

Euclid in tiles: the mathematical *azulejos* of the Jesuit college in Coimbra

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The mathematical glazed tiles (*azulejos*) of the Jesuit college in the city of Coimbra, in Portugal, are remarkable and unique artifacts. They seem to be the only known example of glazed tiles for classroom use displaying geometrical diagrams of true mathematical (Euclidian) demonstrations. Scientific motifs as decorative elements in buildings were widely used in Europe and, in particular, in spaces built by the Society of Jesus.¹ Panels of *azulejos* using ornamental mathematical motifs are well known in Portugal and elsewhere. But the mathematical *azulejos* of Coimbra are unique in that they are genuine *didactical aids* to the teaching of mathematics and not merely decorative artifacts.

Azulejos (painted, glazed, ceramic tiles) are an ancient technique of decorative surface cover used in architecture and other forms of artistic expression. The technique has been known since Antiquity and some remarkable Babylonian examples are still extant. *Azulejos* were widely used in the Muslim world and introduced into Portugal around the fifteenth century. Since then they became a very popular decorative element in Portuguese architecture and are widely employed even today.² Besides their

¹See: Karel Porteman, «The Use of the Visual in Classical Jesuit Teaching and Education», *Paedagogica Historica: International Journal of the History of Education*, 36 (2000) 178–196; Volker R. Remmert, *Picturing the Scientific Revolution*, translated by Ben Kern [= Early Modern Catholicism and the Visual Arts Series, vol. 4] (Philadelphia: Saint Joseph's University Press, 2011), originally: *Widmung, Welterklärung und Wissenschaftslegitimierung: Titelbilder und ihre Funktionen in der wissenschaftlichen Revolution* (Wiesbaden: Harrassowitz, 2005).

²On the general history of glazed tiles (*azulejos*) with ample information about this art form in Portugal, see: *The Splendour of Cities. The Route of the Tile* (Lisbon: Calouste Gulbenkian Foundation, 2013) and João Miguel dos Santos Simões, *Azulejaria em Portugal no século XVIII* (Lisbon: Fundação Calouste Gulbenkian, 1979).

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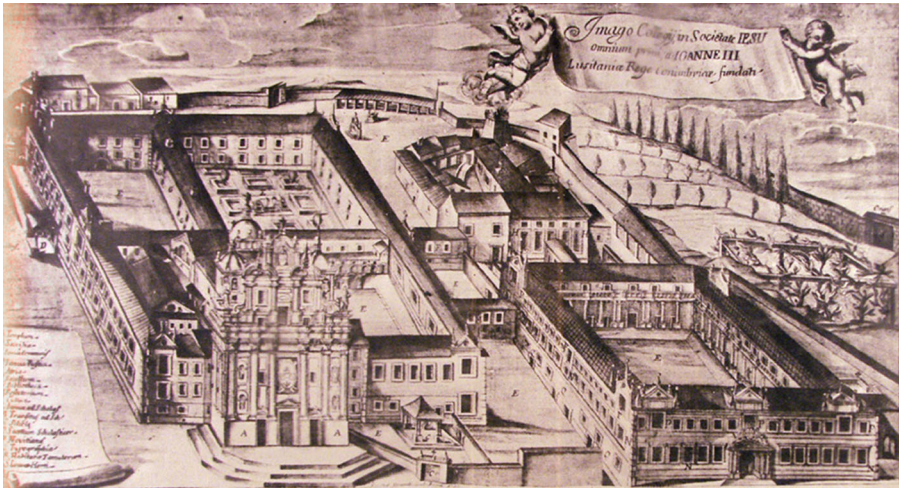


Fig. 1 The Coimbra Jesuit College in 1732

artistic value tile panels have also obvious advantages as protective elements in public buildings such as schools, hospitals or other where intense circulation of people leads to rapid degradation of the walls. Today's Lisbon underground, for example, is known for its exquisite modern tile panels.

In 1982 an article in a Portuguese weekly newspaper pointed to the existence of a few *azulejos* (and fragments of them) that displayed mathematical diagrams.³ Even for a country where *azulejos* are very common this was a surprising find that immediately prompted new searches. Within a few years several other of these mathematical *azulejos* were located, either in private collections or in the storages of museums. Today 31 different tiles (either fragmentary or integer) are known: 20 are at the *Museu Nacional de Machado de Castro* (in Coimbra), 3 are in the *Museu Nacional do Azulejo* (in Lisbon), and the rest dispersed in smaller or private collections.⁴ That the largest group of these *azulejos* was located in a museum in Coimbra was a first indication towards the fact that perhaps the origin of the tiles were to be found in that city. This was confirmed in 2010 when fragments were discovered *in situ* by a team of archaeologists excavating at the former Jesuit college in Coimbra (Fig. 1).⁵

The story of these mathematical tiles is not yet clear in all details but historians agree upon the most important facts. The mathematical *azulejos* of Coimbra are as-

³Francisco Hipólito Raposo in newspaper *Expresso*, November 6, 1982.

⁴In 2007 many of these tiles were on display in an exhibition in Coimbra. The exhibition's catalogue has ample information on the *azulejos*: Carlota Simões and António Leal Duarte (eds.), *Azulejos que ensinam* (Coimbra: Museu Nacional Machado de Castro e Universidade de Coimbra, 2007). See also: Rosário Salema de Carvalho, Samuel Gessner and Luís Tirapicos, «Astronomy and Azulejo panels in Portuguese Jesuit colleges», in: F. Pimenta, N. Ribeiro, F. Silva, N. Campion, A. Joaquineto and L. Tirapicos (eds.), *Stars and Stones. Proceedings of the SEAC 2011 Meeting*, in press.

⁵The fragment of a tile (a 5 × 5 cm fragment) was discovered *in situ* in November 2010 when archaeologists were excavating in the former Jesuit college. See Carlota Simões, «Azulejos com História. A peça que faltava», *Revista Rua Larga* [Universidade de Coimbra], 31 (2011) 38–41.

Fig. 2 *Azulejo* with diagram for Proposition 29 of Book I of Euclid's *Elements*: "If the straight line GO intersects the two straight lines AB and CF such that angle GLB is equal to angle LOF (or, the sum of angle BLO and angle LOF is identical to two right angles) then the two intersected straight lines are parallel". (Tacquet's proposition 29 is usually number 28)

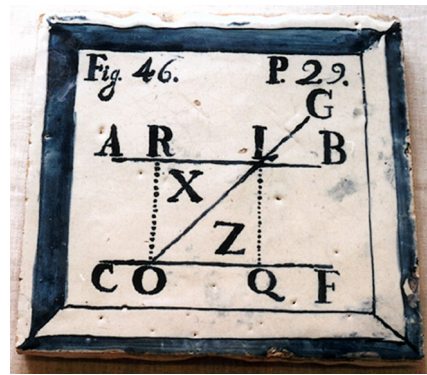
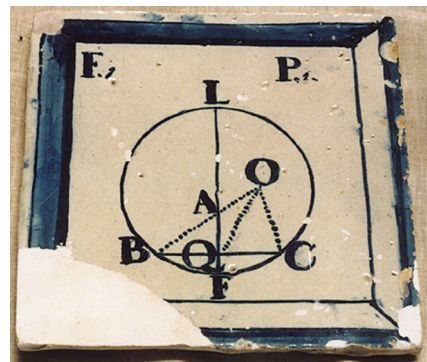


Fig. 3 *Azulejo* with diagram of Proposition 1 of Book III: "Given a circle to find its center"

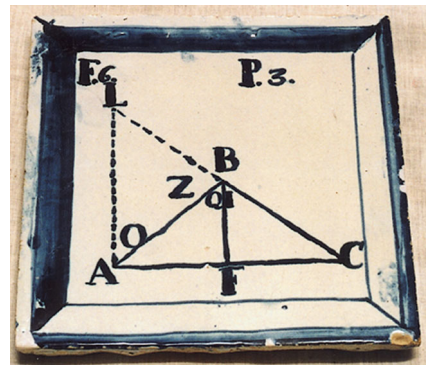


sociated to the Jesuit College in that city and date from the early to mid-eighteenth century, roughly around 1740. Most of the tiles display geometrical diagrams from Euclid's *Elements*, while a few of them illustrate other scientific matters: hydraulics, astronomy, geography. Although the physical appearance of these *azulejos*—the very common Portuguese monochrome tin-glazed earthenware of blue and white type—and the manufacturing technique used are standard for the early eighteenth century, they come in a non-standard size, 20×20 cm, when *azulejos* usually were (and are) cut in squares of 14×14 cm. This was most likely due to the need to fit sufficiently large mathematical diagrams on a single piece so that they were visible in the classroom (Figs. 2, 3, 4).

All evidence leads to the conclusion that they were once applied on the walls of the mathematics room of the Jesuit college in Coimbra and that they were used as teaching aids in mathematical courses. No contemporary descriptions of this room are known, albeit it must have been an impressive sight with, presumably, more than 200 mathematical tiles. Besides the absence of documents or references to the use of these tiles, a certain mystery also surrounds their fate: if they were applied to a wall, why were they torn out and most of them destroyed?

As explained above, the majority of the Coimbra mathematical *azulejos* display strictly geometrical (Euclidian) matters, while a few concern other scientific matters. The Euclidian diagrams are drawn from one of André Tacquet's famous and very pop-

Fig. 4 *Azulejo* with diagram of Proposition 3 of Book VI of Euclid's *Elements*



ular editions of Euclid's *Elements*, which were extensively used in Jesuit schools.⁶ The first edition, with the title *Elementa geometriae planae ac solidae quibus accedunt selecta ex Archimede theoremata* was published in 1654; many other editions and translations were published in the next decades.⁷ A Portuguese translation of Tacquet's *Elements* appeared in 1735, thus roughly at the same time as when the tiles were created, and it is tempting to relate the two events and assume that they were drawn from this edition. However, a closer examination reveals that this is not the case. It is clear today that the diagrams in the *azulejos* were copied from one (or more) of Tacquet's Latin editions.⁸

The *azulejos* were used when students had to study Euclid's *Elements*. It is known that the teaching of mathematics in Jesuit colleges required that students know by heart the demonstration of propositions of the first six books of Euclid. In every class, designated students had to stand in front of the blackboard and explain the demonstration using a diagram. Teaching required detailed analysis of these demonstrations and a considerable amount of repetition. Since in the early decades of the eighteenth century several Jesuit colleges in Portugal had decorative tile panels applied to their walls it seems clear that at some point teachers in Coimbra ordered the production of a collection of *azulejos* displaying the geometric diagrams of all the propositions needed. This would avoid using the blackboard and drawing a diagram every time a demonstration had to be studied while at the same time providing a striking visual impact. The desire for didactical innovation was typical of Jesuit teaching at the period but it is also possible that the decision was made in response

⁶This was identified by António Leal Duarte from the Mathematics Department of Coimbra University.

⁷On Tacquet's mathematical work and information about the various editions of his *Elements*, see: H. Bosmans, «Le Jésuite mathématicien anversois André Tacquet (1612–1660)», *Gulden Passer – Compas d'Or*, 3 (1925) 63–87; O. Van De Vyver S.J., «L'école de mathématiques des jésuites de la province flandro-belge au XVIIIe siècle», *Archivum historicum Societatis Iesu*, 49 (1980) 265–278; A. de Bruycker, «'To the adornment and honour of the city': the mathematics course of the Flemish Jesuits in the seventeenth century», *BSHM Bulletin: Journal of the British Society for the History of Mathematics*, 24 (2009) 135–146; Geert Vanpaemel, «Jesuit Mathematicians, Military Architecture and the Transmission of Technical Knowledge», in: Rob Faesen and Leo Kenis (ed.), *The Jesuits of the Low Countries: Identity and Impact (1540–1773)* (Leuven, Paris Walpole, MA: Peeters, 2012), pp. 109–128.

⁸See: Carlota Simões and António Leal Duarte (eds.), *Azulejos que ensinam* (Coimbra: Museu Nacional Machado de Castro e Universidade de Coimbra, 2007).

to the call for improvement of the mathematical training in Portugal. In 1692, the Society's general in Rome issued a set of regulations with the objective of improving the level of mathematical teaching in the Portuguese colleges. These regulations came with very specific instructions on the number of hours that had to be devoted to mathematics, the subjects to be taught, the manuals to be used—Tacquet's *Elements* were specifically recommended—the materials and instruments that classrooms had to be equipped with, etc.⁹ In the following years a program for the improvement of mathematical classes was established in what can be considered the first large-scale reform of mathematical education in Portugal. The production of the mathematical tiles should be understood within this specific educational context.

If the origin of these *azulejos* seems easy to understand, their fate is much more perplexing: why and when were they removed from the wall they had been applied to and most of them destroyed? The most likely explanation of their dramatic fate amounts to the following: they were torn out from the wall of the Jesuit college in 1759 when, under the orders of the Marquis of Pombal, the Jesuits were banned from Portugal and their assets expropriated. To justify the persecution and expulsion of the Society of Jesus, Pombal resorted to a number of arguments. One of the most serious of these was the accusation that the Jesuits had been an obstacle to the modernization of the country and to the study of science. No historian today accepts such an accusation and indeed the mathematical tiles in Coimbra are tangible evidence of the Jesuits' commitment to scientific teaching and practice. It is very likely that precisely for this reason they were deliberately destroyed when the Jesuits were expelled from their schools. However, some tiles survived as silent but palpable witnesses of an old mathematical tradition.

⁹These regulations and related documents can be found in: Ugo Baldini and Henrique Leitão, «Appendices. [Appendix A: Documents and Letters; Appendices B: Theses of Mathematics from Jesuit Schools; Appendix C: Scientific Manuscripts from the Santo Antão College]», in Luís Saraiva and Henrique Leitão (eds.), *The Practice of Mathematics in Portugal. Papers from the International Meeting organized by the Portuguese Mathematical Society, Óbidos, 16–18 November, 2000*, Acta Universitatis Conimbrigensis (Coimbra: Imprensa da Universidade de Coimbra, 2004), pp. 635–758.