

Window into the south-west stairs, Chartres cathedral

Design changes in 4 similar windows Adapted from The contractors of Chartres, Wyong, ii vols. 1979-81.

When I wonder how the complex geometric systems used by the masters were evolved, I think of these four windows. In them a simple design became increasingly complex and was gradually integrated with major elements beyond the staircase it illuminated. We can see he was trying to link a small item with the greater parts, to create a web of connections that would bind the building into a whole. If he were eager to pursue this process in the small unit of a staircase window, then we should consider how he would approach the larger and more vital structural parts of the building.

There are four windows in the transept porches that look out from the stairs. They are easily accessible from the outside [a]. They were installed by the master Bronze in 1198. The slight 'improvements' to the geometry suggest they were designed in the following order: that into the SE stair was the first as its layout is the simplest, then the SW, followed by the NW and NE on the other side of the building. This order of construction is consistent with the order of other elements in the cathedral.

Generally, windows in medieval stairs are larger on the inside than out – possibly following the reasoning that the smaller the outside the more effectively it would keep out the rain, and the larger the inside the more light will be spread into the room.

From the study of many items designed by Bronze at many levels of the cathedral, I calculated that his foot unit was 336mm, often referred to as the Teuton foot as its earliest known provenance was with the Aryan tribes of

the Iranian uplands. His unit seems to have been divided into sixteen digits rather than twelve inches.

In the SE window [r1], Bronze made the external opening half the width of the wall recess, and placed it in the centre. The splays were set at an angle of 45° to the wall face, forming a triangle with the slot on the axis of the wall. It was 4 digits or one palm wide, 2 palms wide. On the inside he repeated the triangle he had used on the outside, and set it square to the angled wall of the passage which leads from the lobby to the circular stair. Simple.

In the next Bronze again started with the centre of the wall but reduced the width of the external opening to 7 palms with the same slot as before [r1]. On the interior he reduced the angle between the splays from the 90° used in the SE window to a pentagonal angle of 72°. This gave the window a more pleasant fuller feeling, with the outside (at the bottom of the drawing) significantly smaller than the inside.

One additional move was to avoid symmetrical alignment on the passage wall, but the sides were shifted so that the corner D lies on the line drawn from C perpendicular to the passage. CD is shown dashed on the drawing. However, this design relates to the rest of the porch only through the centre. It in no way reflects the thickness of the wall, the position of the stairs or any of the axes.



The window out of the south-east stair

The window out of the south-west stair

He could have designed the window in a different way by drawing the line from A at right angles to the outside wall [r]. He then bisected the shorter line at E to locate the centre of the slot. He now had two equally valid ways to set out the window, from C he placed a square to the inside and from E placed a square to the outside. Then it was simple to use the 72° protractor to fix the internal splays.

Once he had cut that template he seems to have played further with the design (as I am sure he would in spare moments). Bronze would have noticed that the line on the other side drawn perpendicular to the outside at B almost met the inside corners, just as the line from A did. The purpose of A had been to locate the slot, and CD had located the inside splays. But now there was a third element in prospect, the box, that could provide another way to form the window. I would think he found the possible relationships between these three tantalising.

Bronze proceeded in the next window to see if he could bring all these elements together in one single statement. He moved the window more deeply into the wall, slightly widen the outside splays, and reduce the width



of the inner ones. This series of adjustments ensured that the perpendiculars formed an accurate box that joined the corners of the outside splays to those of the inside [r]. The centre of the slot still lay on the bisector of the shorter perpendicular, as before, and the dotted line from C that was set at 90° to the passage would still have met the corner D. We could call this a more integrated solution, though the connection with his foot unit was lost. But that was not all.

A host of other relationships now emerged the tied every part together. Bisect the shorter perpendicular from M until it meets the other at N. From that line M-N draw lines to the corners F, G and H as shown. The remarkable, and for Bronze no doubt exciting fact, was that all the marked angles will measure exactly 45°. While the inside splays still proceed from the 72° of the pentagon, and the centre M-N guarantees the symmetry on the outside, it took care for the geometer to make sure that the inner right corner still lay at 45° to M-N. Sounds complicated, but exciting to a geometrician.

We can imagine the master hugging himself with satisfaction. Perhaps he was in a hurry when he produced the first window, pressed for some decision in one place while someone was demanding a template in another. Can we see him a few nights later thinking over the difficulties of the SE window, sitting by his fire doodling with his instruments, and then next day working on the tracing floor to see how they could be improved.

In the last window, the NE [b3], he used the same template as for the NW, but reversed because it was from the stairs on the opposite side of the central door. He obtained the same correlations as before, but there is one important change. The window is no longer on the centre of the outside recess, but the north-south axis is now a little to one side, in line with one face of the slot. It presents a noticeable and charming asymmetry from the outside, with the larger wall face on the same side as the larger doorway. But why?

The reason may have been that he realised that when the line CD in the NW window was prolonged it passed exactly through the shaft S of the arcade inside the building. The line still lies at 90° to the stairway passage but has now acquired an additional connection that tied the window to an element in the interior.

This was meaningful only if the creation of connections was in itself an important thing to do, as a step in the search for integration. Or maybe it was no more than a geometrician's pleasure at the increasingly intricate relationships that were emerging every time he repeated the same window.

The process of constantly improving a design may have occurred everywhere. His later windows indicate he was becoming increasingly interested in seeking the hidden relationships between the surrounding structures of the building and the design of the windows, even though these relationships would be completely lost once the stones had been laid.

Look at his geometry in the many interludes in *The Contractors of Chartres*. Start with the index and go from there.



Additional geometric connections, NW window

Geometric connection between NE window and shaft

