Abbot Suger’s Saint-Denis: A Study in Early Environmental Design

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Abbot Suger’s choir at the Abbey Church of Saint-Denis is a re-occurring topic of discussion among architectural historians.¹ Completed in 1144 C.E., Suger’s changes to the existing church and his inclusion of prominent stained glass have been noted for their influence on the later architecture of the Ile-de-France.² Similarly, much attention has been paid to the aesthetic and mathematical ingenuity that the architect employed to create such a building while other contemporary examples were failing.³ Although it remains one of the most studied medieval buildings in history, little analysis has, however, been done on what appear to be the most influential and functional aspects of Saint-Denis: the structural efficiency of the plan, and, more importantly, the light distribution made possible by the integrated chapel design. The layout of the plan, more specifically the removal of a party wall typically seen between contemporary chapels, is integral in moving from the dark, insular Romanesque churches to the bright, Gothic choirs, as it allows for the optimum permeation of light into the chevet. This


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architectural study suggests that it is really the inspiration of light that drove the choir design of Saint-Denis, and, as such, was the most influential element in the development of later Gothic churches.

The most direct resource for the study of the choir is Abbot Suger’s manuscript on The Abbey Church of Saint-Denis, where he discusses the intentions behind the design of the choir and briefly how they should be executed:

Moreover, it was cunningly provided that—through the upper columns and central arches which were to be placed upon the lower ones built in the crypt—the central nave of the old nave should be equalized, by means of geometrical and arithmetical instruments, with the central nave of the new addition; and, likewise, that the dimensions of the old side-aisles should be equalized with the dimensions of the new side aisles, except for that elegant and praiseworthy extension, in [the form of] a circular string of chapels, by virtue of which the whole [church] would shine with the wonderful and uninterrupted light of most luminous windows, pervading the interior beauty.⁴

This passage in particular has been the subject of frequent analysis because it introduces the stained glass windows, which will eventually become the most famous addition. However, it also gives insight into the planning behind the new structure, mentioning the position of the new nave and aisles directly on top of their counterparts in the crypt, equalizing the structure and dictating the design. Suger cites the use of geometrical and arithmetical instruments to accomplish this and, although he does not mention it directly, it can be logically assumed that these would have been used on the design of the extension as well. As architectural plans in that period were very uncommon, the plan for the new chevet would have mostly likely been laid out on the ground with certain points or intersections measured from a particular and established point in the existing building. Suger’s suggestion of equalizing the structure might then suggest that the extension was measured from the center of the nave (Fig.1), as this was an established

and stable point of the church and the completed *chevet* is centered on this particular axis. From this central point, the exterior semicircle and interior piers could have easily been placed, especially in conjunction with the existing crypt as a structural support.

Figure 1. Plan of the Saint-Denis *chevet* showing the central axis of the existing nave and multiple points that appear to be mirrored from it. (Drawing by the author)

The design of the new *chevet* shows remarkable ingenuity, especially when compared with other contemporary choirs possibly intended to have the same effect as Saint-Denis but with less success. John James identifies several churches as contemporaries of Saint-Denis\(^5\) that feature some aesthetic similarities, but fail to match the final effect and proportioning. As one of

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5 James, “Multiple Contracting,” 40, cites Ferte-Alais and Chateau-Landon for apse design; for ambulatory, Senlis and Saint-Germer-de-Fly, and much later Notre-Dame in Paris and Saint-Remi in Reims.
the more confused examples, Saint-Martin-des-Champs (Fig. 2) appears to have been attempting a similar type of ambulatory together with an extended tripartite chapel, but the design is unbalanced, lacking the symmetry and order that Saint-Denis flawlessly executes. The most logical explanation for this lack of symmetry is that the construction and layout of the plan was likely begun from one side of the church, instead of from the center, as is suggested with Saint-Denis. The misalignment of the tripartite chapel at the head and the central vaulting apex and the additional misalignment of the chapel walls with ambulatory piers suggest that the builder intended to create a repeatable wedge-shaped module, most likely from the south side, as this is where the structural elements align. From there, it appears that the distances were rotated around the central vaulting apex but misjudged, resulting in the dissolution of the module at the north side. Each of the radiating chapels and ambulatory turning chapels, which at Saint-Denis act as engaged units, instead appear as unrelated entities at Saint-Martin. Most likely, the chapels were rotated around the same point as that of the turning chapels, but with the degree of rotation was slightly different for each, resulting in a grievous misalignment at the north that was more than likely unexpected.

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6 The term “tripartite chapel” here refers to the extended architectural piece that is designed to be segmented into three individual spaces that form a single three-lobed architectural space.
To modern historians and architects, it seems as though the miscalculation of the chapels at Saint-Martin would have been easily rectified if drawn in plan. But at a time when a bird-eye view of the site was not the way the plan was envisioned, the design of the church from the ground level would have allowed for a certain amount of error, especially if the church were designed and constructed quickly—or conversely built over a long expanse of time—with only local masons and possibly no experienced master mason acting in the role we now assign to the architect. The creation of a module for the chapels to be repeated around a central point and started from the north or south would have been a logical design method for the Middle Ages. Many medieval buildings, especially churches, took years to construct and were sometimes the culmination of multiple generations of masons. This resulted in many churches being built in
sections when the money was available, often stopping for long stretches of time when the money ran out, the weather was inclement, or a structural failure occurred that needed reworking. By building with an additive module, construction could be halted for any number of reasons, but the building would remain structurally stable, because each piece would have its own vertical structural system that could be tied into the existing building or the next constructed piece. Saint-Martin has no recorded dates of inception or completion and could represent the work of multiple master masons over a generation, allowing for the confusing arrangement of the plan, if the masons began at the south and moved north with construction. As most buildings were likely laid out on the ground and then the plan staked out where stones should be placed, the design could have easily changed accidentally over time if stakes or markers were lost and mistakenly replaced before some of the lowest courses were laid.

Saint-Martin seems to represent the beginning of a period of development in architectural technology. Although hardly evident once finished, the clumsy plan of the apse resulting from the method of design based on singular modules most likely constructed individually beginning with the southernmost chapel was soon surpassed by a new form of planning, which saw a building design conceived around a central axis. This shift in thinking would have facilitated the construction of vaulting, because one side could be mirrored over an axis, simplifying the arrangement. It is difficult to say what caused the reanalysis in Paris after Saint-Martin, since

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7 Suger himself describes a situation wherein a storm [caused a tree to fall?] fell on the church during the construction of the new choir when the vaulting had not been completed, causing the structural supports to sway. Panofsky, “De Consecratione V,” 104-110. This situation could have caused a structural failure, where the completion of the church would have been delayed while the area was rebuilt. Although Saint-Denis survived the construction process, Beauvais Cathedral was not as lucky and suffered structural failure during construction, resulting in the choir being constructed in the new Gothic style, while a large portion of the church was left in the earlier Romanesque. Although Beauvais is an extreme visual example, many French churches feature pieces added during different time periods and therefore in different styles.

8 Excavations by Danielle Johnson, Philippe Plagnieux and François Heber-Suffrin are currently in progress at Saint-Martin-des-Champs and will hopefully provide additional data as to the construction dates of the church and the original intention behind the design.
many previous churches and other buildings, utilizing the standard cruciform plan, had a central axis. The complication in design arrangement seems to have developed as new choirs were added to older naves and required integration into a previous structural system or plan.

Differing greatly from Saint-Martin, the Saint-Denis chevet seems to have been planned either from a central axis or with the idea of centrality in mind. By planning from an easy to find existing point, the redesign of the chevet would have been facilitated as key piers or points could be easily re-measured from a central point if stakes were lost in the construction process. Although it appears that the majority of the exterior walls were laid out to match the crypt plan, the interior point supports in the radiating plan could be drawn from the identified central axis and replaced by a simple measurement if necessary. Nineteenth-century architect E. E. Viollet-le-Duc asserts that during the Middle Ages – most likely around the time of the construction of Saint-Denis – the organizing principle of behind the design of ecclesiastical buildings shifts from the ground plan to the vaulting plan. This could account for the Saint-Denis architect working from the central vaulting apex to lay out the choir plan, and would also dictate the integration of the vaulting plan with the chapels, as opposed to Saint-Martin-des-Champs, where the vaulting plan appears to be an afterthought, accommodating the awkward ground plan. Although his ideas are not always universally accepted by medievalists, there seems to be some value in considering Viollet-le-Duc’s concept of “architecture from the top down” as acknowledging the beginning of thinking of the space as working in three dimensions. Whereas the crypt seems to have provided the foundation of the plan for the choir at Saint-Denis, it is evident that the architectural space was imagined at least in part before construction began. The vaulting plan

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9 E. Viollet-le-Duc, “Symétrie,” *Dictionnaire raisonné de l’architecture française*, trans. Elizabeth Smith, Vol. VIII (Paris, 1873), 517, writes, “For the master of the Middle Ages, on the other hand, it is the thing to be carried that is the main objective, it is this vault that he must support and buttress. It is the vault therefore, which governs the symmetry of all the elements of the building. It is no longer by the base that the architect conceives his plan, but by the object that commands the position and strength of the base.”
does not seem to be an afterthought, but instead part of the whole concept of the space from the beginning. When compared with Saint-Martin, whose vaulting appears to be accommodating an awkward ground plan, the Saint-Denis floor plan, vaulting plan, and architectural volume all work together in harmonious proportion.

The progression into three-dimensional thinking seems to be a logical shift in ecclesiastical design, and could be attributed to a change in thought by a particularly talented mason. The mason or architect of the Saint-Denis chevet is never mentioned by Suger, who addresses the design considerations as his own methodological thinking, but Stephen Gardner suggests that the chevet genius was the same mason to finish the western block. Gardner attributes this connection to the similarities in the choir ribs and mouldings, as well as the proportioning of the windows and the efficiency of the narrow construction.\(^\text{10}\) Certainly the western block mason would have had experience with tying in new construction to an existing structure, and would therefore be ideal for the completion of the choir, which Suger wished to harmonize with the existing nave.\(^\text{11}\)

The increased ingenuity behind the construction is evident in Peter Kidson’s analysis of the choir from a mathematical perspective, identifying an algorithm possibly used in the extension. Whether the algorithm was intentionally or subconsciously\(^\text{12}\) used, the mathematical analysis suggests a sophisticated arrangement of structural elements. Citing three different types of curvature, all of which are planned from the central-most vaulting apex, Kidson reconstructs


\(^{11}\) Suger specifically mentions that in the construction, his “first thought was for the concordance and harmony of the ancient and the new work.” Although this statement is specifically referring to the materiality of the columns, it can logically be assumed that he wanted to apply this principle to the entirety of the new construction. Panofsky, “De Consecratione II,” 86-92.

\(^{12}\) Kidson, “Panofsky, Suger,” 1-17, uses the formula \(n = \frac{3D}{a}\), an ancient formula for identifying polygon chords, which he relates to the development of the ambulatory design. The formula might have been known at the time of the choir construction, but with the lack of a completely accurate plan, it is difficult to test.
the plan as not entirely symmetrical, although it appears to be, with the apse arranged slightly to the east, a solution that rectified the odd positioning of the eastern flank due to the location of the nave wall. Suger’s desire to rebuild the area with structural congruency to the crypt below seems to have created a difficult situation in the choir design, as the nave walls were not completely symmetrical along the central axis. The inconsistency was then rectified by this slightly modified chevet plan.13

Kidson’s ideas provide an interesting approach to the study of the choir, but also significant is his analysis of Panofky’s translation of Suger as a possible follower of Pseudo-Dionysian thought.14 Certainly, the Pseudo-Dionysian relationship between the heavenly or godly world and the earthly construction is relevant to the design, as Suger has stated that his intention was the bathe the area in light, and later, through meditation on colorful gems, “be transported from this inferior to that higher world…”15 In a sense, the gems in this translation could act as a metaphor for the light that extends from the new stained glass windows in the chevet. But, instead of being provided through human means, the effect is provided by God through natural light, making it an even more apt avenue for meditation and transcendence. As a premeditated design aesthetic, the association of the stained glass of the choir with Pseudo-Dionysian though is an interesting comparison to make. However, like many post-rationalizations, the comparison is difficult to prove without a direct written account. Suger seems very open with expressing his feelings on the design of Saint-Denis and the moments of divine intervention that aided its construction.16 It seems just as likely that he would mention

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14 Kidson, “Panofsky, Suger,” 5-11.
16 As previously cited, Suger mentions the storm that threatened the partially completed choir, and also attributes his ability to find suitable workers columns to Divine Intervention. He writes, “Divinity relieved us of our fears and favored us with its goodwill by comforting us and by providing us with unexpected resources.” See Panofsky, “De Consecratione, II, 86-92.
any further theoretical discourse with which he was working in the design of the new additions. Instead, based on Suger’s specific mention of his intention for the choir, the use of stained glass seems more likely to be a design decision implemented specifically to produce the aesthetic effect of bathing the area in light and not from the implementation of Pseudo-Dionysian thought or principle.

The planning of the choir as a whole can also be associated with Erwin Panofsky’s suggestion that the later Saint-Denis nave follows the development of scholasticism in the thirteenth century. The concept of hierarchical levels within the church and theoretical discourse, suggesting a large main unit broken down into smaller and more easily understood units, can certainly be applied Suger’s choir as easily as to the later nave. As Panofsky writes, “The whole is thus composed of smallest units—one might almost speak of articuli—which are homologous in that they are all triangular in groundplan and in that each of these triangles shares its sides with its neighbors.”17 This statement is made in relation to the uniform vaulting of later cathedrals, but the design of Suger’s chevet incorporating the integrated radiating chapel structural system, 18 also seems to highlight this principle of scholasticism. The Saint-Denis chapel system is a series of parts that form a whole, each architecturally interacting with the units beside it to form a homogenous structural exterior wall system. Again, however, Suger makes no mention of scholasticism, suggesting that the relationship is coincidental and the result of good design and proportioning instead.

Although Panofsky is applying the principles of hierarchical scholasticism to architecture, there is something inherently natural about the proportions that scholasticism

18 For the purposes of this argument and essay, I am defining “integrated radiating chapels” as a series of chapels following the semi-circular curve of the apse, where each chapel touches the next with no intermediary wall and each chapel consists of 50% or less of the full chapel circle circumference and hemicycle utilized as part of an exterior or interior wall, thus leaving the majority of the chapel open to light filtration.
suggests. A similar hierarchy appears prominently in nature where many small units form larger units which in turn are combined to form natural elements. Vaulting in sections and the choir in plan both have a dictated hierarchy reminiscent of a tree, where the larger elements break to form smaller elements, creating a structural balance. Although it is unlikely that a specific natural form was the aesthetic organizing principle of the chevet, the inherent organization of each is strikingly similar.
Regardless of the possible aesthetic or theoretical discourses that can be applied after the fact to Saint-Denis, there is a functionalism to the chevet that I argue is much more likely to have been the main influence of the addition. Suger’s desire to have the entire area bathed in the colored light of the stained glass is probably the most logical explanation for the design. Most previous semi-circular choirs with radiating chapels were designed in an additive fashion, with each chapel having an independent structure, and with small windows (Fig. 3).¹⁹ This is in sharp contrast to the comprehensive integrated structure of the Saint-Denis renovation that eliminates the common wall in between chapels opening the space between the piers.

Figure 3: Natural lighting diagram of Saint Foy at Conques showing the limited sunlight penetration into the apse, due largely to the enclosed nature of the chapels and small size of the windows. Natural sunlight is projected for a clear summer day at 10:00 am. (Drawing by the author)

This innovation seems to stem from a break in the Romanesque idea of the light source in each chapel acting only to influence the chapel in which it was placed and not the entire choir. At

¹⁹ For example, Sainte Foy at Conques and other similar Romanesque churches utilized the concept of the radiating chapel with windows, but because the walls were not as structurally efficient as Saint-Denis and later churches, the window openings were kept small to not decrease the structural capacity of the wall.
Saint-Denis the light of each chapel is intentionally allowed to project into the *chevet* (Fig. 4). Thus, all the chapel windows work together to form a comprehensive unit lighting the interior of the church and not just individual chapels. Saint-Germain-des-Prés, Paris, seems to represent the old Romanesque paradigm, although it was built after Saint-Denis. The *chevet* follows an almost identical layout, except that it encloses the radiating chapels, by adding the party wall that Saint-Denis eliminates. There is strong evidence to suggest that the two abbeys were closely connected, and as William Clark mentions, “the *chevet* of Saint-Germain-des-Prés is universally recognized as…influenced by the design of the *chevet* of Saint-Denis.”²⁰ However, at Saint-Germain, each chapel is its own architectural space with its own light source, preventing the natural light from extending into the ambulatory. The position of the windows high above the height of an average human does, however, help the light extend as far as it can. In contrast, Saint-Denis places the windows down at a human level, so that the light is able to surround the viewer, whereas Saint-Germain leaves the light above the viewer. Although in architectural planning Saint-Germain can be considered as looking backward when compared with Saint-Denis, the large windows still represent a structural and aesthetic progression from the previous enclosed early Romanesque chapels, with small windows and little penetration of light.

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Figure 4: Natural lighting diagram of Saint-Denis showing how far sunlight is able to project into the *chevet* due to the expanse of windows and elimination of the wall between chapels. The blue circles reconstruct the schematic circumference of the chapel and show that only 40% of the circumference is constructed wall, leaving the other 60% open to allow for ample light penetration. Natural sunlight is projected for a clear summer day at 10:00 am. (Drawing by the author)

It can therefore be said that Saint-Germain and Saint-Martin were making progress toward a more illuminated interior, but it is at Saint-Denis that the ideal solution was discovered. The arrangement of the chapels around the choir, as well as the size and location of the windows in each chapel, essentially created an early wall of glazing at the east end of the church, which is a concept seen in the development of later cathedrals. With direct light from the east in the morning in the summer or southeast in the winter, enough sunlight would have penetrated the chapels to go beyond the typical confines of the chapels and into the ambulatory and interior apse. For stained glass, direct sunlight is key; diffused or indirect light does not produce the same effect as eastern and southern sunlight. As opposed to chapels with a common wall, the
permeability of the choir was amplified with the delicate structure of the choir point supports, which allowed light to extend into the interior of the choir and nave, without being obstructed as is commonly seen in contemporary solutions.

Although it is not often addressed, the Saint-Denis chevet is a perfect example of medieval environmental design, where an environmental element, in this case, light, dictates the design of the building. Saint-Denis’s design was extremely functional; the plan ensured that as much light as possible would penetrate into the choir. But, this functionality also allows for a more religious experience. It is not just the natural that inspired Suger, but also the spiritual effect that the natural created. To Suger and many other religious figures, God was the creator of nature, and by celebrating nature through architecture, Suger was celebrating God. This could be the most relevant argument for ascribing Pseudo-Dionysian views to Suger, since here the want of radiating light could be thought of as the specifically the ascending path to Heaven or a celebration of God through pure light.

Saint-Denis seems to epitomize the use of stained glass and is often referenced as influential to later Gothic designs. Despite this connection, the ingenuity of Suger’s chevet was rarely replicated. With the development of the Gothic cathedral, a few contemporary French churches identified in Jean Bony’s Northern Group, are reminiscent of the design, but it is most often the semi-circular wall of glazing in concept that is reproduced. Of the group, Noyon and Soissons both feature integrated radiating chapels, but each is lacking in the structural delicacy of the Saint-Denis solution, especially when comparing light permeability (Fig. 5). At Noyon, the placement of a pier close to the chapel wall encloses each chapel further than originally intended, and at Soissons, the extension of the exterior buttressing blocks some of the direct light from permeating the chapel space fully. Beauvais appears to be the last cathedral to attempt the
integrated chapels, and appears to be the culmination of the Saint-Denis inspired integrated structural style.

Figure 5: Natural lighting diagrams of Noyon and Soissons Cathedrals showing limited light permeability. For Noyon, the pier located at the end of each chapel party wall encloses the area so that more than 50% of the chapel circumference is solid wall, keeping light from permeating into the main space. For Soissons, although less than 50% of the circumference of the chapel is enclosed, the extensive buttressing prevents much natural light from entering the building. Natural sunlight is projected for a clear summer day at 10:00 am. (Drawing by the author)
It seems that the design was eventually superseded by development of the High Gothic style, which took the concept of the semi-circular glazed east end, but instead reverted to the Romanesque additive approach to the organization, although with significantly more glazing in the radiating chapels. This once again isolated the structure of each of the chapels, while allowing for similar light permeability to Suger’s choir. Reims in particular seems to have been influenced by the Saint-Denis choir, and although it does not revert to the additive approach for the chapels, the chapels remain enclosed by a connected pier, significantly diminishing light permeability into the ambulatory. The design reversion can possibly be attributed a revision in the intended function of the chapels as choirs became taller. Although the Saint-Denis integrated chapels achieved a very streamlined structure, the height of each of the structural elements was relatively short. As the focus of the master masons turned to height, even the apse and ambulatory chapels required buttressing. This would have complicated the arrangement in plan, and also removed some of the need for a solid wall structure in the chapels, thus allowing for more glazing without the structure of the interior chapel needing to be integrated, as with Saint-Denis.

Although it appears that the influence of the Saint-Denis integrated chevet was short-lived in twelfth- and thirteenth-century France, the concept of radiating light was not lost on later architects. The development of the Gothic style continued to seek to bring in an expanse of light, but shifted focus away from apsidal chapels, concentrating rather on the use of stained glass in the nave clerestory and the rose window. Instead of being bathed at ground level in the colorful light, designers used the concept of extensive light from above. This seems to reflect a corollary shift in focus away from the clergy in the choir to the entire congregation in the nave, thus allowing members of the community to experience the Pseduo-Dionysian metaphysical effect.
The semi-circular apse remained a consistent design feature, but radiating chapels became less common, possibly due to the development of the flying buttress, which required space beyond the apse to distribute structural loads. In some parts of France, the radiating chapels were eliminated completely, in favor of a semi-circular apse, particularly featured in Bony’s Paris School and specifically Notre Dame de Paris. The smooth wall of glazing allowed for the use of extensive stained glass without having to integrate the structure of the chapels. By eliminating the space needed for chapels in plan, the east end could more easily accommodate flying buttressing without complicating the arrangement of the piers.

Saint-Denis remains the beginning of Gothic for many architectural historians, based on its principles of order, and the use of light and stained glass, which illustrate a progression from the dark, additive Romanesque style into an integrated Gothic structure. Although the structure could have been based on a number of theories during the Middle Ages, the functionalism behind the use of light, and the intentions of Abbot Suger are most likely the main influences on the innovative design. The integrated chevet was short-lived as a design concept, having been usurped soon after by the semi-circular smooth apse, but Saint-Denis’s focus on quality of light continued to be a strong characteristic of Gothic architecture for hundreds of years.

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