

The Mazzocchio in Perspective

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Abstract

The mazzocchio was a part of 15th century Italian headgear. It was also a kind of final exam problem for students of perspective. Painted by Uccello, drawn by Leonardo, incorporated into intarsia and prints through the 16th century, it still appears occasionally in 21st century art. Here we review its history; show 3D models made by hand in wood and using stereolithography in plastic; and report two novel visual effects seen when viewing the 3D models.

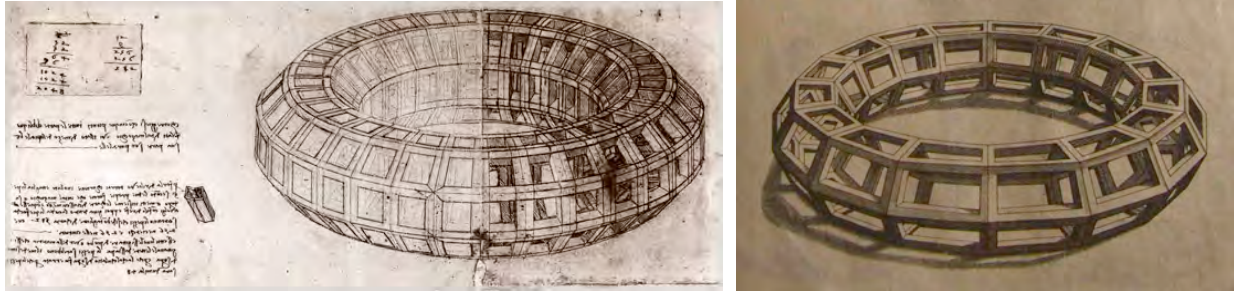
Brief History of the Mazzocchio in Paintings and in Graphics

The origins of the kind of geometrical mazzocchios discussed in this paper are obscure. They are said to derive from supports for headgear worn in Renaissance Italy during the 15th century. No actual three-dimensional examples survive from that period. Mazzocchios are featured in three major paintings by Paolo Uccello made between 1456 and 1460 and in his fresco of “The Flood” (Figure 1a). Leonardo Da Vinci also illustrated them and may have built models of the skeletal version in the late 15th century (cf. Figure 2a). Whether the wooden “checkerboard” version was actually worn on the head or around the neck is unclear. It seems more likely that a fabric version could have actually functioned as a headpiece.



Figures 1 a (l.) & b (r.): (a) Detail from the fresco in Florence “The Flood and Waters Subsiding” by Paolo Uccello (ca. 1448) and (b) a pen and ink perspective study of a mazzocchio by Paolo Uccello (in the Louvre, Paris).

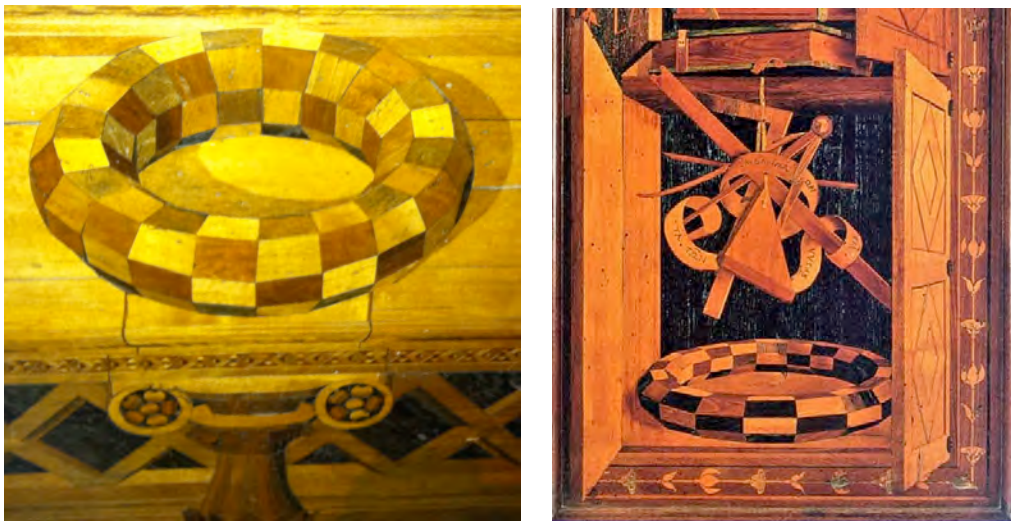
Two-dimensional images of mazzocchios in either the surface checkerboard (faceted torus) version or in the skeletal torus version - sometimes including add-on three-dimensional protrusions to make them look “stellated” - continued to be drawn, painted and etched throughout the 15th and 16th centuries.



Figures 2 a (l.) & b (r.): (a) *Skeletal Mazzocchio* by Leonardo da Vinci from the *Codice Atlantico* (1478) and (b) by Lorenzo Sirigatti from *The Practice of Perspective* (1596).

Intarsia Mazzocchios from the 15th and 16th Centuries

Mazzocchios were also incorporated into many elaborate wood intarsia (cf. Figure 3) produced by craftsman throughout the 15th and 16th centuries, not only in Italy but farther north in Europe as well. The Italian wood intarsia designs may have been largely based on the paintings of Uccello.



Figures 3 a (l.) & b (r.): *Intarsia mazzocchios* (a) from the *Gubbio Studiolo* (1476) of Federico da Montefeltro (now at the Metropolitan Museum, New York); and (b) by Fra Giovanni da Verona (ca. 1520) at the *Monte Olivetto Maggiore Monastery*.

In many of these cases, the mazzocchio seems to have been featured as a demonstration of the technical prowess of the artist or artisan – to show off his or her ability to render perspective convincingly. Sometimes it may have been incorporated into an image to indicate the depth and/or orientation of the wearer, such as in Figure 1a. The early Italian Renaissance polymath Piero della Francesca discussed and illustrated the construction of the mazzocchio in his treatise on perspective *De Prospectiva Pingendi*. Piero was both a painter and a “mathematicus” – a term often applied to a person who dealt with geometry as both basic mathematics and as an artistic tool to effectively render perspective in art. Unfortunately, there does not appear to be a modern book or even an extensive review article devoted to the origins, history, artistic and mathematical aspects of the mazzocchio. However, references [1] and [2] provide some insights into its role in the history of perspective.

The Mazzocchio in 20th and 21st Century Art

The mazzocchio seems to have more or less disappeared between the 16th and 20th centuries as an object for incorporation into works of fine art. It has re-emerged in the 20th and 21st centuries in both painted and sculptural works. A few examples that employ different artistic techniques are shown below in Figure 4.



Figures 4 a (l.), b (c.) & c (r.): 20th and 21st century examples of art that includes mazzochios: (a) wood intarsia by Italian artist Fumagalli Nanni; (b) painting by French artist Sylvie Donomoyer; (c) serigraph by Italian artist Mario Logli.

Modern Three-Dimensional Mazzochios

We have constructed real three-dimensional mazzochios out of both wood and plastic (Figures 5 a, b and c). Holding and viewing the actual objects adds richness to the visual experience provided by the two-dimensional representations that appear in paintings, graphics and in intarsia.



Figures 5 a (l.), b (c.) & c (r.): (a) Edge on view of plastic skeletal mazzocchio fabricated using stereolithography; (b) and (c) face on and edge on views of a handmade wooden checkerboard style mazzocchio. Each of the mazzochios has an outer diameter of approximately 10 inches (25 cm).

Two Mazzocchio Perceptual Effects

When viewing the real three-dimensional checkerboard wooden mazzocchio, two novel visual phenomena reveal themselves immediately. These effects do not seem to have been discussed in the vision science literature. There also appears to be no mention of these perceptual effects in the literature of art history. Looking - either monocularly or binocularly - at the wooden mazzocchio that we have fabricated which consists of 16 alternating dark and light segments circumscribing the overall toroidal shape, the outer sides of the individual segments appear to bow *inward*. That is, the flat outer surfaces appear curved in a direction opposite to the global curvature of the toroidal shape. By making an array of flat paper n-gons, the dependence of the effect on the number of sides of the figure can easily be explored - though only in two dimensions. The concave effect appears to be strongest when viewing a polygon containing 15 - 20 segments. With too few segments the edges appear flat as they indeed are; and with too many segments, the outer edges appear to take on the *convex* outward shape of a circle. What causes the *concave* outward mazzocchio segment effect is not totally clear. The well known Wundt and Hering illusions - that also include straight lines only (but with intersections) - do give rise to the percept of curvature. However in the case of the mazzocchio, there are no intersecting lines.

A second visual effect is less puzzling. When viewing a three-dimensional wooden mazzocchio monocularly, several of the inner segments can appear to form cubes within the torus. This is indeed a fairly clear purely geometrical perspective effect. It can be seen to some extent on the right and left insides of the Gubbio mazzocchio intarsia (Figure 3a) and in the upper and lower inside regions of the photograph of the actual wood mazzocchio shown in Figures 5c.

The first effect cannot easily be seen when viewing the two-dimensional representations of a mazzocchio. Seeing the effect well is something that requires viewing an actual three-dimensional model. Both visual effects do raise the interesting question: did the 15th and 16th century artists have actual three-dimensional models before them when they produced their art? Or were they such great masters of perspective that they only required their mind's eye to be able to see the objects - and then they could depict them accurately as if they were being viewed (monocularly) in three-dimensions?

Summary

The mazzocchio is an intriguing mathematical object. It has not received nearly the attention as have, say, the Platonic solids. Nonetheless, holding and viewing real three-dimensional exemplars is well worth the effort involved in making them.

Acknowledgments

I thank the independent artist/craftsman Randy Rhine for making the wooden three-dimensional mazzocchio shown in this paper. Boston University undergraduate Geshan Weerasinghe created the stereolithography file and Boston University engineer David Campbell "printed" the plastic skeletal mazzocchio shown in this paper. We will post the .stl file that was used to create the skeletal mazzocchio on the web site for "Project LITE: Light Inquiry Through Experiments" (<http://lite.bu.edu>). Project LITE is supported in part by NSF Grant # DUE - 0715975.

References

- [1] M. Kemp, *The Science of Art*, Yale University Press, New Haven, 1990.
- [2] L. Massey (ed.), *The Treatise on Perspective*, Yale University Press, New Haven, 2003.