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*Useful knowledge, technological innovation and economic development
in the European ceramic industries, 14th-18th centuries**

1. Introduction

Despite the evidence to the contrary accumulated by historians, economists such as Joseph Stiglitz and Bruce Greenwald – among many others – continue to argue undaunted that «what distinguishes the modern era of the last two hundred years from the millennia that preceded is *learning*», another way of saying «knowledge» (Stiglitz and Greenwald, 2015, 29). A few years ago, I devoted some time to archaeology and for this reason I feel a predilection for a type of object to which historians pay relatively little attention, despite its unquestionable importance. I am referring to ceramics.¹ For millennia, ceramics have been essential in the domestic sphere and their production has undergone technological and cultural changes whose importance is so obvious that it is not worth pausing to justify it. Like fabrics, ceramics from the thirteenth century presented different modalities: they could be a luxury good or an accessible product, but in both cases, their consumption was very high, with an intense circulation both locally and internationally. The demand was subject to the effects of fashion with a deep cultural background, since the decoration conveyed images, both figurative and abstract, which were representations in the ideological sense of the term. Moreover, ceramics were not subject to reverse engineering. Having a glazed piece did not allow the physical and chemical processes of production to be broken down, and therefore the knowledge transfer necessary to make it had to be carried out by other means, in particular through the displacement of skilled artisans. It is true that ceramics have a limited economic impact compared to other goods, such as textiles, to name the most obvious. Popular ceramics are cheap and luxury ceramics have limited production. However, it is an industry that made the fortunes of some cities and regions and, in

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¹ The literature on the types of ceramics cited in the text is immense, but it comes almost always from the work of archaeologists or art historians. In the latter case, it is mostly from collection and museum or exhibition catalogs and tends to be very repetitive. The citations, therefore, are a very personal reading guide, but, in general, they contain additional bibliography that includes the classic works. In addition, the reader can easily find images of the ceramics discussed in the text on the Internet, which allows them to be omitted in this publication.

general, it was a product of high consumption and complex production that, in addition, is hardly recorded in the general summaries of technological development.²

My aim is to show in a very concise way how the production of European glazed ceramics underwent three phases of intense transformation of useful knowledge related to its production, with a successive accumulation leading to increasingly efficient results and a higher level of productivity. Moreover, it can be safely stated that, without this accumulation, the progress of the 19th century in this area would have been impossible.³

2. *Green and brown ceramics and the archaic majolica*

The first of these rapid increases in creativity and dissemination of ceramic production techniques took place during the 13th century throughout the Mediterranean. Between 1200 and 1250, the technical solutions needed to glaze ceramics, which were known in various parts of the Muslim world,⁴ were transferred to the Christian areas. In about thirty years, ceramics of this type were produced in Marseille, Barcelona, Valencia, Teruel, Pisa and Genoa, that is, throughout the western Mediterranean (*Vert et brun* 1995; Marchesi, Thiriot, Vallauri and Leenhardt 1997; Beltrán de Heredia 2007; Martí 1998; Ortega 2002; Berti and Gelichi 1995). In summary, the technological change consisted of the fact that the table ceramics were made by means of a double firing, the first to form the piece and the second to fix the decoration. This was done by painting with copper and manganese oxides and a solution of lead and tin oxides for vitrification, which give the name to this type of ceramic, «green and brown». Tin was fundamental because it made the background opaque and highlighted the ornaments. In the 14th century, cobalt blue was also introduced to increase the range of colours. The result was an affordable and colourful product, two qualities that ensured its commercialization and that fall within the chapter of «luxury of the poor». However, the same tableware, with heraldic or aristocratic motifs, was used at the tables of the urban nobles and patricians. The price was less important than the distinction derived from the chromatic richness, the images and even the personalization of these table services.⁵ It is nec-

² For example, Mokyr only mentions Josiah Wedgwood's experiments in the 18th century to produce porcelain (Mokyr 2002, 52; 100).

³ I will leave aside the common pottery, unglazed, undecorated or with simple decorations, intended for cooking and storage. It should be noted that many of these problems have been dealt with in the *Atti dei Convegni Internazionali della Ceramica del Centro Ligure per la Storia della Ceramica* (Albisola, Savona).

⁴ During the second half of the 9th century, formulas for firing, vitrifying and decorating ceramic pieces were developed in Iraq, which were accorded a high symbolic content in the aulic circles. In the Islamic West, these techniques were known from the beginning of the 10th century and were widely spread throughout the Maghreb, the Iberian Peninsula and southern Italy: Watson 2004; Bernus-Taylor 1995; Coll 2014; Coll and Salinas 2021.

⁵ Valencian artisans of the 15th century described the quality of the pieces alluding to social hierarchies: *obra de papa*, *obra de emperador*, *obra real* (pieces decorated in gold and blue). The ceramics of *obra de pinzell* were painted only in blue, while those called *obra de contrafeyt* were painted in green and brown: López Elum 2005.

essary, in any case, not to minimize the complexity of the procedures, which included the use of different types of clays, innovative ovens, very controlled firing temperatures, optimal use of metal products, decorative skill and knowledge of the tastes of demand (Berti, Gelichi and Mannoni 1997; Coll 2014, 73-89; Caroscio 2009, 41-48).

Entire towns, such as Teruel, Manises or Paterna, to mention only the Spanish ones, concentrated their industrial activity in the production of enormous quantities of these ceramics, which soon began the path towards an increasing technical sophistication, an increasing variety in ornamentation and extensive commercialization (García Porras 2009). This type of high-consumption cheap ceramics continued to be produced until modern times in Italy under the designation of «archaic majolica» in Faenza (Emilia), Montelupo (Tuscany), Orvieto and Deruta (Umbria), where production sometimes adopted formulas characteristic of rural industries (Berti 1984; Caroscio 2009, 51-112). Between the 15th and 16th centuries, the growing urban demand made the workshops carry out an increasingly standardized production in shapes and decorative motifs. In addition, they were reorganized to include an internal division of labour and to increase speed and productivity. It is also possible to observe the grouping of workshops under a single owner or an entrepreneur who marketed the production, for example, in Tuscany (Caroscio 2009, 40-41). Both Valencian and central Italian ceramics spread in northern Europe where they have been found in hundreds of archaeological sites (Blake 2021; Gerard, Gutierrez and Vince 1995). Finally, the rise of glazed ceramics must be measured by the gradual replacement during the 14th century of wooden or metal bowls and cups by the corresponding objects in this type of ceramics, as well as by the incorporation of sauce boats and large plates for the presentation of food on the table. From the end of the following century, the individual plate was slowly introduced and, with it, new forms of consumption of ceramics, which, in the Italian case, were mainly *ingobbiate* ceramics (the cover of the piece was made by a coating of a type of clay different from that which formed the body). This evolution in the use of table ceramics is much later in the northern areas of Europe (Caroscio 2009, 153-59).

It is important to note that in northern Europe varnished ceramics were produced, these were pieces with a transparent glass overlay that showed the background colour of the clay and therefore offered a much lower visual quality than the Mediterranean ones. Until the early sixteenth century in the Netherlands and until the second half of that century in Great Britain, potters did not obtain the appropriate knowledge to manufacture glazed ceramics, which indicates the difficulty of transmitting very specific industrial know-how. In fact, the vehicle for disseminating these techniques was the emigration of Italian artisans to the Netherlands and, later, of Flemish potters to Britain, fleeing from war and religious conflicts (Poole 1995; Goffin 2012; Veeckman *et al.* 2002).

3. *Gold-lustre ceramics and Renaissance majolica*

Throughout the 14th century, the Muslim workshops in Malaga and Granada perfected the formula for producing «gold-lustre» or «metallic» ceramics, which significantly modified the chemical components of the decorations and introduced a third firing, to obtain brilliant pieces characterized by combinations of gold and gold and blue on white. As it is easy to suppose, this technical innovation required an even more sophisticated knowledge of the physicochemical properties of ceramics and even more complex and prolonged learning processes. By the end of that century, the Valencian artisans of Paterna and Manises were already in a position to execute pieces of this high quality and flood the European market with their products, in which they were dominant until the end of the 15th century (García Porras, 2006; Coll, 2008). The emergence of this new body of technical knowledge led to the separation of high-end ceramics and aristocratic consumers and the most popular ceramics. The first concentrated the sequence of technical and ornamental transformations that we are going to examine, while the lower-level ones continued to use the traditional technical and cultural repertoire, while incorporating new colours and a wide catalogue of shapes and decorations. The success of these gold reflecting ceramics in Italy was particularly noteworthy, since they surpassed in attractiveness the archaic majolica that had not managed to evolve sufficiently to meet the demands of the elites (Spallanzani, 2006; Orlandi, 2019: 571-572). The emergence in the Mediterranean area of ceramics that are often called «de Málaga» or «Hispanic-Moorish», regardless of where they would have been manufactured, is the beginning of the second great phase of technical and cultural creativity to which I have referred.

The hegemony of Iberian ceramics was broken around 1500, when the knowledge necessary to manufacture these productions of gold lustre was disseminated in the Italian centres. During the first decades of the 16th century, Italian ceramics gradually took over the European luxury and semi-luxury market.⁶ On the basis of the previous findings both in the preparation of the pigments and in the firing systems, the *Renaissance* majolica adopted an extraordinarily rich expressive language, both for the complexity of the more or less abstract ornaments and for the figurative designs, with representations typical of the painting of the time.⁷ The success of these ceramics can be measured by the multiplication of the production centres, the specialization of each of them in shapes, colours and decorative aspects, as well as by their export to all Europe and America.⁸ The example of Faen-

⁶ However, still in 1581 *piatti alacatalana de Deruta* and *piatti alacatalana romaneschi* («Catalan dishes from Deruta» and «Roman Catalan dishes») were sold in Rome, indicating the prestige that Valencian productions (here, qualified as «Catalan») still retained (Pesante, 2019: 58).

⁷ The variety of decorations serves to classify these maiolicas into groups: those called *istoriato* for including narrative scenes, *grotesques* for using motifs derived from the findings of the Neronian *Domus Aurea*, and *porcelains*, for imitating the details of Chinese porcelains that were beginning to arrive in Europe (Syson 2016).

⁸ The literature is dominated by catalogs of large museum collections: *Maiolica* 2016; Hess 1988; Thorton and Wilson 2009; Wilson 2017, among many others. For a study of the origins of these centers: Caroscio 2010. A synthesis on maiolica: Wilson 2007.

za, which gave its name to glazed ceramics in English or French, is very significant, but it is not unique: Deruta, Perugia, Urbino and Montelupo are other places where this industry flourished. Many of the surviving pieces are genuine works of art and are listed in the catalogues of the property of 16th-century princes. But the interesting thing about these ceramics is that their value was not as considerable as that of other precious objects and they had a demand that was not restricted exclusively to the upper classes. Price calculations suggest that top-quality ceramics were ten times more expensive than majolica, which was not an unbearable cost for relatively large layers of the population. This implies that marketing remained large on a social and geographical scale.

However, the technical difficulties resulting from the third firing were the cause that high range production was only 10% of the total output of the ovens, judging by the archaeological findings in places such as Cafaggiolo (Caroscio 2010, 99). On the other hand, the circulation of artisans in Italy and outside the peninsula meant that technical knowledge was already far from being a secret at the beginning of the 17th century and multiplied the production centres. Finally, the commercialization favoured mutual influences and imitations between the different areas of ceramic manufacturing, at least in the decorative aspect.

The adoption by Italian potters of the techniques of enamel and gold lustre originating in the Iberian Peninsula marked the beginning of an expansive movement of these productions on a European scale during the early modern age. Therefore, it is reasonable to state that the first feature that characterizes this second phase of the industrial development of glazed ceramics is the loss of Mediterranean exclusivity in the technological knowledge necessary to produce them. From the beginning of the 16th century, the dissemination of Italian technical knowledge passed to France and the Netherlands and reached Great Britain and other regions of the north and northeast of the continent from the following century.⁹

Secondly, ceramics ceased to be only a functional element such as tableware to acquire a huge variety of uses. In particular, the beauty of the large plates and vases commissioned by the aristocratic elites made them objects of artistic exhibition. However, it is not easy to distinguish when these magnificent pieces were also used in sumptuous activities. Orders of complete tableware sets suggest that they often continued to have practical value. In addition, the artistic intention caused the morphologies of the pieces to multiply to include not only practical objects, but also a very wide series of small ornamental sculptures.¹⁰ This obviously implies an uninterrupted sequence of technical progress, in which we find all kinds of forms of knowledge transfer, from industrial espionage to the circulation of artisans.

Finally, it is necessary to emphasize the economic aspect of the manufacture of ceramics in this period. Undoubtedly, raw materials were affordable and, at least

⁹ During the 16th century, several Italian craftsmen specialized in the manufacture of maiolica pottery settled in Lyon and Nevers: Rosen 2021: chap. 4 and 5. In the second half of the 17th century, under the impulse of Colbert and a general increase in the demand for ceramics, the production sites of *faïences* multiplied: Rosen 2021: chap. 6. From 1550, Italian master potters were documented in Delft and other cities in the Low Countries and the production of glazed ceramics began.

¹⁰ I have deliberately left out the use of glaze on tiles, which, however, was one of the important sectors of ceramic activity, since it would involve a problem as wide-ranging as the one discussed here.

since 1450, the skill of painting specialists accounted for most of the final cost of the pieces. As with other items in the pre-industrial era, low artisan pay and accessibility did not preclude considerable buyer interest and significant appreciation for the quality they achieved. However, it is necessary to avoid an exclusively aesthetic perspective of ceramics. Low prices are not synonymous with subsidiary value in the area of the productive economy. On the contrary, as Richard Goldthwaite has shown, the Italian centres had real entrepreneurs, both merchants and master potters. The classic example of Faenza suggests that we should pay attention to the massive increase in production in Italian cities and semi-urban centres and, later, as in Delft, in northern Europe.¹¹ On the other hand, the expansion of majolica must be seen in the context of the increase in the capacity of European societies to consume since the late middle ages, as evidenced by recent historiography, both in economic and cultural history.

4. The age of porcelain

At the same time that Renaissance majolica was triumphant, Chinese porcelain arrived in Europe in increasing numbers, both from Portuguese factories in the East and through the Manila galleon via America. They were immensely appreciated ceramics from several centuries before and their presence in the market caused the third major technological upheaval to which I have referred.

Chinese ceramics were significantly different from European ceramics in their technical processes – in particular, firing – but, above all, because of their essential raw material, kaolin. Without this component, the whiteness, the blue decoration, the rigidity, the nuances of brightness and transparency, in a word, the sensuality of the porcelain, was unattainable to Western potters. That doesn't mean they didn't try to emulate them. From the second quarter of the sixteenth century, Italian artisans sought to reproduce Chinese porcelain through majolica, with appreciable results only in the decorative field. It was the beginning of a major technological effort at European level to supply a market that demanded porcelain or imitations at all costs. The evidence that Chinese ceramics were of a higher technological level – and manifested a production of global dimensions – led Europeans to buy huge quantities of porcelain. It is not worth insisting on the obsessive collecting of some kings and princes of this period, but it is worth noting that porcelain was transformed into a global commodity with a very large cultural impact (Krahe 2016; Weststeijn 2014). The proof is that wealthy Europeans asked Chinese artisans to copy the typologies of typical Dutch, Venetian or French objects and even to adapt the decorations to the Western taste, with narrative and heraldic motifs (Finlay 2010).

¹¹ Goldthwaite (1989, 14) also insists that the economic importance of ceramics should not be overestimated, but the indications of archaeologists are decisive in showing the enormous demand that existed for glazed ceramics. Glazed ceramics are found in all excavated sites of a chronology after the 15th century. A concrete example of the economic importance of pottery on a regional level: Musgrave 1997.

European imitations failed in strict terms, as no porcelain equivalent to Chinese porcelain was produced until the 19th century. But this failure was relative because under a state or private inspiration the third great phase of technical innovation took place with the appearance of the potteries of Delft, Lisbon and Talavera (Van Dam 2004; Lahaussais, Dumortier, Bierboer and Van Dam 2008; Lahaussais 1998; Seseña 1989; Frothingam 1944). A stage that culminated with those of Sèvres, Meissen and the ceramics of Josiah Wedgwood in England already in the middle of the 18th century (Walcha 1975; Brunet and Préaud 1978). As in previous phases, these productions combined medium-range ceramics with true works of art of exquisite level. In any case, they all contributed to meeting a very high demand. By way of example, Delft pottery in the 18th century gave the name – *delftware* – to all the pseudo-porcelain that circulated in Britain regardless of its place of production.

I will take as an example of the economic importance of the ceramic industry at this time the Alcora factory in Valencia, founded in 1727 and directed with an extraordinary personal effort by the Count of Aranda, the greatest politician of the Hispanic monarchy of the Enlightenment (Peris 1996; Coll 2009; *El esplendor* 1995). The declared objectives –besides generally strengthening Spanish industrialization– were twofold: to make porcelain and to supply the Hispanic market.¹² This second part was achieved: the annual average of pieces that came out of the Alcora furnaces was around 220,000, with a maximum between 1752 and 1763, years in which 4 million pieces were produced. At the height of production, more than 300 workers worked in the facilities, of whom a quarter were apprentices. There were schools in the factory where specialists were taught drawing and painting. Six ovens were used to cook the pieces in the different stages of production.¹³ Some more were added for the so-called «*pipe clay*» and for the «soft-paste» porcelain, variants that were not real porcelain but that were as close as they could get with the raw materials available. The marketing included Italy, France and Hispanic America, but the distribution took place mainly in the Spanish territory through an extensive system of shops and factories.

The Count of Aranda failed to obtain authentic porcelain, but it was not for lack of initiative, since he hired French and German experts on several occasions to apply the appropriate chemical formulas, but the lack of kaolin could never be overcome. Despite this, Alcora's ceramics sustained the comparison both in quality and in decorative richness and adaptation to the tastes of the time with the great European factories, at least until 1800, when the war and the disappearance of the American empire definitively weighed down this experiment of enlightenment.

5. Conclusion

This journey through the medieval and modern history of ceramics clearly shows that over these centuries there has been an exceptional accumulation of use-

¹² In 1727 it is stated that they intended to manufacture ceramics «in the manner of China, Holland and other localities» (Coll 2009, 177).

¹³ The two largest kilns could produce between 25,000 and 30,000 pieces. There were 12 potter's wheels working continuously.

ful knowledge about the properties of clays, the chemical components of decoration, the effects of heat and the forms of ornamental representation, through very active phases of experimentation. The circulation of this knowledge led to forms of hybridization of such peculiar products as European Chinese imitation porcelain or Chinese ceramics with western decorative motifs. The transmission of this knowledge includes all possibilities, from the traditional teaching of masters to apprentices to the displacement of specialized artisans and, of course, espionage, not to mention the actions of a state nature to promote these prestigious productions. It is important to underline the notion of «prestige», since raw materials, with a few exceptions, were not expensive and what really made ceramics expensive was the work of painters and decorators. However, only select or custom-made pieces constituted true luxury items, although they are the ones that have survived best. Much of the production was oriented towards markets with a certain purchasing power and in which there was a strong demand for social distinction. Ceramics is part of the development of a modern consumer society, together with silk and cotton fabrics, tea or chocolate, and, consequently, was subject to the imperatives of fashion. This explains the enormous and ever-increasing proliferation of different forms of these objects. The catalogue of Alcora, around 1750, had 300 different models, and in the rest of European industries the phenomenon was similar, at least since the sixteenth century.

Technical knowledge, demand and intense commercialization in the first stage of globalization promoted productivity growth, which should be examined on a case-by-case basis, production centre by production centre, something that is yet to be done, since ceramics are usually studied by art historians and not by economic historians. But in all the phases of development that I have pointed out, processes of specialization or division of labour, economies of scale and standardization took place, the latter even with greatly expanded repertoires. Therefore, it seems to me impossible to deny that productivity grew in each of these cycles and with it a mass production. Other factors, such as differences in quality and management from workshops and craft corporations in terms of target market strata, should be examined. But I will content myself with insisting that the enormous development of the medieval and modern ceramic industry would have been impossible without high technical knowledge in the framework of a pre-industrial knowledge economy.

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