

# The Annotated Arch

A CRASH COURSE IN THE  
HISTORY OF ARCHITECTURE

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To Sid, Alison, and Eliza—my foundation and my peaks

In memory of Meg Colclough  
&  
Sidney and Margaret King Strickland

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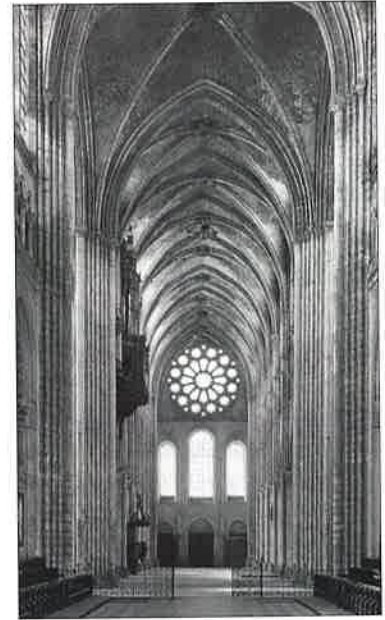
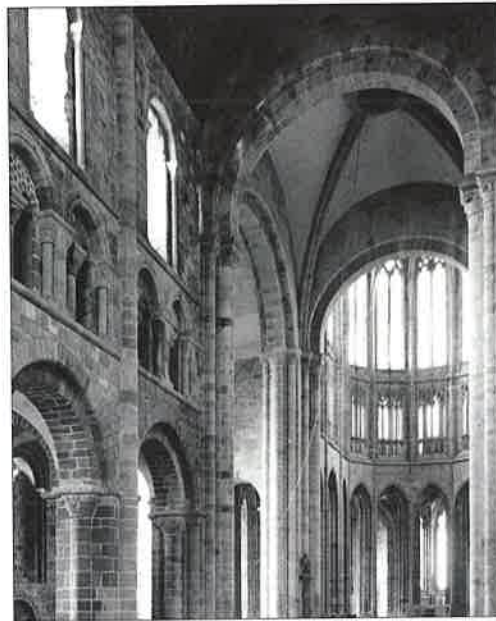
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## HOW TO TELL THEM APART



	Byzantine	Romanesque	Gothic
WHERE:	Constantinople, northern Italy	Western Europe	France, northern Europe
WHEN:	330–1453	1030–1200	1140–1500
MAJOR BUILDING FORM:	Church	Church, castle	Cathedral, university, guild hall
PLAN:	Cross-in-square capped with domes	Compartmentalized, cruciform	Unified interior
SUPPORT:	Pendentives and piers	Sturdy piers, thick walls	Piers, flying buttresses
HALLMARK:	Dome	Round arch, barrel vault	Pointed arch, rib vault
DECOR:	Lavish inside, plain outside; mosaics	Stone sculpture	Sculpture, stained glass
EFFECT:	Mysterious	Massive, segmented	Soaring, vertical, skeletal
INSPIRATION:	Heaven	Roman construction	Heavenly light
GOAL:	To arouse emotion, transport	To accommodate pilgrims	To impress, uplift



## ROMANESQUE: A MIGHTY FORTRESS

In the history of Western architecture, the five centuries between the fall of Rome around 479 and the millennium were mostly blank. Under the depredations of illiterate barbarian tribes bent on destruction, monumental architecture didn't decline; it all but disappeared. Then, after the thousand-year anniversaries of the birth of Christ and the crucifixion (1033), when the world did not end in flames and the Second Coming as many expected, Europe regained its verve. From about 1000 to 1200, two forms of buildings proliferated: castles and churches. Whether built for military or religious purposes, both forms were weighty piles of stone, their massive walls not only for structural support but defense.

With the exception of the Eastern Byzantine Empire, the refined culture achieved by Rome had vanished during the Dark Ages (500–800). In Western Europe, civilized amenities like roads, law, sanitation, and running water were a distant memory. But enough fragments of Rome remained in crumbling triumphal arches and amphitheaters dotting the landscape. When architecture revived, it was these ancient monuments that medieval architects imitated, adapting Roman vaulting techniques and the basilica plan. In the nineteenth century, critics called the style Romanesque—the first coherent, international style to appear in Western Europe after a lapse of five hundred years.

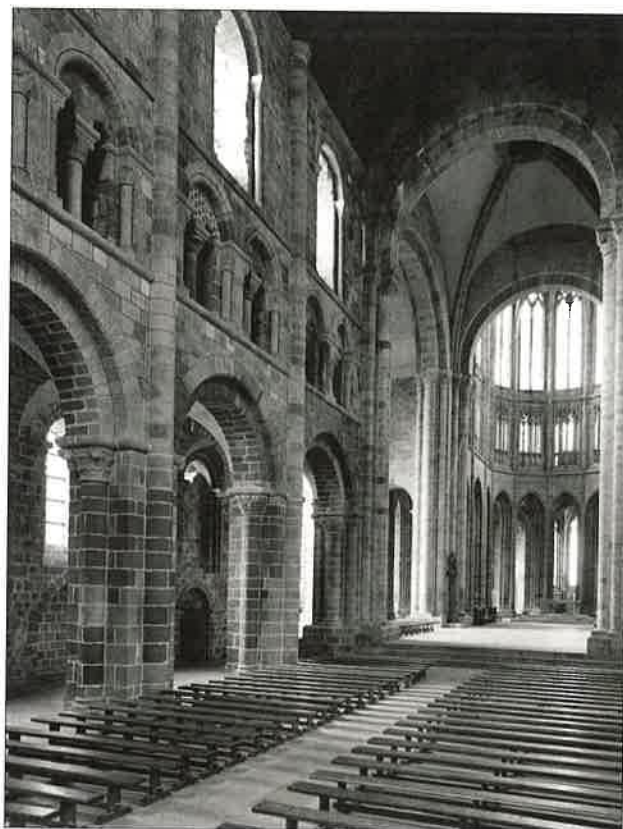
Since warfare constantly threatened, all buildings were strongholds, fortified for security. With thick walls and small windows, both religious and secular architecture had a fortresslike appearance. Other Romanesque traits were a modular system of construction, with interiors divided into squarish bays, and fat piers supporting round arches and barrel vaults. Romanesque architecture varied considerably in different locales, according to the diverse climates, traditions, and materials of France, Italy, Spain, England, and Germany.

**ROMANESQUE CHURCHES: PILGRIM'S PROGRESS.** Around 1050, the monk Ralph Glaber described the upsurge in church building: “Shortly after the year 1000, all Christian peoples were seized with a great desire to outdo one another in magnificence. It was as if the very world had shaken itself, and, casting off her old garments, was clothing herself everywhere in a white robe of churches.”

A general religious fervor, increasing prosperity of monasteries, and the cult of pilgrimages spurred this upswell of construction. Between 1050 and 1350 in France alone, eighty cathedrals, five hundred large churches, and tens of thousands of parish churches were erected.

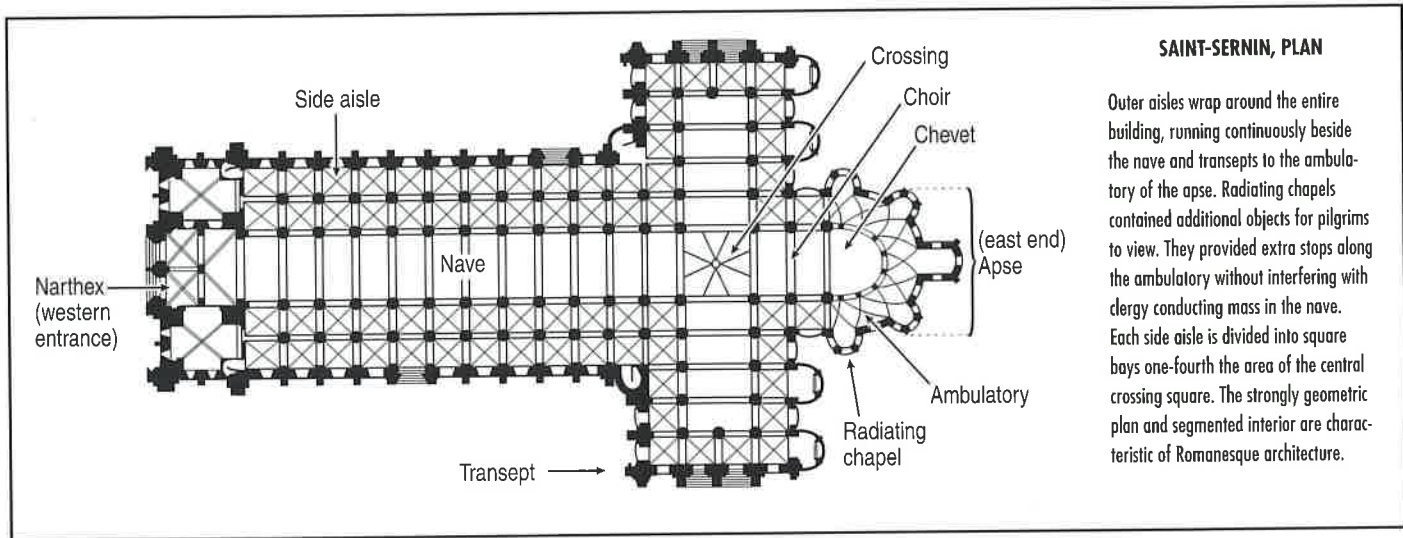


**Mont-Saint-Michel, Normandy, France, 1024–84**  
This Benedictine abbey is a rare surviving example of a wooden-roofed, Romanesque church. (Since interiors were lit by candles and torches, timber construction was prone to catch fire, giving rise to stone vaulting elsewhere.) Built on a rocky islet, the abbey is cut off from the mainland at high tide. Its inaccessible location was considered conducive to a life of asceticism. The Cistercian monk St. Bernard of Clairvaux (1090–1153) was so devoted, he refused to lift his eyes to a sunset, fearful its beauty would distract his thoughts from God. The motto of monastic life was “Ora et Labora” (prayers and work). Since their treasures were subject to theft, churches were built, in Martin Luther’s words, like *eine feste Burg* (a mighty fortress).



### Nave, Mont-Saint-Michel

The nave wall is constructed in three layers, rising from the ground floor to a tribune gallery to clerestory windows. Round-arched openings—a hallmark of Romanesque style—create different horizontal zones, in contrast to the strong vertical lines of half-columns from floor to ceiling that divide the nave into regular bays.



SAINT-SERNIN, PLAN

Outer aisles wrap around the entire building, running continuously beside the nave and transepts to the ambulatory of the apse. Radiating chapels contained additional objects for pilgrims to view. They provided extra stops along the ambulatory without interfering with clergy conducting mass in the nave. Each side aisle is divided into square bays one-fourth the area of the central crossing square. The strongly geometric plan and segmented interior are characteristic of Romanesque architecture.

The largest was the French abbey of Cluny, seat of the most influential monastic order. Founded in 910, Cluny and its successive churches were called by a scholar “the greatest creation of the Middle Ages.” Not only did monasteries preserve ancient and medieval learning in their libraries, they were virtual utopian communities. At Cluny, the church held thousands, twelve hundred monks slept in the dormitory, and there were twelve bathhouses and

fountains fed by running water through underground pipes. A library, refectory, cloistered court, and service buildings like barns, brewery, and mill were standards at a monastery. The sumptuous abbey church of Cluny, torn down in 1810 by antireligious mobs after the French Revolution, had a 600-foot-long nave, multiple towers, fifteen chapels, lavish interior sculpture and frescoes, and a choir for three hundred monks.

**A HANK OF HAIR AND A PIECE OF BONE.** Chaucer described a fourteenth-century pilgrimage in his *Canterbury Tales*: “from every shire’s end/Of England to Canterbury they wend/The holy blessed martyr for to seek.” He was describing a mass phenomenon that set thousands on road trips, wending their way from one church to the next where they paid homage to saints’ relics, like skulls, a splinter of the True Cross, or a spot of Christ’s blood. These remains, housed



Church of Saint-Sernin, Toulouse, France, 1077–1119

A cruciform shape with altar at the east end and main door at the west is typical of Romanesque churches. The entrance is divided into a three-part facade, with each portal indicating the internal division into nave and side aisles. Chapels radiate off the rear apse. (The Gothic tower over the central crossing was a later addition.)



Nave, Saint-Sernin

Compound piers define bays and rise to meet the barrel vault over the nave, banded with transverse arches. The size and grandeur of Romanesque churches were vital to their message, as were the Gregorian chants that bounced off stone vaults, filling the space with celestial music. The English writer Joseph Addison (1672–1719) said, “By opening the mind to vast conceptions they fit it for the conception of God.”





**Basilica of San Miniato al Monte, Florence, Italy, 1062–c. 1200**

Crisp geometric patterns of marble veneer on the exterior and echoes of classical temple shape show the reliance of Italian Romanesque on ancient Roman models.

in jeweled reliquaries, were thought to work miracles. Crippled pilgrims on crutches often camped out awaiting a cure.

Elaborate sanctuaries to house relics rose along the pilgrims' routes, and their popularity as tourist attractions dictated a church's interior form. Since hordes of pilgrims venerating the shrines interfered with daily offices by clergy, the solution was to create a loop for circulation ringing the nave. The rectangular basilica format evolved into two quadrant-vaulted side aisles outside a barrel-vaulted nave. At the east end, a large, semicircular apse behind the altar was supplied with an ambulatory (a walkway around the perimeter) and radiating chapels (smaller apses, each displaying treasure). Linked to aisles around the nave and transept, the ambulatory separated pilgrims from monks and allowed both groups to go about their business without traffic jams. The transept (or horizontal crossing arm) was moved toward the center of the church, creating a strongly cruciform shape.

The Church of Saint-Sernin in Toulouse, France, is a typical abbey church on the pilgrimage path. Thick walls support the barrel vault over the nave, and two side aisles are topped by a second-story gallery called a tribune. Compound piers running from floor to ceiling divide the interior vertically into bays. This articulation into components is further emphasized where the shafts meet transverse arches beneath the barrel vault.

To remedy the lack of light in early Romanesque church interiors (due to thick walls and few windows), churches like Autun Cathedral (1120–30) added a third story to the elevation. Atop the tribune were clerestory windows lighting the nave. Registers of the three-level elevation are separated by a horizontal cornice, which directs the eye down the length of the nave toward the altar. Gradually, as Romanesque approached the succeeding Gothic era, larger windows pierced church walls, and clusters of linear forms visually broke up the stone masses.



**Cathedral, Pisa, Italy (architect, *Boschetto*), 1063–1350; Bell Tower, 1174–1271; Baptistry (architect, *Dioti Salvi*), 1153–1265**

This trio of buildings is united by the pattern of white marble arcades facing their exteriors. On the central-plan Baptistry, only the lower arcade is Romanesque.

**ITALIAN ROMANESQUE: LOCAL QUIRKS.** Italy never completely embraced the Romanesque style. Its version was a hybrid of European and classical forms. Even from one city-state to another, styles varied. Church architecture in the Lombard region and its cities like Pavia and Milan differed from

buildings in Tuscan cities like Florence and Pisa. This local flavor is hardly surprising. Not until 1870 did Italy unite as one country. Cities were fiercely chauvinistic, especially in their architecture, which was seen as evidence of superior culture. The word for local chauvinism, *campanilismo*, derives from the name for a bell tower, or *campanile*, which towered over a city and rang out its claim to fame.

The basilica of San Miniato al Monte in Florence shows classical influence. Five arches springing from Corinthian capitals frame three doors of the lower level of the facade. The shape of upper levels refers to the portico of an antique temple front, and geometric patterns of green-on-white marble resemble inlaid veneers in ancient Roman buildings.

The triad of marble buildings on the green in Pisa forms one of the most perfect compositional groupings since Trajan's Forum. Unified by their graceful

exterior arcading, the domed baptistry, bell tower, and cathedral were built over hundreds of years but share the same decorative features of color, texture, pattern, and materials. Sharply scalloped arcs repeat in regular rhythm on all three buildings of the group, regardless of their differing shapes.

**ENGLISH INNOVATION: THE RIB VAULT.** The Vikings or Norsemen (later called Normans) settled in France and accepted Christianity. Not content to dominate northwest France, they sailed across the Channel under William the Conqueror and added England to their domain in 1066. Until 1200, Norman rulers solidified their kingdom, building castles and churches across England and Wales. The English Romanesque style is often called Norman, as William the Conqueror's legacy.

Aided by an abundance of limestone, granite, and sandstone, the Normans embarked on an ambitious building program that produced a series of magnificent cathedrals and abbeys at Canterbury, Lincoln, Rochester, Winchester, Durham, Norwich, and Ely. Strongly cruciform in character, these churches had long, narrow naves, often twin towers at the entrance, a tower over the crossing, large triforiums (an upper gallery over side aisles, above the tribune), and clerestories. Massive cylindrical or clustered piers supported the roof and featured incised geometric ornaments on their columns and capitals.

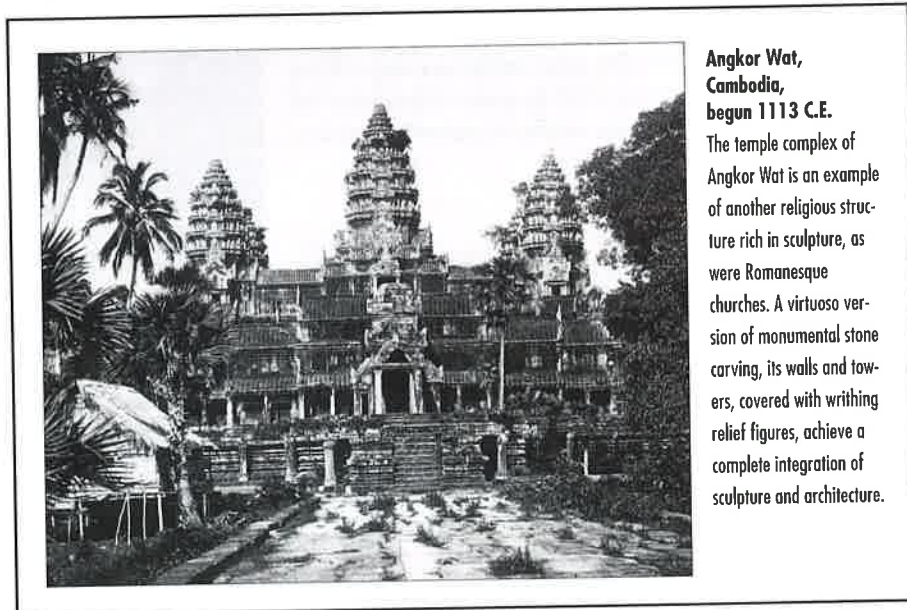
Some of the most enormous churches in Europe are the Romanesque cathedrals of England. Among them, Durham Cathedral is a supreme masterpiece. Built to house the remains of St. Cuthbert and the Venerable Bede (a historian who died in 735), Durham was part of a Benedictine monastery and castle complex.

Down the length of the 470-foot-long nave, huge composite piers with engaged colonnettes alternate with massive cylindrical piers. The columns, carved in zigzag and lozenge patterns, fairly writhe in a visual wave of movement. Originally highlighted with red, blue, and gold paint (before whitewashed by purists in the Reformation), they must have endowed the interior with an impressive zip.

The breakthrough achieved at Durham was not just decorative but structural. To allow more light into the interior (through side galleries and clerestory windows), rib vaults were used for the first time. These stone ribs strengthened the lines of the groin vaults and, coupled with pointed arches in the vaults, more efficiently carried the weight of the roof than could thick walls alone. In aesthetic terms, the stone rib vaults bind the interior together in a web of linear patterns and give it a strong vertical thrust—qualities characteristic of later Gothic architecture.



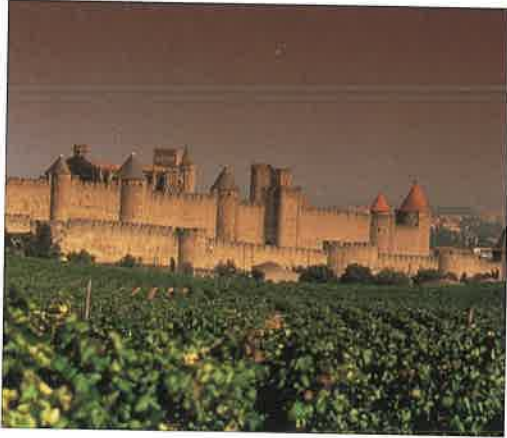
**Nave, Durham Cathedral, United Kingdom, begun 1093**  
The earliest rib vaults make this cathedral an important forerunner of Gothic style. A thin line of blue marble crosses the nave near the front of the church, marking the point beyond which women were forbidden to enter in the Middle Ages.



**Angkor Wat, Cambodia, begun 1113 C.E.**

The temple complex of Angkor Wat is an example of another religious structure rich in sculpture, as were Romanesque churches. A virtuoso version of monumental stone carving, its walls and towers, covered with writhing relief figures, achieve a complete integration of sculpture and architecture.





**Carcassonne, France, thirteenth century, restored by Viollet-le-Duc**

This walled city was built on sixth-century foundations by the Visigoths. Massive defensive walls encircle the castle, houses, and streets. Built on the edge of a plateau, the two concentric walls include fifty-two towers and two miles of battlements.

**CASTLES: ALL ALONG THE WATCHTOWER.** After a hiatus of five centuries, the building of stone castles resumed in Europe around 1000. Between 1066 and 1189, the Normans alone built 1200 castles. Most European stone castles sprang up as by-products of feudalism and the eight Crusades that lasted two centuries. As European Crusaders trekked to Palestine to wrest the Holy Land from Saracenic Turks, they left along the route fortified strongholds, like Krak des Chevaliers Castle (1142–1220) in Syria, called “the bone in the Saracen’s throat.” Returning Crusaders brought back advanced knowledge of fortifications, which they used to improve Western designs. (They also learned how to communicate via carrier pigeon when besieged.)

Castles were essentially fortified villages that replaced Roman cities, which had all but disappeared in the Dark Ages. (The population of Rome plummeted from one million at the end of the empire to less than 50,000 after the barbarians attacked.) Surrounded by exterior walls up to 20 feet thick, the twelfth-century walled castle was a center of government, home for the feudal lord and his dependents, and military base.

The keep (or *donjon* in French) was the most fortified and doubled as a private dwelling for the lord’s family. Its walls could be 15 feet thick, as in the 90-foot-tall White Tower, begun at the Tower of London by William the Conqueror.

## OOPS: ARCHITECTS’ MAJOR GOOFS

Architecture—a blend of fine and applied arts—has suffered some public mishaps. Frank Lloyd Wright’s famous flat roofs on his prairie houses were notorious for leaks. The United Nations Secretariat Building’s disastrous north-south siting made it broiling hot when the glass-wall eastern exposure absorbed morning heat. The Tacoma Narrows Bridge, a 2,800-foot-long suspension bridge in Washington, was known as “galloping Gertrude” because of its tendency to twist in the wind. (A 42-mile-per-hour wind shredded it in 1940.) Wind oscillation caused one wooden bridge to collapse when a German infantry unit goose-stepped across (in unfortunate rhythm with the oscillations). Other structures have become celebrated monuments despite—or because of—their defects.

### TUMBLING DOWN

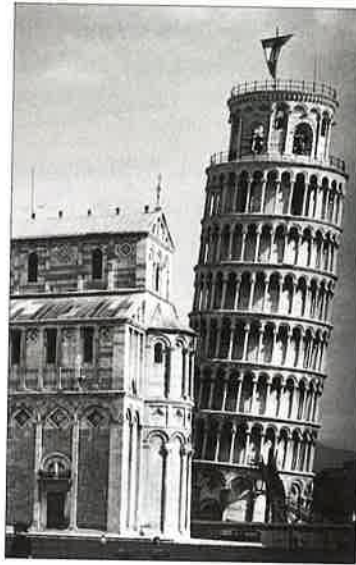
#### **Cathedral of St. Pierre, Beauvais, France, 1225–72**

Its bishop supposedly suffered from the sin of pride. He wished to construct the highest nave in Christendom, to top the celebrated Amiens Cathedral, a nearby rival. At 157 feet tall, Beauvais’s choir vaults are the highest of all Gothic cathedrals. Unfortunately, the exterior buttresses were too skimpy to resist wind forces. Without warning, they buckled, and in 1284 the roof came tumbling down. Fifty years later the vaults were repaired, with extra piers and cross ribs for support. After the transepts were added, a 502-foot stone spire was placed over the crossing in 1569. Big mistake—they should have used lighter wood, covered with lead. The piers supporting this enormous load were inches out of plumb. Four years later, the tower collapsed.

### FALL-OUT

#### **John Hancock Tower, Boston, by Henry Cobb of Pei, Cobb, Freed, 1972–76**

When nearly complete, the 60-story glass-curtain-wall skyscraper developed a problem: its windows fell out. At one point, almost one half of the building was covered with plywood panels. Local wags joked it should be called the U.S. Plywood Building. Besides structural problems that caused the building to pop its panels, the Hancock was accused of disdain for context. The tall, slender parallelogram stands in historic Copley Square near two important nineteenth-century masonry buildings—H. H. Richardson’s Trinity Church and McKim, Mead & White’s Boston Public Library. The Hancock’s abstract, high-tech look is jarringly different. The architect sheathed the structure in reflective glass to mirror the sky and adjoining buildings.



#### **Leaning Tower, Pisa, Italy, 1174–1271**

**Lean Times:** Planted in soft soil, the area of base is too small in relation to the tower’s height, producing excessive load on the foundation. The freestanding bell tower—an alarming 14 feet out of plumb—started to lean almost immediately during construction. To counterbalance the tilt, builders incorporated a wedge-shaped section in the top two stories—all in vain. Until a new foundation was laid recently to arrest subsidence, the 179-foot-tall tower increased its angle of incline by almost one-half inch a year.

**DEFENSE!** Walls were generally splayed or battered, sloping outward at the base, to make the footing more resistant to undermining. Loop-holes and arrow-slits for defense were incorporated into lower levels of the tower keep. At the top, stone walls were crenellated, with crenels (openings in the battlements) alternating with solid upright sections called merlons. Machicolations—projecting battlements cantilevered out from the top of the wall—had holes in the floor for dropping stones or boiling pitch on invaders. Towers were arranged at bow-shot intervals to repel attackers.



The principal gate was the most vulnerable point, and it generally had twin flanking towers, to provide multiple angles for raining missiles down on assailants. Some castles had an exterior gatehouse called a barbican to question potential visitors. A room above had “murder holes” in the floor, through which arrows could be fired or stones dropped. Entrances incorporated right-angle turns to force intruders to expose their unshielded side to fire from above and preclude use of a large battering ram. Castles were always built with spiral stairs that wound around clockwise, so right-handed defenders could swing their swords freely while the center post blocked an attacker’s sword hand.

With these design advantages, a small garrison of perhaps thirty could defend a castle against thousands of foes. (Crafty defenders sometimes propped dummies on the battlements to give an impression of numerous sentries.) At Château Gaillard (1196–98), built by England’s Richard I (the Lion Heart) on a chalk cliff in Normandy, defenders resisted a siege for one year in 1204. The enemy got inside only when an intrepid French soldier crawled up the privy shaft and opened chapel windows—the only openings large enough to admit soldiers.

Not until the fourteenth century, with the use of gunpowder and cannons that could shatter the sturdiest wall, did these strongholds become obsolete. By the end of the fifteenth century, castles had lost their military role. Nobles built manors in the style of modified castles into the eighteenth century, and the Romantic movement catalyzed a widespread taste for medieval architecture in the eighteenth and nineteenth centuries.

### How to Besiege a Castle

The armored tanks of their day, castles were supposed to be impregnable. Refusing to be deterred, invaders devised various strategies to circumvent the so-called invincible walls. The basic methods were to climb over the walls, knock them down, or tunnel underneath.

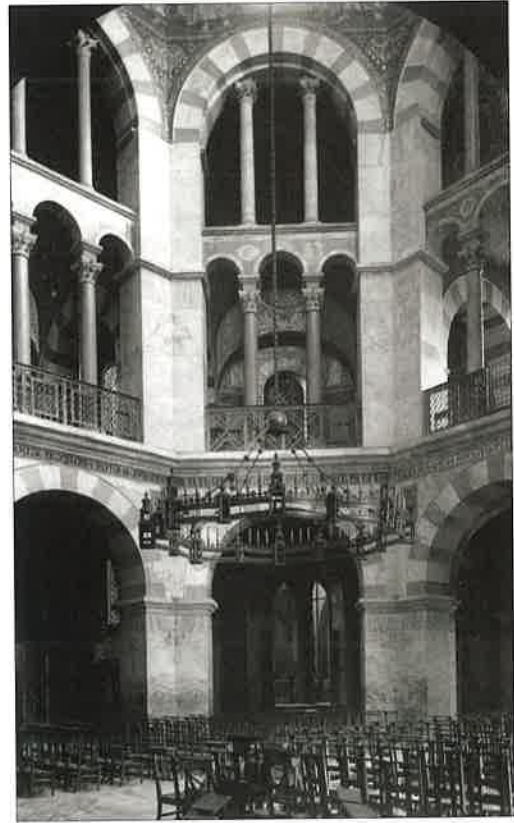
(1) Use a ladder to scale walls. This practice was most hazardous to attackers, who were exposed to fire from archers. (The crossbow bolt was delivered with such deadly force, it could penetrate armor.)

(2) Use a siege tower (a large wooden tower on wheels, covered with hides to protect from crossfire). When rolled into place, streams of attackers climbed the tower and lowered a drawbridge across the wall. Drawback: only works on level ground.

(3) Batter down the walls with catapults that fire stones, iron bolts, or javelins. Richard the Lion Heart used one, which killed twelve men in one shot. Not to be outdone, King Louis of France had a catapult nicknamed “Bad Neighbor” that could demolish long sections of wall. Attackers even hurled dead horses and corpses to land inside castle walls and spread disease.

(4) Dig a tunnel under the wall. This method was most effective, until castle-builders caught on and built round towers instead of square ones. (A rounded base was more resistant to undermining and offered more angles for shooting the enemy.)

### CHARLEMAGNE’S CHAPEL: PRE-ROMANESQUE



Palatine Chapel, by Odo of Metz, Aachen (Aix-la-Chapelle), Germany, 796–804

Considered the Father of Europe, Charlemagne was the first world-class leader to emerge after Rome’s collapse. A burly man more than six feet tall, with eyes the color of the sky, he took it upon himself to reincarnate the Roman Empire in the West. Not only did he order buildings to rival those of ancient Rome, he gathered a cadre of intellectuals to revive classical arts and letters. His empire extended from Denmark to the Adriatic.

The first public architecture to briefly illuminate the Dark Ages was known as Carolingian (c. 768–845), after Carolus Magnus (Charles the Great, or Charlemagne). His two-storied, octagonal chapel, part of a huge palace at Aachen, was a conscious imitation of San Vitale in Ravenna, which Charlemagne admired. Its central space is covered by stone vaulting, a technology that had nearly been lost during 300 years of chaos. When Charlemagne died in 814 at age 72, he was buried in the chapel sitting bolt upright on a throne.

## GOTHIC: BUILDING LITE

Abbot Suger had a problem. On feast days, his church was packed to the brim. Among “the crowded multitude . . . who strove to flock in to worship and kiss the holy relics,” he wrote, “no one among the countless thousands of people because of their very density could move a foot.”

Enlarging the church was an obvious solution. But in remodeling, Suger had a vision. He wanted to tear down bulky walls, enlarge teeny windows, and disperse the general gloom of Romanesque abbeys. The French abbot imagined an interior where space would flow unimpeded by partitions, where walls would be thin and skeletal, where—above all—the light of God would figuratively and literally fill the church. When Suger reconstructed the choir of his church at St.-Denis (1135–44) along these lines, he invented the Gothic style. Within fifty years, officials who attended the consecration ceremony were building cathedrals of their own. From Scandinavia to Spain, edifices consciously imitated St.-Denis, growing progressively larger and lighter.

The Gothic style spread like measles across the face of Western Europe. From its origin near Paris in the twelfth century, for four hundred years it dominated construction of churches, town halls, hospitals, and universities. The desire and means to build on a monumental scale, over multiple generations, were new. This commitment reflected revived confidence in technology and human capacities. Aided by the growing wealth of cities and increasing power and patronage of the church

and monarch, Gothic architecture became the quintessential urban mode.

The Gothic cathedral represented the Middle Ages’ overriding concern: religious faith. A cathedral’s magnificence symbolized the Heavenly Citadel, where virtuous souls would reside after death. Its very grandeur—especially the impossibly high vaults that served no utilitarian purpose—showed how immortality could transcend earthly limitations.

**ENGINEERING: THE TRIUMPH OF LIGHT.** The mania for Gothic cathedrals started soon after the first Crusaders returned from Constantinople. Awed by the splendor of Hagia Sophia, knights spread the word about architectural wonders in the East. They brought back new technology, like winches to hoist heavy stones. The West learned the science of geometry in a new translation of Euclid’s *Elements*.

What made the lightness of Gothic architecture feasible were both structural and aesthetic elements: the pointed arch and rib vault, flying buttresses, and thin walls pierced by expansive stained-glass windows. Other characteristics of Gothic style were an integration of structure and ornament, a sense of interior unity (replacing the compartmentalized Romanesque layout), elaborate entrances covered with sculpture, and a pronounced vertical emphasis.

**POINTED ARCH, RIB VAULT, AND FLYING BUTTRESS.** To produce the Gothic miracle of height and light, master masons used ribbed, groined, four-sided (quadripartite) vaults. In each vault, two half-cylinders intersect at groins. The arched ribs along two diagonals give greater rigidity to the vault in the direction of the groins. The vault’s weight is channeled

toward the four corners, where it is supported by vertical piers. To resist the outward thrust of the arches, external supports called flying buttresses were devised. Wall-like pillars braced nave walls through curved half-arches supporting the groin vaults like giant fingers. The cathedral looked pure and uncluttered on the inside, while the outside bristled with a briar patch of bridges linked to pillars and pinnacles.

The pointed arch added greater flexibility to the modular system of construction, since pointed arches can span different distances while keeping their keys at the same height. By varying the angle of the arch, cross-vaults could be erected over bays of any shape or size. Visually, pointed arches look lighter than rounded arches. Their upward-pointing tip has a buoyancy to enhance the impression of lift.

Architect-engineers based their practice on trial and error, as well as on trade secrets passed down through the apprentice system. They chose to err on the side of conservatism, with masonry overbuilt and stressed only to a fraction of its capacity. Gradually, structures became leaner and more daring. In a century and a half, from Chartres (1194) to Palma de Majorca (1350), cathedral piers became three and a half times thinner. Before flying buttresses were invented at Notre-Dame in Paris, walls were 5 feet thick, but with the new technology used at Mantes, walls shrank to 16 inches.

The system of construction was audacious. Stability depended on interaction of all factors. If even a minor component failed, the whole frame was vulnerable. (See page 42, Beauvais Cathedral goes bust.) Architects pushed materials and methods to the limit to reach aesthetic goals: higher, lighter, grander, more ornate. The result was some of the most extravagant architecture ever created.

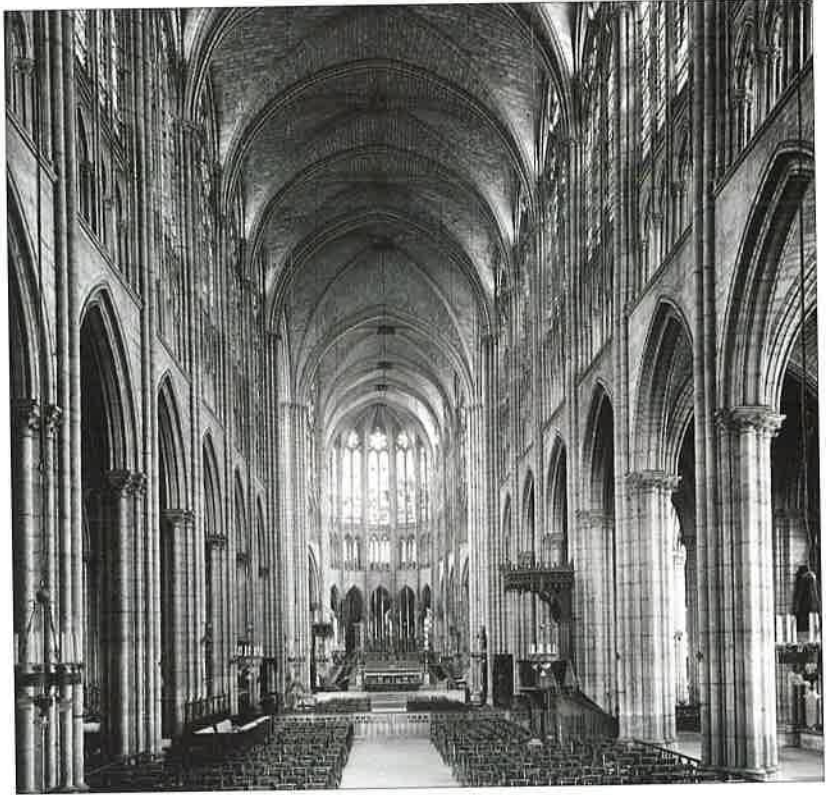


**ST.-DENIS: THE FIRST GOTHIC CATHEDRAL.** In renovating his church, Abbot Suger used the essential elements of Gothic style—the pointed arch and rib vault—to further his theological beliefs. He wrote, “Man may rise to the contemplation of the divine through the senses.” The visual experience of lavish beauty in architecture of color, light, line, and space would make the mind ascend from material glory to immaterial faith. Or, as Suger put it, the churchgoer would be “transported from this inferior to that higher world. . . .”

Equating God with “super-essential light,” Suger replaced stone walls in radiating chapels with stained glass symbolizing divine light. He substituted thin columns for heavy piers in the ambulatory. He subordinated all parts to a holistic design to create a single spacious volume, where crowds and light flowed smoothly from chapels to altar. Increasing the size and number of windows and reducing the chapels’ outward projection so they almost merged with the ambulatory made light flood the whole east end. Rebuilding the west facade, he installed the first rose window between two towers, other Gothic hallmarks.

The abbey church of St.-Denis set the pattern for Gothic cathedrals. Although ornament became more complex as the style evolved and each country contributed its individual fillip, the signature elements remained the same. A three-level elevation became standard inside, with an arcade of tall pointed arches, a narrow passage (the triforium), and huge clerestory windows with delicate stone tracery. Clustered colonnettes affixed to piers rose from floor to vaults, creating a continuous line of uplift. Cathedrals retained the Romanesque format of nave with side aisles, but transept arms became much shorter, reinforcing the sense of an inner spatial whole. Most striking was the virtual disappearance of walls, which became mullions for stained glass.

Profuse exterior sculpture, like the homilies in stained glass, illustrated Bible tales so the entire building became a teaching aid for illiterate masses. Not sure about the wages of sin? Check out the Last Judgment carving, generally in the tympanum above the main portal. A wavering varlet could see monstrous devils snatching sinners off to hell, while Jesus weighs souls and sends the virtuous wafting upward.



**Nave, abbey church of St.-Denis, France, c. 1135–44**

The flow of space and light through ambulatory, chapels, and choir was made possible by removing thick walls, enlarging windows, and thinning supports. The new style invented at this church was later termed Gothic.

### The Architect

At the beginning of the Gothic period, architects were called master masons. (A tombstone inscription for architect Pierre de Montreuil calls him *doctor lathomorum*, master stonemason.) They learned their craft through long apprenticeships before rising to the rank of master. Although trained in carpentry or stonecutting, master builders also possessed intellectual, specialized knowledge (*scientia* in Latin). They were literate and skilled in the liberal arts. Architects occupied a privileged position as designer, contractor, and supervisor of enormous projects.

In some churches, architects are buried with signs of high honor. On tomb effigies, they are dressed like great lords, holding tools like a compass, measuring rod, or model of a building. The French King Charles V was godfather to the son of his architect, Raymond du Temple.

Things could be dicey in the building biz. One hazard was that the better the work, the riskier the reward. The countess of Bayonne had her architect beheaded after he erected a fine tower, to keep him from repeating the miracle for another. Since architectural principles were not founded on factual knowledge but empirical experience, hiring the right architect meant success or failure on a construction site. Tricks of the trade were so jealously guarded, one architect killed his own son for leaking secrets to a bishop.

By the second half of the eleventh century, the architect was a professional in the modern sense, and a quantum leap in the level of originality occurred. Buildings became increasingly sophisticated and daring, less reliant on tradition and more on an individual’s powers of invention and intuition.



**NOTRE-DAME OF PARIS: THE GOLD STANDARD.** Victor Hugo called it “a vast symphony of stone.” It must have seemed even vaster in the Middle Ages, for Notre-Dame (1163–1250) was the first cathedral of colossal scale and the prototype for all that followed. One French cathedral that preceded it, at Senlis (begun 1153), had “gigantic” 69-foot-high vaults. With its 115-foot-tall nave vault, imagine the awe that greeted Notre-Dame—the highest and longest edifice then attempted.

Its architect designed Notre-Dame in a compact plan, as one huge space with transept arms that do not project past the side aisles. He integrated large volumes by applying ornament to suggest lines of construction and stress the continuity of space. Shallow chapels hardly radiate; they sweep around the east end in a gentle curve.

With such enormous height and length, an aesthetic problem arose: how to blend great expanses of wall into the total conception. The solution: to balance horizontal and vertical lines so neither predominates, producing a harmonious whole. Nave walls are a series of recessions with little blank surface. The horizontal zones (arched arcade, tribune gallery, clerestory) lead the eye from entrance to the altar’s crescendo. At the same time, vertical lines of triple colon-

nettes rise from floor to vaults to create an impression of dynamic upsurge. Thin moldings and exaggeratedly slender arches dematerialize walls, making them seem delicate and without depth. Wide clerestory windows further reduce the weight of masonry walls.

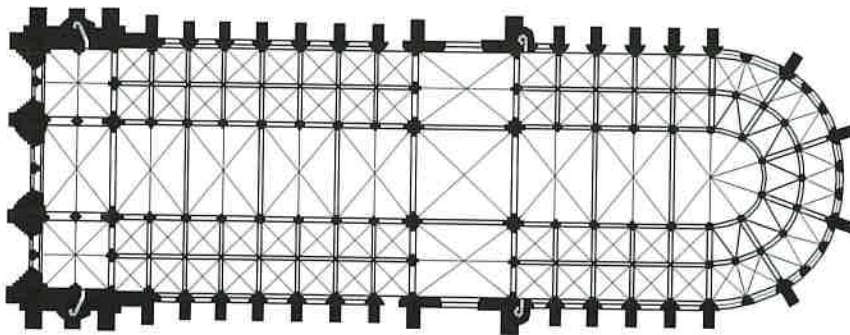
Flying buttresses were first used at Notre-Dame and span 50 feet on the outside of the church. Before, arches in the second-story gallery served as supports for vaults and nave walls. When windows in the tribune gallery increased in size (sacrificing solid walls to allow more light), nave vaults needed additional bracing. The taut buttresses transmit lateral thrust of roof and vaults to exterior pillars. Through this device, Notre-Dame achieves its grand scale without a massive shell.

**Notre-Dame, Paris, France, 1163–1250**

With its flying buttresses to support walls and vaults, the Cathedral of Notre Dame became the prototype of subsequent Gothic architecture.

**Plan, Notre-Dame, Paris**

Its compact plan with a continuous ring of chapels and nonprojecting transepts reinforces the sense of one vast but coherent, unified space.





**CHARTRES: THE QUINTESSENTIAL GOTHIC CATHEDRAL.** Looking at Notre Dame de Chartres, said the writer Henry James, “makes the act of vision seem for the moment almost all of life.” As the most unaltered example of Gothic architecture, Chartres Cathedral (1194–1220) displays all the classic elements of early Gothic design in unparalleled purity.

Built to house one of the most sacred relics of Christendom, the tunic worn by the Virgin Mary when she gave birth to Christ, officials planned a suitably grand edifice after most of the original Norman structure burned down. Since cathedrals were also the heart of a medieval village and symbol of civic pride, funds to rebuild poured in from all classes of society. From lords and ladies to peasants, townspeople harnessed themselves to wagons to drag stones from quarry to construction site.

The main innovation of the design was elimination of the tribune level, with a low triforium (passageway over the slanted arcade roof) substituted. Because flying buttresses made a tribune structurally unnecessary, the designer was free to enlarge the arcade and clerestory to monumental size. With flying buttresses for external support, the clerestory windows became as tall as the main arcade of the first floor. This expansion transformed the upper story into a light show of supreme beauty. The chief glory of Chartres is its 26,000 square feet of stained-glass windows. “Flaming jewellery,” the critic John Ruskin called the windows—90 percent original—because of their luminous blues and reds, which soften the cold stone of the interior.

Replacing the redundant tribune with a small-scale triforium also simplified nave walls and reduced the number of masonry elements, while maintaining a balance between horizontal (the three-tier elevation) and vertical (piers, vaults) elements. The triforium perforates the wall, making masonry less a dead zone than a pause between giant windows.

Chartres maximizes the vertical impulse of Gothic architecture with another contribution: *piliers cantonnés*, columns surrounded by four thin shafts, evenly spaced. These shafts rise uninterrupted to the springing of the vaults, like lines of energy spraying toward the sky.

Another reason to consider Chartres the epitome of Gothic design is its exterior sculpture. Around the portals, thin, columnar statues of Old Testament royalty, prophets, and apostles reinforce the structural lines of the building. Architectonic rather than superfluous, the statues are essential for the design’s visual coherence. Sharply carved figures mold the facade into a play of light and shadow, animating the surface and banishing the monotony of flat planes.

#### Chartres Cathedral, nave interior

Chartres brought together all the Gothic elements of exterior flying buttresses, pointed arches, rib vaults, three-part elevation, stained glass, and vertical accent.



#### Cathedral of Notre Dame, Chartres, France, 1194–1220

Chartres Cathedral exemplifies classic Gothic features with its central rose window, three sculpted portals, and paired towers. The south spire (on the right), constructed c. 1160, represents the simplicity of early Gothic, while the ornate northern tower (1507), capped with a Flamboyant spire, is High Gothic.

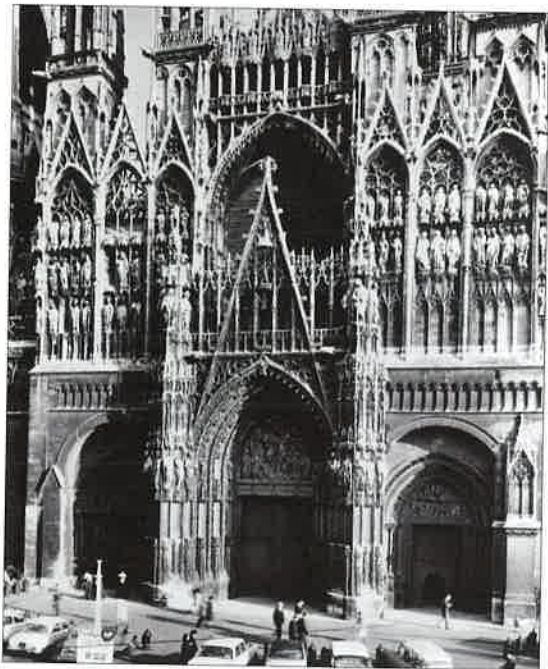






**Nave interior, Notre-Dame Cathedral, Amiens, France, by Robert de Luzarches, Thomas de Cormont, Renaud de Cormont, 1220–88**

This view down the nave shows the extravagantly high arcade, glazed triforium, and elongated clerestory windows. Heavy Romanesque columns were replaced by linear colonnettes, and skeletal walls have become more voids than solids. The floor contains a maze of black stones, which pilgrims followed on their knees to show devotion. The cathedral was built to enshrine the head of John the Baptist, a relic brought back from Constantinople. During times of war, Notre-Dame always escaped destruction. In 1471, Charles the Bold ordered his artillery to spare the cathedral when besieging Amiens. During World War I, the Pope interceded with the German emperor to save the church. During World War II, locals piled up sandbags at the foot of each pier to protect it. Miraculously, after bombardments, the cathedral remained standing among the ruins of the city.



**AMIENS: HEIGHTENED EFFECT.** Amiens Cathedral takes the progressive skeletonizing of architecture almost to a vanishing point. Its exterior facade is so thoroughly carved with tracery, it nearly becomes a screen. Even buttresses are pierced and lacelike. With their spirelike pinnacles, they slice the exterior mass and attenuate its bulk.

One of the largest medieval buildings, Amiens is the most elongated in effect. Its 138-foot-high nave vault has a height-to-width ratio of more than three to one (Chartres' nave was 2.6 times as high as its width), projecting an impression of soaring height. Sixty-five-foot-tall arcade arches are enormously high (compared to 32 feet at Notre-Dame, Paris), making the first level seem colossal. In fact, the aisles at Amiens are taller than most twelfth-century naves. Clerestory windows are so large that they seem to dissolve the upper walls in light. Narrow four-light windows (originally stained glass), topped by traceried rosettes, make the upper level less a wall than a stone doily.

The classic three-stage elevation (arcade, triforium, clerestory) reaches its apogee at Amiens. By glazing the triforium to eliminate the last dark band in the elevation, Amiens punched out walls even more than Chartres. Light pours through windows at all three levels. Linear colonnettes rising from the pavement, thin pier proportions, and skeletal walls add to the streamlined effect.

**SCULPTURE AND BAR TRACERY: HIGH GOTHIC.** No discussion of Gothic cathedrals is complete without mentioning Rheims Cathedral (began 1210), celebrated for its naturalistic sculpture and intricate stone tracery. Inside, Rheims is inundated with light, since three rose windows replaced the tympanum sculpture over portals. Even without the tympanum, five hundred statues, some larger than life, adorn the front. Angels hover in pinnacles, gargoyles peer from the roof, kings reign in niches.

Rheims initiated another crucial component of Gothic architecture: bar tracery. At Chartres, windows were openings punched out of the stone surface (plate tracery). The new bar tracery consisted of long, curved pieces of stone—more delicate and frilly than before. Everything at Rheims became more ornate. Sculpture adorns not just portals but also radiating chapels and the clerestory. Flying buttresses are steeper and compound.

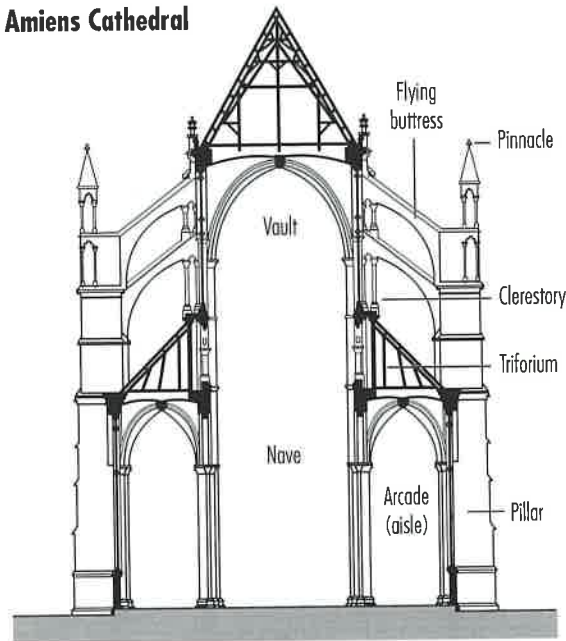
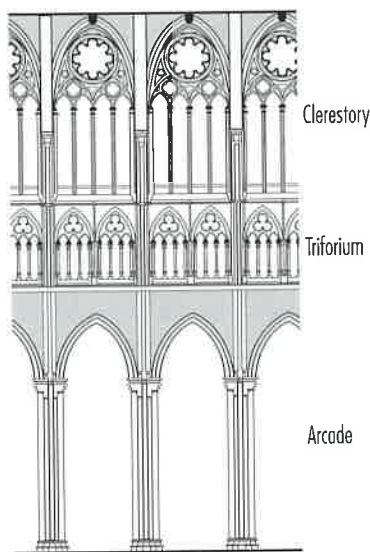
The High Gothic period abandoned the simplicity of Chartres for its ultimate elaboration: Flamboyant Gothic. After 1340, curved tracery became so exuberant in form, it resembled leaping flames (hence the name, from *flambant*, or flaming). At Rouen Cathedral or the pentagonal west front of St.-Maclou in Rouen, stone masses are shredded into angular pinnacles, towers, and spires. Porcupine Gothic more accurately describes the look.

**Rouen Cathedral, Rouen, France, c. 1200–1500**

The extremely ornate front of Rouen Cathedral exemplifies the Flamboyant style of Late Gothic.

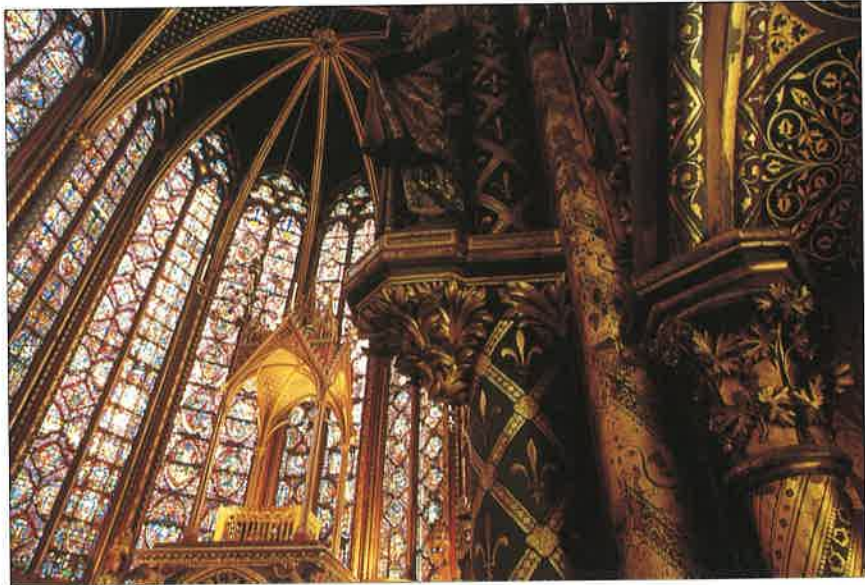


## Elevation and section, Amiens Cathedral



**GOTHIC IN ENGLAND: A BRITISH ACCENT.** Gothic style came to England in 1174 from France, when canons hired the French architect William of Sens to rebuild Canterbury Cathedral. Canterbury and Westminster Abbey remain the truest to the French model, but afterward English builders gave structures their own distinctive flair. By the thirteenth century, English Gothic was at the forefront in innovation.

British Gothic flourished until the sixteenth century, then was revived in the eighteenth and nineteenth centuries. Its characteristics were low, broad proportions and a rambling layout, rather than the French unified plan. Facades were richly decorated, with sculpture in horizontal bands for a layered effect. Doubled transepts projected much farther than in French models, and often not only did front portals of British cathedrals boast towers but the crossing supported a tall central tower. To the east, the apse was squared rather than rounded at the end. Most notably, English ceilings



## HIGH GOTHIC SPLENDOR

**Interior, upper chapel, Sainte-Chapelle, Paris, France, attributed to Pierre de Montreuil, 1242–48**

The ultimate in French Gothic, the king's chapel was a cage of stained glass separated by thin, barely visible shafts. It was built by Saint Louis (King Louis IX) to hold relics of the crucifixion. Louis purchased Christ's crown of thorns from the Byzantine emperor for the exorbitant sum of 135,000 medieval pounds (in comparison, construction of the chapel cost "only" 40,000 pounds). Sixteen windows (more than 700 square yards of glass) illustrate one thousand scenes from the Bible. Mullions and bar tracery holding the glass panes are so slim, they virtually disappear in a crown of light. The "walls"—without horizontal divisions—are outlined by piers painted gold, red, and blue. They dissolve in heavenly light, while the cobalt blue vault with its gilded stars seems to float above.



**Salisbury Cathedral, Salisbury, England, 1220–66**

Sitting on the church green not far from Stonehenge, Salisbury Cathedral's rambling plan is an example of Early English Gothic.

### Ornament

Everybody recognizes gargoyles — those carved mythical beasts that serve as cathedral rainspouts. But not everybody looks for the green man hiding in most Gothic cathedrals. The green man is



a holdover from pagan days, usually a human face with leaves and vines sprouting from his mouth, forehead, and cheeks. Rooted in pre-Christian fertility rites, these stone statues show how medieval craftsmen mixed divine and profane imagery without regard for consistency.

displayed an unprecedented degree of fantasy, with ribs twirling over vaults in nets, stars, or fan shapes. Finally, English cathedrals were not the cynosure of cities but were located on spacious greens in rural settings.

The purest example of the Early English style is Salisbury Cathedral (1220–66). Its foundations were laid only five years after citizens persuaded King John to acknowledge their rights in the Magna Carta. Although Cromwell's troops plundered its treasures in the seventeenth century, the cathedral remains a classic example of English Gothic. Its front is a screen to display sculpture, and its 404-foot-tall tower was the highest of the Middle Ages. Long and low inside (the nave is only twice as high as wide), Salisbury is fragmented into separate square-ended units, even though the nave is unified into one huge space. Horizontal moldings create a lateral emphasis, driving the eye down the length of the nave.

Featuring cloisters (1284) and that distinctive English contribution, the octagonal chapter house (1263), Salisbury reflects the compartmentalization typical of English style. At evensong, when choirboys in ruffed collars sing to ward off the perils of the night, one can almost imagine the Middle Ages still alive.

From 1250 to 1370, the sober Early English style gave way to the Decorated or Curvilinear style. Based on the ogee arch (a double-curved arch that slopes out, then in, on its way to a point), free-flowing forms proliferated. In Decorated interiors like the Lady Chapel at Ely Cathedral, all surfaces are enlivened by a fanciful screen of tracery. At Wells Cathedral (1330), ribs form an ornate net in choir vaults. The front of Wells is also extraordinary. Its 150-foot-wide expanse is a screen of 400 thirteenth-century carved statues, which were once gilded and painted.

From about 1330 to 1540, British architects reined in their curvaceous impulses, enshrining the Perpendicular style. Just as it sounds, this mode stressed rectilinear, vertical panels, as in the large mullioned windows and straight lines of Gloucester Cathedral (1337). This rigidity didn't stop ceilings, however, from transmuting into a decorative filigree. Ribs became less structural and more ornamental, multiplying into rich patterns incised on stone vaults.

The fan vault was a dazzling English invention. A cluster of nonstructural, thin ribs radiates from each column like an inverted semi-cone to create a whirlpool of lines. The trend was away from simplicity toward a more artful, decorative effect, so British carvers could demonstrate their virtuosity in wood and stone. Some ceilings are so extreme in their mesh of lines, they resemble a knight's chain-mail armor.



**GERMANY: THE HALL CHURCH.** Regional variations occurred wherever Gothic took root. In Germany, from the mid-thirteenth to the sixteenth centuries, the need for a large space for preaching produced the hall church. Made of brick rather than stone, these churches had naves and side aisles that were the same height, separated only by rows of columns. Without a clerestory or triforium, the sense of one continuous interior space prevailed.

Simplifying the interior didn't prevent German architects from letting their powers of fantasy loose on the ceiling. Elaborate vaulting with ribs in net or faceted honeycomb formations splay across ceilings. Sometimes ribs (called "flying ribs") were completely independent of the vault surface, protruding into space like scaffolding. Piers took the form of bundles of shafts rising sinuously to become vault ribs.

Even in elaborate cathedrals like Cologne and Strasbourg, which slavishly imitated French designs, Germans added their own twists—in this case, the openwork spire. The spire on Strasbourg's tower is a cage of delicate tracery. The 630-foot spire at Ulm Cathedral (devised at the end of the fourteenth century but not built until 1890) is the highest in Europe.

**ITALY: BARELY GOTHIC.** Italians were disdainful of architectural styles that originated north of the Alps. Nevertheless, they couldn't entirely resist adding an overlay of Gothic details like pointed arches or pinnacles to show they kept up with the latest fashion. Gothic in Italy was generally more highly colored and ornate.

The Doge's Palace (1309–1424) in Venice shows an Eastern influence in its Byzantine delicacy, but is superficially Gothic in its open stonework and stacks of pointed-arch arcades. The pink-and-white patterned marble veneer on the top level looks like a textile weave.



**King's College Chapel, Cambridge, England, Reginald Ely and John Wastell, 1508–15**

Fourteen ribbed panels from each springer and gilded bosses spin a decorative web of tracery. Although fan vaults are at their flashiest here, the severe lines of walls and windows reflect the rectilinear style of Perpendicular English Gothic.



**Church of St. Anne, Annaberg, Germany, begun 1499**

With ribs sprouting like tendrils to form flowers in the vaults, the decorative scheme of this hall church shows the trademark flowing lines of German Gothic.

**Doge's Palace (Palazzo Ducale), Venice, Italy, by Pietro Baseggio, 1309–1424**

Stone pointed-arch arcades and roof finials make this nominally a Gothic exterior, even though Italian builders never wholeheartedly embraced the style. With its frescoed, gilded, coffered, and carved ceiling, the Great Council Hall in the palace has been called "the sumptuouslest room of all Christendom."



Milan Cathedral (1296–1485, with a nineteenth-century facade) is the most Gothic of any Italian building, with a riot of Gothic ornament applied over its basilica structure. The rosy marble exterior explodes in pinnacles, finials, and stone spikes.

Inexperienced in building on such a huge scale, more than fifty architects and sculptors debated the structure and supports at Milan. Although one consultant insisted, “*Ars sine scientia nihil est*” (practical craft without theoretical knowledge is nothing), none of the masons could agree on what size piers were necessary. Each mason proposed the form of the cathedral be determined by multiplying modules of a simple geometrical shape—either a triangle, square, or rectangle. Judging from the finished product, a master mason named Paul Mignot must have carried the day. He advocated a medieval system called triangulating.

In Spain, Gothic cathedrals were constructed with expansive proportions. The cathedral of Gerona contains the widest vaulted span in Europe—73-foot nave vaults. Seville boasts the world’s largest medieval cathedral (began 1402). Its creators planned a church “so great and of such a kind that those who see it finished shall think we were mad.” It was to be so beautiful “that there shall be none its equal.”

Grand scale, glorious beauty, with a touch of mad ambition pretty much sum up Gothic architecture.

**Milan Cathedral, Milan, Italy, by Arnolfo di Cambio, Francesco Talenti, 1296–1485**

Pointed arches and lavish ornament including pinnacles, flying buttresses, and profuse sculpture mark this cathedral as High Gothic. Builders based its architecture on geometric modules, as the triangular shape shows. The building was so huge and complex, construction continued for nearly 200 years. It was only finished when Napoleon ordered a speedup to crown himself king of Italy in the cathedral in 1805.

**What’s in a Name?**

Gothic architecture wasn’t called Gothic when it was invented. It was called *style ogival* (or ogive style) after its signature element, the pointed arch. Not until the sixteenth century did the first art historian, an Italian named Giorgio Vasari, dub it Gothic as a mark of disdain. During the Renaissance, the excesses of Gothic style so horrified Vasari that he was sure it must have been invented by barbaric Goths, whom he accused of sacking Rome and destroying classic structures. With an obvious shudder, Vasari criticized Gothic style for its “malediction of little niches one above the other, with no end of pinnacles and points and leaves.” Gothic builders “filled all Europe with these abominations,” he wrote, adding, “May God protect every country from such ideas and style of building.”



## THE ANNOTATED FLYING BUTTRESS



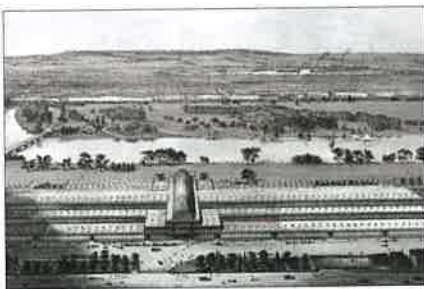
The critic John Ruskin said, "Architecture is the adaptation of form to resist force." Butresses, or supporting structures to resist wind and gravity, have taken many forms in their indispensable role as props.

An aqueduct uses adjacent arches to counteract lateral thrusts that would otherwise cause the arch to spread and collapse. Each arch acts as a buttress to its neighbor, but at the end of an arcade of arches, definitive bracing is needed. In this Roman example, the walls of a canyon spanned by the aqueduct serve as terminal buttresses.



Flying buttresses, or arched bridges projecting from the wall of a cathedral to external pillars, were invented at

Notre-Dame. Transferring load and forces exerted by nave walls to the ground, these buttresses control downward forces generated by gravity and resist horizontal thrust. They spread the vertical load generated by vaults above the nave, distributing weight diagonally, like a person standing with feet far apart. Without buttresses, the open, high, lighted interiors and thin interior masonry supports that are the glory of Gothic churches would not be possible. They are supremely functional, decorative, and expressive.



The Crystal Palace is a whole building converted into a network of nearly invisible support. The glass-curtain wall was a skin more than a skeleton, so the lacy ironwork had to be stiffened by diagonal braces, making the structure a vast truss. Like skyscrapers, it achieves maximum structural performance from minimal materials. Made of prefabricated cast iron and standardized glass panes, the structure enclosed one million square feet—a space six times larger than St. Paul's Cathedral. Compared to a masonry building, its actual support was a frame of very little volume, its mass almost diminished to a vanishing point.

Similarly, modern skyscrapers use steel framing members linked by diagonal braces in the center of a building, forming a trussed spine to resist lateral wind pressure. Steel supports carry the weight of a building to the ground, while a skin of glass hides the actual physical frame. As a building grows in height, its need for resistance to lateral wind and earthquake forces increases dramatically. An interior stiff tower of wind-braced concrete often forms a core to support the outer, light steel frame. As in a Gothic cathedral, butressing makes possible great height and light.

The Sydney Opera House uses steel cables for reinforcement inside precast concrete shells, allowing the building to be perceived as a total sculpture. Nested roof vaults, like leaping waves or puffed sails, rise 221 feet above the harbor. Such structural ingenuity does not come cheap. The original cost of \$9 million soared to \$400 million.



Counterclockwise from top left: flying buttresses, Notre-Dame, Paris, 1163–1250; Pont du Gard aqueduct, Nîmes, France, c. 25 B.C.E.; Crystal Palace, London, by Joseph Paxton, 1851; Sydney Opera House, Sydney, Australia, by Jorn Utzon, 1959–73; Seagram Building, New York, by Mies van der Rohe and Johnson, 1954–58

# Renaissance and Baroque: All Roads Lead from Rome

We've seen it before. The simple, straight lines established in classical Greek architecture got pumped up to ornate Hellenistic frills. At the end of the Gothic era, pure linear forms became flamboyant spikes. Throughout history, architecture oscillates between mini and maxi.

The Renaissance and Baroque periods show the same pattern. Restrained Renaissance design stressed clarity, logic, and flat, straight lines. Exuberant Baroque went for emotion, sensation, and scalloped contours. Renaissance architects revered the rules followed by ancient Roman builders, while Baroque architects stretched the rules to the popping point.

The three Rs of Renaissance design may be Rome, Reason, and Regularity, but four Bs are essential for knowledge of both Renaissance and Baroque architecture: founding fathers Brunelleschi, Bramante, Bernini, and Borromini. It's no coincidence that they're all Italian. Both schools of architecture were invented in Italy, then became international styles practiced throughout Europe.



**S. Ivo della Sapienza, Rome, interior of dome, by Borromini, c. 1660**  
Baroque architects took the smooth Renaissance dome and sculpted it into faceted forms full of visual excitement.