

# The Architectural Drawings of Clermont-Ferrand Cathedral

## A Digital Analysis of Thirteenth-Century Gothic Design

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*architecture – drawings – thirteenth century – digital survey*

A group of full-scale architectural drawings, the most extensive ensemble from medieval Europe, survives on the terrace pavement that covers the vaults of the aisles, ambulatory, and chapels of the choir at Notre-Dame, the Cathedral of Clermont-Ferrand. The collection, compiled in phases during the late thirteenth and early fourteenth centuries, includes three legible tracery patterns, the probable ruins of two others, arcs that set out arches for the choir flying buttresses, two versions of an openwork flyer design and two portal elevations complete with archivolts and gables. Rather than a comprehensive catalog of key elements, the terrace archives one-off designs—a transept portal or the short flyers of the eastern nave bay—or window patterns for specific areas of the building—the chapels and clerestory of the straight bays of the choir or the west wall of the transept. Far from tentative sketches, all of the drawings represent fully developed ideas, even down to details such as the crockets that ornament the gable of the portal elevation on the south side of the terrace (Fig. 1 a,b).

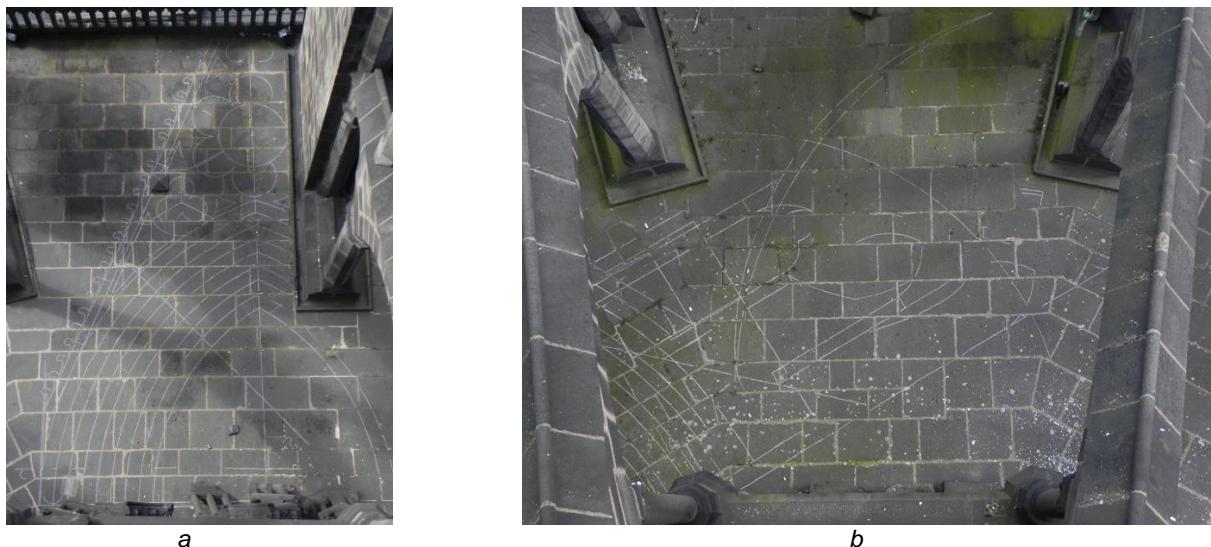


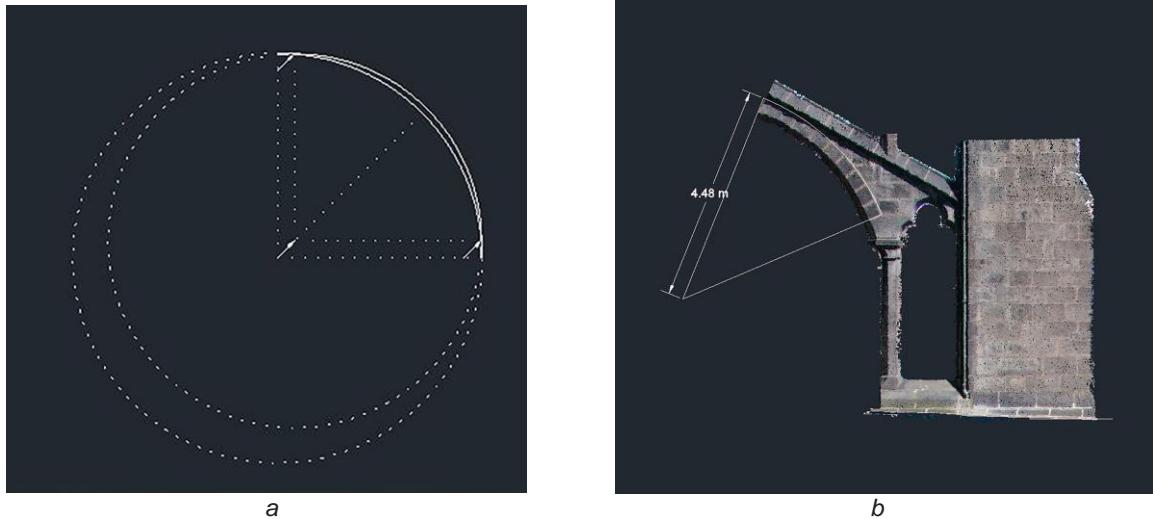
Fig. 1. Clermont-Ferrand, France, Cathedral terrace a) transept portal drawing; b) flyer arcs and openwork arcade  
(© Michael T. Davis and Stefaan Van Liefferinge)

Nevertheless, the fact that the tracery proposed for the western choir bay windows was not built, a three-light pattern replacing the intended four-light arrangement, reveals the fluidity through a construction process in which the drawings no doubt played a role in the critical evaluation of the design.

Like an archaeological excavation, recording these incised drawings is intensely physical. Climb 85 steps up one of the eastern towers of the transept to the terrace, crawl on hands and knees to find the shallow lines etched into the pitted surface of the Volvic stone pavers, and mark with chalk. Change position or wait for the light and shadows to shift to discover additional lines. Repeat. Then what? Scant evidence remains to connect these life-size drawings to preliminary small-scale sketches or to reveal their underlying arithmetical or geometrical matrices. Only occasional masonry joints are indicated. As a consequence, investigative methodologies have focused on the drawings' relation to the finished structure. So the task at hand centers on measuring the drawings as well as the built cathedral fabric. Comparing the two determines their intended locations and an assessment of what, if any, alterations were made between this final stage of graphic rendering and fabrication and installation. At first glance, the drawings appear uncomplicated in their two-dimensionality, incised as they are into the choir terrace pavement, and templates would have been required to turn the drawings into three-dimensional architectural form. However, it turns out that this is not as straightforward as it appears for a deeper analysis of the drawings, made possible by digital technologies, reveals a more complex thought-world of the Gothic mason than imagined.

As a first step, a Total Station served to corroborate hand measurements and locate the terrace drawings within the overall structure of the building. Measurements were then combined with photographs of the terrace to produce calibrated photogrammetric models of the drawings using Agisoft Photoscan (now Agisoft Metashape). Additional models of the cathedral fabric included flyers of the choir and the north and south transept portals. Created in Agisoft, point clouds were converted into Autodesk ReCap format and imported in AutoCad making it possible to compare the geometry and dimensions of the drawings to the building. Two case studies illustrate the potential of digital approaches to invigorate the understanding of historical architecture and the design thinking that informs it.

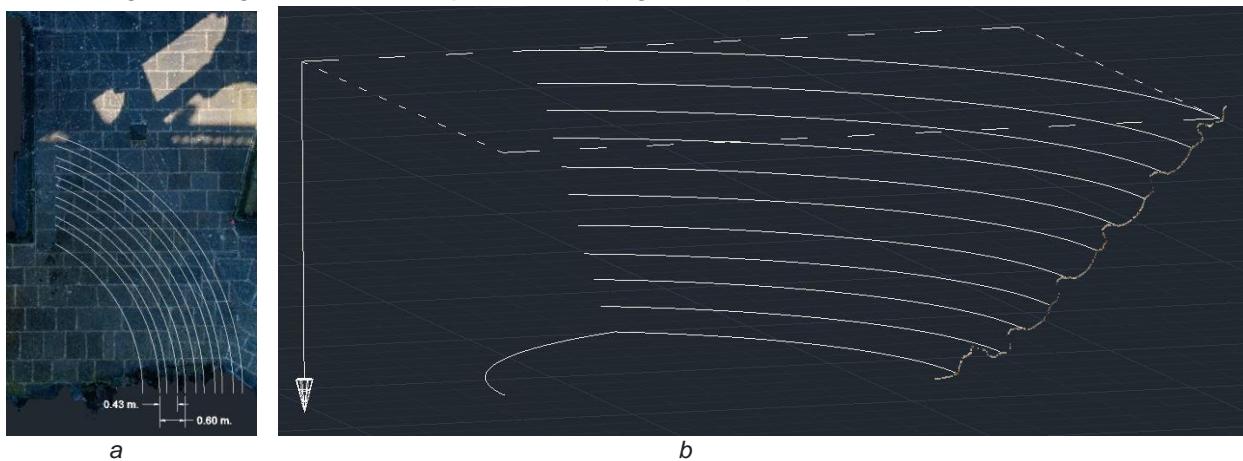
The groups of arcs etched over two radiating chapels of the choir have been ignored or dismissed as rejected designs (Fig. 1b) ; however coordinating their radii with photogrammetric models of the flyers suggests that they played an active role in the fabrication process. Their terse lines offer a flexible and multi-use pattern that could determine the span and shape of the choir flyers, construct form work, generate templates to cut voussoirs, and verify the accuracy of the masonry before installation. (Figs. 2 a,b) Setting out a quadrant arcs that controlled the flyer arch, they illustrate one technique that builders invented to avoid constructing flyers that exerted inward destabilizing pressure on the clerestory wall, yet one that allowed leeway in their slope and placement.



*Fig. 2. Clermont-Ferrand Cathedral, France. a) AutoCad rendering of terrace quadrant arcs; b) photogrammetric model of choir flyer with arc of terrace drawing (© Michael T. Davis and Stefaan Van Liefferinge)*

Although, they are not an attempt to calculate loads and thrusts, these arcs bear witness to an awareness of structural behavior, especially perhaps during construction itself before the flyer, wall, vault, and roof had yet to be locked into a stable whole and the building was at its most vulnerable.

A second phase of the project has focused on the transept portals. At around 10m x 8 m, these spectacular representations of archivolts crowned by a monumental gable, are among the largest extant Gothic drawings (Fig. 1a). AutoCad renderings of the portal arches joined to a section of the archivolts, extracted from then superimposed on a photogrammetric model of the portal, revealed that both transept portal drawings represented the archivolts as they would be built along the diagonal line of the portal wall. (Figs. 3 a,b)



*Fig. 3. Clermont-Ferrand Cathedral, France. a) AutoCad rendering of archivolts of north transept drawing superimposed on a scaled photogrammetric rendering of the terrace drawing; b) view of terrace drawing of north portal archivolts translated into three dimensions with a cross-section of portal archivolts (© Michael T. Davis and Stefaan Van Liefferinge)*

This required projecting the dimensions established by the extant portal jambs onto the flat surface of the terrace, an operation that involved the rotation of the archivolts through 45 degrees, that is, the square root of 2. Thus, the draftsman (draftsmen?) of the portal elevations created drawings that contain both two- and three-dimensional information to act as an intermediary between conceptual intention and built form. However, the drawings do not represent forms in section. Rather, with the portal elevations etched into the terrace, their lines establish the matrix from which templates and cutting instructions for the masons could be generated for the archivolt and molding components. In this case, the drawing determined the frontal dimensions of a dressed stone. Placing the template profile on the stone along a diagonal automatically transfers the correct dimensions to the block. Thanks to the power of digital technologies to document the inaccessible, to slice through solid stone, and to capture with precision the intricacy of finely scaled forms, an enhanced picture of Gothic builders and their design techniques begins to emerge. In their skilled hands, no divide existed between orthogonal and volumetric modes of representation; two- and three-dimensional systems could be merged to convey efficiently and precisely the information needed to turn incised lines into masonry that captured an image of heaven.

Comprehensive documentation and study of the Clermont terrace has become an urgent matter. During the past decade, moss and lichen have spread steadily obscuring significant sections of the drawings. Especially acute on the north side, the process appears to be accelerating and is exacerbated by effects of weathering that have further compromised the legibility of the drawings. Digital technology together with art history have key roles to play in developing protocols and drawing attention to the importance to conserve these precious primary visual documents of Gothic design.

## References

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