



Evolution of the design and decoration processes of ceramic tiles

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Abstract

Ceramic tiles offer a technical and aesthetical solution very attractive for the covering of any kind of floor, regardless size, employment and environmental constraints. The designs of the decorated surface of the product have varied enormously since the beginning of the employment of the ceramic tiles in construction, both in considering the creative phase and the printing technology. In this work we relate the evolution of these two factors, their relationship through time and the last tendencies of the sector, where digital image processing and inkjet printing are gaining importance.

1 Introduction

The ceramic tile sector faces a very competitive market, with a very demanding final user. Researchers and enterprises have put their efforts in the improvement of the ceramic materials, and the diversification of the designs of the decorated surface.

With regard to the decorative design, creative staff offer new proposals every year. Traditional motifs are combined with innovative aesthetics, such as the imitation of wood, metal, natural stone, or the employment of reliefs and landscapes as inspiration.

This work relates the historic evolution of these factors, their relationship along time and the last tendencies of the sector, where digital image processing is gaining importance.

2 Traditional decoration techniques and motifs

First evidences of ceramic tiles in the Iberian Peninsula belong to the expansion of the Neolithic [1]. Ceramic materials have notably evolved through these centuries, and with respect to their decoration, vitrification has widely improved and the color palette has been extended. Until the XV century, ceramic tiles were manually decorated. A white enamel was first applied, and then a raw glaze.

Finally, manual decoration took place [2]. In the XVIII century, the color palette had been considerably extended, since iron (oranges) and antimony (yellows) are used together with copper, manganese and cobalt [3].

Four different traditional techniques were used: tiled, dry string, basin and edge and the pictorial, characteristic of the flat tile.

Tiled is a mosaic of vitrified ceramic parts ("alicerces"); dry string is an ornamental motif delimited by some lines traced with a mixture of manganese oxide and grease; and

basin is the technique where ornamental motifs are separated by a series of cavities created with a stamp [4].

By means of these techniques, Aragonese monochrome tiles of the XIV century can be found, which include white, green and black vitrified parts [5], Seville tiles with reliefs of the XV century, dry string and basin tiles with diverse motifs (female faces, flowers and vegetables, towers and tracery drawings); and Valencian tiles of the XV century [6].

Delft tiles also had a large recognition. They gathered the influence of the Chinese porcelain and its imitations, spread out through Europe from the Netherlands. This decoration kind of decoration, based on independent topics executed with fine brush, is imitated the Iberian Peninsula since the XVII century [7].

3 Current ceramic design and decoration

These days, the available equipment for the ceramic decoration are mostly gravure rolls and silk screen.

By means of both technologies, the decoration of the tiles is produced by the sequential deposition of the different inks. If a design is made of three different colors, the part should undergo three gravure rolls or three silk screens to receive the definitive decoration.

This decoration process could be suitable for simple decoration, whose colors are obtained by the combination of a reduced number of inks. Nevertheless, these technologies are not adequate for more complex motives or textures, where intermediate colors are required, and the accuracy and resolution of the result must be high.

Moreover, these traditional systems have a high variability (undesired color differences between tiles), which causes nonconforming products and additional production costs [8]. They also are systems with high production inertia, and therefore should be used with large lots (something more and more old-fashioned in today's industry).

The design process has changed very little itself. Many companies have integrated CAD (Computer Aided Design) tools in their creative departments, but its usage still is very artisanal. In most cases, images directly acquired by the company or bought from some other company are edited with commercial software to get particular effects and adapt the image to the decoration technology.

The combination of these two factors (design and decoration technology) has resulted in the slow and rigid ceramic design process. All this causes unnecessary launch costs, longer development and manufacturing cycles, and unaffordable stocks. Such waste of time and money is inadmissible in such competitive industry, and it is also constraints the creating and organizational possibilities of the companies.

4 New inkjet decoration for ceramic products

The decoration of surfaces using inkjet also known as inkjet decoration, allows the printing of multicolor complex motifs at high quality standards. With this technology, final colors are generated by the close deposition of drops of the different inks, typically cyan, magenta, yellow and black (the so called CMYK color space). The human eye perceives this fine screening of droplets as an homogeneous surface, whose color is the mixture of the basic ones. In this way, it is possible to print any kind of motifs and textures at high resolution, without the technical limits of the traditional technologies.

Inkjet printing has been widely used in the field of the Fine Arts since the 90s. However, its entry in the ceramic tile has been more recent. This retard has been due to the need of special inks, which were able to have a proper response during the firing process.

There are several companies offering ceramic inkjet printers with similar characteristics. They are specially focused in ceramic tiles, but some machines are able to décor special parts as well. Currently, the decoration of ceramic tiles with inkjet printers is extending their presence in the ceramic tile sector, since it could cover the shortages of the traditional methods [9]. But despite the effort done by the ceramic tile companies in buying this new technology, the actual employment of the inkjet printers has been relegated to the manufacturing of parts whose decoration is impossible to be recreated by the traditional methods [10].

Once implemented, the inkjet technology should be exploited in all its magnitude. To do this, it is necessary to reshape the design process by means of computer assisted mechanisms.

5 Employment of digital image processing in ceramic manufacturing

Digital image processing is a barely used technique in the manufacturing of ceramic tiles. Essentially, it has been used in the classification phase for the detection of superficial defects and undesired color changes.

The most relevant works in the field of the automatic classification have been developed at Asian University of Bangladesh, the University of New South Wales, University of Science and Technology (Korea) and the University of Surrey (United Kingdom) [11] [12] [13] [14].

In the field of the color prediction, the most relevant studies have taken place at the Universidad Politécnica

de Valencia, Università di Modena e Reggio Emilia (Italy), University of Joensuu (Finlandia) and University of Derby (United Kingdom) [15] [16] [17] [18]

With regard to the design of the decorated surface, image processing has been used only a few times. Some researchers have tried to offer tools for the improvement of the management of the design process itself [19] [20] [21].

The employment of the image processing for the adaptation of the design process to the inkjet printing is a new research field. As it has been already commented, most companies are integrating inkjet in their production lines, adapting their current designs with commercial tools. Nevertheless, these tools only permit simple automatic transformations. The production of adapted images, ready to be printed, with the required size, resolution, texture and color still relies in the artisanal expertise of the designer.

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