building of their churches. This may be the case, for the Mosque of Amrou in Cairo, built in 640, shows the pointed arch, used structurally.

The pointed arch was first employed in Europe in the barrel vaulted buildings of the South of France, certainly before the end of the eleventh century, and possibly earlier still. The Chapel of St. Thomas at Molleges (Bouches du Rhone), which, although of unknown date, is certainly one of the oldest memorials in the South of France, has slightly pointed barrel vaults. The nave of St. Nazaire, Carcassone, built in 1096, is covered by a pointed barrel vault, the aisles having semi-circular vaults. In Northern France, it did not appear before 1100 to 1120. It occurs accidentally, so to speak, in arcading formed by intersecting semi-circular arches, as early as the first half of the eleventh century, but the theory that it had its origin in this manner has little to recommend it. Even if the pointed arch had not been in use long before this interlaced arcading was introduced
builders would have been slow to abandon a form sanctioned by centuries of tradition, in favor of a hint conveyed by an accident in decoration.

In Sicily and Southern Italy, the introduction of the pointed arch was early, owing to the influence of the Saracens; it was certainly in use in Sicily before the Normans reconquered the island in 1061, or they would not have used it so universally, for the Normans did not use the pointed arch in their own country.

It might be well before going any farther to correct an impression that has been given out by some of the French writers on art and architecture, regarding the use of the term "ogive", as applied to the pointed arch. Viollet-le-Duc, Corroyer, Reinach, and Choisy all agree that this use—calling the pointed arch the "arc ogive,"--is incorrect, and that the proper use of this term is when it is applied to the diagonal rib of ribbed vaulting. Reinach, says in this connection, "by an error dating from the beginning of the nineteenth century, the term ogive has been applied to the pointed arch; strictly speaking, an ogive (augiva) is the salient rib that sustains a vault, to augment (augere) its power of resistance. We may therefore speak of ogival vaults, and call Gothic architecture ogival, but we must not forget that this characteristic is not essential to the style, and may be absent". The latter part of the statement is not true, however, for the diagonal rib is absolutely required.
The first constructive use of the pointed arch—constructive in the sense of being used with ribbed vaulting—seems to have been in the apsidal aisle of Morienval, which was built about 1120. The awkward forms of the ribs and vault surfaces, as used here, seem to prove that the pointed arch was used solely to get over the constructive difficulties of vaulting a curved oblong area, and not from esthetic motives, after which the artistic value was soon perceived. The interest of this vault of Morienval lies chiefly in this experimental embodying of new principles as yet imperfectly understood. The idea of the pointed arch, in connection with an independent framework of ribs for vaulting, was here taking form in the minds of the builders. Incomplete and awkward as is the system thus worked out, we have in it a type of construction as yet unknown. The form of the pointed arch is also seen in the Romanesque Church of Chatel-Censoir, which is apparently a trifle earlier than Morienval. This vaulting has no groin ribs, but affords an approximation to the form of the pointed arch.

Ruskin has a theory, which he gives in his "Lectures on Architecture," that the pointed arch is a derivation from one of nature's forms; that it is, in fact, a reproduction of the shape of the leaves of trees. In proof of this, he cites the west window of Dumblanc Abbey, in Scotland. This window has, in truth, the shape of an oval leaf, and is decorated with very naturalistic leaves, but can hardly prove the theory in itself; for the theory is that of the poetical painter that we know Ruskin
to have been. He himself admits that such windows were rare in the Gothic style, but he also cites circular or wheel windows, and the apertures in traceries as a further proof of his theory.

Coming now to the origin of the pointed arch from the standpoint of its constructive use, we find that Viollet-le-Duc, Choisy, Corroyer, Heber, and practically all other authorities agree that however the pointed arch was developed as an architectural element of design, it was not used in a true constructive sense—in the Gothic style—until after the invention of ribbed vaulting. Viollet-le-Duc says that when the Romanesque builders used barrel vaults, they found that the thrust of the round arched form was particularly great, and that under this thrust, the walls or piers on which the vault rested tended to spread apart, and allow the crown of the arch to sink. If this sinkage goes far enough, the arch falls, as the builders probably learned by experience. The result of this was a study of the arch or barrel vault, with a view to determining the happenings dueing the sinkage. This study showed that the break usually came above an angle of about thirty-five degrees. The object now was to make the entire line of pressure in the arch as close an approximation as possible to the line of pressure in the lower, or unbroken part of the arch.

It was found that if a pointed arch were used, with a joint at the apex instead of a keystone, the line of action in the arch comes closer to a vertical line, and consequently diminishes the lateral pressure on the walls or piers, thus lessening the dan-
danger of failure in the arch, and making it easier to meet the thrust. Then too, if a round arch is loaded heavily, the natural tendency is to make the crown sink, and the arch give way, while a similar loading on a pointed arch only causes it to come more closely together in its component parts, and thus has a strengthening action upon the arch.

The pointed arch found an additional usefulness in the Gothic style from the readiness with which it was adapted, as has been already mentioned, to the exigencies of irregularly shaped compartments in vaulting. It was particularly useful, in that nearly any weight could be reached without an increase of span, or any necessity for stilting, such as was often done when the round arch was used.

Summing up all that has been said regarding the pointed arch, we find that it has been used since man has erected structures for shelter from the storms and heat of the countries where he has dwelt. In the earliest days of Egyptian civilization, the pointed arch finds a place, and we see its use continued down through all the great civilizations of the world, save that of Greece and Rome, whose trabeated and inertly stable structures had no need of its services. It only came into its own, however, when the hardy and daring builders of the Middle Ages, seeking for some expedient that would make more stable the living, always active vaulting that was coming into being in the Romanesque style, looked about, and catching the coupled suggestions offered by the presence of the pointed arch of past styles, and the line of fail-
ure of the round arch of Roman days, set the pointed arch in the place thus opened for it, and took the final and finishing step in the evolution of the Gothic style. Vital as was the principle of the ribbed vault, it should not take from the pointed arch the honor that it rightly holds, for without that arch, the ribbed vault could not have reached its full usefulness.
CHAPTER VI.

The clustered pier.

The column has been known from the most remote antiquity of the art of building. The Egyptians, the Assyrians, the Persians, the Greeks and Romans, all used the column, and it was the latter that inaugurated the use of the pier, when they began to use the intersecting vault, and desired to use something which would be strong enough to carry the weight of the vaults.

Even in the earliest Saxon work, according to Reber, the supports which divide the nave from the side aisles frequently exhibit an effective alternation of square piers with round shafts, in the manner in which the Gothic architects used them at times. In the construction of the Early Christian basilicas, many attempts had been made to relieve the columns of a portion of the weight imposed upon them by means of isolated piers, discharging arches, etc. This is shown in S. Clemente and S. Maria in Cosmedin in Rome. In the early churches in Syria this had also been the case, many of these even of the second and third centuries showing them, as shown by De Vogue ("Syrie Centrale"), as well as the later Syrian edifices of the sixth century, and the contemporaneous erections in the Coptic style of Egypt.

These early piers were all rectangular and unmolded. The use of the pier became all the more necessary in the architecture of the Romanesque period, as the thickness and weight of the clerestory walls had been increased in greater proportion than
the strength of the shafts that had been used hitherto. The first alterations in the shape of the pier were made in the ninth and tenth centuries, when aisles began to be divided into longitudinal bays by transverse arches. To carry these arches, a pilaster was added to the back of each pier, a corresponding pier projecting from the wall on the other side of the aisle, making the pier T-shape. According to Simpson ("Architectural History"), and Porter ("Medieval Architecture"), this was done earlier, in the case of some of the churches in Syria, notably in that of Roueiha. The next step was to make the pier cruciform in shape, so as to carry an arch across the nave as well. In San Miniato, Florence, the nave is divided into three bays by piers quatrefoil in section, the front and back projections carrying transverse a arches. For the changes which followed, the suborination of arches and vaulting consideration are mainly responsible. Neither a cylindrical column nor a cruciform one is best adapted to support an arch composed of several members lying in different planes; and both forms became still more unsuitable when, in addition to the arch, the ribs of a vault have to be carried as well.

To get over these difficulties, and to reconcile all parts, the subordinated or clustered pier was devised. It is so planned that each order of an arch, and in early examples, each rib of the vault has its corresponding members in the pier below. The clustered pier occurs, fully developed, in the Church of St. Etienne at Caen, otherwise known as the Abbaye-aux-Hommes, and dating from 1064, and there are examples elsewhere in eleventh
century work. In Senlis, which is of about the same date as St. Denis (about 1140-1144), we find what is probably the first true correlation between the vaulting and its supports. The pier consists of clustered members, adapted in weight to the loads of the different ribs they were to carry, and spring up uninterruptedly from the ground to the springing of the arches. The only capitals on the ground floor level are those of the archivolt columns, and the vaulting shafts of the aisles. The intermediate pier is, on the ground story, a single round column, from whose capital rise three slender vaulting shafts to support the intermediate transverse rib, and the two longitudinal ribs, and also the two archivolts, and the transverse and diagonal ribs of the aisle vaulting.

Keber believes that the clustered column might have started by the chamfering that was done to mask the bare and inartistic character of the pier. The corners were thus chamfered, which was followed in turn by the addition of small engaged columns, three-quarters round, to the corners thus cut away—the first step toward the resolution of the pier into a bundle of shafts. These piers are seen in many of the Romanesque edifices. The idea here is probably that the use of the columns was primarily to ornament the pier, and that the engaged columns thus formed suggested a division of the pier conforming to the loads that were to be borne.

Kuskin, as has been stated in a previous chapter, had a theory that the columns of a Gothic building, in accordance with the naturalistic origin of the style, represented the trunks of trees, which supported the branched and intertwining limbs of the
vaulting. Such an idea is not worthy of serious consideration, when applied to such a consistently constructive style as the Gothic is known to be.

The capitals and bases of the columns went through an evolution of their own, corresponding to the other parts of the Gothic style, but though they were combined and adjusted to the clustered shaft that they at once embellished and served, they lost little of the classic feeling that had been their heritage from the days of Greece and Rome. The capitals of Byzantine and Romanesque buildings changed from the classic forms, and took on respectively, the trapezoidal and cubical forms that we see in these styles, but returned to a somewhat classic form in the Gothic style. Capitals and bases will be considered more thoroughly in the chapter on ornamental details, not because they have not an important constructive office, but because the ornament that covers them is the part that strikes and attracts the eye.

The clustered column of the Gothic style is thus seen, from the short outline given, to have the same consistently constructive origin as the other elements that we have thus far considered. Its development followed closely that of vaulting, and may be considered, indeed, as a part of the vaulting system; for the vaulting shafts are merely carried down the wall—in some cases to a capital of a large pier on the ground level, in others to the ground. We may have no fear in considering that the clustered pier had its origin in purely constructive needs.
CHAPTER VII

The Flying Buttress.

Buttresses of some sort have been in use probably ever since the first vault was invented, if one can consider that a great thickness of wall constitutes a buttress. However, we do not have any buttresses, organically designed as such, until the time of the Romans. The great basilicas of the Roman period had buttresses to take the thrust of the vaults, although, owing to the monolithic concrete of which they were made, this thrust was greatly lessened after the concrete had set, so that the buttresses served more to sustain the thrust of the brick centering and the of the green, unset concrete, during the constructive process, than to take care of the thrust of the finished vault.

The Byzantine builders used the buttress extensively, not only in itself, but in its principle, working though other parts of the structure. The Church of St. Sophia, which is typical of the larger Byzantine edifices, shows this to a marked extent. This was the first instance of the use of the Byzantine dome on a large scale, and is of a cross-shaped plan, in which the arms of the cross on the long axis are formed by two enormous apses, the half-domes covering which exercised their thrust against the principal dome, while the piers supporting the latter are buttressed upon the sides by enormous masses of masonry, pierced by arches at the aisles, which take the thrust from that direction. The whole balances well, as shown by the fact that it has stood until
the present day, and furnished a model for some of the Romanesque domes structures of Southern France.

The Minster of Aix-la-Chapelle, according to Reber, shows a rather peculiar structure, which he believes to have had some effect upon the development of the flying buttress. In this church, the galleries around the central polygonal part are covered by eight barrel vaults, inclined against the walls which support the central dome, while in the remaining triangles, there resulted a complicated kind of rampant conical vaults. These inclined barrel vaults take the thrust of the dome and transmit it to the ground, so that the principle here involved was much like that of the flying buttress. It is not probable that this did directly influence any other buildings, although it may have furnished ideas to some of the later builders.

We find in the South of France another construction, much more pregnant with the germ of the flying buttress than anything seen heretofore, unless it should perhaps be the Roman buttress. This expedient is due to the thrust of the barrel vault used so much in this region, and the desire to meet the thrust adequately. The main aisle is covered by a barrel vault, and the side aisles with comparatively small vaults of the same shape. This is shown in the remains of St. Honorat, upon the island of Lerins (Reber, "Medieval Art") dating from the early part of the eleventh century. This same building has a peculiar structure, which shows the evolution of the effort to meet the thrust. The structure is in two parts; the first that has already been mentioned
as having small barrel vaults over the aisles, while the other half has a pointed barrel vault over the nave, the thrusts of which are met by bisected barrel vaults over the naves, giving in effect a concealed flying buttress.

The Convent Church of Vaison, of slightly later date, shows a type that is a peculiar compromise between the bisected and full arch; here the arch has an irregular form due to the impost on the nave side of the aisle being much higher than that on the other, so that the arch looks as though it was composed of half a pointed arch on one side, and half a full-centered arch of considerably smaller radius upon the other.

Notre-Dame-du-Fort in Clermont, dating from about the middle of the eleventh century (Reber), is decidedly in advance of the Provencal models, having a cruciform plan, which had not hitherto appeared in the districts of the Rhone. The ingenious methods by which the constructive difficulties were met had no parallel among the churches of Southern France. The building had a dome over the intersection of the transept and nave, and this was supported, as was the thrust of the ceiling of the nave, by bisected barrel vaults, these being of the same width as the full barrel vaults of the side aisles, but constructed on a much higher level, forming a sort of triforium, so as to abut against the impost of the dome and nave. This marks, as will be easily seen, quite and advance in the science of construction.

The first appearance of the external buttress is probably seen in those Romanesque pilaster strips which are the sur-
vival of the Roman pilasters. St. Apollinare, in Classe, shows such a pilaster strip, which is, if of the same date as the church (sixth century), probably the earliest instance of what ultimately became the external buttress. We also find pilaster strips appearing in the Lombard Romanesque, and used in the apse of San Vincenzo at Milan, dating from the ninth century. These pilaster strips, especially where used at corners, are a constructive necessity, as much as an esthetic one.

With the introduction of intersecting vaults, a new problem arose. The task of counteracting the thrusts of such vaults, especially ribbed ones, is not easy. All the thrusts being concentrated at given points, the wall in between these points is of little or no assistance. This was recognized so thoroughly in France after the twelfth century, that the wall became window. For the same reason, a series of supports was substituted for the continuous abutment. These stretched across from the back of the nave wall to the inside face of the aisle wall, under the aisle roof. They are not solid walls, for that would have weighted unnecessarily the transverse arches over the aisle below, and also interfered with free passage in the triforium. For this reason, they are as a rule, quadrant arches. They are in fact, flying buttresses, although hidden. Much the same kind of abutment was provided in the Roman buildings already spoken of, such as the Basilics of Constantine.

Moore believes that this feature is first seen in St. Germer, in the Île-de-France, dating from the eleventh century.
On the outside of the clerestory of this church, only a feeble buttress in the shape of an engaged column appears; but the thickness of the pier is considerable, the wall of the clerestory is heavy, and the wall arches of the vault are unusually deep. These combined members in themselves offer strong resistance to the vault thrusts. The builders, however, appear to have lacked confidence in their power to resist pressure without further reinforcement in order to maintain the stability of the system. They accordingly resorted to the expedient of springing half-arches from the tops of the outer piers against the internal piers beneath the timber roof of the triforium. Though weakly constructed and hidden from view, these are true flying buttresses in a rudimentary form—features which soon develop into the most essential and conspicuous of those which make up the Gothic system.

Simpson holds with Moore in believing that the Île-de-France was the birth-place of the flying buttress, but thinks that the first appearance of the feature was in the church of St. Vermain-des-Îres (997-1031), which has a strongly projecting buttress. The flying buttress was here introduced as a structural element to receive the thrust of the vaulting of the nave, and transmit it to the walls of the side aisles; according to Mertens, it may be recognized on the Church of St. Denis-sur-Loire (1070-1080). In the cathedral of Noyon, which is about contemporaneous with St. Denis, the upper triforium is so low as to preclude the possibility of concealed flying buttresses, so that it is not improbable that these important members of the Gothic structural system were used
externally here for the first time, although the present external buttresses of the clerestory date only from the Renaissance period.

With regard to the rudimentary flying buttress in the Abbaye-aux-Dames at Caen, the date of the vaulting that it reinforces is uncertain, although, according to Moore, apparently later than that of the Abbaye-aux-Hommes, in which half-barrel vaults had been used. The use of a similar form in St. Germer, in the Ile-de-France, which has already been mentioned, and which may be of earlier date, inclines one to form the belief that the model was found in the Ile-de-France. This is strengthened by the well-known fact that the Norman architects were not fertile in invention, while they did adapt ideas quite readily to their own uses.

One of the earliest remaining examples of the flying buttress is that seen in the Church of St. Martin of Laon, which is probably of about the same date as St. Germain-des-Prés. In Noyon is seen a small finial, rising from the top of the outer buttress, which is, in all probability, the first attempt to ornament this important structural member, and which might be called the progenitor of the later pinnacles. These pinnacles were introduced for the purpose of adding weight to the outer buttress, but soon developed into highly ornamental features as well and in some cases were introduced where there was no structural necessity for them. The first real pinnacle, as such, is seen on the nave buttresses of Amiens, consisting of an upright rectangular mass of
masonry, ornamented on each face with a shafted arch, and a richly sculptured cornice, crowned with a steep pyramid having crocketed angles, and terminting in a finial.

The flying buttress is a logical consequence of a constructive style of architecture, where the thrusts of the vaulting must be met, in order that the building shall stand. Reinach has given an excellent summing-up of the origin and functions of the member. "The flying buttress is a logical consequence of the ogive. As the height of the churches increased, the walls, which had been further weakened by large windows were no longer strong enough to resist the thrust of the vaults; it was found necessary to reinforce them on the outside. To this end, stone arches, supported at the spring by solid masses of masonry called buttresses, were raised against them on the outside. These arches, known as flying buttresses, were therefore designed to carry the lateral thrust of the lofty interior vaults to the outside of the building. There is nothing analogous in any other system of construction."
The chevet is the highest development of the apse of a cathedral or church. The apse itself comes from the part of the Roman and Early Christian Basilica which faced the principal entrance, and which was the seat of the judges or of the priest who was administering the service of the church. This apse was semi-circular in plan, and was covered by vault shaped like the quarter of a sphere. The arch forming the opening of this space was called "absis", whence came the later, and now common term, apse.

Some writers on archaeology and architecture think that the chevet, which consists of an aisle around the eastern end of a church, with chapels radiating from it, had its origin in the circular churches which were built at times, following the models given by some Roman temples and tombs. It is true that these round Roman edifices were sometime converted to the service of the Church, and additions made to conform with the requirements imposed by the ritual or the size of the congregation, but these are, in a way, only makeshifts, and while they may have had some effect, this is considered doubtful by men of such recognized authority as Moore, Reber, and Simpson. Some of these round buildings are; the Minster of Aiz-la-Chapelle, St. Vitale at Ravenna, the Rotunda at Brescia, and the small but important church of St. Thomaso in Limine at Almenno near Bergamo. They all show more
or less ingenuity in the vaulting of the aisle surrounding the central portion. The last named of the above churches, follows the plan of a circular nave, with an oblong beam, or chancel, which finishes with an apse. This church, with many other similar ones, is said to have been modelled on the plan of the Church of the Holy Sepulcher, at Jerusalem, which, as restored by the Crusaders, had a circular nave and a long chancel, but this is not likely, as such a plan was quite common in Byzantine work. It would seem that, as the service of the Church required a semi-circular apse at that time, if the chevet had started its development from these circular churches, the older circular part would have been altered into the apse, and the nave would be the new portion.

In Southern France, the most elaborate treatment was given to the apse of the church. The ornamentation upon the exterior is usually formed by Corinthian pilasters with horizontal entablatures—a device borrowed from the Roman remains existing plentifully everywhere in the region—and that upon the interior by engaged columns and blind arches, the conch being divided by radial ribs. The origin here probably goes back to the Carolingian period, as in the case of the Church of St. John at Moustier (Arles) which is probably of that period (Reber).

Simpson gives an origin for the chevet, which, as it is verified by the ideas of both Reber and Moore, has considerable value. He says, that two plans of eastern extension were followed in the latter half of the eleventh century. The earlier and simpler
one consisted merely in lengthening, the chancel by the addition of two bays or more between the transepts and the eastern apses. The aisles were lengthened as well, though sometimes, as in the Abbaye-aux-Dames, Caen, they are completely cut off from the chancel by walls. St. Georges, Bocherville, and the Church at Cerisy-la-foret, Normandy, are typical examples of this simple elongation. In both the aisles finish square, while the chancel of each has an apse. The transepts stand out beyond the aisles. This was also the original plan of St. Etienne, Caen, 1060.

The chief drawback to the above plan was that circulation was exceedingly difficult at the east end. The aisles formed cul-de-sacs. This was very inconvenient for churches possessing relics, where pilgrims came in large numbers. The other plan, which was perhaps adopted in a few instances at the end of the tenth century, but did not become general for nearly one hundred years, solved the difficulty by providing an ambulatory behind the central apse. The apses to the aisles were swept away, and the aisles continued around the back of the high altar. It is impossible to say in which church this plan was first adopted, or even in which country it was first thought of.

Simpson says that an eastern ambulatory, with a gallery over, occurs round the Church of S. Stephano, Verona, which Cattaneo, with some hesitation, ascribes to the tenth century. In France it seems to have been introduced early in the following century. The choir of Notre-Dame-du-Port, Clermont, shows a continuation of the side aisles around the apse, the conch of which
was supported on columns. Four smaller niches were added to the curve of the exterior wall, their radial axes pointing to the main altar in the central apse. It is not known whether these were here employed for the first time. This eastern ambulatory plan was especially favored, as before mentioned, for churches to which large crowds were drawn by the relics and shrines they possessed, such as St. Martin, Tours, St. Denis, near Paris, St. Sernin, Toulouse, Charroux, etc. The outside wall of the ambulatory forms an unbroken semi-circle in some of the examples, as at Morienville, and St. Saturnin, Auvergne, but in most of the French churches, apses project in front of the wall and contain altars. These apsidal chapels were at first small, and almost without exception, semi-circular in plan. Between them, as a rule, were windows. In most early examples there are only three chapels, as at Vignory (Haute-Marne, 1030), although sometime there are five, as at Cluny, St. Sernin, and occasionally four, as at Notre-Dame-du-Port.

Reber says that the extension of the side aisles beyond the transept soon led to the continuation of the subsidiary choir entirely around the main apse, the columns of the nave forming the boundary of the original chancel, while the outer wall of the surrounding passages was provided with smaller semi-circular niches for altars. This passage appears, at least in principle, in the Church of St. Wipertus at Quedlinburgh, and in the plan of St. Gall. In the latter, however, it is still separated from the main apse by a wall instead of columns. It is possible that the innovation was adopted in the Carolingian structure of St. Mary of the Capitol in Cologne, the presbytery of which, repeating in the transepts the
form of the choir, may be based in arrangements upon the original plan of Plectrudis. There is consequently no sufficient reason to assume that Bishop Bernhard of Hildesheim, who was present at the canonization of St. Godehard by the Council of Rheims in 1131, introduced from France the improvement of plan evident in the Church of St. Godehard of Hildesheim, which was consecrated by him two years later—nor is it proved that the bishop, during his journey, visited Burgundy or Auvergne, the district in which this form first appears. Reber, as is natural with a German, wishes all the credit possible for the innovation to go to the Germans.

Moore says that one of the monuments that belongs to the early decades of the twelfth century is the curious and puzzling choir of St. Martin-de-Champs in Paris. It exhibits, together with very primitive groin vaults, separated by very heavy transverse ribs in the aisles, a celled apsidal vault on ribs which may very possibly be the earliest rudimentary instance of the form of apsidal vaulting; it is found a complete system of ribs, in which few awkward lines or adjustments occur, sustaining a slightly domical vault of elegant form. The wall arches in a chapel opening out of this aisle retain a semi-circular form, and the window opening is also round-arched in the plainest Romanesque manner. Passing into the choir, the eye is met by what we have good reason to believe is the first great Gothic apse ever constructed. Its lofty vaults, stately piers, and superimposed arcades combine to produce an effect of great beauty. The general appearance of the work appear to place it anterior to St. Denis,
and locate it as an important link in the chain of structural progress leading from Morienval to the work of Sugar.

The Church of St. Denis shows a still more distinctively Gothic arrangement in the apsidal aisle. The aisles are double, and the chapel and the adjoining bay of the aisle are united under one vault by the omission of the dividing arch, and the extension of the middle rib of the chapel to the intersection of the diagonals of the aisle. But the opposite branches of the diagonal ribs are so disposed that they meet at an angle, thus placing the point of intersection at any point the architect may choose, near the center of the vault. This makes the cells practically equal.

Thus was born the chevet, the characteristic ending of nearly all the great churches and cathedrals of France. The term is applied to any east end in which an ambulatory—sometimes of one, sometimes of double aisles—is carried round the apsidal ending of a choir or presbytery, with radiating chapels projecting from it. From the time of St. Denis on, the chevet lost its simple character, and developed into a complexly constructed band of chapels, sweeping round a central apse.

From what has been given, we can see that the chevet, like every portion of the Gothic system, developed from a real need that was felt, either in the construction itself, or in the requirements of the church ritual. We may safely say, that it was the need of passages for the processions of pilgrims to sweep their stately way around the shrines and altars of the church, that gave
us the chevet in its first simple form of the ambulatory. This having occurred, it was seen to be a feature capable of a beautiful and dignified development—a development that began at once to take place, until the chevet of the thirteenth century, the purest period of the Gothic style, is a feature of the most graceful beauty that has been produced by the architects of any epoch.
CHAPTER IX

Portals, Windows, and Tracery.

Openings for the ingress and egress of persons, and for the admittance of light have been an integral part of all architecture worthy of the name. It is not until we reach the Romanesque period, however, that we find anything approaching the deeply recessed and ordered portal of the Gothic style.

In searching for ancient prototypes of these openings, we find that in the two basilicas of St. Apollinaris at Ravenna, and in the Basilica Pudenziana, in Rome, there is a use of pilasters and arcades on the outer walls, dating in the first case from the sixth century, and in the latter, from the fourth century. These frame window openings, in such a way that they might have furnished the inspiration for the openings with several orders that we find in the Romanesque and Gothic periods. The Byzantines also used groups of shafted arches in windows, embraced by a larger arch, which was a feature of Romanesque work, and may have had something to do with the beginnings of Gothic tracery. The Byzantines also used to a very limited extent a grouping of arch orders in receding planes, although this does not occur in more than a few cases.

According to Reber and Porter, the early buildings of the Romanesque style had very thick walls, so thick, in fact, as
to cut down very materially the amount of light that could be admitted through them. In order to remedy this, in the Northern Romanesque, the sides of the opening were beveled away, this expedient allowing of the passing of considerably more light. The beveled sides were not left plain for very long however. Soon there was felt a desire to ornament this part of the building, in accordance with the growing esthetic feeling of the times, and recessed and ordered columns and arches were used to frame the opening, and take away from the bareness of the plain beveled surfaces.

As to the reason for the widening and recessing of the portals, Simpson thinks that the great thickness of the walls in the lower stories of churches and towers required the portal to be widened externally to make entrance easier; if the wall was not thick enough for such increased width, frequently demanded for esthetic reasons rather than for convenience, the portal must then be treated as a vestibule, projecting from the wall surface to suit the widening of the portal. According to the thickness of the walls and the dimensions of the doors, the portal naturally became more imposing. This form of widened doorway had its beginning in the Romanesque. The Gothic use of gables over portals is natural, as a means of protecting the carvings from the weather, or affording protection to persons. This gradually resulted in the further projection of these roofs, so that the porches were formed between buttresses. There is also a theory, whose origin is not given, that the Gothic porch had its origin in the portico next to the church which was a feature of Early Christian architecture—the Early Christian churches having in front a court surrounded by
porticos.

Reber says, that particular attention was paid to the development of portals, the correct principle—that the entrance, as well as the apse, should give artistic expression to the character of the interior—governing their arrangement, they holding, as it were, the same relation to the entire structure as the overture to the opera. Although the portal corresponded in size to the dimensions of the entire monument, it was so designed that the swinging doors were not so large as to interfere with their practical usefulness, thus avoiding the disadvantage suffered in this respect by the ancients. This was effected by the adoption of an inclined section for the jambs and soffits, as in the windows the necessary dimensions and the requisits surfaces for decorative treatment being provided by making the entire splay upon the outside, and in some instances even extending the portal beyond the front surface of the wall. The portals thus became three or four times as large as the real door, which remained, even in the larger churches, of such dimensions that it could be easily opened and shut. The interior construction of the building was set forth in the artistic treatment of the sides of the portal, and of the semi-circular tympanum when this was introduced; the former giving, as it were, a perspective view of the piers and columns of the nave, and the latter indicating the divine character of the building by a sculpture or painted representation of the altar niche with its sacred figures.

The portals of the Church of St. Gilles (Gard), 1116, and
St. Trophime (Arles), 1154, are magnificent examples of Romanesque portals; the latter showing considerable of the Roman influence in the gable covering it, and in the character of the Corinthian columns in the spay. In the Cathedral of Senlis, the central bay of the west front is occupied by what is probably one of the first of the magnificent portals that were such a feature of Gothic design. This particular case has a portal of five orders, with pointed arches. In Amiens, the portals are within porches, made by increasing the salience of the buttresses on the ground story level, the outermost archivolts of the portals being brought forward so as to be flush with the outer face of the buttress, and pointed roofs being erected over them.

When the Cathedral of Paris was damaged by fire in the early part of the thirteenth century, there was a development in the line of enlarging the apertures of the walls, and filling these by mullions and simple forms of tracery. The clerestory apertures of the nave of St. Leu d'Esserent, according to Moore, gave the first step in this direction, which consisted in grouping two pointed openings with a circular one under an enclosing pointed arch. The rudiments of this form of compound opening date back before the time of Western Romanesque, although they rarely occur in any variety of Western Romanesque. Indications of it are seen in the Church of Qalb-Louzeh, in Central Syria, where two round-arched openings are grouped with a circular one, although without any enclosing arch. In the later Byzantine style the same thing occurs, with the addition of the embracing arch. In the transit-
ional Gothic, it first appears in the triforium of St. Germer, and later in the triforium of Noyon, where a trefoil takes the place of the upper round opening. In the opening of the clerestory of the nave of St. Leu, coupled pointed arches are surmounted by an open circle having a thinner plate or panel of stone, pierced with a six-foiled opening. Windows in Early Christian and Byzantine architecture were filled with slabs of perforated marble or other stone of light color, the translucency of which somewhat aided the lighting of the interior, and which were sometimes filled with glass.

In the apse of Rheims there is the earliest form of tracery proper, produced by building up an open framework of two pointed arches and a circle enclosing a sexfoil. These bars of stone are not finished by flat surfaces, but are worked into sections composed of rounds and hollows, associated with fillets. The rounds or roll moldings became shafts by the addition of bases and capitals on the jambs and mullions, thus converting plate tracery into true bar tracery. It is said that the Abbey Church of Orbais (1200), has earlier tracery of the same form.

The tracery of the Cathedral of Paris differs from that of Rheims in that the latter is composed of a large number of small pieces, while the former is composed of a few large pieces. By using the former method, it is possible to make the individual bars much more slender, and at the same time, they may be as strong as in the other case.
Mullions and tracery took their profiles from the functions of supporting the glass, and resisting the pressure of the wind—the latter no small matter in the case of large openings. As the window must also admit the maximum of light, these bars must also be narrow, so as to admit the most light possible.

It is believed that the foiling of tracery is perhaps due to the trefoil or cinquefoil arch, found in many of the churches of Auvergne. It is difficult to account for this feature other than by ascribing it to Saracenic influence remaining from the invasion of Europe by the Moslems, or brought from the Mohammedan countries of the East by Pilgrims or Crusaders.

Ruskin, in his "Seven Lamps of Architecture," gives Professor Willis' theory of the derivation of tracery, which is, that it arose from the gradual enlargement of the penetrations of the shield of stone, which, supported by a central pillar, occupied the heads of early windows.

It has been almost impossible to find any material concerning the origin of the rose window. The Early Christian churches in many cases used "oculi" in the clerestory, which would give the requisite form for the origin of such a feature. An oculus is seen in the western facade of St. Honorat, on the Island of Lerins, and also in many of the Norman churches of the eleventh century, as at Colleville, where they are placed high in the tower. Porter thinks, however, that this could not have been the germ of the rose window. It would seem, however, that it might have occurred thus. The oculus, having been transferred to the gable of
the western facade of a Northern church, was, in order to admit more light, as demanded by the climate, enlarged to some extent. This enlargement would naturally cause difficulty in the glazing, which the logical builders of the time would surmount by a use of radial mullions, thus giving rise to the wheel window. Such a theory is, of course, merely suppositious, but has in it elements of reason. The early wheel windows of the Romanesque period are the fore-runners of the later Gothic rose window. The wheel window is said to appear for the first time in the south transept of the Church of St. Etienne at Beauvais.

It can be seen from the foregoing, that the openings of the Gothic style reached their treatment from the necessities of the time, but with a rather larger admixture of esthetic reasons than some of the more purely constructive features. It is probably for this reason—the esthetic one—that these features are found to be enriched with ornament at an earlier date than those of a peculiarly constructive origin.
CHAPTER X.

The Spire.

After the flying buttress, there is nothing which shows more of the Gothic spirit than the stone spire with which the tower was crowned. The spire is, moreover, a feature which, perhaps beyond any other, marks the communal spirit and influence. It formed the governing feature in, and gave a general view of the medieval town, and was a sign of municipal power and prosperity. It was natural, therefore, that the tower should call forth the special enthusiasm and effort of the lay builders. (Simpson)

Ruskin gives as the motive for tower building, not the feeling of religious aspiration, but rather that the architects built high in exuberance of spirit or power—or vanity—for watch-towers, or as a place from which the sound of bells or the sounds of the muezzin's voice might be more easily heard. He also believes that the steeply pitched spire was used first, in the perfected Gothic of the North, to throw off rain and snow the more effectively, and that it was taken up with the other Gothic features when they were adopted in warmer climates.

The use of the two towers on the western facade, Porter says, had its origin in the ungainly shape of the west end of the basilica with a clerestory. To mask this end, two towers were placed here, even in early work, as shown in the basilicas of Qalb-Louzeh and Tourmanin, in Syria. This idea is also upheld by De
Vogue, who, in his work on Central Syria, shows some analogous constructions there, and in Normandy.

Before the twelfth century, nothing like a true spire had been built. In the Ile-de-France, during the eleventh century, the form of the tower roof, when of stone, was that of a low square pyramid, like those still extant on the towers which flank the apse of the Abbey Church of Morienval, which date from about the middle of the eleventh century. In Normandy more acutely pointed pyramids occur, dating from an early period; but they are still on a square base, as at St. Contest (Calvados), where a small round-arched dormer, surmounted by a gable, breaks each side near the base. In the Ile-de-France, however, the true spire, which is octagonal in form, according to Moore, surmounts the square tower early in the twelfth century, as in the small churches of St. Leu d'Esserent and others. Of these Chamant (near Senlis), if it is really as early as it appears, is especially interesting because it exhibits features which afterward appear amplified in the unique spire of the Cathedral of Senlis. These features are; acutely gabled dormers with pierced tympanums, one on each side of the four faces of the octagon that are even with the tower walls, and small openings above in each of the eight faces. Few, if any spires of earlier date than these had been constructed; and from such simple types progress was surprisingly rapid.

The typical Gothic spire was brought into existence in the Cathedral of Chartres. The south tower and spire of this monument were constructed between 1140 and 1160. In this case, the
polygonal drum has a square turret, with a shafted opening in front, and a steep pyramidal roof, set over each of the tower angles against each oblique face of the drum. These turrets, rising directly over the buttresses of the sub-structure, continue their vertical lines, and thus happily unite the drum with the tower. A pointed arched opening in each cardinal face of the drum is surmounted by a high and steep gable, which rises through the drum cornice and abuts against the base of the spire. The apexes of the pyramids of the angle turrets likewise rise above the cornice of the drum, and thus the level line, which is so marked in earlier examples, such as Vendome, is broken up, and the composition as a whole has an organic and inspiring expression.

Porter agrees with Moore in the above story of the transformation of the pyramidal tower roof into the fully developed Gothic spire.
CHAPTER XI.

Moldings, Ornament, Sculpture, Painting, and Stained Glass.

In considering the ornamental arts of the Gothic period, we find that there is such a wealth of material upon which to draw, that it is difficult to condense the matter into a space suitable to such a short sketch as this paper demands. The material that follows is taken largely from Moore ("Gothic Architecture"), and is largely quoted direct from his work, although there is some material taken from Simpson ("Architectural Development"), and nearly all sources have been found to be verified by Reinach and Lubke, as well as Porter and Reber.

The sections of moldings that were used throughout the Middle Ages followed to a great extent the shape of the arch in vogue at the time. When round arches were used, moldings were segments of circles, the most characteristic being the "torus", or three-quarter round, which was used either alone, or in combination with a hollow or cavetto. When the pointed arch made its appearance, the pointed molding took the place of the round. When the principal constructional lines of the building were large and bold, the moldings were few and strongly marked, and as the work in general grew more fine and delicate, the character of the moldings followed suit. Materials also had a considerable effect on the character of moldings, as a soft, easily worked stone would naturally lend itself to more and more delicate cutting than a
harder material. Belt courses in the early Middle Ages are based on late Roman buildings, while those of early Gothic are partially based on Christian buildings in Palestine and Syria, seen by Crusaders. Perfected Gothic freed itself from all historical precedent and tradition in its treatment of belt courses and other moldings.

Coming now to the question of the capitals and bases of the Gothic system, we find, according to Moore, that the earliest development of a form of shaft and capital suitably adapted to an arched system of construction appears to have been accomplished in the arcades of the apsidal alcoves of St. Sophia of Constantinople. In these, classic forms and proportions are wholly thrown aside as no longer adapted to the conditions that had to be met. The column had now to carry a load of considerable bulk and square form, instead of a narrow architrave, and was consequently crowned with a capital of wholly new character. It is a curious combination of elements derived from all three of the classic types, modified and fused together in a creative way, and not a mere adjunction of parts taken without alteration from different forms, as was the Roman composite capital. The Doric element appears in the convex outline and in the thick square abacus; the Ionic in the volutes, which are on two opposite faces only, and are connected on the other sides by the bolsters, or cushion-shaped features that are peculiar to the Ionic capital; and the Corinthian in the height of the member. The height was needed to gain the necessary magnitude of abacus surface without an unsafe and un-
sightly inclination of the outline. The square form of the abacus was needed to fit the square load, and its thickness was required to give strength to its overhanging angles. The capital thus is a structural member of great importance, providing a secure bed for the load with which it is charged. The entire outline of the whole column is no less admirable from an esthetic point of view than it is from that of functional adaptability. The shaft itself, which may be an ancient one, has the slight taper of the best classic shafts, and an entasis of perfectly Greek refinement. It is interesting to find the Greek genius again active, and under changed conditions, creating appropriately new architectural forms, which are no less logical and beautiful than were those of classic times.

The logic and artistic skill thus displayed by the Byzantine designers in the shaping and adjustment of the capital were not followed by the builders of Western Europe until after the eleventh century. Marked traces of the Byzantine influence occur, however, in some of the basilican churches of Rome; and among them are many curious imitations of the form of impost that appears to have been first developed in Constantinople. Of these the arcades of the Church of Sta. Maria in Cosmedin, dating from the close of the eighth century, afford interesting instances. Like many other churches of the period, the builders of this edifice used classic fragments that they found conveniently at hand, and when these fragments were not of such character that they could well be used as they were, such devices as were possible were employed to adapt them to their purpose. One of the fragments used in this church
was a Corinthian capital, which was not well adapted to support such a load as would be placed upon it. Consequently, a square flat slab was used above the abacus, forming a supplementary abacus and with the general shape of the capital, giving an approach to the form of the Byzantine impost.

The shafts of the piers of St. Ambrogio of Milan are in some cases almost as large as the loads which they carry; and while the capital, which is a rude combination of Roman and Byzantine elements, is well shaped to suit such conditions, it has little other use than to adjust the round section of the shaft to the square form of the load. In the early Norman Romanesque this form of impost is frequent, as witness an engaged shaft of the north aisle of Jumieges. Better forms than this were produced, however, during this epoch, especially in the Ile-de-France, where, in the aisles of Morienval, capitals occur which so closely resemble those of St. Sophia as to confirm the belief that a traditional, and perhaps even a direct, Byzantine influence was felt here very early in the Romanesque development.

In France, after the eleventh century, the practice of giving the capital a spreading form to carry a load more than the shaft became practically constant. So with the use of slender monolithic shafts and columns, which led to the production of the distinctly Gothic type of capital, we see in the apse of the Cathedral of Senlis an impost which in all its outlines and proportions is remarkably similar to that of St. Sophia. Students of medieval architecture have hardly hitherto enough observed the
extent and importance of the structural innovations (apart from those connected with the development of the dome on pendentives) that were made by the Byzantine architects, or the cumulative influence of these innovations on the arts of Western Europe, and more especially on the rising art of France in the twelfth century. But so important were these innovations, and so great their influence, that it is hardly too much to say that the Gothic style was made possible by them. The domical groined vault and the expanded capital are forms without which Gothic architecture could not exist.

Of the capitals of the ancient orders, the Corinthian only influenced to any considerable extent the art of the Middle Ages. Derived from the Roman type, and logically modified in part under Byzantine influence, the Corinthianesque capital of the later Romanesque builders was an improvement on its prototype, while that of the Gothic artists of the close of the twelfth century was further developed in its functional character and refined in its profile. This type is one that admits of almost endless changes which adapt it to the varied conditions that Gothic capitals have to meet.

The forms of bases are hardly less interesting than those of capitals. The Gothic base is always some modification of the Attic base of classical antiquity. Bases closely resembling those of the Erechtheum and the Choragic Monument of Lysicrates may be found in Gothic buildings; but the proportions of the parts are more less changed in conformity with the new conditions, and the
profiling becomes, in some cases, even more refined and beautiful than those of ancient times. In the bases, as well as in the capital, the first innovations seem to have been made by the Byzantine architects. In these ancient forms adapted by the Byzantine architects, the lower torus is considerably deepened, and placed upon a plinth of unprecedented thickness. Early Romanesque bases are naturally less elegant in profile than those of St. Sophia (which exhibit the subtle artistic skill of the later Greek designers), but they are usually composed of the same elements. In early Norman Romanesque art, as in the nave of the Abbaye-aux-Hommes, rudely shaped bases frequently occur in which all trace of the Attic profile is lost; but in the later Romanesque of the Ile-de-France, as at St. Etienne of Beauvais, as well as in the early St. Ambrogio of Milan, the Attic profiling is distinct, though the contours are rude. The parts already exhibit Gothic proportions, and the plinths are of remarkable height. In some cases, notably St. Germer, and Paris, the flattened torus is seen that is one of the most subtle of the Attic curves.

The fact that a remarkable school of sculpture—a school far in advance of all others of the Middle Ages—was developed during the twelfth century, in connection with the Gothic architecture of the Ile-de-France, has not, hitherto, been recognized by students of the history of the Fine Arts. The earliest schools of sculpture on this side of the Alps were those of Southern Gaul, where longer than elsewhere the ancient Roman civilization had retained its life and vigor; and where, as we have seen,
the soil was thickly covered with Roman monuments. Among these were vast numbers of sculptures, which, coarse and inferior as they for the most part were, afforded models, in some measure characteristic, of the great art of antiquity. Upon such models the medieval sculptors of this region naturally formed their style, just as the constructors formed their architectural system on that of the extant Roman buildings. But the productions of the medieval sculptors of Southern Gaul abundantly show that other sources of instruction and inspiration were also open to them in the works of Byzantine art—an art which, in its best forms, was of a far more admirable and potent character than the decadent provincial Roman art. The principal examples of Byzantine design offered to the artists of the West as models were the manuscript illuminations and the carvings in ivory, large numbers of which were possessed by the great monastic houses of the early Middle Ages, most of which were active centers of artistic culture and production. The student of Greek art will not fail to perceive in the examples preserved in modern museums that these diminutive figures show many qualities that are plainly of Hellenic origin. The composition of lines and the casting of draperies are closely similar to those of the finest Greek coins and other reliefs. In such works as these were some of the fundamental principles of Greek art preserved to the Middle Ages; and their influence upon the early art of Southern and Central Gaul, and afterwards upon the Gothic schools of the North, will, upon comparison, become apparent.

Byzantine influence is shown upon the sculptures of the lintel of the Church of Notre Dame du Port, Clermont-Ferrand, which
date from the close of the Eleventh century. The similarity of
the early medieval art of France to ancient Greek art, is, in some
cases, even more striking, and is often such as almost to compel
one to believe that there must have been some more direct way of
transmission than has hitherto been supposed. The similarity of
treatment is not seldom surprising. The well-known convention in
the treatment of hair in archaic and early Greek sculpture, as
shown, for instance, in the head of the Apollo of the Temple of
Zeus, at Olympia, is reproduced completely in a head from the
portal of the tympanum of Moissac. In so far as this peculiarity
is concerned, these two heads might be thought to be the product
of the same age and the same school. These, and similar cases,
show that both the early French sculptors and those of Greece,
were working along the same line of inspiration. North of the
Loire, the monastic carvers of Burgundy produced works which,
though not freed from the artistic limitations due to primitive
conditions, gave evidence of a new impulse guided by a fresh ob-
servation of nature. Of this sculpture, the Abbey Church of
Vezelay and the Cathedral of Autun afford, in the jambs and tympanums
of their portals, characteristic examples. These are curious, and
almost barbaric in their general aspect; but they are also remark-
able for movement and expression, as well as for a marked survival
of classical qualities of composition. The works of these early
schools of the South and of Burgundy, together with those examples
of Byzantine art that were common in the monastic libraries, appear
to have constituted the chief source of stimulus and guidance open
to the early sculptors of the Ile-de-France, whose work soon surpassed in excellence all that had been done since the decline of the ancient schools of Greece.

In the statues from the cloister of St. Trophime at Arles, which are a little later than 1140, there is, notwithstanding the fine classical casting of the draperies, much of the rigid effect that is noticeable in the more formal types of Byzantine art. Traces of Byzantine convention in the treatment of the draperies are clearly marked. This is true especially on the breast, where the folds are suggested by simple incised lines on surfaces which are but very slightly modeled.

Some figures from the destroyed Church of Notre Dame at Corbeil have been preserved, which show a surprising likeness to ancient art. The treatment of the draperies is almost identical with that of certain archaic statues which have been found in the Island of Delos.

Some figures from the destroyed Church of Notre Dame at Corbeil have been preserved, which show a surprising likeness to ancient art. The treatment of the draperies is almost identical with that of certain archaic statues which have been found in the Island of Delos.

The tympanum of the north portal of Paris shows a skillful treatment of form, and beauty of modelling, such as had not before been seen since ancient classic times. Here again the likeness to certain qualities of Greek art is both remarkable and instructive. It is a fundamental likeness, showing itself in those
finer peculiarities of composition and execution which escape the merely imitative workman, but are natural to the workman who has been bred on traditional principles. It is due, probably, to the natural propensities of men constituted like the medieval artists of France, and disciplined as they had been by the Greek artistic traditions as transmitted through the Byzantine channel.

The use of grotesques grew primarily out of the old popular belief in the symbolic character of animals and imaginary creatures. As symbols of human qualities, both good and evil, these animals, real and imaginary, were not wrought, for encouragement and for warning, upon the walls of the sacred edifice.

The carved foliate ornament of the Romanesque builders had been mainly derived from the ancient conventional designs of Roman and Byzantine art. These ancient models had been worked over and variously modified, but for a long time with little invention. Fresh motives, however, now began to appear, and the inspiration of nature at length transformed the traditional elements into those living and beautiful forms of endless variety which are peculiar to Gothic art.

One conspicuous element of effect in the sculpture of France of the Middle Ages is now almost entirely lost, and hence the aspect of even the best preserved examples is very different from that which they must originally have had. The color with which these sculptures were enlivened has, for the most part, disappeared, in most cases only a few traces remaining. But there are enough of these to know that color was extensively employed. Such traces may be found in the portals of Paris, Senlis, and many
other churches. In the Sainte Chapelle of St. Germer-de-Fly, several statues, dating from about the middle of the Thirteenth century may be seen, on which the coloring corresponds to that of contemporaneous illuminated manuscripts. Heads, hands and feet are of a creamy white, the cheeks being slightly reddened. Eyes are of a pale blue or brown color, with black pupils. Hair and eyebrows are black, brown or golden; and the draperies are mostly red, blue, and purple, with white and black; while ornaments, as jewels and embroideries, are gilded. It was not until a later period that sculpture was colored in imitation, as in the XVI century choir screen of Amiens. The earlier is so like what we know of the coloring of Greek sculpture, that we may perhaps reasonably believe the ancient tradition to have remained unbroken down to the thirteenth century.

Scarcely any of the mural paintings of France date to the eleventh century, and but few are as old as the twelfth. The earliest appear to be those of the Chapel of Liget (Indre et Loire), or the figures in the Baptistry of St. John at Poitiers, both very Byzantine in character. More extensive remains have been preserved in the Church of St. Savin (Départemente Vienne) in Poitou, where all the walls and vaults, including those of the crypt, were originally covered with paintings. The treatment of these figures is very simple, but the composition and the forms already display a complete emancipation from Byzantine conventionality. The action is easy and expressive, and the forms are not without a certain charm, approaching the slender proportions of
the Gothic. These characteristics are still more apparent in some remains of mural paintings in the chapter-house of St. Trophime in Arles, which are to be ascribed to the end of the twelfth or the beginning of the thirteenth century. These show great beauty of design and expression and show a decided advance in the art.

With regard to the use and origin of colored glass, Sherril says ("Stained Glass Tours in France"), that it is said that St. Sophia contained not only glass mosaics on its walls, but also in its windows. The artists who were then occupied in designing mosaics worked out their pictures in little pieces of glass on the walls until they had developed along that line as far as possible. Then they doubtless thought that these glass mosaics would be even more effective if they could devise a means of illuminating their pictures by allowing the light to shine through the colors. To accomplish this, they contrived to hold the morsels of glass securely in place, first by wooden or stucco frames, and later, by long ribbons of lead having channels on each side to retain the pieces of glass at the edges. This form of mosaic thus held up to the light became a stained glass window. Thus we easily understand that when the idea had arrived of taking the mosaic picture off the wall and placing it in the embrasure of the window, the art of making that picture out of glass had already been developed.

Theophilus, when he wrote his twelfth century treatise on this subject, stated that the art of making stained glass was
a French one. It was to Byzantium that the French were indebted for their quaint style of drawing. In early glass we observe the constrained, ugly poses of the bodies, arms and legs, as well as the staring-eyed, ill-proportioned heads, not only in the medallion type of window but also in the larger figures glaring down from the clerestories. Abbe Texier, in his "Essai Historique et Descriptif sur les Argentiers et les Emailleurs de Limoges," says that French stained glass began in the neighborhood of Limoges, whose highly vaulted school of enamellers were strongly influenced by the Byzantine types of the Venetian school and that therefore it was but natural for the glass artist to yield to the Byzantine influence. A Venatian colony settled at Limoges in 979. Doge Orseolo I came to France in 978 and St. Front is ascribed to him. The older the glass, the more marked is the resemblance to the Byzantine models.

Taken in all, Gothic art shows the inspiration of nature to a high degree. The roots of most of the ornamental work may be traced to antiquity. The ancient ornamental motives had survived, although they were often modified, and frequently imitated without skill or intelligence, until Gothic times themselves, when there is a feeling that is worthy of the best period of Greek art.
CHAPTER XII.
General Conclusions.

In summarising the origins that we have found for the several principal elements of the Gothic style of architecture, we must not lose sight of the fact that, however ancient may be the beginnings of these elements, they are used in the Gothic style wholly with regard to their positions as parts of a great constructive whole.

We find that the Gothic style is pre-eminently a constructive style. The ribbed vault, as used in the perfected Gothic of the thirteenth century, serves its purpose as no other method of roofing large spaces has ever done. There is no portion of a building too irregular in shape to be covered by this means. Its lightness is marvelous, considering the material used, and far surpasses any other method of stone construction. The pointed arch, the addition of which to the ogive vault gave the final touch of adaptability, leaves the builder in a position to disregard the heights of arches of varying span—he is no longer obliged to stilt the arches in order to avoid an excessive doming of the vault. We find that the ribbed or ogive vault, in all probability, had its origin among the builders of Lombardy, and from that region, carried by wandering artisans and by the monks who were moving constantly from place to place, the idea spread to all parts of Europe, and was brought into use everywhere. It is barely possible that the germ of the idea first found expression in some of the vaults of the narthex of St. Sophia, in Constantinople.
The pointed arch was not used in the Gothic style until its usefulness had been discovered to lie in its power of adapting vaulting to all conditions, although it had been used previously in barrel vaulting, on account of the lessened thrust, and decreased liability to fail. This last quality probably led to the change from the round arch.

The clustered pier is a logical development of supports in such a manner that each wall and transverse arch, as well as the diagonal arches, of ribbed vaulting, should have a clearly defined support. The pier was gradually built up, following the development of vaulting.

The flying buttress was also a development of the science of vaulting. When the ribbed vault began to be used, it was found that such vaults would not stand—that the thickness of the wall was not a sufficient buttress against the thrust of the vault. The builders then turned to the South of France, where half barrel vaults had been used to counteract the thrust of the nave barrel vaults, and adapted the idea to their own uses, cutting away that part of the buttressing vault which did not act directly against the support of the vault. These buttress arches were at first concealed, the were placed upon the exterior, when the flying buttress became an actuality.

The chevet was an outgrowth of the needs of those churches whose relics and shrines caused great numbers of pilgrims to come to them. It was necessary to provide a space where these pilgrims could pass in procession around the church, and at the same time obtain a view of the relics or shrines. The side aisles
were in consequence carried around the rear of the ase as a passageway for the processions, and radial chapels placed so as to open from this passage and leave the shrines in view. After this need had been met, elements of beauty were seen in such an arrangement, and it was elaborated until the entire east end of the church became a sweeping band of chapels.

The splays of window openings were devised first in order that more light might be admitted to the church. The bare surfaces thus left were distasteful to the eye, and were consequently enriched by arches in receding planes, and by columns at the sides. The portals were splayed in the same manner, partly for ease in entrance, and partly in order that the opening itself might be in scale with the entire building, while the swinging doors remained small enough to be easily opened and closed.

The spires of the Gothic period were an outgrowth of the communal spirit of the Medieval city. At the beginning of this period, the power of the church was passing from the hands of the monks into the hands of the secular clergy, and as a result, the building of churches fell largely into the hands of laymen. The people as a whole felt pride in the cathedral of their particular city, and labored to make it beautiful, placing on it as a finishing touch, the spire that was a landmark for miles around, and that made the city prominent.

Sculpture, ornament, moldings and paintings of the Gothic period were largely influence by classic models and feeling—so much so, in fact, that many of the best works of the period are hardly to be distinguished from the works of antiquity in their
general style and appearance. During the Romanesque and transition
al periods, the strongest influence was that of the Byzantine art-
ists. This influence still remained uppermost in the painting
and stained glass of the the Gothic period, but was outgrown in
the sculpture and ornament. The details of ornament were largely
taken from the flora of the surrounding country, and were carried
out with a marvelous freshness and fidelity to truth.

I have tried to make clear, that Gothic art is essential-
ly an outgrowth of constructive needs, and of the requirements of
the ritual and congregations of the churches. If I have succeeded
to any extent, I feel that this thesis has been of some value.
Anderson and Spiers—"Architecture of Greece and Rome."
Cattaneo—"L'Architecture en Italie du VI au XI Siecle."
Choisy—"Histoire d'Architecture."
Corroyer—"Architecture Romaine."
"Architecture Gothique."
Dartein—"L'Architecture Lombarde."
de Vogue—"Syrie Centrale."
Dieulafoy—"L'Art Antique de la Perse."
Enlart—"Manuel d'Archeologie Francaise."
Fergusson—"History of Architecture."
Fletcher—"History of Architecture."
Gailhabaud—"L'Architecture du V au XVI Siecle."
Lefevre-Pontalis—"L'Architecture Religieuse dans l'anciens Diocese de Soissons."
Lubke—"History of Art." (Edited by Sturgis.)
Moore—"Development and Character of Gothic Architecture."
Parker—"Gothic Architecture."
Porter—"Medieval Architecture."
Pugin—"Specimens of Gothic Architecture."
"Examples of Gothic Architecture."
Ramee—"History of Medieval Art."
Reber—"History of Ancient Art."
"History of Medieval Art."
Redtenbacher—"Medieval Architecture." (Ricker.)
Reinach—"Apollo."
Revoil—"Architecture Romane du Midi de la France."
Rickman— "An Attempt to Discriminate the Styles of Architecture in England."
Ruprich-Robert— "L'Architecture Normande aux XI et XII Siecle."
Ruskin— "Lectures on Architecture."
"Seven Lamps of Architecture."
Simpson— "A History of Architectural Development."
Sherrill— "Stained Glass Tours in France."
Viollet-le-Duc— "Dictionnaire Raisonne de l'Architecture Francaise."
The plates which follow have been drawn and traced in an effort to show, in some small degree, that development from certain sources which has been spoken of in the main body of the thesis. Plate I. is a good example of a quadripartite vault, and shows also the highly developed clustered pier. Plate II. No. 1, shows the plan of the private Roman basilicas, and also, as these latter were adapted from them, the plan of the Early Christian basilica. Columns are here used, supporting a range of arches, the whole covered by a timber roof. No. 2, shows a further advance of the same plan, in which square piers are substituted for the columns. This plan is seen in some of the basilicas of Central Syria, covered by the so-called Syrian vaulting of stone slabs. No. 3 shows a form in which the nave and aisles are both covered with barrel vaults, the latter having ribs thrown across which help to buttress the thrust of the nave vault. No. 1, shows a form of vaulting in which transverse arches are thrown across the barrel vaults of both nave and aisle, and, the piers being placed rather far apart, an intermediate pier is inserted, thus giving two arches at the side of each bay. This scheme is seen in some of the early barrel-vaulted churches of Southern France. No. 5 is a form such as was used in the early Romanesque of Germany, when the Roman groin vault was used in the aisles, but the builders did not have courage to use any other than a transverse-ribbed barrel vault in the nave. No. 6, shows a use of the barrel vault in the
nave, but with light transverse arches, while the aisle shows a use of the groined vault, with applied rib, having no structural significance, and used apparently for ornament, as in some of the churches of Southern France. This same form was used later, when ribbed vaulting was being used in the same region, by builders who could use the ribbed vault for such a small span as the aisle, but were afraid to use it for the nave, and so retained the barrel vault, to which they were accustomed. No. 7, shows the first real use of the ribbed vault throughout, as in San Michele of Pavia, and in practically the same form in most of the Gothic churches and cathedrals, the principal change being the use of pointed arches. No. 1, Pl. III., shows the sexpartite vault, developed in Normandy in the Abbaye-aux-Hommes, (Pl. III, No. 3) and used in many of the Gothic edifices of the Ille-de-France. No. 8, Pl. II., is the oblong form of vaulting which was common in many Gothic buildings, such as Rheims and Rouen. No. 3, Pl. IV., is an example of a transitional form of vaulting such as is seen at Vezelay. Nos. 3 and 4, Pl. III. are examples of Roman barrel and groined vaults. A plan of a Roman groined vault is seen in the central part of the basilica of Constantino, (No. 1, Pl. IV).

Nos. 1 and 2, Pl. IV. show a peculiar likeness in the layout of the plan that is very unusual considering the difference in the sources of the two buildings, and the lapse of about two hundred years between the basilica and St. Sophia.
Pl. V shows the use of the pointed arch through all periods, from the early days of Egypt, down to the apsidal aisle of Morienval, where the pointed arch first assumes its functional part in Gothic vaulting.

Pl. VI, Nos. 1 and 2 show a use of the aisle barrel vault in buttressing the nave barrel, while No. 3 shows the same thing, but with a form of the arch approximating that of the later flying buttress. No. 4 shows what is practically a buttress in the vault of the aisle gallery, while No. 5 is a true flying buttress, although concealed. No. 6 is a true external flying buttress.

Pl. VII shows by the succession of the numbers the development of the spire.

Pl. VIII. is a beautiful example of an ordered Romanesque doorway, such as one as furnished the models for the magnificent treatment of the Gothic portals.

Pl. IX shows an example of a rose window with flamboyant tracery, which was the culminating effort of Gothic tracery.

Pl. X, Nos. 1 and 2, shows examples of pierced windows which are of about the same date. No. 2 is probably the ancestor of Gothic tracery, as we see much the same form in Byzantium (No. 3), and the first beginning of tracery in France (No. 4) shows the same doubled arch with a round opening above.

Plates XI to XIV inclusive, show a number of profiles taken at random, all of which show to a considerable extent a great deal of classical feeling, if they have not been derived directly from classical sources.
Quadripartite Vault, Cathedral at Rouen.
Evolution of Vault and Pier

(Porter.)
1. Sextpartite Vault, as in Notre Dame.

2. Sextpartite Vaulting from Abbaye-aux-Hommes, Caen (Fletcher)

3. Roman Barrel Vault

4. Roman Groined Vault

Plate III.
1. Basilica of Constantine

2. Main portion of St. Sophia

3. Vaulting without intermediate pier

Plate IV.
1. Two Egyptian Arches


3. Terrae and Chipiez.

4. Sassanian Arches at Cresiphon.

5. Dieulofey.

Chapel at Molleges. Revoir.

Chapel of St. Gabriel, Tarascon. Revoir.

Apsidal Aisle of Mariendol. Moore.

THE POINTED ARCH.
THE POINTED ARCH.
DEVELOPMENT OF "BUCKET"

Plate VI.
CHANGE IN SPIRES

Plate VII
ROSE WINDOW, CHURCH OF NOTRE DAME, LE GRAND ANDELY, FRANCE

Example of Rose Window and Flamboyant Tracery.

Plate IX.
1. Byzantine Window
   Simpson

2. Qalb-Leuzeh
   Moore

3. Byzantine Church in
   Athens
   Moore

4. St. Leu d'Esserent
   Moore

- DEVELOPMENT OF TRACERY -

Plate I.
Abacus of Bethzy-St.-Martin. (Porter)

Abacus of Bonnes. (Porter)

Base of Domery

Base of Soissons. (Porter.)

Capital from Soissons. (Porter.)

Profiles
Base of Saponay

Interior String-Courses Glennes

Barzy-le-Sec

Bellefontaine

Vailly

Arch-St.-Restitut.

Exterior String Courses.

Fontanoy

Montigny-Lengrain

Cornices

Aizy.

Soissons

Lhuys

Soissons

Vailly

Arch Archivolts.

(Plate VIII.)
Morienvil

Berzy-le-Sec

Joissons.

Window Archivolts.

Berzy-le-Sec.

Coulonag.

Doorway Archivolts.

Vic-sur-Aisne

Bellefontaine

Berzy-la-Sac

Vauilly-la-Poterie

Transverse Ribs.

Morienvil

Bellefontaine

Bussieres.

Diagonal Ribs.

(Porter)

Plate XIV.