ARCHITECTURE OF SHAPES AND POLYMERS TILE REINTERPRETATION

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ABSTRACT
This work intends to develop a reinterpretation of the ceramic tile through the analysis of the ceramic industry. In parallel I will carry out an investigation with the Plastic Industry. The ultimate goal is the development of a coating product, a new tile produced in plastic, which accompanies the new forms of Architecture, unconventional forms and the possibility of conjugation with spaces in an objective, harmonious and distinctive way.

Keywords: tile, ceramic, plastic, mass production, customization, architecture.

INTRODUCTION
“Although the birth of the tile is not Portuguese, there was no other country in the European continent as Portugal which has given this material such an expressive and original treatment, well adapted to the various specific economical, social and cultural constraints, which has also been used in such a complex and broaden way, having goals that widely transcend a mere ornamental role.” (Meco, 1993, 11)

The evolution of the Tile in Portugal
The tile is originary of the Mesopotamia, birthplace of the first civilizations, which, deprived of stone and wood, had to use clay brought along by the floods of the Tiber and Eufrates rivers. Its primordial link to architecture is achieved by the creation of sun-dried clay blocks used to build houses. So, its primordial function of structural elements later changes into ornamental elements by giving it chromatic and highlighted effects. The oldest register of these effects can be found in the Museum of the Ancient Near East, in Berlin, having been discovered in the Inanna Temple, in Uruk.

The evolution of the tile is caracterized by the introduction of new effects, gaining a “true artistic personality in Persia, during the caliphate of Bagdade, developing itself mainly in the ceramic centers of Raggês and Kashan” (Simões, 1965: 249).

In Portugal the use of the tile has been accepted as certain after the last third of the XVI century, associated to various influences. Being an item which has suffered various alterations along the way, there are several phases which caracterize the tile, not only through an aesthetic evolution, but also a technical one.

The European pavements of the early Middle Ages and the middle XVI century are called archaic and were formed by ceramic tiles constituted by clay plates with diverse geometric shapes. The influences of this type of pavement derive from the roman tiles, opus tasselatum, and bizantine tiles, opus alexandrinum.
The decorated medieval tiles, which derive from the pavements, are designated engobes and are characterized by red square clay plates on which the decoration was imprinted raw using a wooden mold which made slight depressions on the piece. These depressions were filled with engobe, which distinguishes itself for being a liquid clay that may take on a white or a stained yellow colour. These plates were then baked at one go and glazed with colourless red lead.

A new way of working the tile was introduced, similar to the glaze obtained through the use of red lead. The mixture made between tin oxide and red lead glaze allowed the tin glaze to be decorated with metallic oxides, resulting in opaque colours. This innovation, developed in the Kingdom of Grenada, was essentially applied to two types of ceramics, which were ornamented pieces and tiles and plied coatings.

The plied coatings, widely used in Seville between the XIII and XV centuries are 'ceramic tiles formed by irregular pieces of solid colours, geometrically organized according to various combinations, highlighting the ones which form starry compositions and the ones which come out of interlaced motions' (Meco, 1993, 35).

The main difference between the plied coatings and the European medieval pavements is its application, essentially parietal, due to its own complexity of combinations and its production technique.

The designation *plied* derives from the cut applied to the piece by the plier after baking.

Across the XV century there was a revolution in the production of ceramic coatings in Seville. Due to the difficulty of producing plied coatings, their geometric schemes were used in the production of dry string tiles, which 'may be considered the European tile prototype, through the standardization of the material, allowing the production and application to be separated into different fields, which facilitated tile export and its use in other cultural contexts, namely its wide dissemination in the Portuguese territory' (Meco, 1993, 35).

The conquest of Seville by the Christians in 1248 didn't affect the production of Muslim tradition ceramics, obtaining prominence after the fall of Grenada in 1492. Contrary to the grenadine pieces, known for their decoration on tin glaze, Seville developed the dry string technique. This technique distinguishes itself for the direct application of several colours on the surface of the baked clay, requiring separators to prevent the mixture of colours during the fusion process on the second baking. The separators, made with a mixture of manganese oxide and fat, were applied with a brush, which, after baking, would become dark traces of a metallic tone, which led to the designation *dry string*.

Around 1500, tiles produced using the dry string technique started being replaced by another production technique, namely Edge. This technique involved applying molds with indentations which left on the raw clay plates fine protrusions, called edges. These served the purpose of preventing the mixture of glazes during baking. In spite of coexisting for a period of time, Edge soon overtook Dry String for its technical simplification. Serving the same purpose, that is, preventing the mixture of colours, the introduction of fine protrusions was more effective in the process, and also *represented an expressive element* (Meco, 1993, 35).

The third trend that influenced the Portuguese production of tiles was the development of majolica. Due to the sumptuous needs of Italy at the time of the Renaissance, Chinese porcelains arriving in Europe were coveted by their difficulty of acquisition, making them
exclusive. In addition, the import through Maiorca's port of numerous ceramic pieces with metallic reflections, 'whose production characteristics the Italian sought to imitate' (Meco, 1993, 43), allowed Italians to modernize the ornamental language through a scholarly treatment. It is necessary to obtain a whiter and more stable base to allow the application of metallic pigments. The tin glaze used in the edge and dry string productions neither allowed the tile to be completely opaque, nor did they set the painting completely, letting it spread and marble during baking. The majolica technique has had its impact on European production defining ceramics up until nowadays. Antwerp becomes then the main financial center in Europe highlighting the production of ceramics and disseminating it until its decay at the end of the XVI century. After the fall of the city, ceramic art spreads to others points in Europe, like Hamburg, Montpellier, Northern Flanders, Seville, Talavera de la Reina and Lisbon.

From the mid XVII century on tile painting suffered a sharper evolution, by making the contours with dark traces of manganese concentrated with a metallic shine, thus replacing the traditional cobalt blue. The alteration emphasized the importance of the drawing on the tile and gave compositions a more defined and stronger character, although it wasn't made in the tiling produced in Oporto. This one kept itself faithful, until the beginning of the XVIII century, to the rudimental polychromy characterized by sharp blues and orange yellows. However, it embraced manganese contours later on.

The period between 1745 and Lisbon's earthquake in 1755 determines the development of another aesthetic renovation in tiling. It is clear an attempt to recuperate the chromatic pallete used in the previous century, announced by a discrete use of yellow on tile decoration, enticed by the introduction of the ornamental theme Rococo. Rococo is a style that prefers light colours, that is ornamental, representative and hedonist.

At first, rococó style applied to tiling was characterized by delicate and sensitive painting, aided by thin and expressive strokes. Lisbon's earthquake didn't affect tiling production. After the earthquake, and combined with reconstruction works around the city, tiling production decreased its quality, maintaining its rococo language, although 'adapted to constructive and ornamental contexts, more rational and programmed, reflecting the spirit which presided the conception of the remarkable Pombaline Downtown of Lisbon (where tiling had a fundamental contrasting and enriching role' (Meco, 1993, 70).

The production of tiles embebbed in rococóostyle reflects an initial phase designated by pombaline tile, distinguishing itself by the lack of refinement and creative individuality. The strokes are thick and the ornates are stereotyped, despite keeping the efficiency of the ornamental feature due to the depth and volume games coming from the contrast of colours used in painting.

The final phase of the rococo style prolonged the use of ornaments derived from the pombaline period, in spite of the distance from the volume effects distinctive from the early phase of rococo, substituting them for a progressively linear expression.

The neoclassic tiling is developed from the linear trends present at the final phase of rococo and for a language derived from fresco paintings, developed at the end of the XVIII century. The influence from the frescos came out in the intense polychromy that substitutes almost entirely the painting in blue and white. Therefore, the colours used in neoclassic tiling were spontaneous, resulting in quick strokes that created watercolour effects. Parallel to the mixture of colours and spontaneous strokes, polychromatic notes were acquired, which, associated to the scraping technique, demonstrated an exceptional adaptation from the neoclassic style to
tiling. The tiles that represent patterns and are embedded in this style show simple pombaline patterns or imitate cloth linings from that period.

The great political and social transformations that happened in the first half of the XIX century reflected themselves on the consumption and production of tiles, used on the outside coating of facades and produced using large scale industrial processes. Mass production reflects itself in potteries and small factories which can't adapt themselves to new production methods, ending up closing.

The raw material was also changed according to the new methods and artistic teaching was abandoned, which resulted in the lack of qualified labour. This way, the price of non-serial tiling increased significantly, limiting the access of less fortunate social classes. The scarcity and inavailability to obtain tiles produced and decorated by hand meant an increase on the demand for industrialized tiles, which made it possible to open new factories, centered in Lisbon and Oporto. However, relating a tile to its factory of origin was complicated, as there rarely was mention of the production location at the back.

Tile production, despite becoming scarce in terms of specialized labour, continued being used to aesthetic and ornamental means, preserving its decorative value without being linked to any characteristic aesthetic trend, using the various influences gotten throughout the centuries without homogeneity. It is necessary to mention that a big part of serial production made in the XIX century comes from rough systems that reduce the production to two types of tile: stamped tile and embossed tile.

Stamped tiles, produced mainly in Lisbon, allowed the creation of numerous patterns used mostly on building facades. Viúva Lamego ceramics gained special attention in the production of these tiles, which consisted on the use of waxed paper, called stamp. The stamp was cut according to its own drawing which would later be drawn on the tile through a process of sticking to the glaze and painting with a brush on paper. The number of colours included on each tile would depend on the number of stamps used, one per colour. The stamping process is very similar to majolica's drawing.

Embossed tiling in Oporto acted as a production that opposes a long period of lack of ceramics production. Massarelos factory is an important reference on tile production and played a major role on the production of embossed tiles.

Tiles were made by using tins, filled with fat clays crafted manually. The most prominent parts of the embossment were refined to prevent the clay from deforming while baking. Regarding the tile surface, this was entirely glazed in white, getting a slightly coarse opaque painting, generally in blue, yellow and green. The method was mostly manual, and was therefore substituted by molds and countermolds which were pressed resulting in the desired embossment. In spite of this, tiles didn't have such a sharp embossment.

The innovation in relation to the mechanical pressing was also the decoration, which was stamped on the presses and automatically placed during the respective industrial process.

Later, due to technological advancements and the strong presence of the industry in the production of tiles, the factories in Lisbon also adopted the stamping through the pressing process, leaving as a differentiating characteristic the use of white pastes used in the manufacturing of english crockery, commonly called stone dust, while the factories in Oporto carried on using yellow clay.
In the first half of the XX century, the stone dust plates stood out for being an excellent holder for manual painting, because they didn't need a tin glaze coating and presented themselves as very solid surfaces comparing to the holder. This material favored the emergence of tiles and loose plates. The main goals of these tiles, due to their size, were ornamentation and integration in furniture. Stone dust also enabled the development of mid embossing, whose variety of tones depended on the thickness of the glaze and the colour one wanted to include. The value given to these tiles was decisive, defining the first decades of the XX century and entering in the Art Noveau period.

However, the technical processes faced several trends derived from the romantic style, far from homogeneous and extended to a vast period, as well as historicist and nationalist trends, which have as main driver Rafael Bordalo Pinheiro and the artistic ceramics factory in Caldas da Rainha, between 1884 and 1905.

The mastery of Bordalo Pinheiro comes out in his productions characterized by blushing glazes with various colours, mainly metallic green and black, in dense tones applied in thin and translucent layers which enhance the clay's embossment.

Jorge Colaço also distinguishes himself for his work. Divided in two phases, the first associated to the first two decades of the XX century, Jorge Colaço worked in the ceramics factory of Sacavém. His tile compositions were of 'heightened and vibrant chromatics' (Meco, 1993, 87).

The second phase represents the period between 1923 and 1942, starting to work at Lusitânia ceramics, in an independent studio, where he used yellow clay plates covered in baked tin glaze and where he painted predominantly in blue, adopting a traditionalist and academic side.

Besides the historicist demonstrations and influences, the Art Deco style influenced tiling during the period between 1920 and 1940. This style was characterized by geometric and purified shapes, it enabled the systematization and made the production processes profitable. From this simplicity, several ceramic industries in Portugal adopted their own Art Deco style of tile production.

The advent of modern architecture in the fifties, which was trying to keep away from academic and imperial historicisms of the dictatorship's constructions, imprinted a creative freedom in ceramic artists and painters like Jorge Barradas and Eduardo Leite. Viúva Lamego's factory played a crucial role by its technical conveniences and specialized labour and enabling the creation of more representative works of modern Portuguese tiling.

There were two fundamental trends coming from the aesthetical freedom derived from the renovation of architecture and the experimental and creative possibilities of coating.

The first trend relates to artists of predominantly pictural training, innovative in the conception of compositions but without an individualized exploration of the respective production methods. Maria Keil, Sá Nogueira, Eduardo Nery, Júlio Pomar and Lima de Freitas, among others, are representative examples of this trend. The work of these artists was mainly aesthetical.

The second trend encompasses artists of ceramic training, like Manuel Cargaleiro, Querubim Lapa and João Segurado, whose work valued mostly the expressive potential of materials.

Serigraphy was a method developed and applied with great emphasis in Calouste Gulbenkian Avenue in Lisbon.
In the seventies and eighties negative symptoms are visible in relation to tile production, due to the appearance of several pottery workshops, whose final goal was to copy old tiles, imitating mainly tiles from Viúva Lamego’s factory and Sant’Ana. These copies were 'often wrongly misinterpreted as a renovation of a portuguese tradition' (Meco, 1993, 250) since they were limited to reproducing without having creative freedom or the creativity to build their own image, distinctive from this period.

CASE STUDY OF THE STATE OF ART. CRUISE PORT, LEIXÕES
ARCHITECT LUIS PEDRO SILVA

The cruise terminal of Oporto, Figure 1, was born out of a project developed in 2004 included in the Strategic Port Development Plan, being a combination of projects and actions under a common architectural conception and coordination.

The architecture of the main building, which has an usable area of 17500 m2 and was included in the curved sector of the peer, enabled the development of three blades that 'embrace' the various functions being sustained by the building. Therefore, the building is a kneecap among three main functions, which are a new peer for cruise ships, a new port for recreational crafts and a new access to the city of Matosinhos. The construction becomes the key point of unloading and flow of people to the various areas and objectives, becoming the sole connection, which has long light plans characterized by a textural surface.

The project is influenced by the curved lines where the building is placed and it suggests an inspiration from the Mobius strip, but also from the Finnish architect Eero Saarinen, who privileges the use of curved shapes. Sorting out the inner necessities of the project through a single trace, the construction becomes a spiral coated in tiles which extends from the inside to the outside, through an helical ramp, which constitutes a fourth blade that runs across the inside of the building working as a connecting axis between the inner functions of the building. In addition to giving emphasis to the connections between the inside and the outside, the architect offers natural light to the entire building as well, through the blade that unloads inside and covers a quadruple height.

The tiles covering the outside of the building characterized by their diverse sizes, are transported to the inside through the ramp, which, besides promoting inner connections, also enables an architectural cohesion and a complete fusion with the chosen coating, taking part and contributing to the shape dynamics highlighted by the building. The concern with the natural light shines through the choice of material for the coating, the tile, due to its glaze, which can reflect natural light and its several tones, not only during the day, but also throughout the seasons.

The different heights owned by the hexagonal pieces enable the creation of a texture throughout the building, playing with the curved shapes and creating a greater adaptation to them, revealing the shape further and becoming a part of it. The cruise port building of Leixões, from de architect Luís Pedro Silva, is an example of the search for new architectural shapes which aspire a total integration with the area where they are placed as a functional dynamics associated with its functions, city and user. This way, the tile becomes a reference ally, since, in addition to enabling and emphasizing the shape, it aims at its own personal character as a key part in the success of Architecture.
Fig. 1 - The cruise terminal of Oporto
THE PLASTIC TYPE

The reinterpretation of the traditional tile comes of the need to keep up with the new architectural shapes. Through the advances of CAD programs, shapes that were unthinkable are now possible and have become a characteristic of modern day architecture. The plastic tile comes from a reinvention where the word “tile” is kept but the designation of the material is added - “Plastic”. Until now tile was tile and there was nothing more to it. Now it can be something else, more adaptable, more flexible, more resistant and more appealing with its infinite possible shapes.

This new coating material can now be fused with the old symbol of the classic tile in a symbiotic connection where both have a leading role, without interfering with their main function.

However, the plastic tile to improve and give a more effective answer, to problems that may arise into the current architectural specter, when it comes to its inclusion into a building.

Due to the unusual and demanding shapes that the buildings can acquire nowadays, it becomes urgent to develop a coating material that can be shaped to the building and, in a complementary way, assume itself tridimensional forms.

Objective

The plastic tridimensional tile was thought as an alternative way of coating, which could be molded and adapted, to the new architectural shapes. But this is not enough to describe it all.

The idealized plastic to materialize the plastic tile is the polypropylene (known in industry as PP) is a thermoplastic polymer which, as we will see, fulfills all needed requirements in terms of functional demands of decorative coatings but it allows as well the possibility of using recycled material. This side of the plastic tile enables the use of a reusable wall coating, not just a second application of the same tile on a different place but also the reintroduction of the same raw material, by submitting the plastic tiles to a recycling process.

It is in an assertive way that we conclude this to be an added value to the project we intend to develop. This will promote a sustainable cycle between raw material, and final product, where the end consumer will feel part of the planet earth protection.

But the added value of this project is not only on the recycling capability. With its ability to assume any possible form, the plastic allows us to have audacious and “Avant-gard” shapes.

This way, the easy application of the product gives it the ability to bring a different character to a space in a very appealing way to the customer.

The low cost of the raw material makes the plastic tile a product without direct competitors on the market.

The design of the fitting fixtures has the objective of giving the tile extra added value and allow an easy and correct use once that the fitting itself works as a guide for a correct fixation to the wall.

As we will be able to see further ahead, several fixation solutions were tested and the correspondent pros and cons were evaluated, always thinking on the end consumer, providing him an easy application solution.

The product is directed to the common user that intends to give a personal and unique touch to his living space. But that does not tell everything about the plastic tile. It also intends to be
a coating material for public, commercial and recreation spaces. Finally we also intend to preservation and restoration purposes. The product was initially conceived for interior use but we are now aiming also for external applications. Our case study is the Cruise Ship harbor of Leixões, where the ceramic tile assumes a leading role on the coating of the internal and external walls. The final purpose of our project is the same, to have a communion between interior and exterior spaces, allowing a different dynamic on building fronts without, for that matter, to require a huge investment. Thinking also in rental spaces, the plastic tile allows the user to have a highly customized space without spending a considerable amount of money. Furthermore, the plastic tiles can easily be removed and taken somewhere else, if the consumer so desire it.

Finally, starting with the simple and more basic product we have to offer, the decorative plastic tile, we are also exploring the possibility of having plastic tiles with utility functions. This way, the consumer can chose to have a plastic tile that would help him organize and have a better use of his space, tools and equipment. For example, we intend to develop tiles to be used as a support for mobile phones or tablets and tiles with electric sockets. With these solutions, we could have some of the most important functions of a household, hidden on a decorative part.

The Plastic Tile and Customization

As mentioned above, the plastic tile intends to create a communion with architecture. The mass production of the plastic tile, using plastic molding technologies and steel tools, allows us to produce and sell thousands of parts, with different colors or shapes. Although the mass production of these parts is important to get to the general public, we recognize that, to have a complete inclusion in architecture, we will also need to work on the possibility to have more expensive but fully customized products, using additive manufacturing (AM).

AM technology, despite being on a constant development, still presents considerably higher costs than mass production. However, it has huge advantages when the customer looks for small series or unique parts. In these conditions, due to tool development and construction costs, mass production will be less cost effective, to produce the exact same product.

We strongly believe that in the near future AM technology can be the main productive process for our product, giving the customer a “customized mass production”. This means that we will be able to design and produce specific tiles for a specific construction, giving it the ability to be fully adjusted and fused into the building.

With this solution, the architect can now make the design of the coating material a part of the architectural project, allowing the creation of shapes and colors specially designed for a specific space.

The final goal of this solution is to enhance creativity, originality and uniqueness on a building.

The Plastic Tile and Mass Production

The main purpose of this project is to extend the range of possibilities for wall coatings, in this specific proposal choosing the use of plastic. In communion with the concept of sustainability, the plastic tile allows us to compete with the other coating materials, in terms of cost, shapes and application.
When it comes to the shape of the part, the objective is to use the tile together with other parts with different shapes. This allows the end user to create unique patterns, without shape or direction restraints.

Mass production gets closer to customization through the singularity of patterns, finishing and conjugations of different colors and shapes, creating unique feelings adjusted to each individual consumer.

However, mass production will bring problems when it comes to the adjustment to architectural shapes. Since the plastic tile will be first produced in an industrial way, the consumer will be the one responsible for the better adjustment of its application to the wall, having to consider available area and possible pattern conjugations.

These technical questions can, in part, be solved through the fixation fixtures. Initially they were intended to be used only as application guides, but then we saw a better use for them as clipping fixtures between the tiles itself, allowing a gap reduction between tiles.

**The fittings**

As it is possible to see on the pictures below, the final fitting came from an experimental process using 3D modeling. Despite the final solution presented here, we will proceed with further experiments and trials to improve and optimize the solution, always with the objective to make it easy as possible to end consumer.

The current system does not allow movement on x and y axis, the tile must be placed using exclusively the z axis. This way, at the end of the application, in case we only have one available place surrounded by other parts, we can always fit the last part with a movement in z axis (movement from above).

In addition to this, we propose the tile to be hold to the wall using glue. The glue will only be applied on the small component that will link the tiles. This way we avoid the use of glue directly on the tile, allowing it to be reused just by changing the linking component.

**Square**
Triangle
Hexagon
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