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OTTO G. VON SIMSON teaches at the University of Chicago. This article is drawn from two public lectures he gave last January for the Committee on Social Thought there. He wishes to dedicate it to his mother. His analysis of the philosophical approach to architecture, which St. Augustine, St. Bernard and other eminent divines fostered, would give pause to those who think we ought to make up our minds as to what the cathedral was built with: all science or all intuition.

THE GOTHIC CATHEDRAL: DESIGN AND MEANING

Within the last century the history of architecture has sought to explain the origin and meaning of the Gothic cathedral by singling out, one after the other, three of its main aspects: function (Gothic solution of static problems), design (Gothic form as the expression of certain esthetic principles), and significance (Gothic form as the symbolic expression of certain ideas). The interpretations based upon each of these three aspects stand in a curious relationship to one another. Developed polemically and antithetically, each has sought to interpret Gothic architecture in terms of one of the three aspects, denying or belittling the significance of the two others. In point of fact, each of the three approaches has greatly advanced our knowledge; it seems to us today as if they not only complement, but actually point toward one another, encircling, as it were, a truth that lies in their midst.

Thus it is precisely to the history and analysis of Gothic form that we owe the knowledge that this form cannot be entirely understood in terms of stylistic development. Gothic architecture emerges suddenly and almost simultaneously with the great expressions of Romanesque art, not its heir or "logical sequel," but its rival and antithesis. The first Gothic art, moreover, is geographically so closely identified with one territory and its historical destinies that the late Henri Focillon suggested, paradoxically but wisely, that Gothic be defined as the Romanesque of the Ile de France. The new style, finally, seems to have been the creation of a small group of men whose ideas we know and who were mutual friends; we are prompted to ask whether Gothic art must not be understood as an expression of these ideas.

In other words, the stylistic analysis of Gothic architecture has suggested its interpretation as the expression of certain ideas. And this second approach, the symbolic one, though long regarded with some suspicion, has

recently attracted a good deal of attention. We have been reminded that the Christian sanctuary is, liturgically and mystically, an image of the heavenly Jerusalem, the eschatological vision described by the Book of Revelation. The medieval dedication rite establishes this relationship in explicit terms and the twelfth and thirteenth centuries appear singularly preoccupied with this symbolic significance of sacred architecture. May not this significance have actually determined the design of the cathedral? Indeed, a brilliant and provocative attempt has been made recently to interpret all the essential aspects of Gothic design as representations of the celestial city.¹ Such an attempt, to be sure, encounters serious difficulties.² But it is heuristically valuable in that it compels us to define the exact relation between the stylistic structure and the significance of the Gothic cathedral, throwing an entirely new light upon its esthetic as well as structural aspects.

The most striking feature of the new style is a new relationship between function and form, structure and ornament. In Romanesque (and Byzantine) architecture structure is a technical means to an artistic end; it remains concealed behind painted or stucco ornaments. Indeed, the entire edifice is often but an invisible scaffold for the display of great murals and mosaics. These compositions, especially the figure of Christ in Majesty surrounded by his heavenly court that usually adorns the Romanesque apse, evoke the symbolic significance of the sanctuary as an image of the celestial city. That the structure of the building is concealed by these images reveals the spiritual source of Romanesque "anti-functionalism": the celestial vision depicted is to make us forget that we stand in a building of stone and mortar. In the Gothic cathedral the relation between structure on the one hand and ornament and its symbolic function on the other is quite different. Here the design is entirely

determined by the pattern of the structural members, vault ribs and shafts. It has been remarked that the flowering of the Romanesque mural was in large part due to the technical imperfections of the buildings it adorned, that wall painting declined in the measure in which these imperfections were overcome. In Gothic architecture, the wonderful precision with which every single block was shaped in the vault (leaving no ragged joints that it was necessary to conceal) suggests a new esthetic appreciation of the dignity of structural perfection.³ This tectonic system is never concealed but rather underscored by Gothic wall painting. Even the stained glass windows submit, in composition and design, increasingly to the pattern of the stone and metal armature in which they are imbedded. The esthetic function of these windows is not only the creation of a new luminosity; the light they admit dramatically underscores the web of tracery, ribs, and shafts.

This new esthetic dignity ascribed to structure cannot be understood in terms of modern functionalism. Architectural form reveals function if it actually shows the physical interaction of weight and support as it does in the Greek temple. What concerned the Gothic builder was not such naked expression of static function but rather the translation of function into an essentially graphic system. By concealing volume or "dissolving" it into a bundle of frail shafts, he obtained the visual effect of a geometrical grid on a two-dimensional surface.⁴ With this qualification, however, Gothic architecture is indeed functionalist. And its emphatic recognition of structure is all the more remarkable if we recall the symbolic significance of the sanctuary. As we shall see, the "functionalist" aspect of Gothic art will help us understand the precise nature of its symbolic aspect, just as the latter is indispensable for a correct definition of Gothic functionalism.

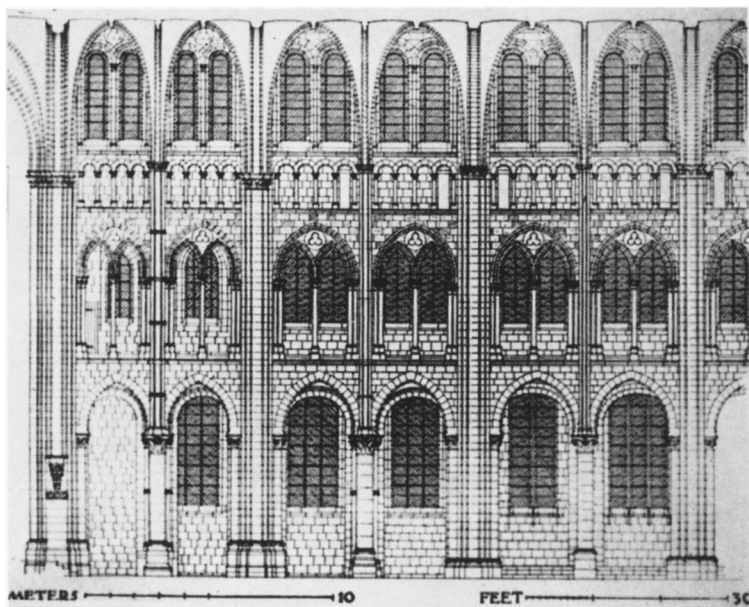
It is hardly necessary today to stress the overwhelming importance of geometry in Gothic design. The reliance on geometrical formulae, apparent in every Gothic ground plan and elevation, is amply attested by medieval documents. So much research has been done in recent years on this question that I can limit myself to a brief summary. With but a single basic dimension given, the Gothic architect developed all other magnitudes of his ground plan and elevation by strictly geometrical means, using as "modules" certain regular polygons, above all the square. The knowledge of this way of determining proportions was considered so essential that it was kept a professional secret. Only toward the end of the fifteenth century—and of the cathedral age—was it made public by Matthew Roriczer, the builder of Regensburg cathedral. He teaches "how to take the elevation from the ground plan" by means of a single

square. From this figure Roriczer derives all proportions of his edifice inasmuch as its dimensions are related to one another as are the sides of a sequence of squares the areas of which diminish (or increase) in geometrical progression. The proportions thus obtained the master considered to be "according to true measure."⁵

It was not only this late Gothic architect or the German lodges that made such modular use of the square. Perhaps the most important single piece of evidence regarding the principles of Gothic design is the famous model book by the Picard architect Villard de Honne-court, who was active in the second quarter of the thirteenth century. He, too, demonstrates how to double (or halve) a square for the purpose of determining the proportions of a building, in this case the ground plan of a cloister. That this is no mere theory is shown by Villard's plan of one of the towers of Laon Cathedral, considered by him the most beautiful in the world. This plan indicates, as Ueberwasser has shown, that all horizontal subdivisions of the tower are recessed "according to true measure."

The square—along with the other polygons, such as the famous $\pi/4$ triangle, which the medieval architect derived from the square—and the proportion "according to true measure" have determined Gothic design to a remarkable extent. The façade of Notre Dame of Paris is composed of a sequence of four squares developed according to true measure. Of course geometrical formulae had been used by pre-Gothic architects too. Here, however, they were practical rather than artistic devices of which the observer usually remains unconscious. Nowhere do they determine the esthetic impression as they do in the Gothic system. One might almost say that the development of the style, from its origin to the classical maturity reached in the mid-thirteenth century, is marked by the gradual triumph of geometrical proportion. If we compare the façade of Notre Dame with the similar and earlier one of Noyon, we realize the increasing clarity with which the geometrical principle is realized in the Paris façade.

The same principle rules over all parts of the Gothic cathedral. F. Bond was struck by the tenacity with which the square is retained in the Gothic ground plan even after the advantages of oblong bays from the viewpoint of vaulting had been discovered. We shall soon return to this phenomenon. The square is equally apparent in the Gothic elevation. That of Noyon is a good starting point. The nave was built during the last third of the twelfth century. Thanks to the fine analysis of Charles Seymour, Jr., we know how the work progressed from East to West and how this progress involved stylistic changes that mark this transition from Romanesque to Gothic. In the proportions of Noyon the geometrical element is, as Seymour observes, not yet prominent. We

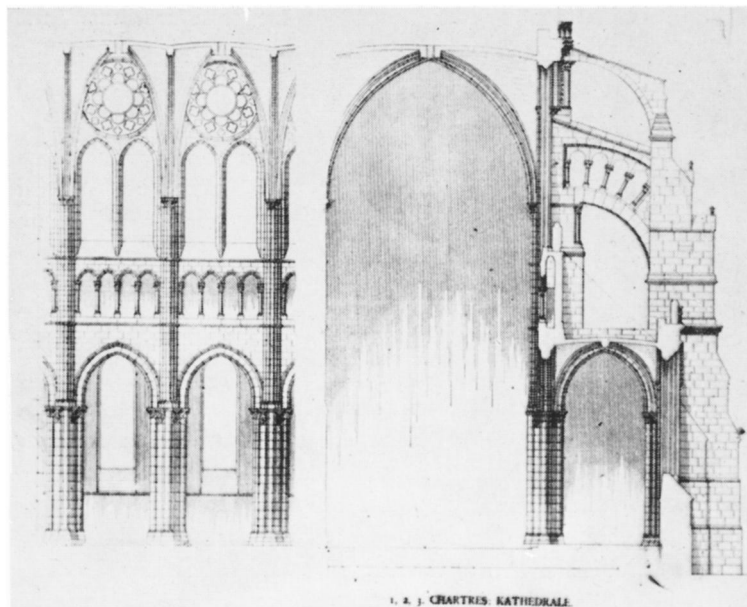


Noyon, elevation. (After Charles Seymour, Jr.)

encounter “shifts of design and alterations of proportions” in almost every bay. Even so, it is significant that only in the three Western bays, which were completed last, is the relation of the width of an aisle to that of the main vessel “brought to a ratio of nearly exactly one to two.” In the elevation of the nave, moreover, the stringcourse under the galleries marks off a height equal to the distance between the main piers; and the square thus described occurs a second time since the distance from the stringcourse to the windowsills of the clerestory is again the same.

But the Gothic trend toward “geometrical functionalism” appears elsewhere at Noyon. He who designed this elevation perceived the relation of weight and support not as the interaction of physical bodies, but as an abstraction, as an interplay of lines. The columns under the nave arcades are the only architectural members designed and articulated according to their statical function; they alone unequivocally suggest volume. But they represent an old-fashioned element, doomed gradually to disappear from Gothic architecture. The main piers remain partly embedded within the wall which conceals their bulk. The intermediary shafts, slender like bamboo shoots, could not even maintain themselves were not they, in turn, braced by the walls between them. As the work progressed, the architects suppressed everything that might divert attention from the interplay of lines. Thus ornaments and even corbel rings disappear from the later sections of the nave, capitals become smaller and simpler until only the austere web of horizontals and verticals remains.

If, on the other hand, we compare Noyon with the first—and mother—of the classical cathedrals, that of



Chartres, elevation and cross-section. (After Dehio-V. Bezold.)

Chartres, geometrical proportion suddenly seems to have come into its own. The ground plan of Noyon is Romanesque in that it suggests an additive process of composition: one could easily add or eliminate one or more of the rectangular units of which it is composed. The ground plan of Chartres presents the compact unity and cohesion of an organism. This unity is due to proportion. Dehio was the first to notice that this plan is based on the Golden Section, since the center of the crossing divides the entire edifice in the ratio 5:8. The main proportions of the ground plan, moreover, determine those of the elevation. The church is as high as is the distance from the center of the crossing to the end of the choir (excluding the apse) and of the transepts. And the great square described by the crossing and by each double bay of the nave also reappears in the elevation: the height to the first stringcourse being equal to the side of this square, the architect has created a series of “spatial cubes” that is quite noticeable to the observer. And this square reappears once again in the elevation, since its side is equal to the length of the slender shafts that support the vault ribs. If we increase this square “according to true measure” we obtain the height of the entire nave to the windowsills. Finally, the Golden Section appears in the elevation as it does in the ground plan, determining the proportion between the piers (to the arcade imposts) and the shafts above them.⁶

What matters is not only the existence of these measurements, but the way in which the architect has brought them to our attention. He has sprung his four-partite vaults over transverse oblong bays, but has not entirely sacrificed the square: Chartres cathedral presents the alternating system of supports, in some respects

an obsolete feature that occurred in Sens and Noyon but had already been dropped in Notre Dame of Paris. It is interesting to see how the master of Chartres employed alternation without sacrificing the homogeneity of identical supports. His piers consist, alternatively, of a cylindrical core surrounded by octagonal colonnettes and of an octagonal core surrounded by cylindrical colonnettes. The variation is just sufficient to induce the eye to see not one but two bays as one unit and thus to notice the square in the ground plan and the "cube" in the elevation. The main proportions of the elevation are made evident by the simple grid of intersecting verticals and horizontals. And our eye is similarly directed to notice the proportion (of the Golden Section) obtaining between the main parts of the supports; only one of the shafts in each compound lacks a capital under the nave arcade; it is the one facing the nave and just beneath the respond that rises to the springing of the transverse rib. We thus see the entire vertical member as one, harmonically subdivided, unit.

It is worthwhile to compare the elevations of Noyon and Chartres. The younger cathedral is nearly fourteen meters higher, yet it conveys the impression of far greater horizontal unification. The abandonment of the four-partite elevation in favor of the three-partite one is an important means to this end. The harmony of the Golden Section welds both the vertical and horizontal system of Chartres into an indissoluble unity. These proportions strike one as necessary and definitive, whereas the master of Noyon appears to be still groping for the right ratios. Equally increased is the tendency toward the two-dimensional in Chartres. With the elimination of the galleries, the side aisles have become narrower and lighter, a luminous membrane rather than a shadowy depth enveloping the nave. The *piliers cantonnés*—which the master of Chartres, as Panofsky observes,⁷ employs for the first time—further accentuate the graphic tendency, seemingly reducing the solid core of the supports and dissolving their volume into the vertical rhythm of lines.

It ought not to be assumed that the line drawings we have been studying convey an inaccurate notion. In every other architectural style they would indeed give but a faint semblance of what the architect actually intended to build. Not so in Gothic. One has to look at the architectural drawings of the age—such as Villard de Honnecourt's or those of the contemporary Reims palimpsest, or the magnificent later collections from the cathedral lodges of Prague and Vienna—to realize that for their authors these drawings were not abstractions but the ideal which the completed edifice must seek to approximate. These wonderful systems of lines suggest neither space nor volume. Not until the end of the fourteenth century is there any indication of perspective.⁸

It is as if these masters, as unconcerned with physical laws as with appearance, had been preoccupied solely with the reality of geometrical proportions.

Why this submission to geometry? One reason often given is a practical one: with measuring units varying from place to place, yardsticks were unknown or unusable; hence the use of proportions, in architectural drawings or models, that could be translated into large dimensions by geometrical means only. This explanation is but partially adequate, however. Villard de Honnecourt supplies numerical indications of size in a technical drawing, but always relies on geometry in his architectural designs. The proportion "according to true measure," whatever the facility of its practical execution, occurs, as Ueberwasser has shown, in Gothic paintings and engravings where the problem of translating one dimension into another did not enter. The Gothic artist would have overthrown the rule of geometry had he experienced it as a fetter. Yet he did not use geometrical formulae for purely esthetic reasons either; they occur in places where they are invisible to the observer. In short, the alternative "practical or esthetic" does not make sense in medieval terms. Happily, at least one literary document survives that explains the use of geometry in Gothic architecture: the minutes of the architectural conferences held during 1391 and the following years at Milan.

The cathedral of Milan was begun in 1386. After a few years difficulties developed and foreign advisors were called in from France and Germany. The minutes of the discussions between them and their Italian colleagues have survived. Two aspects of the deliberations are of importance in our present context: first, the reliance on geometric figures, attested by the German architect, Roriczer, of the fifteenth century, and the French architect, Villard de Honnecourt, of the thirteenth, is emphatically confirmed by the Italian document of the intervening century. The question debated at Milan is not whether or not the cathedral is to be built according to a geometrical formula, but merely whether the modular figure to be used is the square (which had already determined the ground plan) or the equilateral triangle.⁹ The second and even more significant aspect of the Milan documents is that they suggest the reason for this use of geometrical formulae. The minutes of one particularly stormy session recall an angry dispute between the French expert, Jean Mignot, and the Italians. Overruled by them on a technical issue, Mignot remarks bitterly that his opponents have set aside the rules of geometry as if science were one thing and art another. Art, however, he concludes, is nothing without science, *ars sine scientia nihil est*. The terms art and science do not mean what they mean today. Art for Mignot is the practical know-how gained from ex-

perience; science the ability to account for the reasons that determine sound architectural procedure by rational and more precisely by geometrical means. In other words: architecture is scientific inasmuch as it is based on geometry, and unless he obeys the laws of geometry the architect must fail. This argument was considered unassailable even by Mignot's opponents. They hasten to affirm that they are in complete agreement and have nothing but contempt for an architect who presumes to ignore the dictates of geometry. It is taken for granted by both sides that the stability and the beauty of the edifice are not distinct, do not obey different laws, but are both comprehended in the perfection of geometrical forms.

Thus, the Milan document answers our question regarding the function of geometry in Gothic architecture. I think it also provides the clue to the reasons underlying what seems to us an almost superstitious belief in mathematics. Jean Mignot's juxtaposition of *ars* and *scientia* recalls, like a faint echo, the distinction that occurs almost a millenium before in the most influential esthetic treatise of the Middle Ages.

In the first book of his treatise, *De Musica*, St. Augustine defines music as the "science of good modulation." Before telling us what good modulation is, he explains why music, properly understood, is a science. He does not deny that music can be produced by instinct or practical skill, just as music can be appreciated by one who just "knows what he likes." Such understanding of music, however, creative or receptive, is but of a low order, according to Augustine. Vulgar performers and vulgar audiences have such an understanding; even a singing bird has. In fact, there is little difference between man and beast in regard to this kind of musical knowledge which Augustine calls contemptuously *art*. The true understanding of music, on the other hand, that knows the laws which are of its very essence, applies them in musical creation and discovers them in music, is what Augustine calls the *science* of music, and he goes on to explain the nature of this science as mathematical. The science of good modulation is concerned with the relating of several musical units according to a module, a measure, in such a way that the relation can be expressed in simple arithmetical ratios. The most admirable ratio, according to Augustine, is that of equality or symmetry, the ratio 1:1, since here the union or consonance between the two parts is most intimate. Next in rank are the ratios 1:2, 2:3, and 3:4, the intervals of the perfect consonances octave, fifth, and fourth. It is to be noticed that the pre-eminence of these intervals, for Augustine, is not derived from their esthetic or acoustic qualities. These are, rather, audible echoes of the metaphysical perfection which Pythagorean mysticism ascribes to number, especially to the four numbers of the

tetractys. Without the principle of number, as Augustine calls it, the cosmos would return to chaos. Taking up the Biblical passage *Omnia in mensura et numero et pondere disposuisti*, Augustine applied Pythagorean and neo-Platonic number mysticism to the interpretation of the Christian universe, its creation, and its order. He shares with Plato both a distrust of the world of images and the belief in the absolute validity of mathematical truths. Platonic metaphysics is also the basis for Augustine's philosophy of art. The views he formulated, not only as regards the function of the arts in the Christian commonwealth, but also, one may say, as regards its style, have left their imprint on Christian art during a thousand years. This influence has three aspects.

1. The principles of good musical modulation and its appreciation which Augustine established in *De Musica* are mathematical principles and therefore apply, in his opinion at least, to the visual arts as they do to music. On the monochord, the musical intervals are marked off by the divisions on a string; the arithmetical ratios of the perfect consonances thus appear as the proportions between different parts of a line. And since Augustine adduces the musical value of the perfect consonances from the metaphysical dignity of the ratios on which they are based, it was natural for him to conclude that the beauty of certain visual proportions derives from their being based on the simple ratios of the *tetractys*. The place Augustine assigns to geometry among the liberal arts, like the place he assigns to music, is due to its "anagogical" function, that is, its ability to lead the mind from the world of appearances to the contemplation of the divine order. In the second book of his treatise *On Order* Augustine describes how reason, in her quest for the blissful contemplation of things divine, turns to music and from music to what lies within the range of vision: beholding earth and heaven, she realizes that only beauty can ever satisfy her, in beauty figures, in figures proportion, and in proportion number. The esthetic implications are clear. Augustine was quite as sensitive to architecture as he was to music. They are the only arts he seems to have fully enjoyed, and he recognized them even after his conversion, since he experienced the same transcendental element in both. For him, music and architecture are sisters, since both are children of number; they have equal dignity, since architectural mirrors eternal harmony as music echoes it.

2. Augustine uses architecture as he does music to show that number, as apparent in the simpler geometrical proportions that are based on the "perfect" ratios, is the source of all esthetic perfection. And he uses the architect, as he does the musician, to prove that all artistic creation follows the dictate of number, even though the architect, if he is a mere practitioner rather than a scientist of his art, may be unable to account rationally

for his instinctive use of mathematical rules. Such views, of course, confine artistic design and composition within the rigid limits of metaphysical doctrine. Along with a real appreciation of the abstract mathematical beauty that may and perhaps always does underlie artistic composition, Augustinian esthetics harbors a profound distrust and contempt of the image, the semblance of living form that may obscure the anagogical function of the work of art. And even the proportions he admits are limited to the "perfect" ratios of Pythagorean mysticism.

3. That Augustinian thought has profoundly influenced Western art during the Middle Ages, both in its recurrent iconoclastic tendencies and in its mathematical character, is beyond question. We are apt to underrate the positive consequences of this influence. While stripping the arts, and above all architecture, of much of their life, it also assigned to them an extraordinary dignity and mission. Because true beauty is, according to Augustine, anchored in a metaphysical reality, the contemplation of visual and musical harmony will actually lead the soul to the experience of the ultimate harmony and unity that is God.

The Middle Ages never questioned Augustine's authority. The passage from the Book of Wisdom "Thou hast disposed everything according to measure and number and weight," and the interpretation he had given to it, became, as has rightly been observed, the key word to medieval thought and learning until the advent of Aristotle. E. R. Curtius has recently shown how this world view, through number composition, has affected both the content and the form of medieval poetry. It has left an even greater impact on medieval art.

Augustinian esthetics were never forgotten during the Middle Ages. In the twelfth century, however, they gain an unprecedented importance in the Ile de France, under the influence of two movements, the first intellectual and speculative, the second spiritual and ascetical. The first centers in the group of Platonists assembled at the school of Chartres, the second in the monastic reform emanating from Citeaux and embodied by Bernard of Clairvaux. French civilization in the twelfth century is in an important sense the synthesis of these two trends which, though distinct, are yet closely interconnected by personal and intellectual ties. Their common bond is the legacy of St. Augustine, their lasting achievement the creation of Gothic art.

The Platonism of Chartres was in many respects a true Renaissance movement. The group of men who gathered there in the second quarter of the twelfth century were primarily interested in theological and cosmological questions, to be solved by means of a synthesis of Platonic and Christian ideas. These early scholastics approached their task in a spirit of tolerance and respect with regard to the thought of antiquity that often reminds

one of the "universal theism" of the fifteenth century; yet, theirs was a strange Platonism indeed. It was almost entirely based on one single treatise, the *Timaeus*. Of this treatise but a fragment was available; of this fragment not the Greek original, but only a garbled translation along with two commentaries—by Chalcidius and Macrobius—that viewed Plato's cosmology through the lenses of an eclectic and confused neo-Platonic mysticism. The Platonic fragment (and the two mediocre commentaries) were approached by the theologians of Chartres with nearly the same awe and respect as was the Book of Genesis. Both works, it was believed, were in substantial agreement in what they revealed about the creation of the universe, indeed, about the Creator himself. If one considers that the theology and cosmology of Chartres resulted largely from the interpretation of two documents as different as Plato and the Bible, but approached with the notion that they must not contradict each other and that the interpreter must not contradict either, one can but marvel at the wonderful and daring speculative system that resulted.

The aspects of the theology and cosmology of Chartres that interest us most in our present context are, first, the emphasis on mathematics, particularly geometry, and, second, the esthetic consequences of this thought.¹⁰ The masters of Chartres, like the Platonists and Pythagoreans of all ages, were obsessed with mathematics; it was considered the link between God and world. The most influential exponent of the system, Thierry of Chartres, hoped to find, with the help of geometry and arithmetics, the divine artist in his creation; he went further and sought to explain the mystery of the Trinity by geometrical demonstration. The equality of the Three Persons is represented, according to him, by the equilateral triangle; the square unfolds the ineffable relation between Father and Son. Thierry recalls that Plato "like his master Pythagoras" identified the metaphysical principles of monad and dyad with God and matter, respectively. God is thus supreme unity, and the Son is unity begotten by unity as the square results from the multiplication of a magnitude with itself. Rightly, Thierry concludes, is the Second Person of the Trinity therefore called the first square. It has been said, that, under Thierry's influence, the school of Chartres attempted to transform theology into geometry. The attempt, which appears so strange to us, conveys a glimpse of what geometry meant to the twelfth century.

More daring than this theology, more dubious from the standpoint of orthodoxy, and more significant for the art historian is the cosmology of Chartres and the philosophy of beauty which it engendered. In the *Timaeus* Plato describes the division of the world soul according to the ratios of the Pythagorean *tetractys*. The esthetic, especially musical, connotations of this

idea, barely hinted at by Plato, are underscored by Chalcidius who points out that the division is effected according to the ratios of musical harmony. He, as well as Macrobius, insists that the Demiurge, by so dividing the world soul, establishes a cosmic order based on the harmony of musical consonance.

It was easy to fuse this notion with the Augustinian idea of a universe created "according to measure and number and weight." As a result the creation appeared as a symphonic composition. It is so described in the ninth century by John Scotus Erigena, and the idea was seized upon by the school of Chartres. William of Conches, the teacher of John of Salisbury, and Abelard, who seems to have studied mathematics under Thierry and whose cosmology is that of the school of Chartres, both identify the Platonic world soul with the Holy Ghost in its creative and ordering effect upon matter; and they conceive this effect as musical consonance. The harmony it establishes throughout the cosmos is represented, however, not only as a musical composition but also as an artistic one, more specifically, as a work of architecture. The ease with which the transition from the musical to the architectural sphere is here effected must not surprise us in view of the sistership of the two in Platonic and Augustinian thought. But for the theologians of Chartres, the notion of the cosmos as a work of architecture and of God as its architect has a special significance, since they assume a twofold act of creation: the creation of chaotic matter, and the creation of cosmos out of chaos. The Greek word *cosmos* signifying ornament as well as order, it was plausible to view matter as the building material, the creation proper as the "adorning" of matter by the artful imposition of an architectural order. In the Platonic cosmology, moreover, the masters of Chartres could detect the design and method according to which the divine architect had built the universe, the cosmic temple as Macrobius calls it.

In the *Timaeus* the primary bodies of which the world is to be composed are conceived as building materials ready to be put together by the builder's hand. This composition is effected by means of fixing the quantities in the perfect geometrical proportions of squares and cubes (1:2:4:8 and 1:3:9:27)—the same proportions that also determine the composition of the world soul. According to this composition, the world's body, consisting of the four primary bodies, whose quantities are limited and linked in the most perfect proportions, is in unity and concord with itself and hence will not suffer dissolution from any internal disharmony of its parts; the bond is simply geometrical proportion.¹¹ In this view, the perfect proportions, the beauty of which we may admire in musical and in architectural compositions, also acquire an explicit technical or tectonic function: these proportions chain and knit together the different elements of which the cosmos is composed. William of Conches quite correctly interprets the Platonic passage in this sense. Here, then, perfect proportion is thought to account for both the beauty and the

stability of the cosmic edifice.

The significance of these ideas for the history of architecture is very real. Some years ago N. Pevsner pointed out that the term architect is rarely used in the Middle Ages and, if it is, denotes either clerics interested or experienced in architecture, or masons.¹² Pevsner concluded that the professional architect, in the classical sense (which is also the modern one), hardly existed in the Middle Ages, and suggested that the revival of the term in the mid-thirteenth century coincides exactly with the change from the humble master mason to the architect of the thirteenth century, no longer considered as a craftsman but as the principal artist and a "theoreticus" or scientist. There may be a good deal of truth in all this, but Pevsner is surely wrong when he seeks to connect this sociological and philological development with the introduction of Aristotle's *Metaphysics* (where *architect* is defined in our sense) to Western thought after 1200. Quite apart from the writings of Vitruvius, known and studied since Carolingian times, it was Augustine who kept alive the classical definition of the architect. His distinction between the mere practitioner and the true architect who deliberately applies scientific principles occurs in at least three different treatises, all studied and admired throughout the Middle Ages. While this definition permitted the application of the term architect even to the mere craftsman, it left no doubt that only the "scientist" schooled in the liberal arts was truly entitled to it. And since knowledge of the *quadrivium* was generally the privilege of clerics, it is not surprising to find so many ecclesiastics among medieval builders and the term architect so often applied to them.

But it was the school of Chartres which dramatized the image of the architect in the classical sense (more than a century before Aristotle's *Metaphysics* could have done so) by depicting God as a master builder, a *theoreticus* creating without instrument or effort by means of an architectural science that is essentially mathematical. And not only Augustine but Boethius, the greatest mathematical authority of the Middle Ages, taught the school of Chartres how to visualize in geometrical terms the perfect consonances. He points out that the proportions of double, half, triple, and third—those, in other words, that marked the perfect ratios on the monochord—are as readily perceived visually as they are acoustically, for, he continues, echoing the *Timaeus*, "the ear is affected by sound in quite the same way as the eye is by sight." And Boethius confines this doctrine of synesthesia not only to the proportions of line or surface; he discovers "geometrical harmony" in the cube since the number of its surfaces, angles, and edges—6:8:12—contains again the ratios of the consonances.

Toward the end of the twelfth century—at a time when the first Gothic cathedrals were nearing completion—

Alanus ab Insulis described the creation of the world. To Alanus, the *doctor universalis*, the Platonism of Chartres owes probably its widest influence and diffusion. To him, God is the artful architect (*elegans architectus*) who builds the cosmos as his regal palace by composing and harmonizing the different genera of created things with the "subtle chains" of musical consonance.

The impact of these views on the architecture and architectural procedure of the twelfth and early thirteenth centuries cannot be overestimated. Since art is an image of nature, Professor de Bruyne asks, "must not the ideal church be constructed according to the law of the universe?" We suddenly understand why the high Middle Ages defined and practiced architecture as applied geometry; why the experts at Milan pay such astonishing tribute to this discipline. And we also understand why the great lay architects of the Gothic period have themselves invariably depicted, ruler and compass in hand, as geometricians. With these same attributes the creator himself was represented. Only by observing geometrical principles did architecture become a science in Augustine's sense; by submitting to its laws, the human architect imitated his divine master and in doing so his calling acquired metaphysical significance.

In order to understand this significance of Gothic architecture we must bear in mind that the musical harmony which the Christian Platonists beheld in the cosmos is primarily not a physical but a metaphysical principle. Medieval man looked upon the creation as the first of God's self-revelations, the Incarnation of the Word being the second. Between the two the twelfth century perceived innumerable mystical correspondences. The theological meaning of the universe had been obscured through Adam's fall on earth. It still appeared clearly in the perfection of God's celestial palace. Hence the tendency, familiar to every reader of Dante, to link the realm of the stars with the celestial mansions; hence also the seemingly dual symbolism of the cathedral which is at once an image of the cosmos and of the celestial city. If the Gothic architect designed his sanctuary according to the laws of harmonious proportion, he did not only imitate the perfection of the visible world but also created an image, in as much as that is possible to man, of an invisible one.

The symbolic concatenation is well explained in a passage of Abelard. After identifying the Platonic world soul with world harmony, he first interprets the ancient notion of a music of the spheres as referring to the "heavenly mansions" where angels and saints "in the ultimate sweetness of harmonical modulation" render eternal praise to God. Then, however, Abelard transposes the musical image into an architectural one. He relates the celestial Jerusalem to the terrestrial one, more

specifically to the Temple built by Solomon as God's "regal palace" and at once a model for the Christian sanctuary and a mystical image of Heaven. This temple, Abelard remarks, was pervaded by the divine harmony as were the celestial spheres. The passage reflects the influence of Platonic cosmology upon Christian eschatology and symbolism in the twelfth century, the notion of an ineffable harmony gradually subdues the imagery by which the celestial city had formerly been depicted. This notion goes far to explain the transition from Romanesque to Gothic, the striking rule of harmonious proportion in the new style that emerges around 1140.

It must be emphasized at this point that the musical mysticism of the Platonic tradition was by no means the exclusive property of the School of Chartres. Embodied in Augustinian thought, it influenced the spiritual formation of the monastic movement that centered in Cîteaux and Clairvaux and is personified by St. Bernard. As I remarked earlier, this movement contributed as much to the civilization of the twelfth century as did the Platonism of Chartres, and both trends are intimately related. It is time to consider Bernardine thought in its impact upon Gothic art.

Bernard's artistic views are usually described as those of a Puritan. They are in point of fact Augustinian. No other author has had greater influence upon Bernard's theological formation than Augustine. He considered the Bishop of Hippo the greatest theological authority after the Apostles; with Augustine, Bernard writes, he wants to err, as well as to know. And Augustine musical mysticism could claim as its greatest spokesman. The following passage gives an idea of the place and function of music in Augustine's theological experience. In his treatise *De Trinitate* he meditates on the mystery of Redemption by which the death of Christ atoned for man's twofold death of body and, through sin, of soul. As the Bishop of Hippo ponders this "congruence," this "correspondence," this "consonance" of one and two, musical experience gradually takes hold of his imagination, and suddenly it dawns upon him that *harmony* is the proper term for Christ's work of reconciliation. This is not the place, Augustine exclaims, to demonstrate the value of the octave which seems so deeply implanted in our nature—by whom if not by Him who created us?—that even the musically and mathematically untrained immediately respond to it. Augustine feels that the mystery of Redemption is conveyed to human ears by the consonance of the octave, the musical expression of the ratio 1:2. The remarkable passage conveys an esthetic experience radically different from our own. It was not the primary enjoyment of musical consonances that led Augustine to interpret these as symbols of metaphysical or theological truth. On the contrary, the consonances were for him echoes of such truths and the enjoyment

which the senses derive from musical harmony (and its equivalent, geometrical proportion) is our intuitive response to an ultimate reality that may defy reason but to which our entire nature is wonderfully attuned.

This experience determines the medieval attitude towards music. It accounts for the emphasis on musical studies even, and especially, in the monasteries of strict ascetical observation. To take a typical example, Othlon of St. Emmeram (1032-70), in embracing the most austere monastic ideal, renounced all his former humanistic interests. But arithmetic and music retain their mystical function for him; he uses them in his writings to convey divine secrets to his fellow monks, to prepare them for the life in a world to come. Even the order prevailing among the heavenly hosts, he writes, corresponds to the intervals of the perfect consonances.

Bernard's attitude towards music was quite similar. He was profoundly musical, and, as Father Luddy observes, an Augustinian even in musical matters. Something of a composer himself, he was once invited by the abbot of another monastery to compose an office for the feast of St. Victor. Bernard's reply is noteworthy. What he demands of ecclesiastical music is, above all, that it "radiate" truth, "sounding" the great Christian virtues and kindling the light of truth. Music, Bernard thinks, should please the ear in order to move the heart; it should, by striking a golden mean between the frivolous and the harsh, wholesomely affect man's entire nature.

These are not the views of a Puritan. Bernard must have responded to musical experience with unusual sensitivity. In demanding that music be attuned to the great metaphysical and ethical experiences of Christian life, he confronted music, not with an attitude restricting its creative scope, but with a challenge. The importance of Bernard's views on music for our present inquiry lies in the fact that they also provide an indispensable clue to his convictions regarding the visual arts. That the laws of music, generally understood, "embrace everything," that they extend to all the arts is a view frequently expressed during the Middle Ages.¹³ And to a man steeped, as Bernard was, in the Augustinian tradition, not only the metaphysical dignity of the perfect consonances but their presence in the sister art of music, architecture, must have been self-evident.

The appraisal of Bernard's views regarding religious architecture must rely not only on the opinions he expressed in literary form but on the testimony of Cistercian architecture, the design of which was certainly determined by his views. Bernard's demand that the "monstrous" imagery of Romanesque art—and in fact all images besides the crucifixus—be banished from the Cistercian cloister and church; his attack upon the "immense" height, the "immoderate" length, the "super-vacuous" width of the Cluniac churches are but a nega-

tive statement of his views. To understand its meaning we must bear in mind that the sumptuousness of Cluniac sanctuaries was considered incompatible with monastic humility. More important than this ethical consideration, however, was a spiritual one. To Bernard the life of the Cistercian cloister—the *paradisus claustralis*—was an image and foretaste of Paradise. He sought to prepare his monks, even while in this life, for the fruition of an ultimate truth which the relatively crude imagery of Romanesque art could never convey.

Its elimination from the Cistercian monastery was therefore inevitable. Significantly, however, music maintained its place. And the disappearance of figurative sculpture and painting from Cistercian churches cleared the way for a purity of proportions that is all the more remarkable in view of the role which sacred architecture played, in the mystical contemplation of the Order, as an image of Heaven. For Bernard, as for Augustine, the perfect consonances, visible or audible, were not delusions of the senses, but echoes of transcendental reality.

We do not yet know all the geometrical modules used by the Cistercian builders. Yet the use of such modules is strikingly obvious in their churches. Augustine's "perfect" ratio 1:2 generally determines the elevation. In the abbey of Fontenay (1130-47), the best surviving example of early Cistercian architecture, this octave ratio determines the proportions of the ground plan as well. Moreover, the bays of the side aisles being of equal length, width, and, up to the stringcourse, height, we obtain in each of these cells a spatial cube—the "geometrical harmony" of Boethius which, later, we also encounter in Chartres. The austere façade, if we include the buttresses and the upper stringcourse, describes a square. The distance between the upper and lower stringcourse is determined "according to true measure." Medieval preference for this proportion appears in a new light if we recall Augustinian preference for the octave and the preoccupation with the octave and with the square in the thought of Augustine on the one hand and of the school of Chartres on the other: the proportion "according to true measure" may be defined as the geometrical expression of the ratio of the octave based on the square as module. It can hardly be a coincidence. Nowhere in Western architecture are the Augustinian consonances as present as they are in the simple and solemn proportions of this Cistercian church. Its design, in any event, is singularly attuned to the musical mysticism of the twelfth century.

Thus we have seen that the use of geometrical formulae in sacred architecture—so emphatically evident and yet so surprising to the modern observer—is rooted in the very world view of the twelfth century. Such interaction between the spheres of thought and of art is, of course, most evident in the case of Cistercian architecture.

But what renders this evidence important in our present context is the close relationship between Cistercian and early Gothic architecture. This relationship has often been described. It would be incorrect to define Gothic as the daughter of Cistercian architecture. In criticizing the art of the Cluniac order, St. Bernard himself had made it very clear that his views as regards religious architecture applied to monastic buildings but not to the secular cathedrals. He readily conceded that the latter, "since they cannot excite the devotion of the carnal populace with spiritual ornaments, must employ material ones," in other words, that cathedral art had to make concessions to sensuous experience which the mystic no longer required. On the other hand, St. Bernard's insistence that all religious art and music must be attuned to spiritual experience, that they are justified only inasmuch as they lead man to ultimate truth, confronted cathedral builders with the same basic challenge which monastic architecture had answered with the creation of the Cistercian style. Cistercian and Gothic may be described as two branches of religious architecture—the one monastic, the other episcopal—growing out of the same basic experience.

There is nothing surprising about this close relationship. St. Bernard was the most forceful exponent of a vision of art, the basic tenets of which had their champions in cathedral schools like that of Chartres. It would indeed be a serious mistake to consider the two intellectual movements we have studied as entirely distinct. The Platonists of Chartres and the Augustinians of Cîteaux and Clairvaux were united by innumerable personal ties as well as by a common heritage. Of particular interest in this connection are the relations between St. Bernard and the three men who commissioned the three monuments with which Gothic art begins: Suger, Abbot of St. Denis, and the Bishops Henry of Sens and Geoffrey of Chartres.

Suger's place in the history of art is mainly due to the importance of the west façade and choir of St. Denis which, for the development of architecture as well as sculpture, mark an epoch. But his fame also rests on the fact that, unlike any other medieval builder, he has, in two treatises, rendered account of the significance of his art and indeed of the spiritual motivations that prompted him to adopt a style the dramatic novelty of which he himself seems to have sensed.

The interpretation of Suger's writings—and of his art as well—has generally suffered from the assumption that "an irreconcilable contrast" existed between his artistic views and those of the Abbot of Clairvaux. In point of fact, Bernard's views were from a twelfth-century viewpoint far less extreme than is usually believed and, as I hope to have shown, offer many points of contact with the esthetic convictions of his con-

temporaries. Suger in particular, steeped in the neo-Platonism of Pseudo-Dionysius, must have been singularly attracted by Bernard's insistence that religious art is admissible only inasmuch as it guides contemplation toward the transcendental source of all beauty. This thought is the continued theme of Suger's treatises in which he interprets his artistic creations as he believes they ought to be understood. We have no reason to doubt his sincerity in this regard. In fact, there is good reason to think that the art of St. Denis may actually reflect Bernardine influence. The same influence, as I can but mention in passing, may have inspired the building activities of Henry of Sens and Geoffrey of Chartres.

St. Denis, Sens and Chartres West mark a beginning. But the "classical" Gothic cathedrals that follow their lead embody the same metaphysics of beauty. During the second half of the twelfth century the Platonism of Chartres and the spirituality of St. Bernard lose nothing of their influence. On the contrary, this influence is consolidated through a union of the two movements that is often as intimate as is, during the same period, the fusion of Cistercian and Gothic architecture.

This fusion, and its origin in the metaphysics of musical harmony, is most clearly embodied in the work of a professional architect. I have already mentioned the model book of Villard de Honnecourt. One of his designs represents the ground plan of a Cistercian church drawn *ad quadratum*, i.e., the square bay of the side aisles is used as a module, as a measuring unit from which all proportions of the ground plan have been derived. And these proportions, as E. de Bruyne observes, correspond in each case to the ratios of the musical consonances. Thus the length of the church *in opere* is related to the transept in the ratio of the fifth (2:3); the ratio 1:2 determines the relation between side aisle and nave, length and width of the transept, and, we may assume on the basis of Cistercian practice, that of the interior elevation as well. The 3:4 ratio of the choir evokes the musical fourth; the 4:5 ratio of nave and side aisles taken as a unit corresponds to the third, while the crossing, liturgically and esthetically the center of the church, is based on the 1:1 ratio of unison, most perfect of consonances.

Villard's testimony is of great significance. He seems to have received his architectural training at the Cistercian monastery of Vaucelles and certainly was employed as an architect by the Order. His design embodies the esthetic principles of the Cistercian tradition. While it does not seem to represent any church actually built, it shows sufficient resemblances to Pontigny and other churches of the Order to warrant Hahnloser's suggestion that Villard's ground plan was designed as the ideal type of a Cistercian church.

Villard's authority and interest was not confined to

the sphere of monastic architecture. Trained during the first third of the thirteenth century and active during the second, he saw, completed or in the process of building, nearly every one of the classical cathedrals of the Ile de France. He was a distinguished Gothic architect in his own right, and it is all the more significant that, not only in his Cistercian ground plan, but on nearly every page of his model book he stresses the importance of geometry for the realization of harmonical proportion.

But it is the Gothic cathedral itself that bespeaks this artistic conviction. The proportions of the great sanctuaries of the thirteenth century are based on the simple ratios of the musical consonances that also determine Gothic music. This affinity between architecture and music was an esthetic truism to an age which perceived in the "science" of music the all-embracing principle of the universe. Abbot Suger, in the opening passages of his treatise on the consecration of the church, describes the universe as a symphonic composition in terms strikingly similar to those used by Alanus ab Insulis in the

passage on the work of the divine architect. Suger invokes this vision as the sublime prototype of the sanctuary he is going to erect. But if his musical phraseology suggests that he considered his architecture a "frozen music," musical writers of the High Middle Ages, conversely, compare musical composition to architecture.

To sum up: the metaphysics of "measure and number" explains the design as well as the symbolic significance of the cathedral and influenced architectural procedure itself. The observation of geometrical canons was imposed by an endeavor that had less to do with artistic invention than with science (as these terms are understood today). Designed in an attempt to reproduce the structure of the universe—not unlike the great scientific experiments of our time in this respect—the cathedral is perhaps best understood as a "model" of the medieval universe. It is the theological transparency of this universe that transformed the model into a symbol.

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1. H. Sedlmayr, *Die Entstehung der Kathedrale*, Zuerich, 1950. See my review in *Kunstchronik*, IV, 1951, pp. 78 ff.

2. The Book of Revelation is neither the only source on which the Middle Ages based their eschatological vision, nor is Gothic architecture a better monumental "illustration" of that source than other styles. The temple of Solomon, especially as described by Ezekiel, probably influenced ecclesiastical symbolism as much as did St. John's description of the Heavenly City. And if a contemporary writer compares the Romanesque *Trinité* of Fécamp to the celestial Jerusalem, the sanctuary evokes for him the splendor of the biblical vision by means very different from those of the Gothic design and yet quite as effective. See V. Mortet, *Recueil de Textes*, I (Paris, 1911), p. 345.

3. See the remarks of F. Bond, *Introd. to Engl. Church Arch.*, I (London, 1913), p. 321 on French and English methods of web filling.

4. See J. Bony, *French Cathedrals* (Boston, 1951), pp. 9 ff., who defines Gothic "functionalism" much as I do.

5. Cf. esp. W. Ueberwasser, "Nach rechtem Maasz," *Jahrb. d. preuss. Kunstsgn.*, 56, 1935, and P. Frankl, "The Secret of The Medieval Masons," *Art Bulletin*, 27, 1945.

6. The most exact measurements of Chartres Cathedral are still those given by Lassus, *Monographie de la Cath. de Chartres* (Paris, 1867). Measurements vary from bay to bay and the proportions given above are but approximations. Variations seem to be due partly to changes of plan and considerations imposed by

the earlier building, and partly to the rather crude methods of setting out—by means of pegs and strings—employed by the medieval builder. See now J. Harvey, *The Gothic World* (London, 1950), pp. 16 ff. and L. F. Salzman, *Building in England* (Oxford, 1952), p. 17.

7. *Gothic Architecture and Scholasticism*, Latrobe, 1951, pp. 74 ff.; Panofsky's analysis of the elevation of Chartres is illuminating even if one does not accept the author's interpretation.

8. See O. Kletzl, *Planfragmente aus d.d. Dombauhütte von Prag* (Stuttgart, 1939), pp. 19 f.

9. *Annali della Fabbrica del Duomo di Milano* (Milan, 1877-85), esp. I, pp. 68 ff. and 209 f. The best discussion of the subject is that of J. S. Ackerman, "Ars sine scientia nihil est," *Art Bull.* 31, 1949.

10. The first comprehensive interpretation of the esthetic system inherent in the thought of the school of Chartres we owe to E. de Bruyne, *Études d'Esthétique médiévale* (Bruges, 1946), II, pp. 255 ff.

11. See F. M. Cornford, *Plato's Cosmology* (London, 1948), pp. 59 ff.

12. "The term 'architect' in the Middle Ages," *Speculum*, 17, 1942. On the entire question see now the very sensible remarks of Salzman, *I. c.* pp. 1 ff.

13. See M. F. Bukofzer, "Speculative thinking in medieval music," *Speculum*, 17, 1942, and L. Spitzer, "Classical and Christian ideas of world harmony," *Traditio*, II, 1944, and III, 1945.