

Notre-Dame of Paris and the Anticipation of Gothic

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In his *Entretiens sur l'architecture* Eugène-Emmanuel Viollet-le-Duc presented four schematic plans that, seen in sequence, project a dynamic theory of medieval architecture (Fig. 1).¹ In the first plan two parallel lines of small circles run inside two continuous bands; one is invited to think of the slender columns and thin outer walls of a wooden-roofed Roman or Early Christian basilica. In the second (hypothetical) basilica the weight and thrust of masonry vaults has necessitated thickened walls and supports. In the third, the vaults are supported by compound piers and thick exterior walls reinforced with buttresses.² In relation to these three paper “edifices,” expressing the first millennium of ecclesiastical architecture, the fourth is seen to be radically different. It is as if the exterior wall had been broken into segments and each segment rotated through ninety degrees to provide the potential for a series of rigid external props capable of bearing arched struts (flying buttresses) to receive the lateral thrust of high vaults. Thanks to the inherent strength and rigidity of this exterior space frame the designer of the fourth “edifice” could deploy relatively slender supports in the main arcade, referring back to the first “edifice.” The result was the potential for a kind of sleight of hand or deception—a tall, fully vaulted superstructure that could be supported (apparently) on slender interior supports. This was truly a revolution in the art of building.³ It was a revolution that depended on foresight, or *anticipation*. Thus, the structural requirements of the superstructure are anticipated by the radically new forms of the infrastructure.⁴

In his *Dictionnaire raisonné de l'architecture française du XIe au XVIe siècle* Viollet-le-Duc explained that it was in the twelfth-century nave of Notre-Dame of Paris that this radical change took place (Fig. 2).⁵ Most important for Viollet-le-Duc were the revolutionary aspects of the monument: “The Romanesque tradition of construction is already completely abandoned in the cathedral of Paris at the end of the twelfth century: there is nothing left but supports and arches. The rib-vaulted system of construction is frankly inscribed in this remarkable monument.”⁶ Viollet-le-Duc believed that the builders of Notre-Dame were men capable of taking a great leap and radically rethinking the principles of architectural design held by their contemporaries and predecessors. Was this a conclusion that he imposed on the monument as a result of his own peculiar nineteenth-century mentality and his chauvinistic assessment of *la génie française*? Was it a shrewd political strategy to exaggerate the importance of “his” monument in order to assure a generous flow of funds for the enormously expensive campaigns of restoration—work from which he himself gained directly? These are certainly the potential solutions favored by our own deconstructive climate of thought.

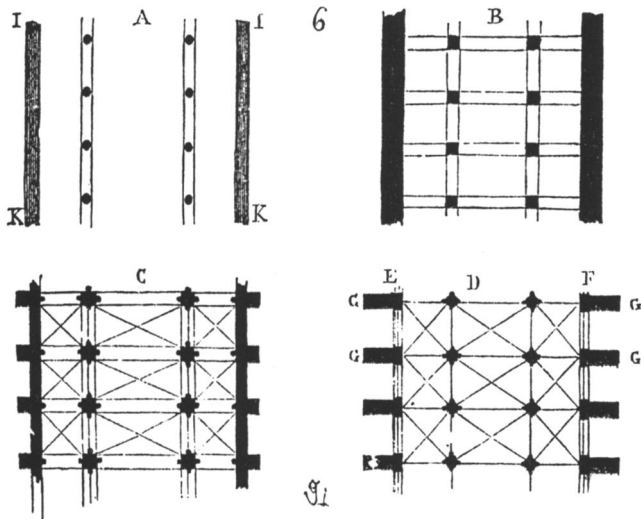
Recent scholarship, while refraining from any direct engage-

ment with the archaeological data underlying Viollet-le-Duc's understanding of Notre-Dame of Paris in the history of architecture or from any systematic review of the enormously rich historiographical documentation, has dismissed such teleological conceits, compromised, as they are, by the taint of modernism. We are told in the most recent monograph that Notre-Dame was, in fact, conceived and built entirely without flying buttresses; that flyers are not even necessary for the structural integrity of such an edifice.⁷ Flying buttresses, it is alleged, were added only in the thirteenth and fourteenth centuries—principally as a means to evacuate the rainwater from the high roof along the gutters set in their crests. The massive outer uprights of the cathedral, it is claimed, result from a later intervention. The intellectual atmosphere of our own postmodern world, generally hostile to the idea of the developmental, forward-moving dynamic inherent in Viollet-le-Duc's four-unit progression, tends to reject the idea of the “great monument” as a vehicle of change. Today's agenda tends to privilege the retrospective power of buildings, calling on us principally to identify ways in which meaning is encoded in the edifice through “quotations” of venerable prototypes known to the beholder rather than recognizing the occasional intellectual and technological leap that might allow a particular structure to be utterly different from what went before, anticipating the future.⁸

To reanimate the debate over what might, at first sight, appear to be an excessively familiar monument (Fig. 3), three strategies are here proposed. First, we must recognize the inherent slipperiness of the very architectural forms themselves. Second, an overview of existing historiographic sources will provide an archaeology of knowledge in which we can recognize a clear pattern in the range of solutions proposed over a one-hundred-and-fifty-year period. And third, a limited archaeological exercise will allow us to test existing wisdom and finally to reach surprising new conclusions.

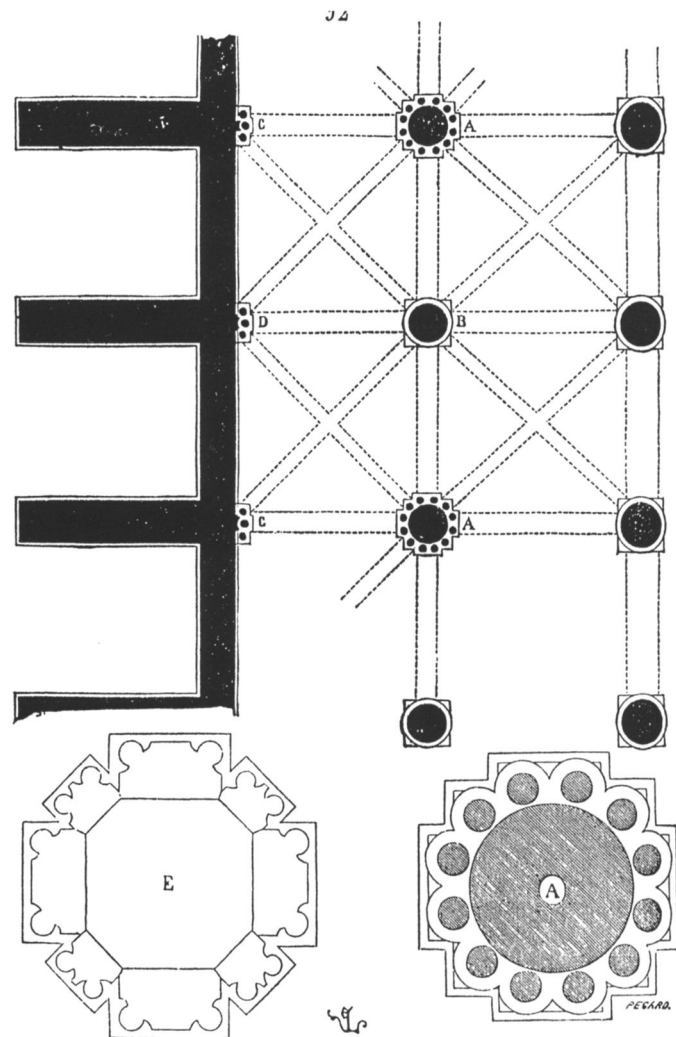
It is first necessary to own up to the difficulties (semantic; epistemological; historical; physical) involved in the definition and understanding of the architectural elements in question: the exposed external arch or “flying buttress” springing from the vertical entity that the French call a *culée*. English does not even provide appropriate language to deal with this vocabulary of support; how, without a word, can we hope to understand the thing? Whereas the French language distinguishes *contrefort* (buttress) from *culée* (upright) and *arc boutant* (flyer), in English we may apply the word *buttress* to describe the masonry spur set at ninety degrees to lend additional rigidity to the wall, or (loosely) to the entire system.⁹ There is no satisfactory English word to correspond to *culée*.

The unit in question at the Parisian cathedral begins in its lower parts as a powerful *contrefort*, absorbing the weight and



1 Eugène-Emmanuel Viollet-le-Duc, the four plans of medieval architecture, from Viollet-le-Duc, *Entretiens sur l'architecture*, vol. 1, 211

thrust of the aisle vaults (Figs. 2, 3). But then above the level of the roofs of the aisle and chapels it is projected upward as a freestanding support (*culée*) to launch a single arched strut clear across the eleven-to-twelve-meter space of the double aisles to butt against the clerestory (Figs. 4, 5). We might invoke the duality of purpose in the massive upright through the use of the descriptive phrase exterior buttress-support.¹⁰ The *contrefort* anticipates the existence of the *culée* and the flyer. This is true both physically, since the one is built on top of the other, seeming to grow out of it, and chronologically, since in any given building one was constructed before the other.¹¹ It is precisely this apparent morphology of growth, this immanent potential, that makes these units so difficult to deal with.¹² In certain critical twelfth-century churches the upper parts of the system (*culée* and flyer) have been subject to rebuilding one or more times, and only the massive lower buttress belongs to the original fabric. Does the considerable projection in the buttresses that surround the St-Denis choir, for example, *prove* that flyers were anticipated by the original designer?¹³ How can we ever be sure of our ability to read the minds of the builders? This inherent ambiguity has led to the formulation of widely divergent views on the history of the flying buttress and the architectural character of the cathedral of Notre-Dame as it was first constructed in the twelfth century.¹⁴ Certain archaeologists maintain that flying buttresses were already in use in the early twelfth century at Sens Cathedral and perhaps even at Abbot Suger's St-Denis and elsewhere (Anne Prache, Louis Grodecki, Francis Salet, Jacques Henriot, John James, Philippe Plaignieux, Caroline Bruzelius, Christopher Wilson), while others have resisted the idea that flyers were used before the construction of the nave of Notre-Dame in the period between the 1170s and the early thirteenth century (Marcel Aubert, Jean Bony, Robert Branner, William Clark, Robert Mark).¹⁵ The very existence of such a radical disagreement suggests that the grounds of the argument need to be redefined, that the debate needs to be located more clearly within the changing climate of the



2 Notre-Dame, Paris, plan of nave aisle (from Viollet-le-Duc, *Dictionnaire*, vol. 4, 166)

thought of our own time, and the monuments themselves reexamined with new questions and a new degree of rigor.

Whereas the internal supports (columns and responds) of Notre-Dame (Fig. 6) are articulated with their bases, columns, and capitals conceived according to the classical canons formed in antiquity and perpetuated and transformed through the Middle Ages, in the exterior buttress-supports of the nave, functional-looking rectangular masses elbow rudely outward and upward from the body of the edifice, dissolving its exterior mass into broken planes (Fig. 5).¹⁶ It might be concluded that whereas the force of historicism (*renovatio*) has shaped the interior of the cathedral with its overt references to the glorious Merovingian and Early Christian past, the power of modernism (*innovatio*) is everywhere triumphant in the brutal rectangular masses that march around the exterior of the edifice, breaking the silhouette into a hundred faceted surfaces.¹⁷ In the transverse section emphatic exterior verticals have been imposed on the venerable tiered triangular composition with its direct and self-conscious references to Old St. Peter's in Rome (Fig. 4).¹⁸ Is it possible that our "postmodern" age, poised at the millennium, and paradoxically timid about its own forward movement, is more comfort-



3 Notre-Dame, exterior, seen from the southeast (photo: Murray)

able with the retrospective message of the interior of Notre-Dame than with the bold modernism of the exterior?

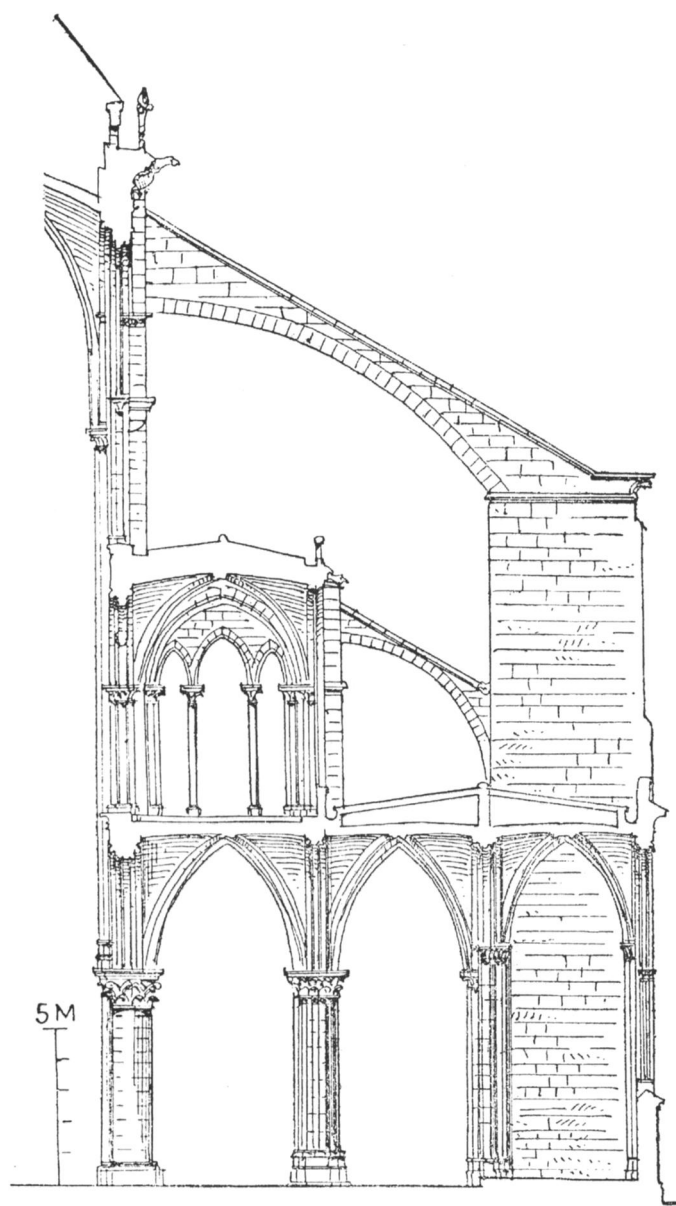
It is certainly true that historical circumstances have conspired to render the innovative exterior space frame at Notre-Dame quite invisible. Thus, in our Parisian cathedral (as also in many other churches) the generous pockets of exterior space created through the projection of the exterior buttress-supports, in the thirteenth and fourteenth centuries, have been pulled into the interior of the edifice through the construction of the lateral chapels that now lend a smooth, screenlike periphery (Fig. 7).¹⁹

Inside the cathedral one is equally unaware of the presence of the massive units, since they are perceived only as the dividing walls between chapels (Fig. 8). It is very hard to gauge their thickness or to assess the vital structural role that they play in the support of the superstructure. It is only at the level of the aisle and gallery roofs and in distant views that the role of the massive exterior buttress-supports can be appreciated (Fig. 5).

To the medieval beholder, familiar with the smooth and self-contained silhouettes of the great churches of Romanesque style, the novelty of the broken outlines and

exposed structural members that frame the sky must have been quite overwhelming—a powerful sign of the process of dynamic change that affected all aspects of contemporary life. But in light of the issues raised in recent scholarship we must finally attempt to resolve the question as to whether the image of this innovative structural envelope was, indeed, entertained by the builders who, in the mid-twelfth century, first broke ground for the choir of the Parisian cathedral, or those who continued with the nave in the second part of that century.²⁰ In laying out the foundations and lower walls, buttresses and supports, did the builders of Notre-Dame initially *anticipate* the potential of these exterior buttresses to *become* the supports that would project the flyers in their forward leap over aisle and gallery to the main vessel? Or is the entire buttressing system the result of a retrofit?

Adding an additional layer of complexity is the problem of the modifications made to the buttressing system in the nineteenth century and earlier. Our Lady of Paris is dressed in a largely modern fabric.²¹ In the middle decades of the nineteenth century the edifice was radically rebuilt (“restored” would be too mild a word) by Jean-Baptiste Lassus and Eugène-Emmanuel Viollet-le-Duc.²² Missing elements of



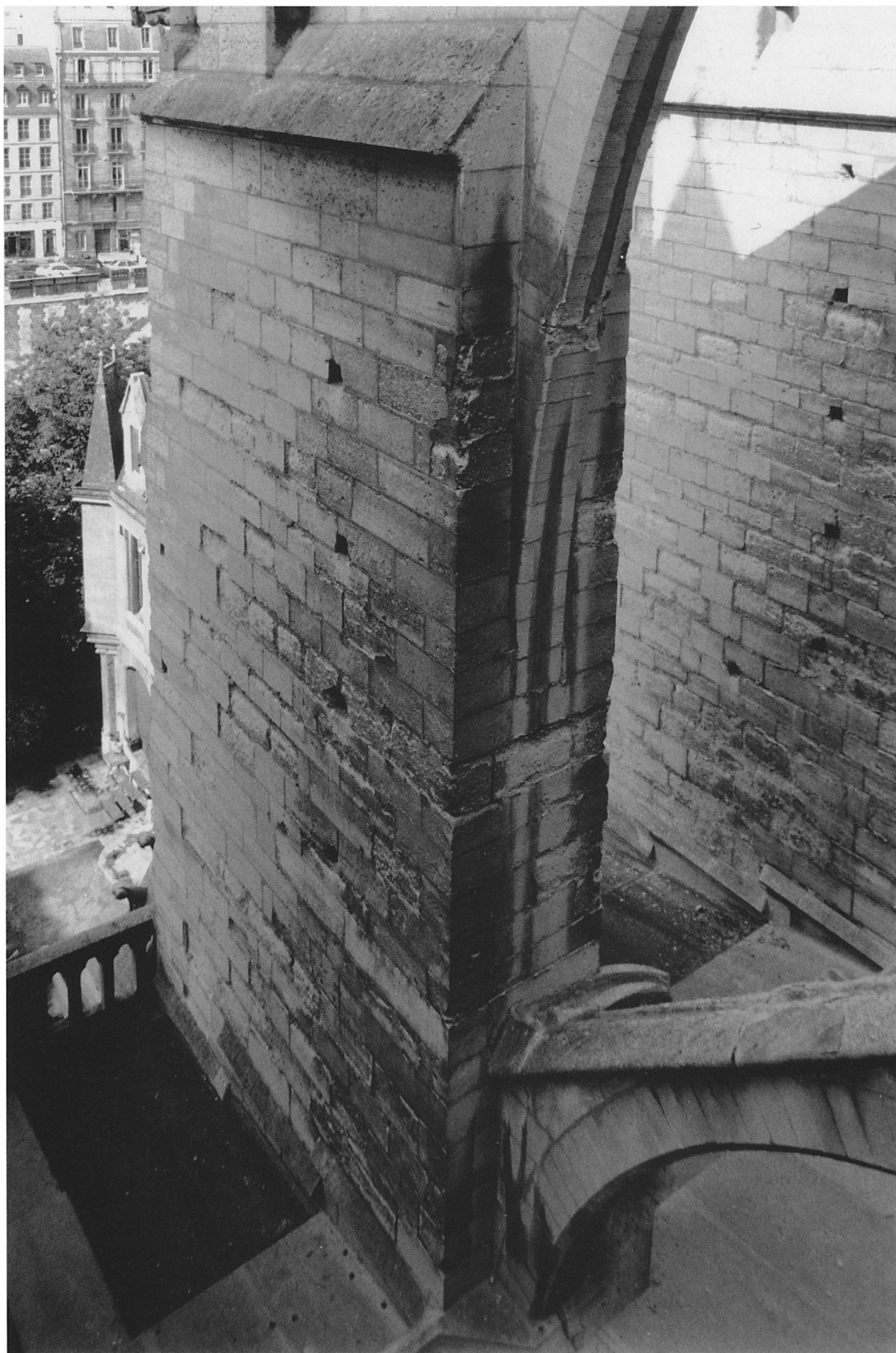
4 Notre-Dame, transverse section of nave, before the 19th-century restoration (from Aubert, *Notre-Dame de Paris*, fig. 10, after Viollet-le-Duc)

the west facade sculptural program were replaced; a new steeple constructed; a version of the “original” four-story elevation concocted in the bays around the central crossing; chapels and windows reworked; chapel and gallery vaults rebuilt; transept facades reconstructed; the interior refitted with liturgical equipment and new paint work; and, most important for the present study, the flying buttresses and uprights rebuilt with significant changes that transformed their appearance. The little tabernacles atop the great exterior buttress-supports around the nave, for example, are a fiction invented by the nineteenth-century restorers of the cathedral. Such changes are easy to spot. Far more insidious for the historian attempting to come to grips with the archaeology of the edifice is the peculiar history of the monument in the half century prior to the great restorations of Lassus and Viollet-le-Duc. In an attempt to save the disintegrating surfaces of the cathedral in the decades before

and after the French Revolution the clergy resorted to a nefarious strategy—the cladding of affected areas with a thin skin of stone attached with iron pins.²³ The new veneer did not necessarily respect the lines of the original courses of masonry. Of course, the iron pins were quickly subject to oxidization, damaging the stones of the cathedral and ultimately sloughing off the protective skin. Attempts were then made to remedy the situation through the removal of remaining elements of the veneer and the application of layers of cement and mastic.²⁴ It was even believed that this was an appropriate material for the replacement of lost sculptural details.

In response to a monument that was compromised both structurally and in its protective skin, Viollet-le-Duc and Lassus resorted to a range of different strategies, each considered appropriate in relation to the severity of the problem. The lightest treatment was brushing or scraping and repointing (*brossage, grattage, ravalement, and rejointement*). The vaults of the choir, for example, were treated in this way. The most radical was demolition and complete rebuilding, with more or less respect for the original form of the feature involved. This fate befell the exterior buttress-supports of the choir. Between the two extremes, and posing the most serious problem for the archaeologist, was the strategy termed *incrustement*—the imposition of a new surface of ashlar blocks. This was preceded by *refouillement*, or the cutting back of the old masonry surface to prepare the way for the implanting of new stones.²⁵ It is recorded that old stones were occasionally reused in the process of *incrustement*, so the analysis of a given stone in terms of whether it came from a medieval quarry will not necessarily tell us whether that area of masonry has been reworked. Of great value here are the *attachements*—the daily statements (written and graphic) made by the architects recording the materials used and the activity of the artisans.²⁶ No systematic study of this material has ever been published. In addition, we have the copious daybook of the work, “Journal rédigé par l’Inspecteur au chef des travaux de restauration de la Metropole,” now preserved in the Archives de la Bibliothèque du Patrimoine.²⁷

We thus have a paradox. This is an edifice that might lead the casual visitor or student to conclude—especially on the basis of the exterior view—that there is nothing new to be learned from this excessively familiar, substantially nineteenth-century monument.²⁸ Yet this is also an edifice where, despite a string of learned articles and a lavishly produced recent monograph, the most basic questions have gone unresolved and sharp disagreements remain. Was this an experimental and forward-looking edifice—the expression of a high level of intelligence, foresight, and ingenuity—built precisely at the time that Paris was becoming capital and France was assuming the geographical shape that it was to retain down to the present?²⁹ Or was it an ambitious but ill-conceived and conservative cathedral, devised principally as a bridge to the Merovingian and Early Christian past and serving mainly as a negative example in the forward movement of Gothic, vitally flawed in its structural envelope and demanding an expensive retrofit in later decades to correct initial errors and bring it in line with developments that were taking place elsewhere?³⁰



5 Notre-Dame, nave exterior buttress-supports (photo: Murray)



6 Notre-Dame, interior of nave
(photo: © Arch. Phot./CNMHS, Paris)

We will now track the way the cathedral has, in the eyes of its students, been radically transformed from the one to the other: from the revolutionary to the timid and reactionary.

Historiography: The “Archaeology of Knowledge”³¹

A review of the historiographical sources reveals four solutions (with variants) to the problem of reconstructing the original structural envelope of Notre-Dame.

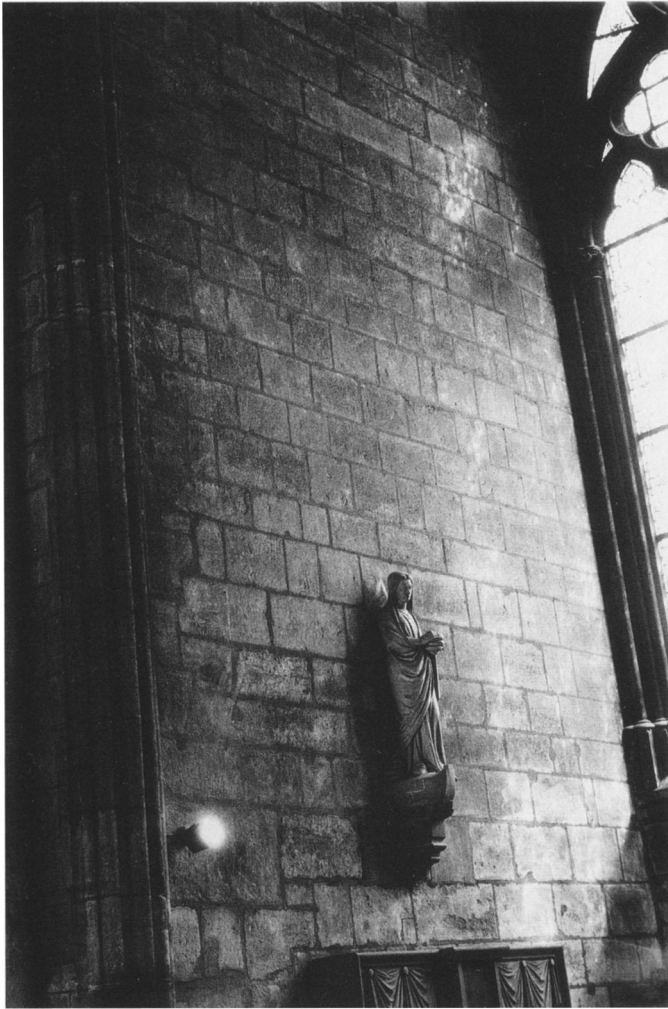
Solution 1(a): Massive exterior buttress-supports and flying buttresses pitched along a single line with an intermediary support. Just as the work of Viollet-le-Duc the restorer (working together with Lassus) has dictated the physical appearance of Notre-Dame as it actually exists, so Viollet-le-Duc the thinker has left his powerful intellectual imprint on our understanding of the great Parisian cathedral and its place in Gothic architecture. Over the years, his drawings, intended as tentative graphic projections of ideas and suppositions still in formation, have

been transformed in the mind of the public to “pictures” of the cathedral, “as it actually was.”³²

An element of the greatest importance in the new Gothic structural system was, according to Viollet-le-Duc, the massive buttress-support placed on the periphery of the edifice and intended to receive the flying buttresses that provide lateral supports for the high vaults.³³ He considered that the external buttress-supports of the nave of Notre-Dame were essentially unchanged from the twelfth century. These same units, with some surface reworking of the outer edges and weather moldings, have survived to the present day (Figs. 3, 5). The principal difference between the hypothetical original nave flying buttresses and those existing in the nineteenth century resulted, according to Viollet-le-Duc, from the thirteenth-century extension of the clerestory windows downward to invade the area between the gallery openings and window sill (Fig. 9). The oculi that had originally occupied this area were



7 Notre-Dame, exterior of nave showing chapels and buttress-supports (photo: Murray)

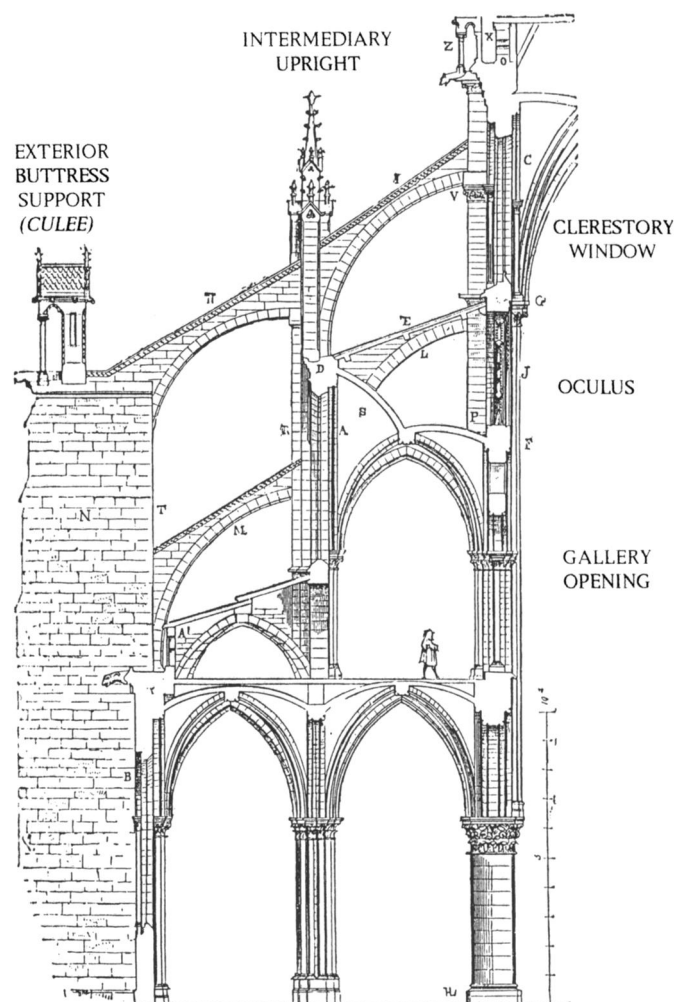


8 Notre-Dame, nave, interior walls of chapels (photo: Murray)

removed.³⁴ At the same time, he suggested, the roofs of the gallery and the gallery windows were modified, and intermediary uprights that had existed over the supports dividing the double aisles were removed. The flyers were then allegedly rebuilt to spring directly from the outer upright to the main vessel without the agency of an intermediary upright (Fig. 4).³⁵ There is an inherent assumption here that the technology necessary for the construction of a twelve-meter flyer existed only by the mid-thirteenth century and not at the end of the twelfth.

Viollet-le-Duc distinguished between the nave, where chapels were inserted between existing buttresses that already projected to the depth that they have at present (more than five meters), and the choir, where the twelfth-century buttress-supports did not project to the full depth of the existing ones but had been extended outward by about one and a half meters during the fourteenth-century work on the chapels.³⁶ At the same time (in the fourteenth century) pinnacles were added at the springing points of the choir flyers, and gabled tracery windows were inserted in the ambulatory gallery. It should be emphasized, however, that Viollet-le-Duc took no consistent position on the structural envelope of the choir, expressing different ideas at different times.³⁷

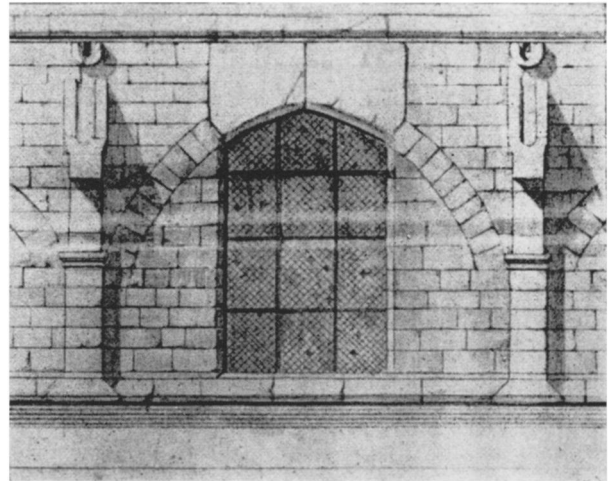
Solution 1(b): The nave with flyers; the choir without. It is principally to Marcel Aubert and to Eugène Lefèvre-Pontalis that we owe the view—dogmatically and positivistically expressed—that the choir of Notre-Dame had no flying buttresses. The former author thought that the upper choir was supported by masonry spurs (*murs boutants*) concealed under the gallery roof; the latter disagreed, insisting that no trace of such supports could be found and that support was provided originally by thick buttress strips attached to the exterior of the clerestory wall between the windows. He claimed that these heavy buttresses were reduced in thickness and in projection in the fourteenth century when the existing system of flyers was introduced.³⁸ Aubert's reconstruction of the "original" Notre-Dame choir without flying buttresses (Fig. 10) has become canonical.³⁹ In the nave, however, according to Aubert, the new flying buttress system was intended from the start.⁴⁰ Aubert accepted Viollet-le-Duc's reconstruction of the original nave and agreed with him that the existing massive exterior buttress-supports that carry the nave flyers are the original twelfth-century units.⁴¹ He developed the idea that the nave flying buttresses were placed only against alternating supports, reflecting the rhythm of the sexpartite vaults of the main vessel. The basis of this argument lies in the alternation of the aisle piers between a simple column



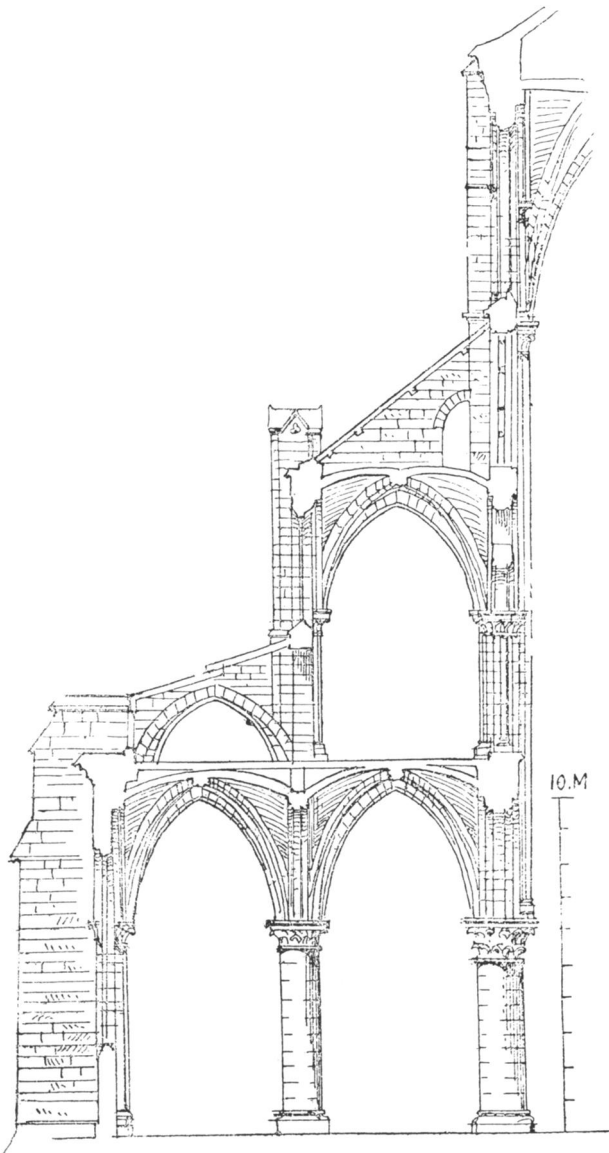
9 Notre-Dame, reconstruction of the 12th-century nave (from Viollet-le-Duc, *Dictionnaire*, vol. 2, 289)

(diameter of about 0.92 meter) and a column surrounded by twelve detached shafts. The major aisle piers, it was alleged, possessed the additional strength to allow them to carry intermediary uprights, helping to support the double-rank flyers. Aubert claimed that before the restorations of Viollet-le-Duc traces of the intermediary upright could still be seen.⁴² One can certainly see the projecting buttress strips referred to by Aubert in the drawing of the state of the gallery wall before restoration (Fig. 11). However, there is nothing to indicate that the narrow projecting strip carried an intermediary upright—in other words, that the buttress was extended upward to *become* support. Given the slipperiness of the buttress-support as defined above, it might also be seen as a simple buttress and nothing more.

Solution 2: Twelfth-century flyers resembling the present units, choir and nave. Louis Grodecki reacted strongly against the ideas of Lefèvre-Pontalis and Aubert, arguing that the Notre-Dame choir already had flying buttresses. Noting the considerable mass of the exterior buttresses around the choir (Fig.



11 Notre-Dame, drawing of the choir gallery wall before restoration (from Aubert, *Notre-Dame de Paris*, pl. IXc)



10 Notre-Dame, section of 12th-century choir (from Aubert, *Notre-Dame de Paris*, fig. 15)

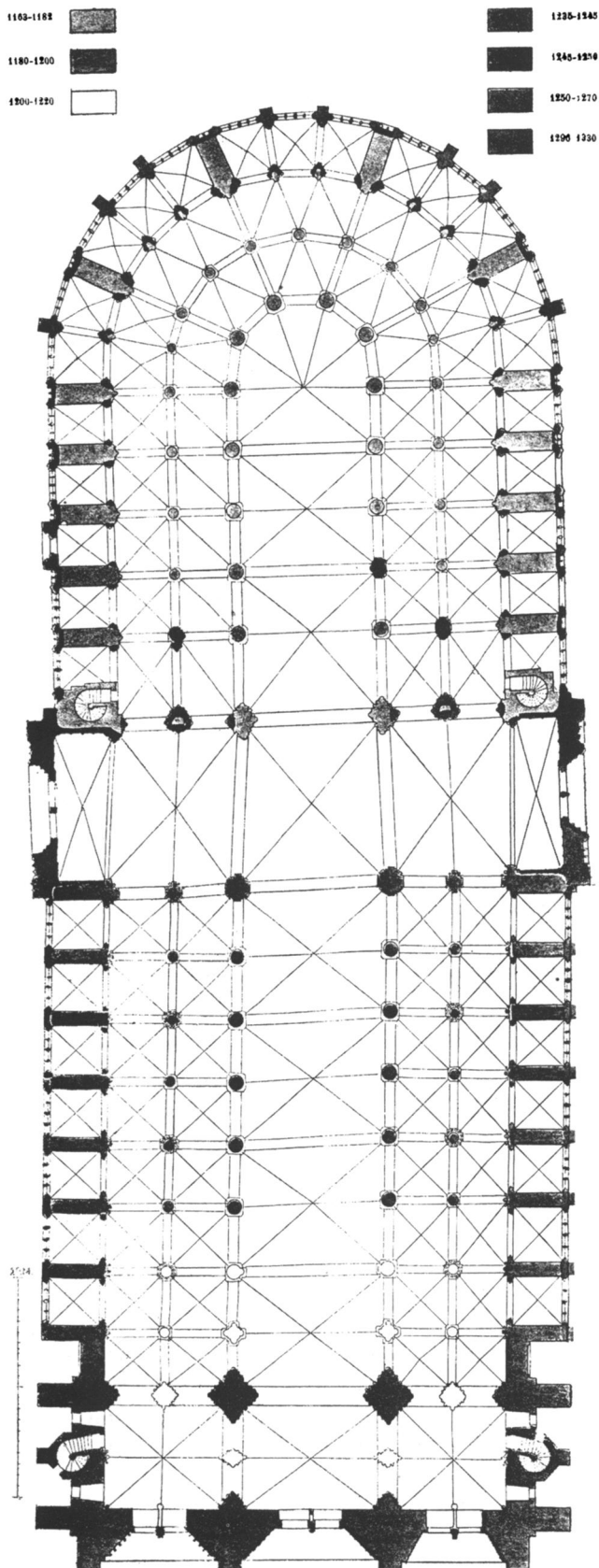
12), Grodecki suggested that they served a function that went beyond the support of the ambulatory vaults—in other words, that the builders *anticipated* flyers around the choir.⁴³ In both choir and nave Grodecki thought that the present structure resembles the twelfth-century cathedral—“the body of the work remains that of the twelfth century. . . .”⁴⁴

Grodecki’s ideas were extended and reinforced by Anne Prache, who argued that Viollet-le-Duc and Aubert were both incorrect in their understanding of the twelfth-century flying buttresses of Notre-Dame. She suggested that the original system, like the present one, already incorporated flyers that leaped over outer and inner aisles in a single arch without the intervention of intermediary uprights, much like the system in the choir of St-Remi, Reims, a monument that also contains a double aisle (Fig. 13).⁴⁵

Francis Salet’s comments on Notre-Dame were in tune with those of Grodecki and Prache.⁴⁶ Of particular interest is his emphasis on the gap in time that separated the start of work (ca. 1160) from the construction of the upper choir and high vaults (possibly in the 1180s). By this time flying buttresses were in general use.⁴⁷ In the strongest terms Salet challenged Aubert’s assumption that this one-hundred-foot-high choir was erected without the use of flyers.⁴⁸ He emphasized the extraordinary inventiveness of the architect of the nave, under construction in the 1180s at the same time that the choir vaults were being installed.⁴⁹

Solution 3(a): Double-tiered nave flyers in the form of a quarter circle (quadrant) with inner and outer units at sharply different levels. In 1962 Robert Branner addressed the structural design of the Parisian cathedral in relation to the form of the flying buttresses at Bourges Cathedral (the Gothic construction at Bourges began in the 1190s, as the Notre-Dame choir was completed and the nave was under construction).⁵⁰ Branner generally tended to understate the dependency of Bourges on the metropolitan cathedral.⁵¹ At Bourges a steeply pitched upper flyer follows a single line from the exterior buttress-support with the support of a slender intermediary placed atop the inner aisle (Fig. 14).⁵² Branner believed that the present configuration in the nave of Notre-Dame, where the flyers ascend in a single line from the exterior buttress-

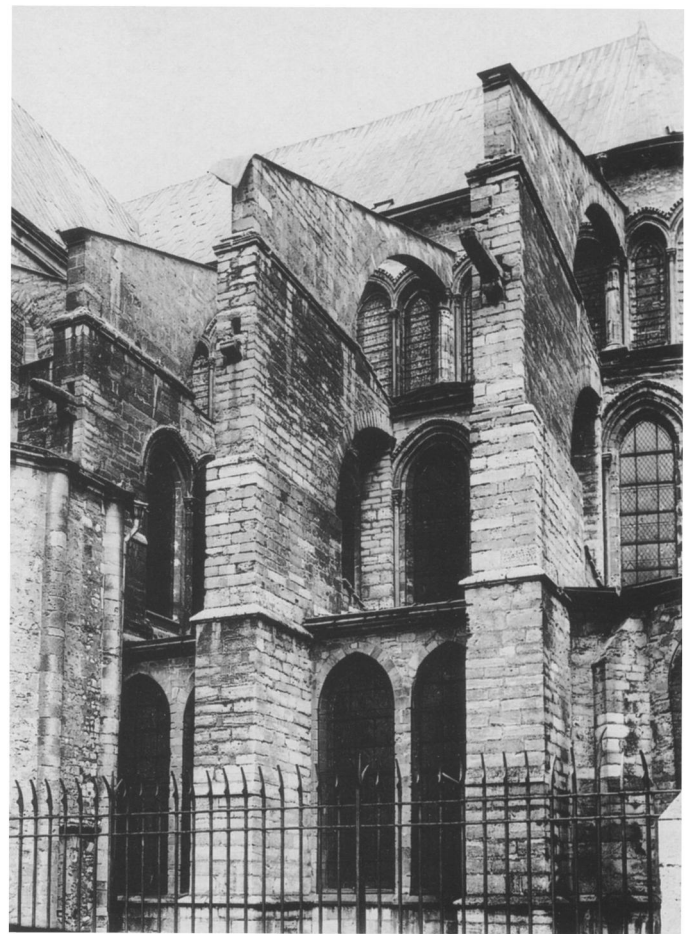
support, has nothing to do with the twelfth-century arrangement. He described the original system at Notre-Dame as having “two batteries, each containing a single flight of



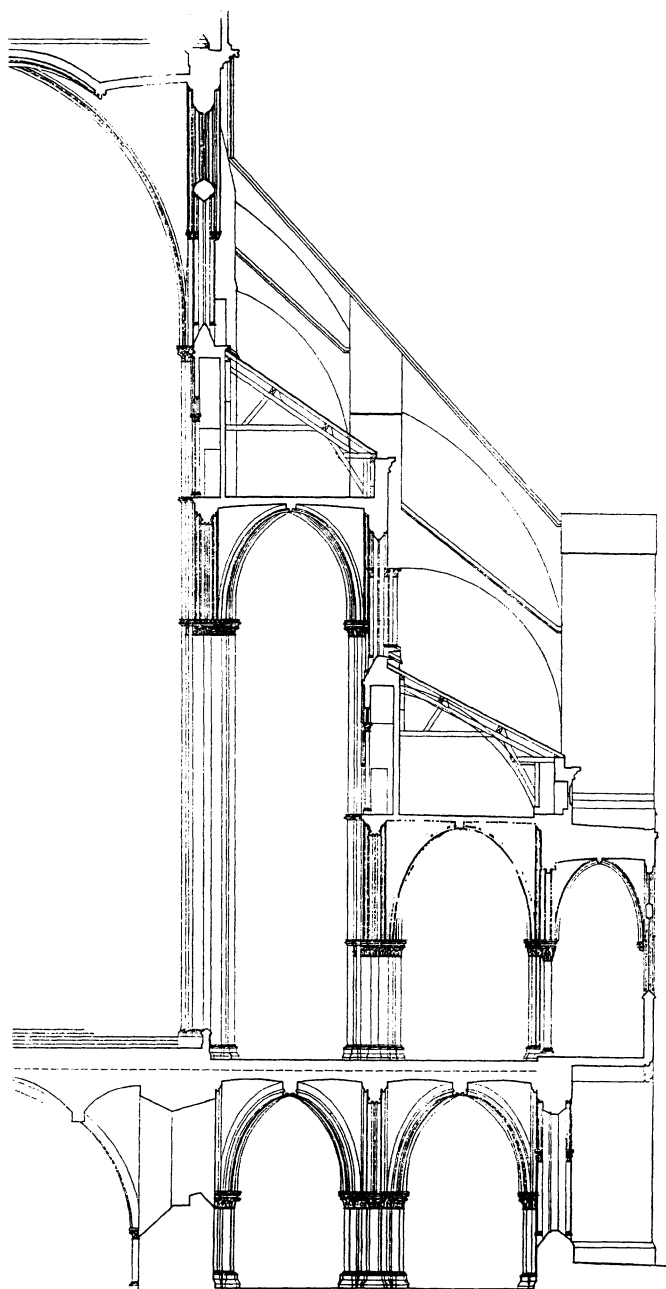
12 Notre-Dame, plan (from Aubert, *Notre-Dame de Paris*, foldout plate)

arches, but with each flight at a different level, rather than with a continuous register extending from the clearstory out to tall exterior butts. . . .”⁵³ Since the existing “tall exterior butts” at Notre-Dame were not necessary to his proposed structural system, it is not surprising to find that Branner felt free to remove them, claiming that they did not belong to the original twelfth-century structure at all and that they were merely thirteenth-century additions.⁵⁴

Robert Branner’s understanding of twelfth-century Notre-Dame was developed in consultation with Jean Bony.⁵⁵ In his 1983 book on Gothic architecture Bony argued that the clustering of so many of the monuments that incorporate early flyers (St-Germain-des-Prés, Champeaux, St-Leu d’Esserent, and so on) in and around Paris confirms that the metropolitan cathedral was “the first structure ever conceived and built with exterior flying buttresses.”⁵⁶ He accepted the thesis first proposed by Viollet-le-Duc and developed by Aubert—that the nave of Notre-Dame had alternating flyers reflecting the alternation of the aisle piers and the sexpartite vaults of the main vessel. In order to avoid the contradiction inherent in Aubert’s argument (alternating flyers; identical exterior buttresses) Bony reinvented the great external buttress-supports of the nave. Thus, his “original plan” of the cathedral shows alternating major and minor units around the edge of the cathedral (Fig. 15). They are all relatively shallow. He justified this extraordinary reworking of the

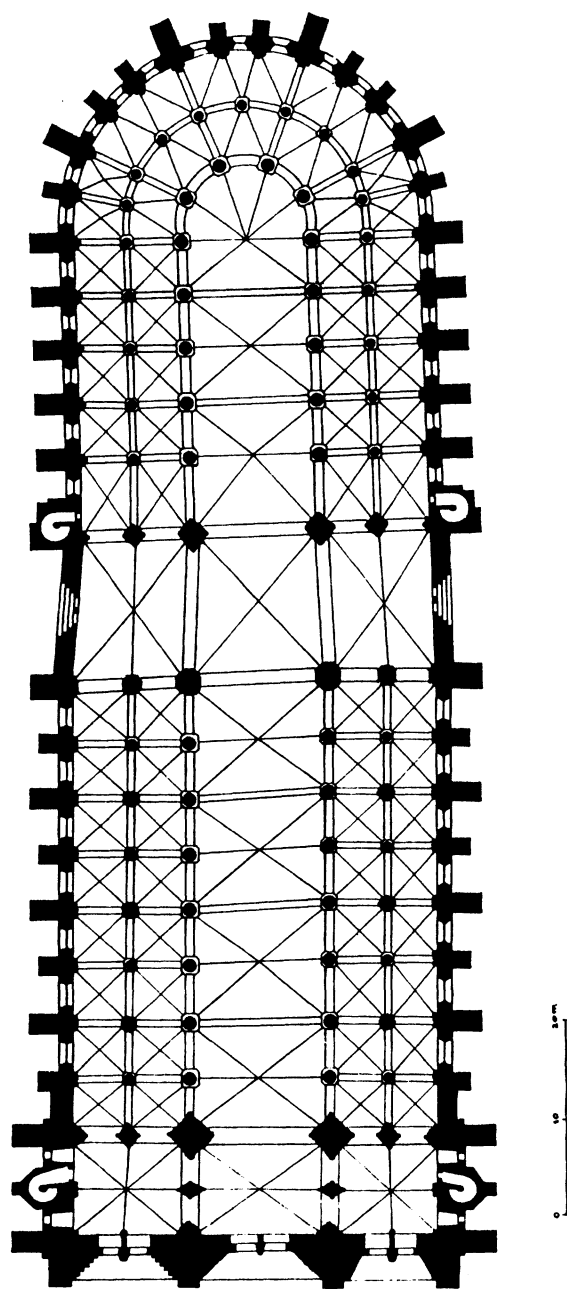


13 St-Remi, Reims, south side of choir (photo: © Eugène Lefèvre-Pontalis/Arch. Phot./CNMHS, Paris)



14 Bourges Cathedral, transverse section (from Branner, 1962)

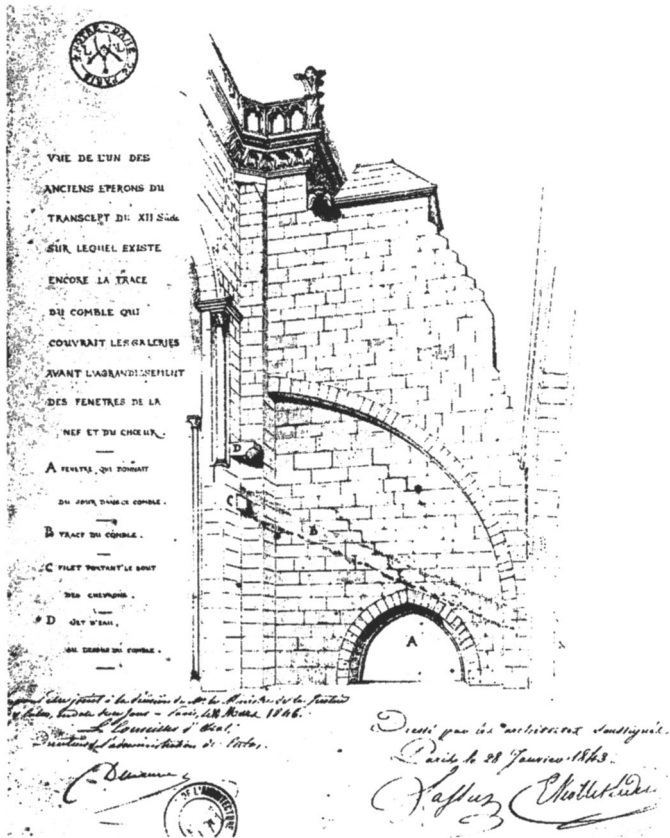
fabric of the Parisian cathedral not on the basis of an analysis of the stones but by alleging that Viollet-le-Duc's restoration had left nothing of the original twelfth-century masonry.⁵⁷ What, we might ask, of the emphatic statements made by Viollet-le-Duc and Aubert that the existing buttress-supports *are*, in fact, the original units?⁵⁸ Should we not have expected from Bony some kind of archaeological demonstration to support such a radical (hypothetical) reworking of not merely the fabric of the cathedral but also the established framework of understanding? A similar leap allowed Bony to offer a graphic reconstruction of the twelfth-century flyers in an entirely new form.⁵⁹ Among the drawings of Notre-Dame in its prerestoration state, there exists in the Bibliothèque du Patrimoine a sketch of a masonry spur situated on the west side of the south transept facade (Fig. 16).⁶⁰ The spur incorporates a relieving arch that allows the wall to be



15 Jean Bony, "original" plan of Notre-Dame (from *French Gothic Architecture*, 138, fig. 130A)

reduced in thickness in the area of the gallery window below. In the relieving arch, according to Bony, "the original angle of the buttress of the transept is preserved." Now, within the skeptical framework of the present essay, such a remark cannot be allowed to pass unchallenged. *Why*, we must demand, must such an arch attached to the south transept facade reflect the original angle of the flyers? There is, of course, no good reason at all, and the evidence should be assessed not on the basis of what it might be, but only as what it actually is—a solid spur with a relieving arch against the south transept, nothing more (Fig. 17).⁶¹

The idea of the two-tiered system was also embraced by William Clark and Robert Mark (Fig. 18).⁶² Thus, in their reconstructed nave of Notre-Dame we find a quadrant arch (forming a quarter circle) springing from a shallow exterior buttress-support, hopping over the space of the outer aisle to



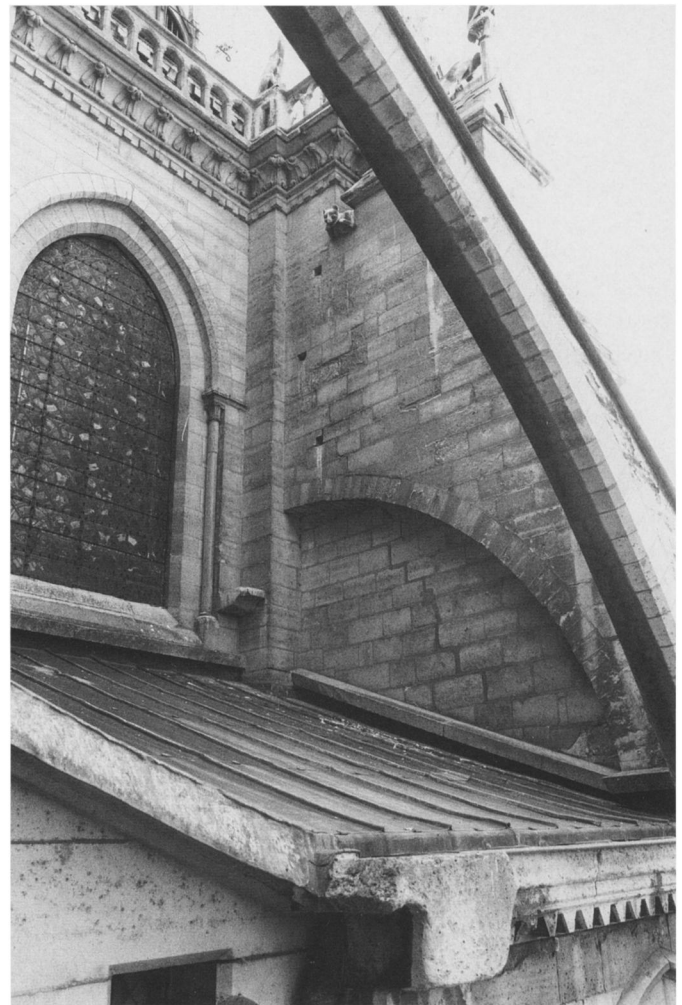
16 Notre-Dame, drawing of the spur against the south transept, Paris, Arch. Bibl. Pat., 21.701 (from Aubert, *Notre-Dame de Paris*, pl. X)

support the gallery vault. A second arch, of identical design, springs from an upright rising from gallery wall; bridging the space of the inner aisle/gallery, it butts against the clerestory.⁶³ In a structural sense, they argue, the arches would behave separately. Thus, whereas in Viollet-le-Duc's reconstruction and in the present building, the thrust of the main vault would be delivered in a single straight line to the massive exterior buttress-support, in the new reconstruction this same thrust is delivered by the inner flyer to the intermediary supports between the aisles. It should be remembered that these are slender cylindrical columns having a diameter of about 0.92 meter. They carry not only the vaults of the aisles but also the weight of the gallery above. In that it delivers the weight of the high vaults and roof to the weakest supports in the system, namely the slender intermediary piers of the aisles, the structural scheme favored by Clark and Mark is to be understood as a most defective one—indeed, the authors (for other reasons) recognize the existence of real problems in their proposed reconstruction and suggest that such problems provide the reason for the rebuilding of the structural system of Notre-Dame in the thirteenth century.⁶⁴ In other words, the structural logic of the designer of the nave of Notre-Dame was critically flawed.

The two-tiered solution to the flying buttress system of Notre-Dame was, according to Clark and Mark, deployed without anticipation—rather, “perhaps almost as an after-thought”—within the framework of the redesigned nave.⁶⁵ The form was based ultimately on the quadrant arches that

had allegedly been used under the gallery roof of the choir; thus, the invention of the flyer came within a framework of minor adjustments when an architectural element that was intended to be concealed was marshaled above the level of the gallery roof.⁶⁶ The new exposed flyers were used at two levels in the nave.⁶⁷ Clark, like Bony, had concluded that the form of the twelfth-century spur on the west side of the south transept (Fig. 16) provides a reliable indication of the shape and trajectory of the nave flyers. He thus gives us a hypothetical section much like that by Bony (Fig. 18). However, the reservations expressed above in connection with Bony's hypothesis apply equally to Clark's. It is hard to understand how such a leap could take us from a form that was exceptional at Notre-Dame (a solid spur designed to support the west flank of the transept yet reduce its thickness in order to make it lighter and avoid blocking a gallery window) to the standard and repeated forms of the flying buttresses of the nave.⁶⁸ Such hypothetical flyers would have butted against the upper wall at a relatively low level—yet we will demonstrate that the masonry of the upper piers, still apparently intact, shows no sign of their existence.

Mark and Clark invoke other archaeological “discoveries” in favor of their reconstruction. Thus, it is alleged that the massive outer buttress-supports of the nave had, in the twelfth

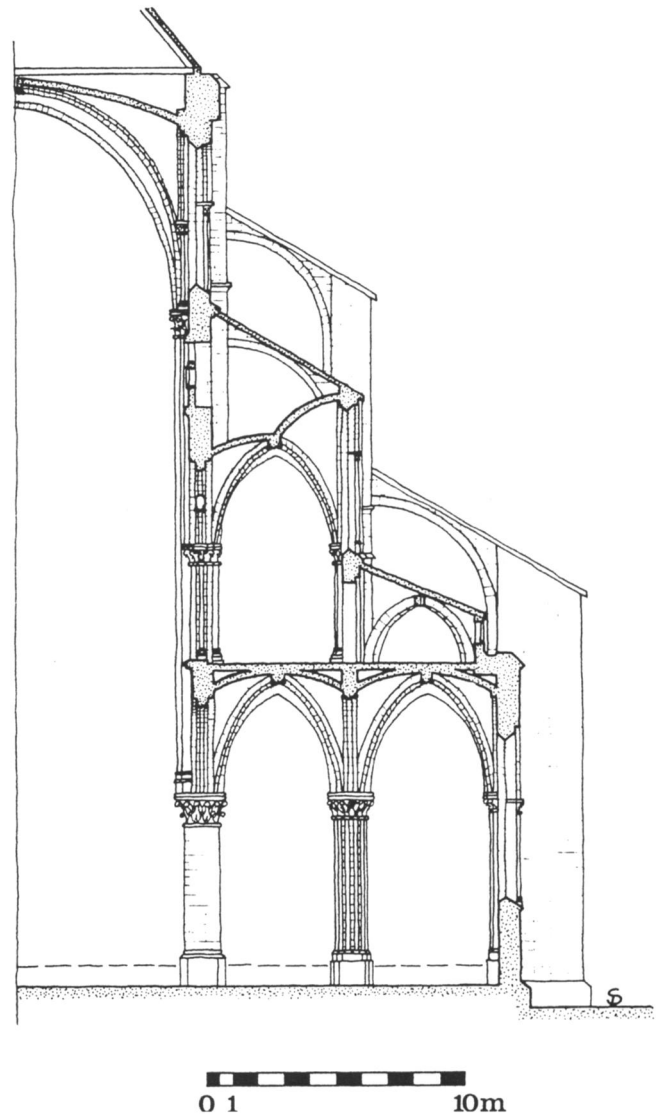


17 Notre-Dame, the existing spur against the south transept (photo: Murray)

century, only half the projection that they have today, their present mass being the result of a thirteenth-century rebuild.⁶⁹ The “proof” of this comes in Robert Branner’s recollection of a suture seen when a nave chapel wall was temporarily exposed in the 1960s.⁷⁰ Whatever Branner might have seen, the lower surfaces of the nave buttress-supports are now completely free of nineteenth-century paint and plaster and are fully visible (Fig. 8). It can be seen that twelfth-century masonry extends without break the full depth of the unit. Viollet-le-Duc and Aubert were perfectly correct in treating these units as extraordinary examples of twelfth-century constructional genius.

Like Aubert, Clark and Mark affirm that the choir of Notre-Dame had no flyers.⁷¹ However, in order to reach this conclusion the authors rely on evidence that might, in fact, be turned to support an alternative scenario. Thus, the authors observe that the twelfth-century masonry of the upper choir supports at the level of the clerestory windows, still intact, does not show signs of interruption at the points where the heads of hypothetical twelfth-century flyers met the upper wall.⁷² We will see that in this they are perfectly correct. From this observation, however, a conclusion quite different from that proposed by Clark and Mark might be reached. It might be concluded that *if* twelfth-century flyers existed *then they must have met the clerestory at the same point as the present flyers*. The other vital observation made by Clark and Mark may then be applied to the problem. The authors note that their preliminary structural analysis of the choir indicates that simple buttresses (that is, projecting strips or pilasters attached to the clerestory wall without flyers) *would not have been adequate to support the load of the high vaults and roof*.⁷³ These two most important findings—that flyers were structurally essential in the Notre-Dame choir and that twelfth-century flyers, if they existed, must have been at the same height as the existing flyers—seem to suggest that in its general lines the twelfth-century structural envelope of the choir of Notre-Dame might have resembled the present one—just as argued by Grodecki, Prache, and Salet.

Solution 3(b): The same two-tiered flyers in nave and choir. Combining rigorous and systematic empiricism with enlightened skepticism, Caroline Bruzelius provided the first extended attempt to think through what we might call “the process of becoming” associated with the construction of all parts of the Parisian cathedral.⁷⁴ Most important, she avoided the assumption that the edifice was built in a series of neat vertical slices from east to west, or that the choir was conceived and built by one master mason and the nave by another. Instead, Bruzelius hypothesizes work under way in widely separated parts of the building simultaneously, involving rapid-fire statement and response. The form of the nave was thus not the response to the completed choir but *to problems encountered and insights gained in the construction of the upper choir*. Although there will certainly continue to be quibbles about the exact role of the seven successive masters that Bruzelius finds at Notre-Dame and the extent of their work, the overall vision of an overlapping chronology is certainly the right one.⁷⁵ Thus, for Bruzelius, the outer wall of the south nave aisle was laid out while the upper choir was under construction. The radical rethinking of the structural



18 Notre-Dame, reconstruction of nave section (from Clark and Mark, “The First Flying Buttress,” Fig. 6)

envelope inherent in the nave is thus contemporaneous with the construction of the upper choir—indeed, the design of the nave resulted, to some extent, from a response to problems encountered in the construction of the upper choir. We thus rediscover the most important conclusion already anticipated by Francis Salet—that the upper choir was built by masons who were familiar with the use of the flying buttress. Would they have been led to attempt to introduce such a unit? Bruzelius concluded that this was, indeed, possible, and she projected a structural envelope for the choir with two-tiered flying buttresses very much like that envisaged by Branner, Bony, and Clark for the nave.⁷⁶ For reasons that she does not explain, Bruzelius accepts (presumably from Bony) the idea of relatively short-throw alternating exterior buttress-supports.

Solution 4: No flyers at all: neither in the nave nor in the choir. It is intriguing to find the tendency to downplay the structural innovations of Notre-Dame of Paris brought to its climax in the recent monograph by Alain Erlande-Brandenburg.⁷⁷ He finds in the choir of Notre-Dame of Paris no evidence

whatsoever to lead him to believe that flying buttresses were employed.⁷⁸ Since the high vaults of the transept have survived without flyers, then, according to this author, the choir vaults could have done the same.⁷⁹ A reconstruction drawing of the smooth outline of the twelfth-century choir of the Parisian cathedral looks somewhat like the older and much heavier church of St-Germer-de-Fly.

In the nave Erlande-Brandenburg finds only a nineteenth-century rebuild of a thirteenth-century buttressing system. He dismisses the arguments of Viollet-le-Duc for the presence of flying buttresses in the nave, concluding with the remark, "The absence of flying buttresses around the choir precludes their presence in the nave."⁸⁰ It is difficult, indeed, to know what to make of this kind of logic, and the time has probably come to return to the primary sources themselves—the stones and the written accounts left by the nineteenth-century interventions.

Primary Sources: Archaeology⁸¹

Any study of Notre-Dame of Paris that draws on the archaeological evidence must, of course, be preceded by an emphatically worded caveat—it is sometimes impossible to know whether a given area of masonry is, indeed, medieval or the result of a later intervention. Such interventions began in the Middle Ages; continuing in the postmedieval period (even in the late eighteenth and early nineteenth centuries) they reached a crescendo in the middle decades of the nineteenth century with the restoration work conducted by Viollet-le-Duc and Lassus. Fortunately, the institutional system under which these restorers worked generated copious quantities of written and graphic records. At Notre-Dame the stones of the cathedral should be read only in relation to this prolific evidence.⁸² In some instances, where demolition has entirely removed the original element, the written and graphic sources are all that are left on which to construct a paper "archaeology."

The upper parts of the buttressing system have been irretrievably changed through later interventions: there is not a single medieval flying buttress in the entire cathedral. The lower parts of the massive exterior buttress-supports, however, are still in place, and, oddly, have never been subjected to even the most rudimentary descriptive analysis.⁸³ Thus, we have seen that with more or less regard for the evidence of the monument itself students of the cathedral have felt free to reconstruct the twelfth-century exterior buttress-supports in a remarkable variety of different ways: deep (Viollet-le-Duc and Aubert); shallow (Clark and Mark); and alternating (Bony and Bruzelius). The evidence is actually still there to allow us to resolve this most important question; we do not need to rely only on affirmation and counteraffirmation or on "theoretical" assumptions about what was possible or not possible. What does the edifice itself reveal?

The Notre-Dame nave is flanked by a series of massive masonry buttress-supports, extending outward to a total depth of more than five meters from the peripheral plane originally formed by the windows and wall of the outer aisle (Fig. 8). It can be seen on Aubert's plan (Fig. 12) that similar deeply projecting buttress-supports surround the choir, but the choir buttresses are somewhat thicker than in the nave—

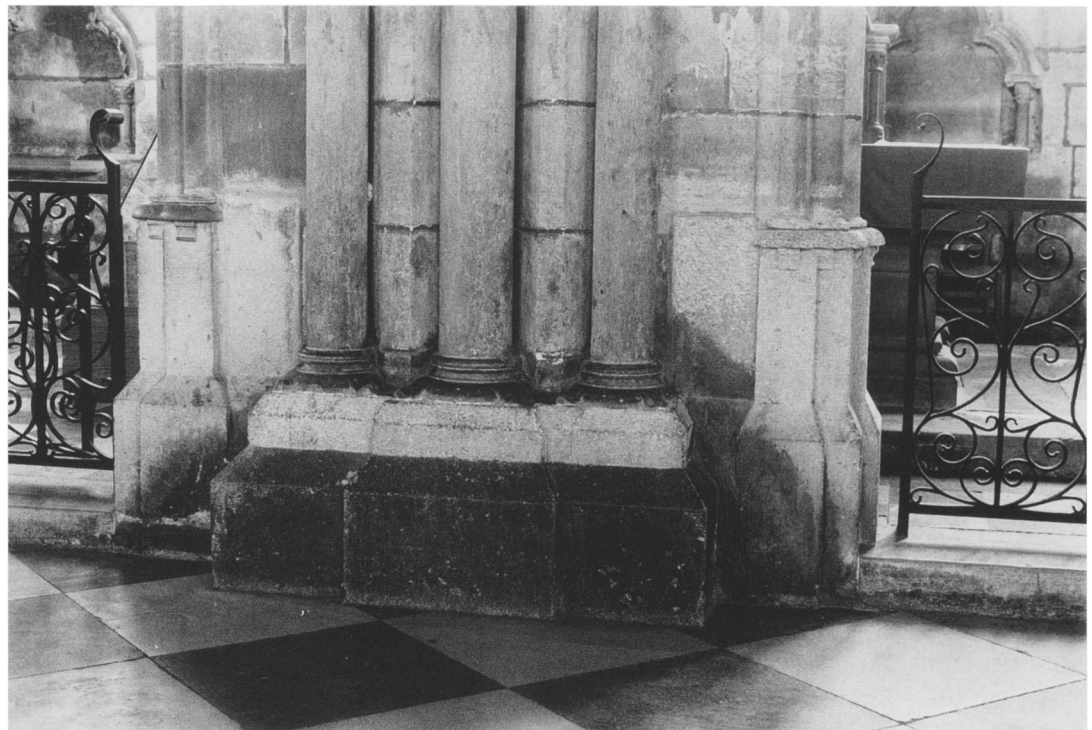
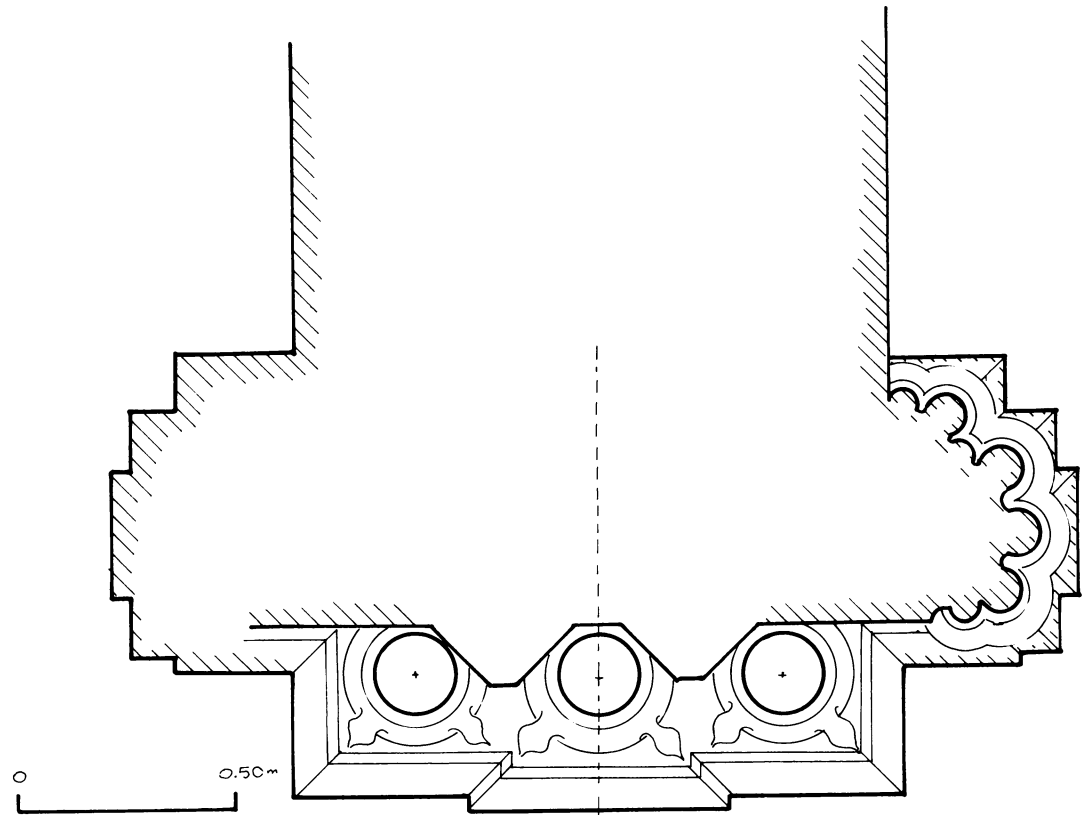
almost two meters, as opposed to about 1.34 meter in the nave.⁸⁴ We have seen that in the thirteenth and fourteenth centuries lateral chapels were inserted in the spaces between these deeply projecting buttresses. In the choir the mass of the buttresses has been skillfully concealed in the encircling screen of panels and niches and with added interior articulation.

The full lateral spread of the flank of each of these buttresses is readily visible in the nave chapels (Fig. 8). When, in the thirteenth century, the chapels were inserted between the buttresses, the builders removed the original outer aisle wall with its windows. This work of removal left ragged edges on the inner flanks of the great buttresses and in the arch that defined the outer edge of the aisle vaults. These areas were patched up and delicate bundles of colonnettes and triple-order enclosing arches were inserted to frame the aperture that would now open into the chapel (Figs. 8, 19, 20). The relationship between these shafts and the flanks of the buttresses can be understood through a study of the masonry coursing. The interrupted horizontal regularity of the stone courses indicates without doubt that the thirteenth-century bundles of colonnettes framing the chapels have, indeed, been *inserted*; the rhythm of the courses corresponds neither to the stones of the twelfth-century aisle responds nor to the flanks of the buttresses (Fig. 20).⁸⁵ The signs also suggest that this area was left relatively untouched by the regularization of the masonry associated with nineteenth-century resurfacing (*incrustement*). The horizontal lines of the coursing in the flanks of the buttresses themselves continue without any break at all to the (added) outer walls of the chapels. There are some signs that the outermost edge of some of the buttresses has been modified to facilitate the insertion of the walls and window frames of the new chapels.⁸⁶ But there is no evidence whatsoever that the buttresses were extended outward as they were, for example, at Amiens. Had this been the case we would expect to see interruptions in the horizontal coursing.⁸⁷ There is certainly no indication of an alternation in the thickness and projection of the units as postulated by Bony and Bruzelius. The appearance of the stones of the nave buttress-supports is consistent with the idea of *continuity*. It actually seems possible here to reach a firm conclusion: *as far as can be seen at the level of the nave chapels the archaeological evidence interpreted in tandem with the written and graphic sources is unambiguous in indicating that these are essentially the original twelfth-century buttresses*. Viollet-le-Duc was in a position to know more than anybody on the subject; we may accept his conclusion.⁸⁸

Above the level of the nave chapels and aisles the buttresses continue upward to form the supports of the flying buttresses (Fig. 5). There is no sign on the flanks of these supports to justify the idea that they have been extended in their projection or increased in height. It must be recognized, however, that extensive nineteenth-century resurfacing makes it very hard to reach positive conclusions here.⁸⁹ However, since the *culées* sit directly on top of a massive twelfth-century base (certainly designed to support *something*), there is no reason to doubt that they also belong to the twelfth-century construction.⁹⁰

If we may be relatively certain about the state of the exterior

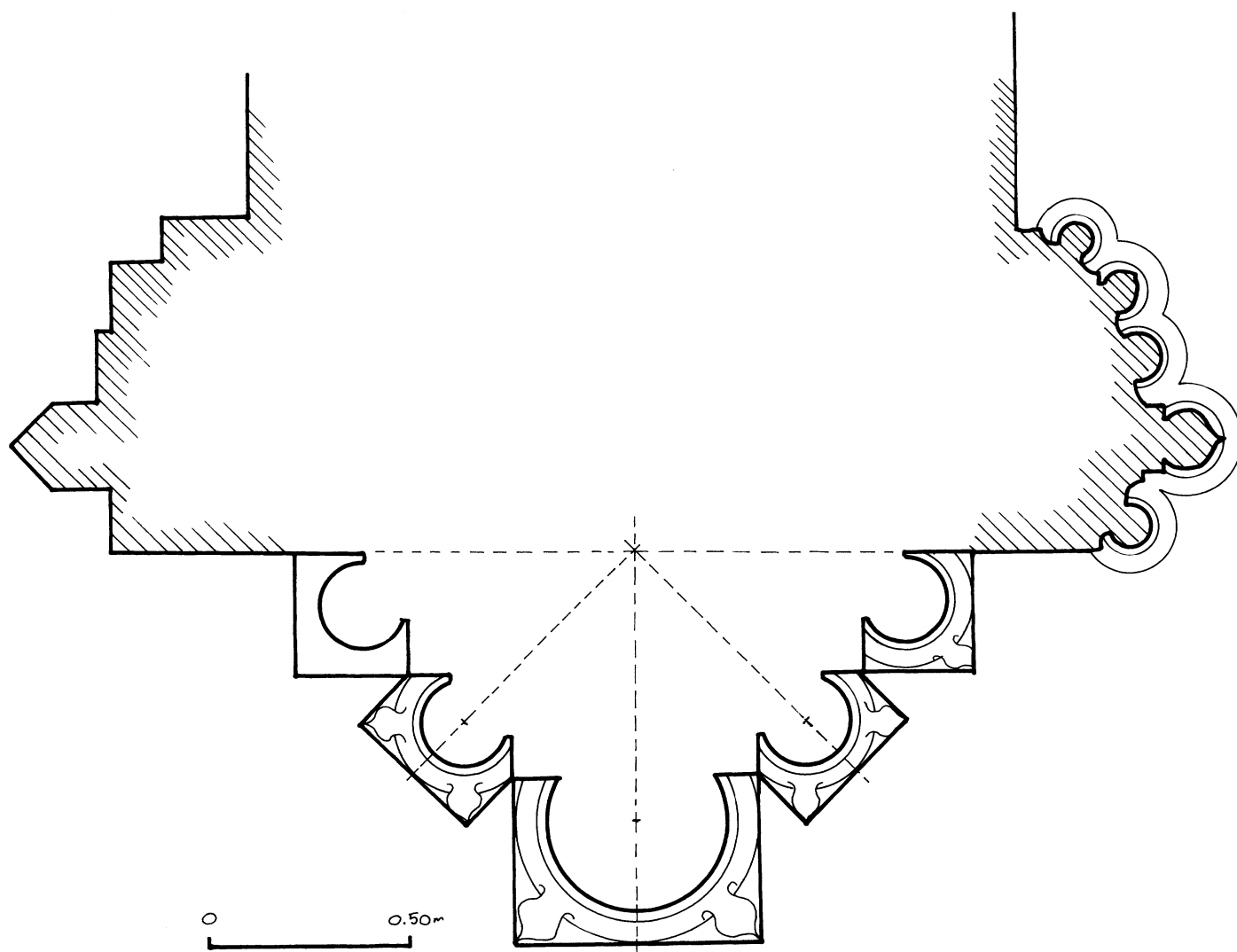
19 Notre-Dame, nave, outer aisle respond, and exterior buttress-support, plan, cross-hatching indicates 13th-century additions (drawing: Murray)



20 Notre-Dame, nave, outer aisle respond (photo: Murray)

buttress-supports of the nave, the evidence to be derived from the study of those of the choir is fraught with ambiguity. In their present form the units in question have the same projection as their nave counterparts but are in their lowest parts considerably thicker—close to two meters (Figs. 12, 21). The flanks of these buttresses, now enclosed in their lowest parts within the added chapels around the choir, are covered

with plaster and darkened paint, making it impossible to read the masonry. It is likely that the buttresses were thickened at the time the chapels were added in the late thirteenth and fourteenth centuries. This work introduced the sturdy, diagonally placed pilasters that flank the original twelfth-century responds attached to the outer aisle wall of the turning bays of the choir. The bulk of the pilasters adds considerable addi-



21 Notre-Dame, choir straight bays, outer aisle respond, and exterior buttress-support, plan, cross-hatching indicates 13th-century additions (drawing: Murray)

tional thickness to the composition. Second, we might point to the existence of a chamfered setback high up on the flanks of certain choir buttresses, a feature that suggests a gain of at least 0.20 meter in the thickness of the lower wall. And third, certain chapels have blind tracery applied to the dividing walls (that is, to the flanks of the buttresses), suggesting that the unit has been cased in a new skin of masonry in the fourteenth or nineteenth century (or both).⁹¹ Thus, the evidence will not permit us to assume that the great mass of these units in the choir belongs entirely to the twelfth-century cathedral—although the additional thickness gained by the operations described above could only have added half a meter or so to the total width of the unit. The new outer skin of stone added to the flanks of the choir buttresses prevents us from seeing the original stone surfaces or establishing visually whether the units have been extended outward. However, there is no reason to doubt the accuracy of the information supplied by Viollet-le-Duc—that the units were extended in depth by about a meter and a half at the time of the addition of the chapels.⁹²

The differences between the responds and exterior buttress-

supports of the twelfth-century choir and nave may be defined as follows. In the choir the builders relied on the massive respond itself as a structural element, projecting as it does almost a meter into the space of the outer aisle (Fig. 21). The external projection of the original buttress in the choir was less than in the nave, but with the addition of the interior respond as well as their slightly greater thickness, the units in the choir would have had an overall mass similar to their counterparts in the nave and would have provided a substantial base for the supports of a system of flying buttresses. In the nave the designers freed the outer aisle of the projecting responds with the use of three slender detached shafts set against the wall (Fig. 19).⁹³ They compensated for the loss of mass by extending the exterior buttress outward by an additional meter and a half.

Above the level of the roofs of the choir aisles and chapels the lower flyers (all of them rebuilt) that spring from the exterior buttress-supports to support the gallery wall carry a decorative band along their upper rim in the form of a series of zigzags or half lozenges (Fig. 22).⁹⁴ Such decoration, characteristic of the second half of the twelfth century,

suggests that the original units belonged to the construction period of the upper choir (ca. 1170/80s).⁹⁵ Chevron decoration is entirely absent in the thirteenth-century work on the clerestory wall—and the use of such decoration and flat-topped flyers would be quite inconceivable in the fourteenth century, the date often given to the construction of the choir flyers.⁹⁶

The main *culées* around the choir and the flyers themselves were all entirely rebuilt in the 1840s and 1850s.⁹⁷ Before the restoration work of Lassus and Viollet-le-Duc the main buttress-supports, as they rose clear away from the roofs of the aisles and chapels on the south side of the choir (extending into the axial bay of the hemicycle), had a peculiar form (Figs. 23–26). A mass of masonry articulated with a thick inner segment and a thinner portion toward the outside rose from each of the buttresses that surround the choir.⁹⁸ It is possible that these are the original twelfth-century *culées*.⁹⁹ The main mass, with its divided surface, is extended outward with a narrower strip (about 0.60 meter thick) terminating in a Y shape with diagonally placed pilasters and pinnacles (Fig. 26). This configuration fits well with Viollet-le-Duc's comment that the twelfth-century buttress-supports were extended a meter and a half outward when the chapels were added. The added spur was probably bound together with the mass of the unit by means of *insertion*—in other words, the stones of the new portion would penetrate the old, leaving a vertical strip of cement. The *attachements de maçonnerie* provide sections of the units in question (Fig. 26); I have reproduced such a section, indicating how the added spur was probably bonded into the original mass. It is apparent from the diagram that the chronological relationship between the two parts of the *culée* was susceptible to being read in two very different ways; the stones of the main mass would appear to overlay the stones of the fourteenth-century spur, making it seem as if the spur has been consolidated with a later reinforcement.¹⁰⁰ Viollet-le-Duc pointed out that the units were so massive that the thickest portions actually overhung the buttresses on which they sat. This *porte-à-faux* is a good indication that the full mass of these particular uprights had not been *anticipated* by the initial builders of the lower choir in the 1150s or 1160s. Yet the graphic evidence indicates quite clearly that each of these blocks with their thick inner part and thinner outer section formed a coherent mass of masonry, not an added overlay of an existing unit. They might, indeed, have resulted from the campaign devoted to the construction of the upper choir in 1170, or the 1180s. The superstructure of the choir provides further evidence to reinforce this possibility.

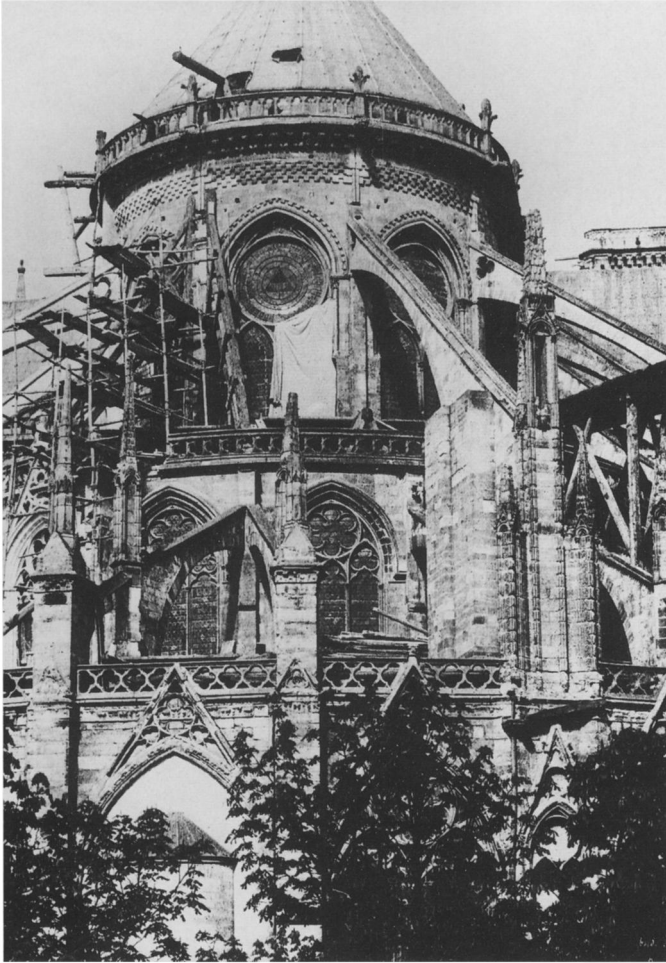
Having determined that the infrastructure of the choir as well as the nave was adequate for the task of carrying flyers, we may now turn our attention to the upper edifice with a view to testing the assumptions of the various students of the cathedral as rehearsed above. It might be as well to continue in the area of the choir.

We have seen that the flyerless state of the upper choir has been predicated on the claim made by Lefèvre-Pontalis that the original substantial buttress strips necessary to stiffen such a tall superstructure have all been removed.¹⁰¹ Let us, for a moment, consider the implications of such a supposition. Whereas most interventions in Gothic cathedrals were in-



22 Notre-Dame, choir exterior, lower flyers with chevron decoration (photo: Murray)

tended to reinforce and comfort a building in structural distress, here, it is claimed, the opposite took place. The clerestory wall of the Notre-Dame choir, unlike the clerestory walls of great thickness that supported the high vaults of flyerless edifices such as the third abbey church at Cluny or the cathedral at Speyer, is astonishingly thin (about 0.60 meter). Are we to believe that later builders actually intervened to make the structural envelope even thinner? What motive would have led them to expend resources and labor on such a hazardous and essentially useless operation? Should we not expect to see some signs of such an intervention, had it taken place? Or are we to believe that Viollet-le-Duc's restoration work has swept all such traces away? I have not found any specific mention in the *attachements* or "Journal" relating to any work on the part of Viollet-le-Duc on the pilasters of the choir clerestory, and the masonry of the clerestory wall obviously, for the most part, dates from the twelfth and thirteenth centuries.¹⁰² This can be seen from the fact that the thirteenth-century extension of the clerestory windows can still be read in the masonry without difficulty, and any nineteenth-century refacing of the clerestory would have obliterated all such signs. The slender pilasters dividing the clerestory windows (with a projection of 0.22–.23 meter and a thickness of 0.46–.47 meter) are perfectly coursed in with the



23 Henri le Secq, Notre-Dame, choir under restoration, photograph (photo: Henri le Secq/Arch. Phot./CNMHS, Paris)

wall and apparently composed of the same type of stone.¹⁰³ They seem to belong to the original twelfth-century construction and show no signs of having been refaced. With this observation we can dispel not only the idea of a fourteenth-century rebuild but also the supposition that reinforcements (*murs boutants*) existed under the old gallery roof. The same evidence precludes the possibility of low-level flyers; there is simply no mark to indicate the point where the heads of such flyers met the clerestory wall.

Further evidence suggests that prior to the mid-nineteenth-century restorations, elements of the early system of flying buttresses had survived in the choir—and that this early system bore a strong resemblance to the present one. It was seen that the flat tops and chevron decoration of the lower buttresses at gallery level in the choir (Fig. 22) may be used to date these units in the second half of the twelfth century—probably in the 1170s–1180s, but certainly not in the fourteenth century. The plaster model of the cathedral in the Centre de Recherches sur les Monuments Historiques (Palais de Chaillot), made before Viollet-le-Duc's work of restoration, shows that three of the main flyers on the south side of the choir next to the transept also had flat tops and carried the same chevron decoration (Figs. 24, 25).¹⁰⁴ Viollet-le-Duc made specific reference to these archaic-looking flyers, suggesting that they had survived from the original twelfth-century

choir construction: "Below the level of the present cornice the choir still has a wide billet molding belonging to the original construction. As for the flying buttresses, they probably resembled the two that still exist against the choir clerestory on the south side, capped with [flat] slabs decorated with slightly projecting denticulation."¹⁰⁵

It is, then, quite certain (based on evidence drawn from multiple sources) that the choir of Notre-Dame had several long-reach, high-level flyers of an archaic type (probably late twelfth century) before the restoration work of Viollet-le-Duc and Lassus. These archaic flyers sprang directly from the heavy blocks of masonry that we have described above, providing confirmation of their early date. The intuition displayed by Louis Grodecki and Anne Prache that the twelfth-century flying buttresses may have resembled the present system thus finds dramatic corroboration.¹⁰⁶

These findings can be extended from the choir into the nave. Viollet-le-Duc himself admitted that his idea of intermediary uprights in the nave flying buttress system was only a hypothesis based on what he considered "normal" in cathedrals of around 1200.¹⁰⁷ Intermediary uprights, had they existed in the Notre-Dame nave, would have been extremely tall. I have found no evidence—written or archaeological—on which to base an argument in their favor.¹⁰⁸ There is also no evidence for the existence of masonry spurs hidden under the gallery roof.¹⁰⁹ The completion of the upper nave probably continued into the first years of the thirteenth century: there is no reason to believe that a double system of flyers was first built at the end of the twelfth century to be replaced by a system resembling the present one in the second or third decade of the thirteenth century.¹¹⁰ It is more likely that the present system in the nave with its long-reach flyers reproduces the original one.

Conclusion

Certain clear conclusions are, surprisingly, possible at the end of this skeptical essay. The historiographical overview with which we began revealed four broad solutions to the problem of reconstructing the original twelfth-century structural envelope of Notre-Dame. This envelope has been understood in a range of forms, from the bold (Viollet-le-Duc; Grodecki; Prache; Salet) to the flawed (Bony; Mark and Clark) and the conservatively "serene" (Erlande-Brandenburg).

What have we learned from the building itself? When it comes to the design and chronology of the deep buttress-supports around the exterior of the nave of Notre-Dame of Paris, we may conclude, without doubt, both on the evidence of the stones themselves and from the words and graphic evidence left by the man who restored the stones, Viollet-le-Duc, that these units do, indeed, belong (with some resurfacing) to the original twelfth-century structure. These massive buttress-supports with their total projection of more than five meters were built around the nave in *anticipation* of flyers—such an outlay of material and effort would hardly have been entertained without a distinct objective within the overall structural economy of the edifice.

The original twelfth-century buttress-supports of the choir had an overall mass close to that of the units of the nave—a projection of about three and a half meters (plus an addi-



24 Plaster model of Notre-Dame (Paris, Centre de Recherches sur les Monuments Historiques, Palais de Chaillot) (photo: Murray)

tional meter for the interior respond) and a thickness of one and a half. Placed atop and overhanging these masses were even thicker supports that projected single-leap flyers to support the upper choir. It was seen that the prerestoration flyers on the south side of the choir can be dated on the basis of their archaic form to the decades between ca. 1180 and ca. 1200.

In the nave the exterior buttress-supports rise to a considerable height without any sign of breaks or additions. The height and mass of these uprights suggest that the two-tiered, short-throw solution proposed for the outer and inner flyers by Bony and Clark and Mark is less plausible than the straight-line solution originally proposed by Viollet-le-Duc and Aubert (Fig. 9) or the solution of Grodecki and Prache. In this way the height and lateral projection of the massive outer buttress-supports rendered it possible to have flying buttresses springing along a single trajectory to butt against the main vessel, thus delivering much of the weight of the main vaults directly to the exterior buttress-supports. The designers of these massive units created a solution that reconciled two potentially conflicting kinds of spatial expansion: horizontal (the five-aisled plan with relatively slender supports between the aisles) and vertical (this is the first building in northern Europe to push beyond one hundred feet in height). We have to conclude that while it is impossible, with existing evidence, to prove or disprove that

intermediary uprights existed in the nave, the building itself affords no signs of their existence, and the prerestoration graphic evidence is equally negative.

We thus reach an image of the twelfth-century structural envelope of Notre-Dame (Fig. 4) that is much more similar to the present edifice than had been realized by most recent students of the cathedral. The changes that accompanied the transition from the Notre-Dame choir to the nave were entirely in line with what we know about contemporary practice elsewhere. The steeply pitched flyers of the choir, springing from a relatively low buttress-support, resemble those of Bourges Cathedral (Fig. 14), a monument begun while the Notre-Dame nave was under construction and under its direct influence. Anne Prache has adduced the example of the choir of St-Remi of Reims, where a flyer leaps outer and inner aisles in a single bound (Fig. 13). A later example of the same kind of long-reach flyer can be found in the choir of Coutances Cathedral.¹¹¹ In the Notre-Dame upper nave, however, several decades later than the choir, we find the tendency to project the exterior buttress-supports to a greater height and to pitch the flyers less steeply—more closely resembling the solution in Reims Cathedral.

Each generation finds in the great monument an image of itself. The buoyant nineteenth century found in Notre-Dame an example of the potential power of human reason, combined with technology, to transform radically the old architect-

Uo dei contrafforti

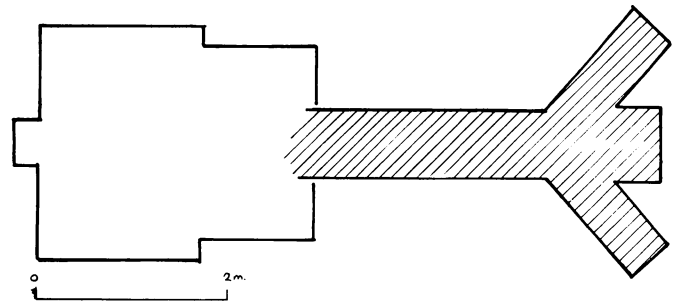


25 Plaster model of Notre-Dame, detail of south side flyers with chevron (photo: Murray)

ture. "Gothic" was hailed as a revolutionary new structural system that anticipated contemporary modernism. Our own postmodern world, on the other hand, may find in the same monument a flawed and backward-looking structure whose builders, having failed to anticipate problems resulting from poor lighting, poor drainage, and structural deformation, were forced to retrofit the cathedral in belated response.

It is hoped that this skeptical exercise in historiography and archaeology will serve to reopen the question of the twelfth-century structural frame of Notre-Dame. **We do not need to choose between the understanding of Gothic as, on the one hand, a kind of *renovatio*, or, alternatively, a kind of medieval modernism.**¹¹² **Notre-Dame of Paris projects a past (Early Christian and Merovingian) palpably and radically transformed through the technology of exposed structural supports.** The builders clearly anticipated a structure quite different from what had gone before. Their power of anticipation, expressed in the establishment of the massive outer supports that belong to the earliest phases of construction, allowed them to realize a structure that, like the art of Giotto, burst fully developed on the scene.

George Kubler taught us to understand the potential impact of human inventiveness placed within the liturgy of repetitious production.¹¹³ Just as it was difficult for the artisan to invent, so it is difficult for the historian, faced with an interrelated sequence of design solutions, often modified



26 Notre-Dame, section of *culée* (prerestoration), south side of choir, with suggested indication of junction between 12th-century and 14th-century (crosshatched) work (drawing: Murray)

through subsequent interventions, to understand the texture of the creative rhythm and ascertain the moment that the breakthrough took place. Given our hazy understanding of the dynamics of change in the architecture of the late twelfth to early thirteenth centuries, how can we be certain that what we consider possible in 1230 was not possible in 1180? There is, of course, no theoretical method for determining such things. Our understanding must be tempered by frequent and prolonged references to the buildings themselves, together with the attendant documentary sources. If our reading of the archaeology of Notre-Dame is correct, then it is in the twelfth-century Parisian cathedral (not in the later rebuild, nor at Coutances or elsewhere) that the critical paradigm shift took place.

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Notes

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1. Viollet-le-Duc, 1965, esp. vol. 1, 211–12.
2. Or deep pilasters.
3. Viollet-le-Duc, 1965, 212. For more on this revolution Viollet-le-Duc referred the reader to the article “Construction,” in his *Dictionnaire*, Viollet-le-Duc, 1854–68.
4. The idea of “anticipation” can be developed in a variety of ways. Erwin Panofsky suggested that with buildings like Notre-Dame we are at the threshold of the routine and standard use of flyers in Chartres and Bourges. Panofsky’s rejection of the conventional concept of “transition” (based, as it is, on a deterministic view of history) and his ideas on “anticipation” were summarized by Jean Bony, introduction to “The Transition from Romanesque to Gothic,” in *Romanesque and Gothic Art*, vol. 1 of *Studies in Western Art: Acts of the Twentieth International Congress of the History of Art*, ed. Millard Meiss (Princeton: Princeton University Press, 1963), 92–104. The idea of anticipation obviously might be extended to our own response to the Gothic edifice and to its eschatological powers that project us forward to the end of time and the Second Coming of Christ.
5. Viollet-le-Duc, 1854–68, esp. vol. 4, 165–66: “the vertical pillar carrying the vaults plays only a secondary role and . . . a considerable part of the weight of the vaults supported by the flying buttresses is transferred onto the exterior buttress-support (*culée*) of these flying buttresses.” Viollet-le-Duc illustrated his point with the diagram reproduced here as Fig. 2.
6. Viollet-le-Duc, 1854–68, vol. 2, s.v. “cathédrale,” 292.
7. Alain Erlande-Brandenburg, *Notre-Dame de Paris*.
8. Richard Krautheimer’s concept of the “iconography” of architecture, “The Carolingian Revival of Early Christian Architecture,” *Art Bulletin* 24 (1942): 1–38; idem, “Introduction to an ‘Iconography’ of Medieval Architecture,” *Journal of the Warburg and Courtauld Institutes* 5 (1942): 1–33, exercises an enormous power over current thinking: he was, in a sense, a harbinger of postmodernism. For an assessment of Krautheimer’s contribution, see P. Crossley, “Medieval Architecture and Meaning: The Limits of Iconography,” *Burlington Magazine* 130 (1988): 116–21. Henri Focillon, *La vie des formes* (Paris: Ernest Leroux, 1934), on the other hand, with his belief in a continuously developing, forward-moving “life of forms,” is distinctly out of favor in the current intellectual atmosphere.
9. Christopher Wilson, *The Gothic Cathedral: The Architecture of the Great Church, 1130–1530* (London: Thames and Hudson, 1990), 39, reminds us that the word *buttress* is derived from the medieval French *boterez*, from *bouter*, to thrust. Like *Strebewerk*, the word should actually designate an element that actively “butts” rather than a passive projecting strip applied to consolidate a wall. The English word counterfort is not generally used to designate such units.
10. The units at Chartres Cathedral and at Notre-Dame of Mantles actually express in their physical articulation these two distinctly different roles, one incorporated in and growing out of the other.
11. And, of course, the simple *contrefort* was in common use for centuries before the *culée* was invented.
12. The phenomenon certainly lends itself more easily to interpretations within the framework of reference provided by Henri Focillon than that of Richard Krautheimer. The idea of Gothic as an “immanent process” was developed by Paul Frankl, *Gothic Architecture* (Harmondsworth: Pelican, 1962). Existing scholarship has hardly begun to address the problem of the “iconography” of the flying buttress; see Robert Bork, Robert Mark, and Stephen Murray, “The Openwork Flyers of Amiens Cathedral: ‘Postmodern’ Gothic and the Limits of Structural Rationalism,” *Journal of the Society of Architectural Historians* 56 (1997): 478–93.
13. Wilson (as in n. 9), 39–42, fig. 28.
14. The same problems have clouded our understanding of many other edifices, including principally Sens Cathedral and St-Germain-des-Prés, Paris.
15. Bibliographic references to key sources will be provided below.
16. On the self-conscious use of the classical orders for ideological reasons in order to refer to the glorious past, see William Clark, “The Recollection of the Past Is the Promise of the Future,” Continuity and Contextuality: Saint-Denis, Merovingians, Capetians and Paris,” in *Artistic Integration in Gothic Buildings*, ed. Virginia Chieffo Ragun, Kathryn Brush and Peter Draper (Toronto: University of Toronto Press, 1995): 92–113; also John Onians, *Bearers of Meaning: The Classical Orders in Antiquity: The Middle Ages and the Renaissance* (Princeton: Princeton University Press, 1988).
17. On the idea of “modernism” in Gothic architecture, see Marvin Trachtenberg, “Gothic/Italian ‘Gothic’: Toward a Redefinition,” *Journal of the Society of Architectural Historians* 50 (1991): 22–37; and Willibald Sauerländer, “Mod Gothic,” review of *French Gothic Architecture of the 12th and 13th Centuries* by Jean Bony, *New York Review of Books* 31, no. 17 (Nov. 1984): 43–45. Of particular interest for Notre-Dame of Paris is Sauerländer’s “‘Première architecture gothique’ or ‘Renaissance of the Twelfth Century’? Changing Perspectives in the Evaluation of Architectural History,” *Sewanee Medieval*

Colloquium, Occasional Papers, vol. 2 (Sewanee, Tenn.: University Press, 1985), 25–43, esp. 36–39, where the author points out that the very tall vessel is supported not on heavy compound piers, as in so many Romanesque structures, but on cylindrical columns with a girth that is adequate in relation to the great height of the edifice. These columns “must have given the impression of a return to the original form of a basilica with columns” (36). With these columns in mind, and with no sideways look at the other parts of Notre-Dame, Sauerländer associates the Parisian cathedral with the “Renaissance of the Twelfth Century.” These thoughts are pursued by the same author in “Medieval Paris, Center of European Taste: Fame and Realities,” in *Paris, Center of Artistic Enlightenment*, Papers in Art History from the Pennsylvania State University, vol. 4 (University Park, Pa.: Pennsylvania State University, 1988), 12–45; also “Integration: A Closed or Open Proposal,” in Ragun, Brush, and Draper, eds. (as in n. 16), 3–18.

18. An equilateral triangle may be inscribed in the lateral section of the Notre-Dame nave, its base framed by the responds of the outer aisle wall and its apex at the keystone of the high vaults. These vaults match the roof of Old St. Peter’s in height; the double aisles refer to the same prototype.

19. Viollet-le-Duc suggested that one reason for the addition of the chapels was the unacceptable appearance of the exterior of the edifice; see Jean-Baptiste Lassus and Eugène-Emmanuel Viollet-le-Duc, *Monographie de Notre-Dame de Paris et de la nouvelle sacristie* (Paris, n.d.) 8: “However, [since] the flying buttresses had assumed such importance [i.e., size] at their base up to the height of the chapel roofs that they had really become walls, we may understand that churches must have then presented a disagreeable appearance from the exterior. But since, when it came to the service of God at that time of faith, the spirit of invention was certainly not lacking, the remedy was soon found through the simple addition of a screen wall, as high as the reach of a man, between each buttress [and] through the establishment of an immense bay and a vault covering the entire space up to the wall of the church (making a third level of roofs). [In this way] they not only regularized the monument, but they also gained new spaces that would be connected with the interior space, becoming the present chapels.” In an urban church the pockets of space created by the projection of the buttresses were liable to be appropriated by individuals for their own—sometimes subversive—use.

20. Although we shall, no doubt, continue to quibble over the details, the overall chronology of construction at Notre-Dame is well known; see, most recently, Erlande-Brandenburg; Clark and Mark, 47–64; Bruzelius, 540–69. The choir was begun in the late 1150s or early 1160s; the choir was vaulted toward 1180, when the nave was already begun; the west facade was built in the early to mid-13th century. We have no clear date for the completion of the upper nave; it presumably continued some way into the 13th century.

21. On the 19th-century restoration business, in general, see Jean-Michel Leniaud, *Les cathédrales au XIXe siècle* (Paris: C.N.M.H.S., 1993).

22. On the restoration of Notre-Dame in particular, see Jean-Michel Leniaud, *Jean-Baptiste Lassus (1807–1857) ou le temps retrouvé des cathédrales* (Paris: Droz, 1980); Pierre-Marie Auzas, “Viollet-le-Duc et la restauration de Notre-Dame de Paris,” in *Actes du Colloque International Viollet-le-Duc, 1980* (Paris: Nouvelles Éditions Latines, 1982), 177–84; Bruno Foucart et al., eds., *Viollet-le-Duc*, exh. cat., Galeries Nationales du Grand Palais, Paris 1980 (Paris: Réunion des Musées Nationaux, 1986), esp. 72–81; Alain Erlande-Brandenburg, “La restauration de Notre-Dame au XIXe siècle,” *Archeologia* 141 (April 1980): 26–31; Chantal Hardy, “Les roses dans l’élévation de Notre-Dame de Paris,” *Bulletin Monumental* 149 (1991): 154–99.

23. This situation is described in Jean-Baptiste Lassus and Eugène-Emmanuel Viollet-le-Duc, *Projet de restauration de Notre-Dame de Paris: Rapport adressé à M. le Ministre de la Justice et des Cultes* (Paris: Imprimerie de Mme de Lacombe, 1843), esp. 7. See also Paris, Archives Nationales (hereafter Arch. Nat.), F¹⁹ 7803.

24. Auzas (as in n. 22), 178, describes this material as a mixture including ground brick, lead oxide, and linseed oil. See especially Paris, Arch. Nat., F¹⁹ 7803 for this work. A report of 1820 specifies, “La restauration des murs des contreforts, des arcs boutants, ogives et croisées, corniches et galeries à jour au dessus les terrasses et en contrebas du grande comble . . . toute la longueur de la nef (The restoration of the walls of the buttresses [*contreforts*], the flying buttresses, ribs and windows, cornices and openwork galleries [balustrades?] above the aisle and gallery roofs [*terrasses*] and below the great roof along the entire length of the nave).” A report dated April 14, 1838, comments, “Les murs extérieurs de la Métropole de Paris ont besoin d’une restauration complète. Les parements des pierres sont rongés par le temps et les infiltrations dans les joints ont augmenté les dégradations qui cependant ne paraissent pas avoir altéré la solidité de l’édifice; des réparations faites il y a 50 ans avec des dalles de liais de 0.03m d’épaisseur n’ont pas eu du succès, par ce qu’on avait employé des goujons de fer dont l’oxidation a détruit la pierre (The exterior walls of the metropolitan [cathedral] of Paris need a complete restoration. The exterior facing [*parements*] of the stones has been eaten away by the weather and [water] infiltrations into the joints have exacerbated the damage which, however, does not yet seem to have affected the solidarity of the edifice. Repairs made fifty years ago with thin slabs [*dalles*] of limestone three centimeters in thickness have not been successful since iron pins were used and the rust has destroyed the stone).” A report of 1837 by the cathedral architect, Godde, documents the work between 1819 and 1822, including “la restauration des murs des contreforts et arcs boutants côté du Nord, à partir de la tour jusqu’au 2e contrefort du chœur, après les bras de la croix (the

restoration of the walls of the buttresses and flying buttresses on the north side from the tower up to the second buttresses of the choir after the crossing)." "D'autres restaurations ont été faites par le chapitre avant 1789 mais elles ont été plus funestes qu'utiles parce qu'elles ont été fait dans un mauvais système. Alors les pierres décomposées à leur surface extérieur ont été couvertes par des dalles de lias de 0.03 de l'épaisseur fixées au moyen de broches en fer qui bientôt se sont oxydées et elles sont tombés ou elles sont prêtes à tomber . . . (Other restorations have been made by the chapter before 1789 but they have been more destructive than useful since they followed a defective system. At that time the exterior surface of the decomposed stones was covered by thin slabs of limestone three centimeters in thickness fixed by means of iron pegs which soon rusted and have fallen or are about to fall)." The architect Godde proposed to remove the remaining elements of the old masonry skin and to cover the surfaces with *ciment de Molême et de Vassy*. In 1841 this work was begun on the western buttresses on the south side of the nave but was brought to an end in 1843.

25. This cutting back was sometimes done with a *pointon*, a mason's punch, and sometimes with a *masse*, a sledgehammer. It is to be assumed that the old stone was cut out course by course rather than taken down in entire walls at the same time. As any stone was removed the masonry above would be supported provisionally with short wooden struts. Thus, the technique of *incrusement* might be expected to respect the horizontal levels of the old courses and even, to some extent, the vertical joints.

26. Written *attachements* are to be found in Paris, Arch. Nat.; see esp. F¹⁹ 7798–7812. Graphic *attachements* are in Paris, Archives de la Bibliothèque de la Direction du Patrimoine (hereafter Arch. Bibl. Pat.), 55.760–771. See also the graphic documents belonging to the Agence Notre-Dame, now conserved in Arch. Bibl. Pat. 37.501–909.

27. The manuscript was copied in a typewritten version intended for publication by Auzas and his assistants, Paris, Arch. Bibl. Pat., Fonds Auzas, ms 471. I have made extensive use of this typewritten version.

28. The numbers of such casual visitors on summer days are said to amount to more than fifty thousand.

29. Thomas Kuhn, *The Structure of Scientific Revolutions*, 2d ed. (Chicago: University of Chicago Press, 1970), explored the power of the new paradigm to impose itself, rapidly making the old "professionalism" obsolete: see esp. 7, "a discovery like that of oxygen or X-rays does not simply add one more item to the population of the scientist's world. Ultimately it has that effect, but not until the professional community has re-evaluated traditional experimental procedures, altered its conceptions of entities with which it has long been familiar, and, in the process, shifted the network of theory through which it deals with the world." On how and when Paris became capital, see Robert-Henri Bautier, "Quand et comment Paris devint capitale," *Bulletin de la Société de l'Histoire de Paris et de l'Île-de-France* 105 (1978): 17–46, where the author identifies the critical decades precisely in the same years that the Notre-Dame choir was under construction.

30. It is to Marcel Aubert that we owe the idea of Notre-Dame as a negative example, in *Notre-Dame de Paris: Sa place dans l'histoire de l'architecture du XIII^e au XIV^e siècle*. Speaking of "serious problems" (180) and the "triumph" of the rival three-story Sens Cathedral type, he concluded, "In general, the influence of Notre-Dame is, above all, negative."

31. Of course, I do not pretend to have included here every scholar who has ever commented on the flying buttresses of Notre-Dame. The historiography of the Notre-Dame flying buttresses is characterized generally by a lack of systematic positive critical interaction. This makes it essential to attempt an overview and correlation of what has been said. I have tried to be concise and direct at the risk of sounding impatient at what I perceive as an extraordinary flight from empiricism.

32. Françoise Boudon, "Le réel et l'imaginaire chez Viollet-le-Duc: Les figures du *Dictionnaire de l'architecture*," *Revue de l'Art* 58–59 (1983): 95–114.

33. Viollet-le-Duc, 1854–68, vol. 2, s.v. "cathédrale," 288–89: "This construction, solid, ingenious and beautiful at the same time, was rendered forever stable by the enormous buttresses [*contre-forts*] . . . which alone present a considerable mass of material placed at the exterior of the edifice."

34. Geneviève Viollet-le-Duc, "Découverte par Viollet-le-Duc des roses des travées de la nef," in *Monuments Historiques*, fasc. 3 (1968): 108. The discovery is reflected in Viollet-le-Duc's shifting understanding of the Notre-Dame elevation. Thus, Viollet-le-Duc, 1854–68, vol. 1, 192–93, shows his first interpretation of the elevation with three stories; vol. 2, 289–91, reflects his exciting new discovery. Viollet-le-Duc's discovery and the problems with his restored elements have been carefully documented by Hardy (as in n. 22). Although there were many problems in the form of his reconstructed roses, Viollet-le-Duc's overall understanding of the enlargement of the clerestory was correct and may still be verified through an examination of the exterior masonry of the clerestory wall; more on this below. It would not be inappropriate here to recognize and applaud Viollet-le-Duc's role as a pioneer in the art of reading medieval masonry as a language capable of revealing the history of the monument. In a sense, he realized Victor Hugo's vision of the cathedral as a history book. However, we must recognize that this "book" is susceptible to being read in different ways.

35. Viollet-le-Duc, 1854–68, vol. 2, s.v. "cathédrale," 292. The rebuilding of the flying buttresses is attributed to damage caused by a fire and dated in the decade 1230–40. We will demonstrate that whereas the evidence for Viollet-le-

Duc's reading of the clerestory is still clearly manifest in the fabric of the cathedral, there is nothing to justify the idea of intermediary uprights.

36. *Ibid.*, 293: "In 1296 Matiffas de Bucy, bishop of Paris, began the construction of the choir chapels between the twelfth-century buttresses, going beyond them by about one and a half meters."

37. Eugène-Emmanuel Viollet-le-Duc, "De la construction des édifices religieux en France," *Annales Archéologiques* 4 (1846): 267–83, esp. 277, where the author states that the long-reach flyers of the choir were first built in the 13th century. In his *Projet de restauration . . . Rapport* (as in n. 23), on the other hand, he argued that the 12th-century choir of Notre-Dame was already equipped with long-reach flyers like the present ones; see n. 105 below.

38. Eugène Lefèvre-Pontalis, "L'origine des arcs boutants," *Congrès Archéologique* 82 (1919): 367–96, esp. 379: "Around the choir [*chevet*] of Notre-Dame of Paris, begun in 1163, the same year that the choir of Saint-Germain des Prés was dedicated, the master of the works relied upon the thickness of the walls and the old buttresses [*anciens contreforts*] to resist the thrust of the vaults, just as at Saint-Remi of Reims, where the choir was going up around 1170." Lefèvre-Pontalis could find no trace in the choir of supporting arches (*murs boutants*) concealed under the gallery roof. It should be noted that it is now believed that the choir of St-Remi of Reims did, indeed, originally have flyers. The archaeology of the Notre-Dame upper choir will be examined later.

39. Aubert, 43: "The architect who constructed the choir does not seem to have been aware of the use of flying buttresses, added at the beginning of the thirteenth century and completely rebuilt in the fourteenth century by Pierre de Chelles and his successors, Jean Ravy and Jean le Bouteiller." Or, again, p. 86: "At the date when the choir was begun it is impossible to admit that the architect could have thought of using flying buttresses." Aubert argued that the heavily domed quality of the choir vaults would exert little exterior thrust. He based his argument partly on the example of Sens Cathedral, thought at that time to have been without flyers. It now seems probable that Sens did, indeed, have flyers; see Jacques Henriët, "La cathédrale Saint-Étienne de Sens: Le parti du premier maître et les campagnes du XII^e siècle," *Bulletin Monumental* 140 (1982): 81–174. Prior to Henriët's work it had been thought that the flying buttresses at Sens had been added at the same time the clerestory was extended. Henriët's demonstration that the flyers belonged to the original 12th-century construction is convincing. We might apply the lesson learned from Sens to Notre-Dame—that the work of extending the clerestory windows did not necessarily bring reworking of the flying buttresses.

40. Aubert, 43–44: "The architect of the nave supported the vault of the central vessel with double-rank flying buttresses [*arcs boutants à double volée*] with intermediary uprights placed on the thin columns separating the double aisles, alternatively simple and reinforced, depending on whether they correspond to the intermediary transverse arch or the main transverse arch and diagonal ribs of the main [sexpartite] vault." Or again, 103: "The architect who constructed the nave of Notre-Dame, between 1180 and 1200, employed flying buttresses. . . . These flying buttresses no longer exist today, but they resembled the ones that we still see in place."

41. *Ibid.*, 105: "This flying buttress was borne up by these immense narrow piers, long and tall, surrounding the nave and erected at the same time as the nave, as is proved by the style of their moldings in the places not renewed by Viollet-le-Duc. This [architect] extended the spurs of these piers, now projecting beyond the thirteenth-century chapels, whereas formerly the wall of the chapels was on the same plane as the buttresses. He also crowned these same piers with a tabernacle [*niche*] that was not there originally."

42. *Ibid.*, 106, "Avant la restauration de Viollet-le-Duc, les traces de cette culée intermédiaire apparaissaient encore au niveau du mur des tribunes, derrière le nouveau contrefort plus étroit sur lequel on appuya au XIII^e siècle l'arc-boutant des tribunes (Before the restoration of Viollet-le-Duc, the traces of this intermediary upright [*culée intermédiaire*] could still be seen at the level of the gallery wall behind the new narrower buttress against which the flying buttress of the gallery was set in the thirteenth century)."

43. Louis Grodecki, "Les arcs boutants de la cathédrale de Strasbourg et leur origine," *Gesta* 15 (1976): 43–51, esp. 47: "the massive buttress-supports [*culées*] built already in the twelfth century around the circle of the ambulatory that serve today as divisions between the chapels must have had another function beyond that of supporting the ambulatory vaults." The "other function" would involve the support of the *culées* for flying buttresses.

44. *Ibid.*, 47. However, Grodecki refrained from any attempt to demonstrate his point with reference to the archaeology of the building itself.

45. Anne Prache, "Les arcs boutants au XII^e siècle," *Gesta* 15 (1976): 31–42, esp. 32: "Did the flying buttresses of Notre-Dame really have an intermediary upright as early as 1180? They would then have been unique of their kind. We wonder if they did not rather look like the flyers of the choir of Saint-Remi of Reims: certainly with two levels, but without any intermediary upright."

46. Francis Salet, "Notre-Dame de Paris: État présent de la recherche," *La Sauvegarde de l'Art Français* 2 (1982): 89–113.

47. Salet based his conclusion on the comment of Robert de Thorigny (1177) that the choir was complete, "excepto majori tectario." This, according to Salet, refers to the unfinished vaults.

48. Salet (as in n. 46), 100–101: "It used to be held that these vaults, thirty meters high, had been erected before the exterior flying buttress had been invented around 1180, and that the choir of Notre-Dame was one of the most remarkable realizations of a kind of 'flyerless Gothic architecture.' This supposition should be abandoned."

49. I would extend Salet's idea to the "modernistic" flat pilasters that articulate the piers on the western side of the transept. The prismatic forms of these units mimic the flat-sided buttress-supports that dominate the exterior. It is as if the reign of historicism in the interior of the edifice is being challenged by the modernistic forms of the exterior.

50. Robert Branner, *La cathédrale de Bourges, et sa place dans l'architecture gothique* (Paris: Tardy, 1962), translated as *The Cathedral of Bourges and Its Place in Gothic Architecture* (New York: Architectural History Foundation; Cambridge, Mass.: MIT Press, 1989).

51. In fact, the plans and cross sections of Bourges and Notre-Dame are closely related.

52. This upper flyer stiffens the clerestory wall; there is a lower flyer to support the high vaults. Branner proposed that the original scheme for Bourges envisaged a single flyer. He gives relatively little attention to the design of the flyers and fails to document the sequence of experimental units in the hemicycle where the upper flyer leapfrogs over the lower unit without a real intermediary upright. The arrangement is reminiscent of the flyers of St-Remi of Reims. Richard Schneider first brought my attention to the existence of experimental forms in the Bourges hemicycle.

53. Branner, 1989 (as in n. 50), 171.

54. See n. 70 below.

55. Jean Bony, *French Gothic Architecture of the 12th and 13th Centuries* (Berkeley: University of California Press, 1983). Bony had already addressed the question of the structural envelope of Notre-Dame in the memoranda presentation in German prison camp Oflag IV D, "Essai sur la spiritualité de deux cathédrales: Notre-Dame de Paris et Saint-Etienne de Bourges," *Chercher Dieu, Rencontres*, vol. 13 (Lyons: Éditions de l'Abeille, 1943), 150–67. Bony stressed the paradoxical sameness and difference of the two cathedrals, one with its spatial compartmentalization and the other with prodigious spatial unity facilitated through the bold use of flying buttresses. At this period of his life Bony was convinced that Notre-Dame was conceived and built entirely without flyers. The support of the high vaults, he affirmed, was secured through the use of spurs (*murs boutants*) concealed under the gallery roof.

56. Bony, 1983 (as in n. 55), 180.

57. *Ibid.*, 182, "The huge flying buttresses which now flank the nave of Notre-Dame date, in their present form, from Viollet-le-Duc's restoration and in the pre-restoration state, from the alterations of ca. 1230.

58. See nn. 33 and 41 above. Similarly, Bony refrained from addressing the published comments of Salet, Grodecki, and Prache.

59. It is hard to trace the exact generation of the new interpretation of the Notre-Dame structural system since Branner, who had already in 1962 published the idea, acknowledged that he had exchanged letters with Bony; see Branner, 1989 (as in n. 50), 171 n. 50, "I concur on this point with J. Bony, whose opinions are set forth in a letter to the author."

60. Paris, Arch. Bibl. Pat., 21.701, dated 1843.

61. The spur is still there and we can confirm the accuracy of Viollet-le-Duc's drawing; see Fig. 17.

62. Clark and Mark, "The First Flying Buttresses"; *idem*, "Le chevet et la nef de Notre-Dame de Paris: Une comparaison entre les premières élévations," *Journal d'Histoire de l'Architecture* 2 (1989): 69–84, esp. 70, where it is suggested that flying buttresses were added to the choir in the 13th century. These flying buttresses were, it is claimed, rebuilt in the 14th century.

63. This reconstruction has gained credence as the "orthodox" understanding; it was applied by Christopher Wilson to the choir of Notre-Dame. See Wilson (as in n. 9), fig. 41(b).

64. Clark and Mark, 63.

65. *Ibid.*, 53, "The structural changes between the choir and the nave of Notre-Dame de Paris that led, perhaps almost as an afterthought, to the creation of the exposed flying buttress, parallel the interior changes of design."

66. *Ibid.*, 53–54, "... it is impossible not to see the concealed quadrant arch above the gallery vaults as the direct source for the exposed quadrant arches, or more properly, the flying buttresses that supported the extended nave gallery wall and vaults." The arches concealed under the gallery roof certainly exist in the reconstruction drawings of Viollet-le-Duc; however, Francis Salet (as in n. 46), 102, noted that there is no evidence for the existence of *murs boutants*. This question will be pursued in the archaeological exercise below.

67. In favor of the argument that flyers appear in the upper nave but not the choir, Clark reminds us that the nave is somewhat wider than the choir; Clark and Mark, 53.

68. Clark and Mark, 55, recognize the problem: "Although this arch is the only surviving evidence of the quadrant curve of the first flyer arch at clerestory level on Notre-Dame, it is well to remember that this particular example is part of the transept terminal buttress and was never an open flyer arch [emphasis added]."

69. *Ibid.*, 54. Thus, the exterior buttress-supports are referred to as the "enormous thirteenth-century *culées*..."

70. *Ibid.*, 58 n. 34. The authors concede that they were "unable to verify it [Branner's understanding of the alleged suture in the exterior buttress-support] by direct observation and it is not found in the literature."

71. Clark and Mark, 1989 (as in n. 62), 70, 77. This conclusion is rendered more plausible by the authors' early dating of the monument, said to have been begun in 1150/55; Clark and Mark, 50; *idem*, 1989 (as in n. 62), 70; and

William Clark, "The Early Capitals of Notre-Dame de Paris," in *Tribute to Lotte Brand Philip, Art Historian and Detective* (New York, 1985), 34–42.

72. Clark and Mark, 1989 (as in n. 62), 77: "No sign on the clerestory buttresses allows us to think that they have lost their [original] exterior facing."

73. *Ibid.*, 77: "Our preliminary study of the wall structure at clerestory level suggests that simple buttresses [*contreforts*] could not have been adequate to support the principal vaults and the roof that covers them."

74. Bruzelius, 540–69.

75. Chantal Hardy (as in n. 22) has pointed out that some of the masonry forms used by Bruzelius to establish her chronology are, in fact, 19th-century inventions.

76. Bruzelius, 549–50, suggested that the master of the upper choir introduced flying buttresses, and the nave, with its walls and supports dramatically reduced in mass, was conceived from the start with flying buttresses.

77. Erlande-Brandenburg, *Notre-Dame de Paris*. It should also be remembered that Bony believed for a while that Notre-Dame was originally built entirely without flyers; see n. 55 above.

78. Erlande-Brandenburg, 74: "There is in the choir of Notre-Dame of Paris no trace of twelfth-century buttressing. Neither does Viollet-le-Duc refer to any [such trace]. Documents earlier than the restorations are no more eloquent." We will demonstrate below that in fact Viollet-le-Duc had some very specific comments on the existence of 12th-century flyers of the choir of Notre-Dame: that the existing lower flyers (against the choir gallery), although entirely rebuilt by Lassus and Viollet-le-Duc, echo the form of their 12th-century predecessors. There is, moreover, clear evidence—both graphic and written—relating to the existence of 12th-century high flyers around the choir before the restoration work of Viollet-le-Duc.

79. This argument is open to question since the transept is relatively short and receives support both from the body of the cathedral itself and the heavier masonry associated with the facades.

80. Erlande-Brandenburg, 90.

81. I am grateful to Annie Blanc, Jean-Yves Le Corre, and Veronique Gailly, who allowed me to climb onto the aisle and gallery roofs of Notre-Dame; also to Larissa Taylor, Anne Prache, Dany Sandron, Philippe Plaigieux, Paul Papillo, and Jonathan Snyder, who accompanied me at various times and who shared their ideas.

82. Of particular importance are the *attachements* in Paris, Arch. Bibl. Pat., especially 55.760–772; I am grateful to the director, M. Pariset, for allowing me access. In Paris, Arch. Nat., cartons F¹⁹ 7803–12 are of significance. Paul Papillo helped me explore the contents of these ten boxes.

83. Grodecki, to the best of my knowledge, is the only recent scholar to make vital use of these units in his argument; see n. 43 above.

84. The westernmost units in the choir appear to be thinner than the others.

85. We can still detect the thickness of the old aisle wall.

86. And here, along the outer edges adjacent to the chapel windows, are plentiful signs of 19th-century work.

87. It is quite impossible to conceive that a hypothetical 13th-century reprise of the nave buttresses would have removed the *entire* 12th-century unit leaving no sign at all. Such an operation would necessitate extraordinary measures for the provisional support of the edifice. It is certainly true that the vaults, formerets, and outer walls of the nave chapels were reworked by Viollet-le-Duc. However, the *attachements* for this work, Paris, Arch. Bibl. Pat. 55.762–764, indicate that the lateral walls of the chapels (i.e., the bases of the *culées*) were touched only lightly. This work is mentioned repeatedly in the "Journal"; see, for example, June 22, 1849, "... découverte dans la 1ère. chapelle de la nef côté sud de l'ancienne corniche du long côté du XIIe et XIIIe siècles; reprise des contreforts de ces chapelles (discovery, in the first southern nave chapel of the original 12th–13th-century longitudinal cornice; reworking of the buttresses of these chapels)." The vaults of the nave chapels were heavily reworked, June 29, 1849, "démolition des voûtes et parties refaites des premières chapelles de la nef côté sud (demolition of the vaults and portions of the first southern nave chapels redone)." Also, July 2, 1849, "continuation de la reprise des contreforts des chapelles sud (continuation of the repair of the buttresses of the southern [nave] chapels)." July 10, 1849, "continuation de la reprise des chapelles et des contreforts de la nef (façade sud) (continuation of the repair of the chapels and buttresses of the nave [southern facade])." Also on Aug. 10, 1849, "On ferme la voûte de la 1ère. chapelle sud de la nef (The vault of the first southern chapel of the nave was closed)." Aug. 24, 1849, "... suite de la construction de la voûte de la 2e chapelle (continuation of the construction of the vault of the second chapel)." Far from being *extended* in their projection, these buttresses had, according to Viollet-le-Duc, actually been cut back; see the report of 1850, Paris, Arch. Nat., F¹⁹ 7805, "Nous avons reconnu l'existence des saillies des contreforts de la nef antérieurement à la construction des chapelles bâties dans le milieu du XIIIe. siècle (We have recognized the existence of projecting buttresses in the nave before the construction of the chapels built in the middle of the thirteenth century)."

88. Had the restorer seen evidence of the extension of the nave buttresses he would certainly have recorded it in his *Projet de restauration... Rapport* (as in n. 23) or in subsequent notes, partly as a means of justifying additional expenses. In fact, Viollet-le-Duc generally took a positive pleasure in the discovery of such anomalies and in explaining them.

89. I am very grateful to Annie Blanc, who worked with me in July 1995 to gather stone samples from the flanks of the uprights on the north side of the nave. She has informed me (letter of Dec. 4, 1995) that on the south flank these buttresses were partially refaced using limestone from the Oise (Roche des Forgets) or from Yvelines (St-Nom). On the north side restorations have also taken place, but here the stone used by the 19th-century restorers came from quarries to the south of Paris (Bagneux), which had been already employed in the Middle Ages, making it difficult to distinguish between modern and ancient work. For the stone used in the construction of Notre-Dame, see Annie Blanc and Claude Lorenz, "Observations sur la nature des matériaux de la cathédrale Notre-Dame de Paris," *Gesta* 29 (1990): 132–38. The graphic *attachements* in Paris, Arch. Bibl. Pat. indicate reworking in the form of the replacement of individual stones, but certainly not a complete replacement of the surface; see, for example, Arch. Bibl. Pat., 55.760(4); 55.762(5–8). The work is documented in the "Journal"; see, for example, Aug. 2, 1849, "On reprend par incrustement les côtés des 2 contreforts de la nef sud (The flanks of two buttresses of the nave on the south side are repaired by means of refacing [*incrustement*]"); Sept. 20, 1849, "Reprise dans les 3 premiers contreforts de la nef attenants aux chapelles neuves (Repairs made in the three first buttresses of the nave adjacent to the new chapels)"; Oct. 24, 1849, "On fait les incrustements aux culées des 2 premiers contreforts de la nef côté sud. . . . (Refacing of the *culées* of the first two buttresses on the south side of the nave)"; Aug. 13, 1853, "On commence à poser les assises en glacié du 2e contrefort de la façade de la nef du côté sud (Start of work laying the courses of the weather molding of the second buttress of the southern flank of the nave)." The *culées* and clerestory on the south side of the nave were more heavily reworked than on the north. Work was proceeding on the north side in 1857: Dec. 8, "On continue la pose des clavaux du premier grand arc boutant de la nef (côté nord) (Continuation of the laying of the voussoirs of the first great flying buttress of the nave on the north side)"; Jan. 27, 1858, "On commence le ravalement des premiers contreforts de la nef nord (Continuation of the demolition of the first buttresses of the nave on the north side)"; May 8, 1858, "On commence le reprise par incrustement des 1e et 2e contreforts de la nef nord (Start of work of resurfacing [*incrustement*] of the first and second buttresses on the north side of the nave)"; Aug. 13, 1858, "On continue l'incrustement des 3 contreforts de la nef (Continuation of the resurfacing of the three buttresses of the nave)"; Dec. 23, 1858, "On poursuit la reprise en vieux matériaux des 2e et 3e arcs boutants au-dessus des bas-côtés du triforium de la nef nord ainsi que les incrustements partiels des faces latérales des contreforts (Continuation of work using old material on the second and third flying buttresses above the gallery of the nave on the north side as well as the partial resurfacing of the lateral faces of the buttresses)." It is interesting to note that the stones of the intrados of the flyers have been *let into* the existing masonry of the uprights. The date 1820 is inscribed on a stone that forms the base of one of the northern flyers of the nave (third from the transept). Since the stone bearing the date 1820 has been let into existing masonry, the surface of this buttress support must predate the 19th century.

90. As argued by Viollet-le-Duc, Aubert, Grodecki, and Prache. Bony, Clark and Mark, Bruzelius, and Erlande-Brandenburg would, on the basis of their published opinions, disagree.

91. "Journal," Mar. 9, 1847, "Continuation de la retaille des deux parements aux contreforts du XIIe siècle dans la deuxième chapelle pour loger le formeret des voûtes de cette chapelle. . . . Ordre de reprendre à partir du rez de chaussée les deux parements intérieurs des contreforts formant la chapelle sur la cour du cloître (Continuation of the recarving of the two surfaces of the twelfth-century buttresses in the second chapel in order to place the window arch [*formeret*] of the vaults of that chapel. Order to rework from the ground the two interior surfaces of the buttresses forming the chapel of the cloister courtyard)." We learn that the 12th-century walls dividing the choir chapels at the entrance to the sacristy were originally pierced by doors, Mar. 27, 1847: "Continuation de la maçonnerie qui bouche les deux portes transversant dans des contreforts du XIIe siècle dans les chapelles près du sacristie (Continuation of the masonry that fills in the two doorways penetrating the twelfth-century buttresses in the chapels next to the sacristy)."

92. Building accounts for the period 1333–40 record work on the buttress-supports of the choir; I am grateful to Michael Davis for sharing his transcripts of the accounts (Paris, Arch. Nat., LL 270) with me.

93. At first sight the design of the responds in the choir and the nave seems to be entirely different (Figs. 19, 21). It is interesting to note, however, that in both designs the center points of the shafts intended for the diagonal ribs are separated by exactly 0.85 meter. The nave master was obviously intimately familiar with the design of the choir.

94. The reconstruction of these flyers is documented in the "Journal"; see, for example, July 4, 1849, "Continuation de la démolition des petits arcs boutants du chœur (Continuation of the demolition of the little flying buttresses of the choir)." Aug. 27, 1849, "Reconstruction du 2e et 3e petits arcs boutants de la partie circulaire du chœur (Reconstruction of the second and third little flying buttresses of the turning part of the choir)."

95. The original flyers of the choir of Domont (mid-12th century) had just such a form; see Philippe Plaignieux, "Les arcs boutants du XIIe siècle de l'église de Domont," *Bulletin Monumental* 150 (1992): 209–22. The author's early dating of the flyers carries conviction, since the same form of chevron decoration is found around the body of the Domont choir itself. Similar

decoration is found around the rose windows in the Mantes gallery (Bony [as in n. 55], fig. 148), in the flyers at Champeaux and St-Leu d'Esserent, and around the windows in the choir at Larchant.

96. The 12th-century gallery flyers of the choir were probably all flat-topped: most were converted to carry gutters. The restored units preserve this diversity.

97. Restoration work on the choir flyers began with the units on the south side of the choir adjacent to the transept. A report to the Chambre des Députés dated 1845 (Paris, Arch. Nat., F¹⁹ 7805) indicates that these units were found to be in a dangerous condition. See also "Journal," April 19, 1845, which reports the discovery that one of the southern buttresses was in immediate danger of collapse. For this, see also Arch. Bibl. Pat., 2116. The written sources indicate that the old *culées* were demolished; see, for example, the "Rapport sur les Travaux" dated Dec. 15, 1850, and signed by Viollet-le-Duc (Arch. Nat., F¹⁹ 7805), "Dans le parti du chœur touchant la sacristie les contreforts se sont trouvés tellement salpêtrés par les infiltrations d'eux pluviales qu'il a été nécessaires de les reprendre depuis le sol . . . les grands arcs boutants ne pouvaient être réparés autrement qu'en les démontant et les refaisant à neuf (In the part of the choir next to the sacristy [to the south of the choir next to the transept] the buttresses were so salt-petered [*salpêtrés*] as a result of the infiltration of rainwater that it was necessary to rework them from the ground up . . . the great flying buttresses could not be repaired in any way other than demolition and complete reconstruction)." Demolition and rebuilding followed in the ensuing months; for example in Aug. 1846 we read of "la démolition de l'arc boutant ci-dessus et de la culée du contrefort (the demolition of the above-mentioned flying buttress and the *culée* of the buttress)." As this work proceeded the outer wall of the choir chapels was completely reworked and chained in with the old masonry. By Feb. 1847 work had moved to the demolition of the second buttress on the south side of the choir. This work extended into Aug. 1847, "Idem de la démolition du 2e contrefort du chœur après le transept sud. Idem de l'élévation de la tête du premier contrefort même place. Reprise du premier contrefort du 14e siècle après les chapelles neuves (Similar demolition of the second buttress of the choir after the south transept. Construction of the head of the first flying buttress in the same place. Reworking of the first fourteenth-century buttress after the new chapels)." This work on the choir flyers continued on through the events of 1848. Work included demolition and rebuilding not only of the flying buttresses but also of the *culées*. It included the *incrustement* of other *culées* of the choir. By June 1848 work included the chapels and buttresses at the west end of the south side of the nave. By the time that work was suspended temporarily in the early 1850s, the choir buttresses had been completed around the south side to the hemicycle and three bays of the south nave had been completed. In the 1850s work continued in a counterclockwise direction around the choir and advanced to the north side of the nave.

98. There is much graphic and written evidence to confirm this observation, including the pre-restoration plaster model of the cathedral in the Palais de Chaillot; the drawings of E. Leconte, *Notre-Dame de Paris* (Paris, 1841–43); the photographs of Henri Le Secq; the *Monographie* of Lassus and Viollet-le-Duc (as in n. 19); as well as Paris, Arch. Bibl. Pat., *attachements* 55.767(1, 3, 5) and 55.768(5). There are also many prints and photographs in the Cabinet des Estampes of the Bibliothèque Nationale (H33031–H34593) that record the same feature.

99. As already suggested by Caroline Bruzelius, 551. Clark and Mark, 1989 (as in n. 62), 77 and n. 27, disagree with Bruzelius, claiming that the units resulted from a later intervention. However, the two distinct lateral surfaces of the unit certainly express the idea of the buttress-support as defined earlier in this essay. Similar forms are to be found at Mantes, Chartres, and the west facades of Senlis and St-Denis. Such comparisons would suggest that the units might belong to the 1180s. In the longitudinal section by Danjoy (Paris, Arch. Bibl. Pat., 21. 698) the massive upright supporting one of the flyers of the axial bay of the choir is actually seen to extend up above the flyer—it certainly does not look like a later reinforcement.

100. This was the conclusion reached by Viollet-le-Duc in an 1850 report (Paris, Arch. Nat., F¹⁹ 7805), ". . . la réfection des grands arcs-boutants du chœur particulièrement a attiré toute notre attention. En démolissant les contremurs qui bâtis après coup sous le prétexte de maintenir les culées ne font que hâter leur destruction et masquer leur état de ruine; nous avons bientôt acquis la certitude que ces anciennes culées n'avaient pas un degré de résistance suffisant pour recevoir la poussée de ces grands arcs-boutants. Force nous a été d'employer des moyens d'étalement assez puissants pour neutraliser provisoirement la poussée des grandes voûtes de démolir les culées jusqu'au niveau de la corniche des chapelles là où la construction ancienne a conservé toute sa sûreté et de les bâtir entièrement en pierres neuves de choix posées avec le plus grand soin pour éviter un bassement (Our attention has been particularly occupied with the reworking of the great flying buttresses of the choir. As we demolished the added walls [*contremurs*] which were later built on the pretext of supporting the *culées* [but which] only hastened their destruction by masking their ruinous state, we quickly became certain that these old *culées* were entirely inadequate to receive the thrust of the great flying buttresses. We were forced to employ powerful means of support in order to neutralize provisionally the thrust of the great vaults, demolishing the *culées* down to the level of the cornice of the chapels where the old construction retained its integrity, rebuilding [the *culées*] with new high-grade stone laid up with the greatest care in order to avoid settlement)." See also Lassus and

Viollet-le-Duc (as in n. 23), 32, "Au dessus des chapelles du choeur du côté du midi et à l'abside les éperons qui reçoivent la poussée des arcs boutants ont été flanqués de lourdes constructions en maçonnerie, dans le but de les consolider. Ces placages mal combinés, portant à faux et du plus fâcheux effet, doivent être enlevés, et les éperons réparés en les renfermant dans leur ancienne épaisseur (Above the chapels of the choir on the south side and in the apse, the spurs [*éperons*] that receive the thrust of the flying buttresses have been flanked by heavy masonry constructions intended to consolidate them. These additions, poorly integrated and overhanging [the lower buttresses] in the most regrettable way, should be removed and the spurs repaired, returning them to their original thickness)." Hana Losowski also believed that the mass of the buttresses resulted from a later (18th-century) intervention, "Recherches sur l'état des fonds concernant la cathédrale de Paris et ses annexes au XIXe siècle," manuscript, 3 vols., 1983, Paris, Arch. Bibl. Pat., esp. vol. 1, "Quelques années plus tard [after the 1773 work of Boulland] on consolide les arcs-boutants du choeur en les enfermant dans une lourde maçonnerie que contrairement au but souhaité précipite leur destruction (Several years later the flying buttresses of the choir were consolidated through encasement in massive masonry that, contrary to the intended objective, accelerated their destruction)." I am grateful to Michael Davis, who brought this reference to my attention.

101. See n. 38 above.

102. This is not, of course, to say that the clerestory wall entirely escaped the attentions of Viollet-le-Duc. Thus, for example, in Paris, Arch. Bibl. Pat., 2117, devis supplémentaire, 1850, "la réparation des fenêtres du haute-choeur même côté [south] et des parements dégradés des murs dans lesquels ces fenêtres sont percés. . . . (the repair of the windows of the upper choir on the same [south] side and the damaged surfaces of the walls through which these windows are pierced)." Also, "Journal," Sept. 16, 1849, "Suite de la reprise des fenêtres hautes du choeur (Continuation of the repair work on the high windows of the choir)." Some of the work was done with a suspended platform, "Journal," June 1, 1857, "Les charpentiers commencent à poser l'échafaud en bascule destiné à faire des soubassements et appuis des fenêtres hautes du choeur [north]. . . . (The carpenters begin to place suspended scaffolding intended for the masking of the bases and sills of the high windows of the [north] choir)."

103. Stone samples gathered by Annie Blanc in June 1997 are currently under analysis.

104. This model is attributed to L.T.C. de Villepin (1843–48). However, there is also a letter dated June 15, 1846, to the Ministre d'Instruction Publique in the Arch. Bibl. Pat. mentioning the gift of models of the cathedrals of Notre-Dame, St-Omer, and the collegiate church of St-Bertin by an architect from St-Omer named M. Cardinal.

105. *Projet de restauration . . . Rapport* (as in n. 23), 12–13. The same flat-topped units are depicted in the *attachements* in Paris, Arch. Bibl. Pat., 55.767(1) and 55.767(3). The three flyers in the Notre-Dame model are remarkably similar to the nave flying buttresses at Champeaux; see Mark and Clark, fig. 20. The difference between the 12th-century units on the south flank of the choir adjacent to the south transept and the 14th-century units further to the east is recognized in an entry in the "Journal," Aug. 12, 1847, "Reprise du premier contrefort du 14e. siècle après les chapelle neuves (Repair of the first fourteenth-century buttress after the new chapels)."

106. It has long been argued that the original choir roof, constructed around 1180, was demolished when the top of the choir clerestory wall was heightened (indicated by the presence of a crocket band above the billet moldings) and a gutter system introduced; see Marcel Aubert, "La charpente de Notre-Dame," *Congrès Archéologique* 82 (1919): 397–406. Some of the timber from the choir roof has recently been subjected to dendrochronological analysis; see Georges Lambert and Virginie Chevrier, *Étude dendrochronologique: Cathédrale Notre-Dame de Paris* (Besançon: Laboratoire de Chrono-Ecologie, 1996). The authors indicate a date of about 1177 for some of the timber analyzed. Aubert had argued that the *form* of the choir roof itself suggests a date of about 1220; of course, the roof might have included reused

elements. The introduction of a high gutter may have affected the form of the flying buttresses: one of the archaic flyers on the south side seems to have had a gutter added in its crest to evacuate the water from the high roof; see Paris, Arch. Bibl. Pat., 55.767(5).

107. Paris, Arch. Bibl. Pat., 2117, letter of Oct. 16, 1849, "Il y a tout raison de croire même que les grands arcs boutants devaient autrefois se diviser en deux volées . . . et porter et bouter sur une pile . . . intermédiaire suivant ce qui est pratiqué dans la plupart des édifices du commencement du XIIIe siècle. En effet, les grands arcs boutants actuels ne se relient nullement aux grandes culées des contreforts et ont évidemment été refaits après coup. Mais ceci n'est qu'une hypothèse (There is every reason to believe that the great flying buttresses must once have been divided into ranks . . . carried and resting on an intermediary upright just like the arrangement in most structures of the beginning of the thirteenth century. Indeed, the existing great flying buttresses are not all tied into the great culées of the flying buttresses and have clearly been reworked subsequently. But this is only a hypothesis)."

108. The section of Danjoy made before the work of Viollet-le-Duc does not indicate traces of an intermediary; see Paris, Arch. Bibl. Pat., 21.661. With the help of Annie Blanc and Jonathan Snyder I was able to remove the lids from the entrances into the space between the roof terrace and the south nave gallery vaults and to confirm what is already apparent from the outside and from the written sources—that the gallery vaults and outer walls have been entirely rebuilt. The absence of such traces constitutes evidence of a negative kind; there is, however, further direct evidence that plays against the existence of intermediary flying buttress uprights in the nave. The builders of the nave have not taken care to align the intermediary columns dividing the aisles with the columns of the main arcade; the intermediary columns in the north aisle are around 0.30 meter too far to the east, and their counterparts on the south side a similar distance to the west. Flying buttresses anchored by supports on top of these misplaced intermediaries would have been seriously skewed and structurally compromised.

109. The removal of such spurs would have left telltale marks in the surfaces of the buttresses, and such marks are entirely absent. The clerestory buttress and wall on the south side still carry the moldings that mark the point where the old gallery roof met the main vessel. On this (the south) side, many of the 13th-century stones in the sides of the windows were replaced in the 19th century. The clerestory on the north side of the nave was less heavily reworked and permits a clear reading. This rules out a reconstruction of the 12th-to-early-13th-century upper nave with *murs boutants* or low-level flyers.

110. The dendrochronological dating of elements of the nave roof has been fixed at ca. 1220 although, surprisingly, some of the main ties were replaced around 1275; see Lambert and Chevrier (as in n. 106). This evidence might indicate a later date for the completion of the upper nave than had been anticipated.

111. Joel Herschmann, "The Thirteenth-Century Chevet of the Cathedral of Coutances," Ph.D. diss., New York University, 1978; idem, "The Norman Ambulatory of Le Mans Cathedral and the Chevet of the Cathedral of Coutances," *Gesta* 20 (1981): 323–32. I have proposed that the choir of Beauvais was begun with the same kind of long-reach flyers in mind; see Stephen Murray, *Beauvais Cathedral: Architecture of Transcendence* (Princeton: Princeton University Press, 1989).

112. The inherent links between the teleological and the cyclical were explored by Stephen Jay Gould, *Time's Arrow; Time's Cycle: Myth and Metaphor in the Discovery of Geological Time* (Cambridge, Mass.: Harvard University Press, 1987).

113. George Kubler, *The Shape of Time: Remarks on the History of Things* (New Haven: Yale University Press, 1962), esp. 68–69, "Thus the human situation admits invention only as a very difficult tour de force. . . . A special character of major artistic inventions resides in their apparent remoteness from what has gone before them. Useful inventions, when seen in historical sequence, show no such great leaps or discontinuities. Artistic inventions, however, seem to cohere by distinct levels between which the transitions are so difficult to identify that their existence may be questioned."