Ivory Polyhedra Turned on a Lathe

Tibor Tarnai
Department of Structural Mechanics
Budapest University of Technology and Economics
Müegyetem rkp. 3.
Budapest, H-1521 Hungary
E-mail: tarnai@ep-mech.me.bme.hu

Abstract

A morphological survey of nested ivory spheres and polyhedra made by turning in Europe between the 16th and 18th centuries is presented, different polyhedra are identified, and examples of related objects of art of known ivory collections are shown. These examples convincingly demonstrate the high level of geometrical knowledge of the old master turners who produced these objects.

Ivory Polyhedra as Works of Art

Nowadays souvenir shops in China sell “devil’s work balls” or “puzzle balls”, that is, multiple spherical nested shells made of jade, sandalwood or artificial ivory. During the Qing Dynasty, such multi-layer balls turned on a lathe were made of ivory with piercing and rich figurative carving. The manufacturing technology required radially drilled conical holes whose number is 12 or 14; 12 holes at the face centres of a regular dodecahedron, while 14 holes at the face centres of a cuboctahedron. For these Chinese balls, mainly the aesthetic appearance was important, and geometry was just something necessary to it. It is little known how their making started. The only thing that we know is that Chinese balls already existed in the 14th century. The book [1] made mention of a three-layer ball.

Similar ivory art objects appeared in Europe in the second half of the 16th century [2]. Their manufacturing method [3] was developed in Germany. The art of turning ivory was prosperous until the 18th century when with the appearance of porcelain the art of ivory carving started to decay and gradually ceased to exist. Contrary to the Chinese balls, the European balls have a smooth surface and a polyhedron-like shape and their beauty came from the perfect geometry. The polyhedral form shows a high level of geometrical knowledge of the artists, and this is also why the number of applied holes is not only 12 or 14, but many more (e.g. 6, 18, 20, 24, 26, 32). Another feature is that often radial spikes come through the holes from the core of the ball, but such spikes are missing from the Chinese balls. Multi-layer spheres and polyhedra usually occurred as parts of objects, for instance, decorations on the lid of a goblet as shown in Figure 1.

Ivory carvings were among the rarities collected by wealthy people and displayed in a *Kunstkammer* (cabinet for art or curiosities). The ducal and royal *Kunstkammer* pieces formed invaluable collections.

In this paper, we present a morphological survey of nested ivory spheres and polyhedra made by turning, and show examples of related objects of art of known ivory collections, e.g. Grünes Gewölbe, Dresden [4], Kunsthistorisches Museum, Vienna [5], Danish Royal Collections, Copenhagen [6], Museo degli Argenti, Florence [7], Ashmolean Museum, Oxford [8], Conservatoire National des Arts et Métiers (CNAM), Paris. We want to determine what kinds of polyhedra are present at these objects.

(a) (b) (c)

Figure 1: *Turned ivory goblets, Danish Royal Collections, Rosenborg Castle, Copenhagen: (a) Inv. no. 2701, probably made in Nuremberg, 1600-1650, (b) inv. no. 2703, probably made in Nuremberg, c. 1650, (c) inv. no. 2748, goblet with crowned CA for Duke Christian Albrecht of Holstein-Gottorp, turned by Caspar Zick the elder in Nuremberg in 1685?*

Results

Turners of the Renaissance and of the baroque era knew well geometry in general and polyhedra in particular. Over that period, several books were published on regular polyhedra and their derivatives. This is why so easy to find examples of the five *Platonic solids* among ivory turnings. Two of them are represented in Figure 2: tetrahedron (Figure 2a), dodecahedron (Figure 2b).

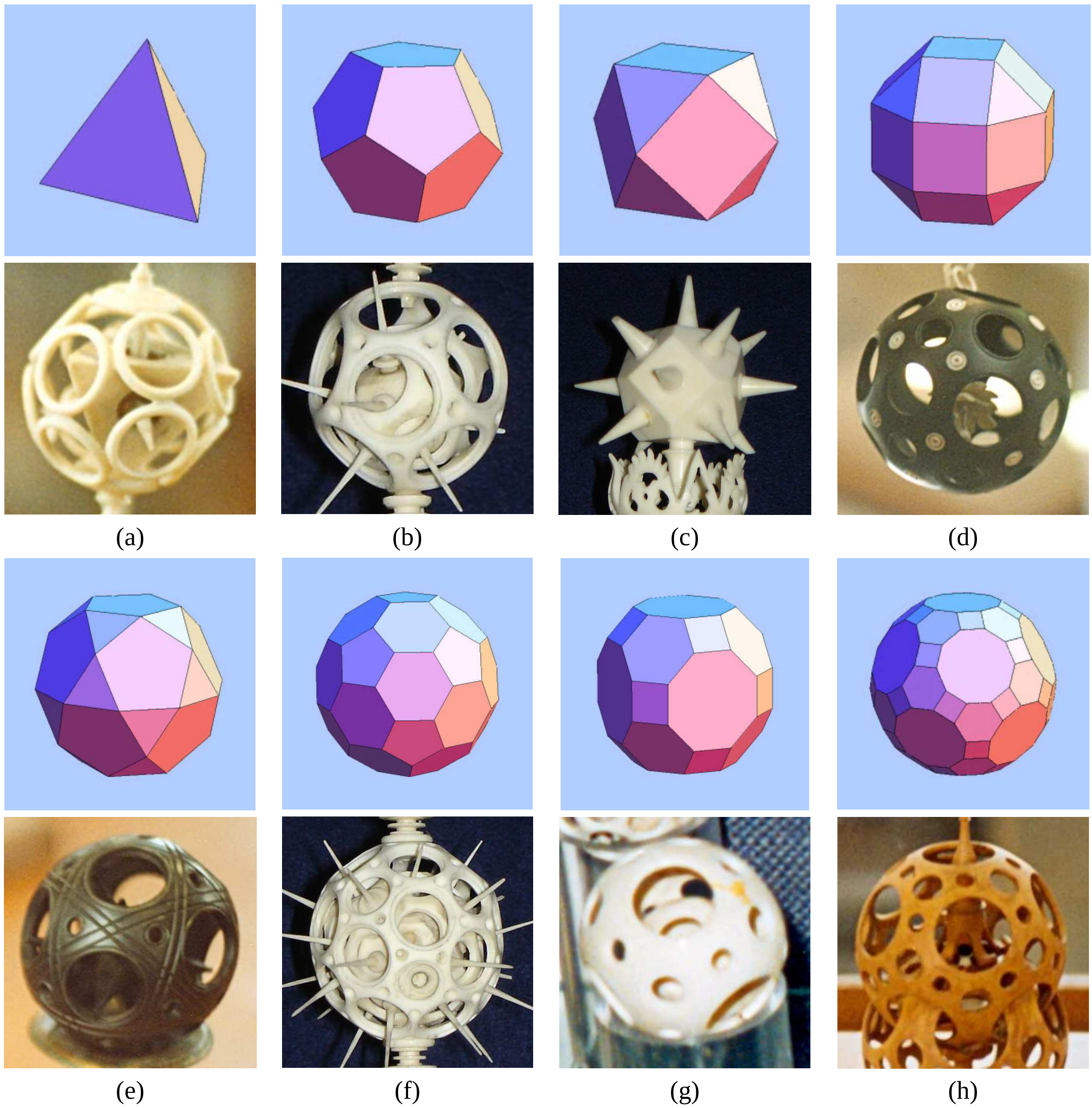

Figure 2: *Some identified polyhedra. (a) Tetrahedron, François Barreau, around 1800, detail, inv. no. 104-23, CNAM Paris. (b) Dodecahedron, detail of the goblet in Figure 1a. (c) Cuboctahedron, detail of the goblet in Figure 1b. (d) Rhombicuboctahedron, F. Barreau, around 1800, ebony, inv. no. 104-2, CNAM Paris. (e) Icosidodecahedron, F. Barreau, around 1800, ebony, inv. no. 104-57, CNAM Paris. (f) Truncated icosahedron, detail of the goblet in Figure 1a. (g) Great rhombicuboctahedron, probably German, first half of the 1600s, inv. no. Pl. CXX No. 242, Tradescant Coll., Ashmolean Museum, Oxford. (h) Great rhombicosidodecahedron, F. Barreau, boxwood, around 1800, inv. No. 104-8, CNAM Paris.*

The *Archimedean solids* are solid polyhedra whose all vertices are equal but not regular, and all faces are regular but not equal. In the late Renaissance, these solids were known. There exist 13 Archimedean solids (and two additional infinite classes of prisms and antiprisms) from which, among the studied turnings, we could find: cuboctahedron (Figure 2c), rhombicuboctahedron (Figure 2d), icosidodecahedron (Figure 2e), truncated icosahedron (Figure 2f), great rhombicuboctahedron (Figure 2g), great rhombicosidodecahedron (Figure 2h), and the truncated octahedron that is not presented here.

The *Catalan solids* are solid polyhedra whose all faces are equal but not regular, and all vertices are regular but not equal. Catalan solids are duals of the Archimedean ones. In the Renaissance, only some of them were known. We found one Catalan solid among ivory turnings in the Grünes Gewölbe collection in Dresden: deltoidal icositetrahedron (the dual of the cuboctahedron) and another one in the Museo degli Argenti in Florece: rhombic triacontahedron (the dual of the icosidodecahedron). We cannot show them.

Concluding Remarks

Studying ivory spheres and polyhedra made by master turners on a lathe in the 16th, 17th and 18th centuries, we discovered their geometrical background. From the studied material, in the actual turned ivory (wood) objects, we could identify five Platonic polyhedra, seven Archimedean polyhedra, and two Catalan polyhedra.

Although the art of turning ivory does not exist today, fortunately, the spirit of the Renaissance and baroque master turners survives in the activities of ornamental turning professionals such as David Springett [9] who is able to reproduce such an intricate piece as a pair of interlocked hollow spheres (Figure 2h) introduced by the French virtuoso turner François Barreau, that is difficult to think how it was produced on a lathe.

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