Modeling the Cathedral of St. John the Divine

Zachariah Munoz
ztm3@msn.com
December 3, 2003

The digital modeling process for St. John the Divine began with a series of architectural blueprints that were scanned as TIFF images and then imported into AutoCAD as templates from which to trace the geometry. Though laser-range scan data of the cathedral was available, it proved more cumbersome than helpful in illustrating the geometry of the architecture. A multitude of jagged lines and regions of missing information in the scan data suggested that the architectural drawings would be the more practical tool to use. Of the drawings selected for scanning, only the plan of the choir and a section cut parallel to the nave were found to be complementary in terms of their geometry (Fig 1). While some of the other sections offered helpful information, such as the section through the ambulatory, they were intentionally not traced so as to limit the discrepancies already existing between the selected plan and section. Some of these discrepancies were rather minor, probably due to the character of hand-drawn documents. The plan of the inner choir, for example, revealed a horizontal symmetry that was off balance at moments by a couple of inches. These types of inaccuracies were resolved by shifting two symmetrical elements so that their final composition would be a mutual compromise, rather than one piece of geometry overruling the other (Fig 2).

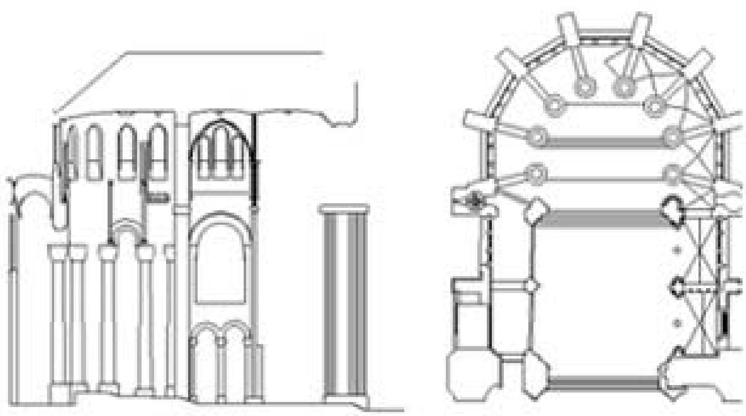

Fig 1. AutoCAD templates produced from scanned blueprints.

Once the selected architectural plan and section were traced in AutoCAD they were then imported as DXF files into Alias|Wavefront Maya. The plan was positioned on the horizontal plane of the modeling grid and the section rotated perpendicular to it so that the three-dimensional volumes could be extracted through a process of intersection between horizontal and vertical elements (Fig 3). For the production of the central columns in the choir, for example, the geometry of the plan was primarily used as the generator of the model skin while the section acted more as a gauge against which to measure the extrusion. In these cases, the modeling tool used most frequently was the loft command as it involved merely copying the geometry from the plan to a vertical distance determined by the section and then melding a skin between the two. Alternatively, the section was used as the primary means of generating volumes that had shapes defined by complex profiles in a primarily vertical dimension such as column capitals, triforium, etc.

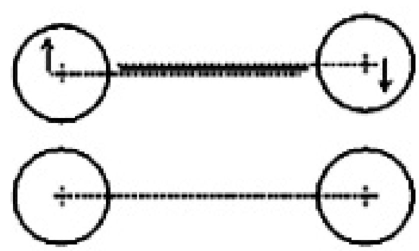

Fig 2. Method for resolving symmetry anomalies.

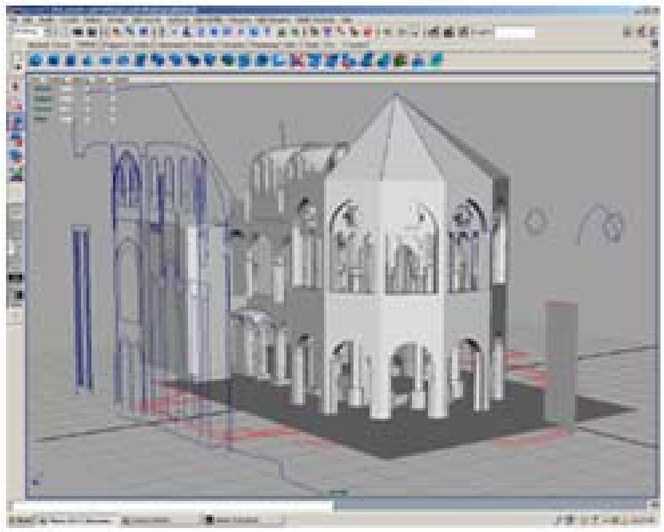

Fig 3. Maya model with sectional information combined with plan to produce volumes at the intersections.

Between site visits and an examination of photographs of the cathedral, including the QTVR tour provided by Columbia, various discrepancies emerged between the actual construction and documentation of the cathedral. First minor items were identified and corrected, such as the varying levels on the ground plane – something not portrayed accurately in the section – but then a host of other curiosities were revealed, particularly dealing with the ceiling of the choir. Given the cathedral's complicated history, one in which the design passed through the hands of multiple architects, the blueprints of different sections did not correspond to each other above the main columns of the central choir. One section illustrated a dome shape, while another would portray the ribbed vaults that actually do exist. Furthermore there were differences in the way the ceiling of the ambulatory was portrayed as well as the relationship between the clerestory windows and the exterior of the structure (Fig 4). It was not a matter of discovering that one drawing was correct and another wrong, but that the two shared complementary aspects with each other; components that when assembled and compared to photographs taken during site visits would be used to model the actual structure.

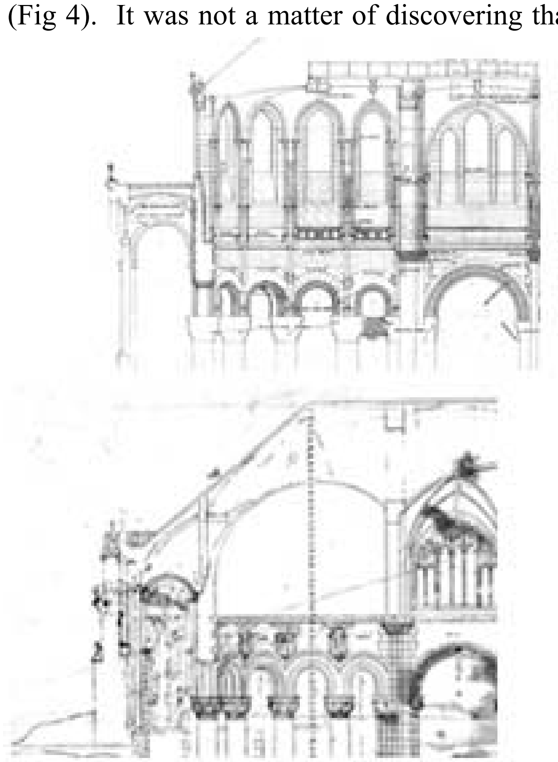

Fig 4. The upper section illustrates the choir ceiling correctly yet the lower one is drawn with the actual relationship between the clerestory windows and ambulatory ceiling.

Modeling the clerestory windows of the inner choir involved this process of cycling through drawings and photographs until I reached the conclusion that the windows currently are not exposed to the exterior, which would explain the lack of natural light in the space. Other complexities in the architecture that were not documented by the drawings were the ambulatory ceilings above the triforium. One of the sections illustrates the ceilings as being Guastavino vaults yet site visits revealed a concave shape resembling a half arch rather than a vault.

The modeling of the inner choir, including site visits and research, roughly spanned over a month and a half, nearly 100 hours. The surrounding chapels were the next component to be modeled. Initially lacking documentation of the chapels, with the exception of a few incidental sections found in the original scanned blueprints, I explored various sources for information until a rough plan was provided by the tourist bureau of the cathedral. Though it was not intended as an architectural blueprint, this document was the only source of information regarding the chapels available at the time and thus carefully adapted so as to meld with the existing model. The plan was scanned, imported into AutoCAD, and traced in the same manner as the plan of the inner choir. Because this new plan contained an illustration of the inner-choir, albeit a poorly detailed one, the proportions of the space could be scaled so as to overlap the previous drawing (Fig. 5).

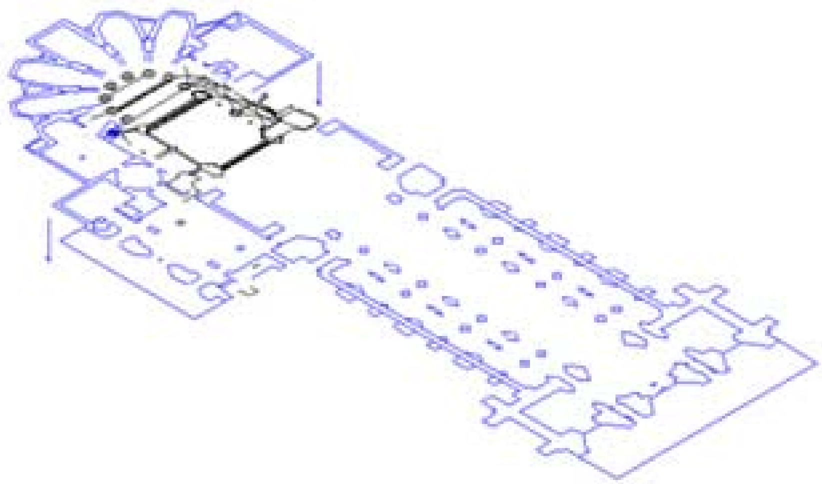

Fig 5. The lines in blue, which were taken from a drawing supplied by the tourist bureau, were scaled so as to mesh with the pre-existing choir plan (black lines).

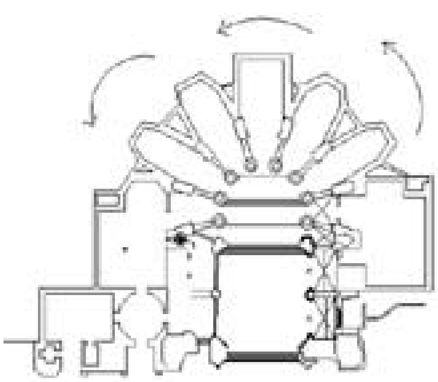

Fig 6. Process in modeling the chapels.

Once the overall plan was completed it was re-imported into Maya and the modeling methodology continued as before with the exception of a lack of sectional information regarding the chapels. Given the original sections of the inner choir I had vertical information for three of the chapels and had to use these dimensions, combined with site visits, to determine the heights of all vertical components in the chapels. Because each chapel is different from the next, the QTVR tour combined with sketches on site became essential to drawing accurate vertical relationships between the chapels. The process of modeling these chapels followed a counter-clockwise fashion (Fig. 6), ultimately spanning over three months: roughly 300 hours. The model in its present state represents the architecture beyond the intersection of crossing and nave excluding the northern transept, which burned down in 2001. The model includes the plan of the rest of the cathedral so that as modeling continues beyond the choir all geometry will be correctly proportioned.

Given the abundance of information regarding the inner choir, this part of the model is probably the most accurate. While there is no definitive way of knowing how it may dimensionally compare to the actual structure, given the stormy relationship between design blueprints and actual construction in practice, I would say that the tolerance ranges from a few inches to a foot maximum. As for the chapels, the tolerance may be somewhere in the neighborhood of six inches to three feet depending on the quality of information available. But the most important aspect of the chapels is that they are proportionally correct within the context of the cathedral. Concessions were made on a chapel-to-chapel basis to ensure this degree of conformity and maintain the big picture.

In regards to the technical aspects of the model, it was primarily created using NURBS geometry that was then converted to polygons based on different scales of decimation. In its completed state, roughly 70% of the geometry had been converted with about three remaining chapels still remaining as NURBS. Once completely converted, the projected face count would be somewhere in the range of 70,000. This number, however, could vastly be reduced through a more thorough conversion of geometry on an item-by-item basis. Planar elements such as stairs or walls can be grouped together through a layering system that would streamline the process of prioritizing geometry and then decimating it based on its complexity.