CLADDING IN ARCHITECTURE: ITS PROJECTION TOWARDS NEW TECHNOLOGIES FROM A RETROSPECTIVE VIEW

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1. PRESENTANTION

This paper is based on the doctoral thesis, directed by Doctor Jaume Avellaneda Diaz-Grande and prepared for the Universidad Politécnica de Cataluña, by the architect María Celina Vacca entitled "The Cladding of Architectural Surfaces with Ceramic Tiles – a Comparative Study of the Evolution of Materials, Manufacturing Techniques and Installation in the Main Production Centres in Spain and Other Countries from the Industrial Revolution to the Present".

The primary reason for writing this thesis is to identify the role of ceramics in the history of Spanish architecture. Based on the Spanish-Arab tradition and passed on over the centuries, the industry started with the first earthenware tiles made in Malaga in the XIIIth century, then in Manises in the XVth century and in Catalonia in the XIXth century. It was in that century that Spain was recognized throughout Europe as the country with the longest historical tradition in this material. This is why this thesis focuses on studying ceramics in the period from the Industrial Revolution to the present day from the perspective of new trends and technological advances in the manufacture, installation, and architectural language of the ceramic tiles used for cladding purposes in each historical period. In this analysis the variables which affect the development of the material within a socio-political context like that of the contemporary era are taken into account: the mass migrations from the country to the city, the emergence of new social classes with their respective needs, the establishment of liberal regimes, the scientific and technological development which directly affected productive processes, improvements in medicine and hygiene, the current concern about the environment and sustainability, etc.

By presenting itself at QUALICER, this thesis is not only trying to impart knowledge, but also to stimulate the interest of the building sector, professionals and research and development groups; and to get the reader to learn to observe and appreciate with enthusiasm the vital role that ceramics plays in architecture and that architecture has in the human habitat; not only because of the value ceramics has as a construction material and its functional performance, but also because of its artistic value and the language its rich expression leaves embodied in the outer skin of a building.

2. DEVELOPMENT

For the comparative analysis three historical periods have been defined, establishing dates for their separation as a result of a technological advance which serve as points of inflection in manufacture and the architectural period which represents them. The first period covers the years from the Industrial Revolution to 1930, while the second period goes from 1930 to 1980 (the arrival of natural gas in the region of Valencia), and the third from 1980 until the present day.

First Period: In general, we can see that great advances were contributed to the building world by the Industrial Revolution. This is more noticeable in the rest of the world than in Spain, where these changes were late in their arrival. Up until then, Spain was at the forefront of Arab manufacturing and decoration techniques. Moorish kilns were used for firing, and dry cord and "cuenca" techniques with metal lustres for glazing.

At the end of the XVIIIth century the arrival of the steam engine in England encouraged the creation of new industrial centres and, in ceramic technology, it was essential for grinding processes. The stamping and printing techniques introduced in 1740 by John Brooks and John Sandler were also developed. Round about the beginning of the XIXth century England and France became pioneers with the advances they achieved in the composition of pressure powders, which favoured the press system, based on the screw press introduced by Minton in 1840. Bottle kilns with up to 10 floors, reaching firing temperatures of up to 1200ºC, also began to be used. It may be said that industrialization was brought to Spain by the Marquis de Sargadelos, in about 1789, with the contribution of the mechanized processes in the earthenware manufacture, the use of reverberation kilns, and moulding workshops that considerably cut down on manual work.

In Spain between 1850 and 1855 new suburbs were built and the concept of town planning, architecture and the city emerged with them. Then came the arrival of running water. Urban centres began to grow and health movements, which would resort to the use of the wall tile as a "hygienic" material in homes, made their appearance. The main Spanish wall tile production centres were Andalusia, the region of Valencia and Catalonia, and they continued to employ flat decoration, which involved the use of raised edge and dry cord techniques. In about 1857 there were already 30 factories with 34 kilns in Valencia.

Between 1857 and 1878 people started to use hydraulic energy sources as the driving force for mills; stone rollers were replaced by horizontal millstones and instead of pressing mud, slightly dampened clay was used (semi-dry pressing), substituting manual decoration with flat decoration applied by means of a stencilling system.

From 1850 onwards, in his factory La Cartuja in Seville, Pickman started to manufacture earthenware tiles and he continued the industrializing process initiated by Sargadelos, making feldspar earthenware tiles and introducing mechanized manufacturing processes, stamping techniques using steam-heated presses, new pressing and casting technologies and coke-fired bottle furnaces for drying and firing. He also recovered the dry cord and raised edge methods for glazing. And at the end of the XIXth century Nolla manufactured the first English-type stoneware tiles (with English technology in the style of the English Maw factory, and it is the first porcelain tile of continental Europe), using Spanish style firing and introducing the principle of single firing. He achieved flooring that had not been made until then.

The arrival of the railway at the Spanish tile-manufacturing centres facilitated the transport of raw materials and brought with it the development of communication links, together with the first exports to Latin America.

The products we find in Spain during this period still had very high porosity, such as the majolica of Spanish-Arabic origin, involving red-body tiles with a porosity of 25%, white-body soft earthenware tiles (with a porosity of 15/25%) and the hard earthenware tiles with a porosity of 5/12% made with feldspar powders introduced by Pickman, were still highly porous. It was also the period of prominence for glazed or unglazed terracotta, which was widely used in Catalonian Modernism, owing to its formal versatility, for bespoke and die-cast three-dimensional pieces.

According to the literature, the availability of Portland cement was a key factor in the development of adhesive mortars for the installation of these pieces, only using the thick-bed system, which was employed for all other cladding, such as hydraulic tiles.

As for architecture and the use of ceramic tiles, five buildings which are representative of this period are offered as examples. In them there is a predominance of historicism, art déco, eclecticism (the "neos") and Catalonian modernism, which is what gives a vital boost to the Spanish iconographic repertoire that the ceramics industry has shown itself to be capable of. The ideas of Gottfried Semper and his theory of the textile origin of architecture and the wall as a "hanging curtain" which decorates and dresses a building prevails, offering a formal alternative to the Vitruvian classicism that would subsequently predominate in rationalism.

1. El Palacio de las Aguas (The Water Palace) (Bateman, Parsons & Bateman), Buenos Aires – Argentina (1887 – 1894): I have chosen this work, as a building which is representative of my country, in order to illustrate the use of English ceramic pieces that give us some idea of what architecture demands of ceramics all over the world and what it has to offer in response. It is a large building which houses the water tanks that supplied the city of Buenos Aires at the height of its economic boom and it represented the concern of the government for public hygiene. It consists of a structural contention wall which is completely enveloped in a self-supporting cladding system, like a beautiful curtain that encloses the building. This cladding component is made up of three-dimensional glazed and unglazed terracotta bricks designed by the Norwegian architect Olaf Boye and made to order by the Royal Doulton & Co. factory, which subcontracted the order to the Burmantofts Company in Leeds. A total of 170,000 ceramic tiles and 130,000 glazed bricks were installed using cement. The work covers a whole block right in the centre of the city and its sculptural value has made it a national cultural heritage monument.
2. The Majolika Haus (Majolica House) (Otto Wagner), Vienna – Austria (1898 – 1899): A house with a flat façade, it exemplifies Semperian theories and is

located right in the heart of Vienna. Its flat façade is a tribute to colour and joy in the grey, run-down city centre. It is like a decorated curtain hanging over pieces of majolica embroidered with foliage, floral motifs and highly colourful ornaments endowed with movement, which are so typical of Art Nouveau. For its time it was a revolution and was severely criticized..

3. La Casa Batlló (The Batlló House) (Antoni Gaudí), Barcelona – Spain ((1904 – 1906): A remodelling of a pre-existing house, to which upper floors and a roof were added. The roof was built using superimposed layers of glazed terracotta, simulating the skin of a reptile, and the ridge was constructed with made-to-order glazed tiles resembling jugs and forming what looks like seams where they meet the façade. The façade is decorated with a broken-mosaic composed of fragments of tile, glass and pieces like multi-coloured plates, the appearance of which varies, depending on how they reflect the sun. It is one of the major works of Catalonian Modernism.
4. National Farmers Bank (Louis Henry Sullivan), Owatonna, Minnesota – United States (1907 – 1908): It has a brick façade framed by a cornice which is made of pieces of green glazed terracotta with plant motifs and decorated inside with small pieces of blue tile. On the upper joints of the cornice there are large terracotta medallions, from which a curtain hangs and unfolds towards the plinth, the large semicircular windows silhouetted against it. It is a sober and elegant façade, which serves as an example of the agricultural boom in the United States.
5. The Parc Güell (Güell Park) (Antoni Gaudí), Barcelona – Spain (1900 – 1914): The serpentine bench has been chosen as an example of the use of tiling in public works and the broken-mosaic technique, which is so characteristic of Catalonian Modernism. The completely curved balcony with its panoramic view, from which the city of Barcelona can be viewed, is covered with a broken mosaic composed of pieces of different sizes, colours and textures, representing ornamental plant, animal and religious motifs. It is another building which exemplifies Catalonian Modernism.

1. Palacio de las Aguas.

2. Majolika Haus.

3. Casa Batlló.

4. National Farmers Bank.

5. Parc Güell (serpentine bench).

Second Period: The arrival of electricity in Spain in 1929 was another production landmark, as it introduced significant improvements in wall tile manufacture. At the same time new earth grinders, passage kilns, semi-automatic semi-dry friction presses (all driven by electricity) and mass decoration by means of an automated stencilling system appeared. Concern for raising awareness of ceramic products increased and the edition of catalogues to ensure access to information was encouraged. Whilst in Spain clayey earths continued to be used, the rest of Europe was already using kaolin and feldspar clays.

Demographically, there was a significant increase in the population and also of the bourgeoisie, who, influenced by health movements, began to use mass-produced earthenware tiles for new functions: bathrooms, kitchens, hospitals, markets, spas, stations, pharmacies, etc.

In 1930 Herman Segel discovered the pyrometric cone as a way of controlling kiln temperature, and passage and continuous firing kilns were developed.

The Spanish Civil War in 1936, compounded by the country's subsequent isolation after the 2nd World War, led to a slump in earthenware tile production. During this period Onda consolidated its position as a production centre, as a result of the quality of local raw materials and the railway, which delivered them to the ports for exportation.

Italy strengthened its position as an export centre, exposing the weakness and backwardness of Spain in the international market and forcing it to undergo industrial upgrading in order to reinforce the sector and restore its ability to compete.

Between 1960 and 1965 the Italian process technology called double firing with a complete cycle was introduced, with tunnel and channel kilns, automatic presses and the first glazing and decoration lines using mechanical screen printing, in order to respond to the demand encouraged by the IInd Housing Plan, and

growing number of factories and total production. The first attempts were also made to introduce wet milling (Brihuega factory) and the manufacture of glazed stoneware by the double-firing process.

In 1975, Italy already undertook the third process technology upgrading with the introduction of single firing in single-deck kilns and the progressive incorporation of spray-drying processes, all thanks to the availability of natural gas and the already traditional synergy with the metal mechanics industry in the Emilia Romagna region, while at the same time enriching the offer with the diversification of sizes, surface treatments (mainly decorations), and the appearance of a phenomenon of undoubted economic weight, namely the "signed earthenware tile", and low-temperature (third-fire) decoration process. However, Spain could only address this second aspect in its almost exclusive production of earthenware wall tiles, owing to the impossibility of incorporating the single-firing technology, since it had no natural gas. At the end of the 1970s, the production of white body tiles had already been introduced with a minor production of glazed stoneware tile for flooring. Low-temperature decoration would also be implemented in Italy, albeit to a lesser extent, with lines of sophisticated products for bathroom and kitchens. All production went to the bathroom and kitchen and, at that time, there was no specific offer focused on the world of architecture yet.

There was a lot of industrial growth as a result of mass production. Production increased considerably, to the detriment of product quality, and the rich iconographic repertoire achieved by Modernism during the previous period was reduced.

As for the most widely manufactured products in this period, we can make a distinction between flooring and vertical cladding, and special pieces for abutments and joins:

For vertical cladding systems the manufacture of majolica with a minimum porosity of 10/15% continued and between 1930 and 1950, thanks to the arrival of new presses with greater compaction capabilities, stoneware (simple and compound-body) tiles and salt-glazed stoneware, which is barely manufactured nowadays, appeared. Ceramic mosaics, made with small fragments of stoneware, were also used.

For flooring, glazed and non-glazed porous floor tiles (body intermediate between majolica and stoneware) with a porosity of 4/15%, fired earthenware tiles with a porosity of 3.5/20% (long thin tiles, red matt tiles, rustic tufa, etc.) and rustic stoneware tiles were used.

Joins in specific areas, such as staircases, swimming pools, washrooms, operating theatres, etc. were resolved using a series of special modular pieces, which were specially designed for each application and also mass-produced or made to order from catalogues.

From 1930 to 1950 tile installation systems increased their adhesion capabilities, owing to the reduction in porosity of the new tiles that were available.

Thin layers became possible with the advent of chemical adhesion which afforded elastic properties; the addition of additives of organic origin to mortar led to the appearance of adhesive mortars: natural rubber, methyl-cellulose, polyvinyl acetate, acrylic resins, synthetic fillers, etc.

1970 saw the introduction of European regulations that defined "adhesive mortars" (for applications on gypsum, with ultra-fast setting, and conduction and anti-acid properties, epoxi mortars), "organically based glues" (with synthetic additives, epoxi resins, polyethylene resins, vinyl or acrylic copolymers, etc.) and "adhesive cements" (with greater amounts of casein and less aggregate, solely for use in interiors). Now it was joints that posed a problem which needed to be solved and this was done using Portland cement grouts, "dry set" cement mortars, latex cement mortars and organic-based mortars.

During this stage architecture the world over was expressed by two broad movements: rationalism and organicism. In Barcelona a local movement known as Realism was developed by the Barcelona School. These movements resorted to the use of ceramic tiles more for their functional value, performance and low cost as a result of mass production than for aesthetic reasons and they mostly relegated ceramics to sectors where its use had become irreplaceable. Whatever the case, the outer skin of a building clad with tiles always constituted the formal language of the building, giving it radiance and colour. The examples selected to represent this period are as follows:

1. La Casa de la Marina (The Navy House) (J.A. Coderch – M. Valls Vergès), Barcelona – Spain (1951 – 1954): On the façade of this apartment block, an example of the Realism of the Barcelona School, hangs a curtain of flat, glazed, monochromatic, sienna-coloured elements which are composed of vertical strips clad with glazed majolica alternating with strips with window systems. Its "folded" sides crown a corner of the run-down Barceloneta quarter.
2. Law Faculty (G. Guiraldez, P. Lopez Iñigo and X. Subías), Barcelona - Spain (1958): It is a building that was built in record time with a structure consisting of modular elements, as are the cladding system and terminations: ceramic mosaics consisting of pieces of white glazed stoneware.
3. La Ciudad Pasillo (The City Walkway) (Alvas Aalto), Seinajöki – Finland (1958 – 1860): This is a building which is part of an exclusively rationalist urban project. Its sides are entirely clad in dark blue, semicircular, glazed wall tiles, a format specially designed to protect the joints, which are critical in such extreme temperatures. Here the success of the material, when it is used intelligently and with an eye for design, is demonstrated.
4. Casa La Ricarda (La Ricarda House) (Antonio Bonet), Barcelona – Spain (1962): an example of ceramic roof tiling: vaults clad in salt-glazed stoneware tiles (from the former Cucurny factory). The slats in the cladding system were also executed using made-to-order design pieces of salt-glazed stoneware which have a glass eye in the centre.

5. Sydney Opera House (Jørn Utzon), Sydney – Australia (1973): Using the latest avant-garde materials, methods and installation systems in the world, this building demonstrates how backward Spain was at the time. It is covered in vaults encased in prefabricated, reinforced concrete tiled alternately with opaque or shiny square pieces of self-cleaning glazed white clinker, which were manufactured by extrusion and single fired, and installed in the form of mosaics (Partek Högäns AB factory). The adhesive materials which were used were specially designed for the installation of pieces on substrates, both items having practically zero porosity.

1. Casa de la Marina.

2. Law Faculty.

3. Ciudad Pasillo.

4. La Ricarda.

5. Sydney Opera House.

Third Period: While Italy was consolidating its position as a centre for wall tile manufacture in the 70s, Spain was just starting to do so in 1980 with the arrival of natural gas in the region of Valencia. Fuel oil was replaced and the industry started to use non-muffled single-deck roller kilns, which reduced firing cycles to an hour, and virtually full mechanization of its processes was achieved. Double- and single-firing processes were applied definitively to floor tile and wall tile production processes. The auxiliary 3rd fire industry, which would be exclusively responsible for glaze firing, came into existence. Vertical dryers and robotic systems which facilitated the introduction of mechanized production lines were included. Great advances were made in wet milling and the spray-drying process with continuous mills; added to this, there were hydraulic and oleodynamic presses with powerful pressure capabilities, which produced pieces with very low levels of porosity and minimal thicknesses. The great achievement of this period was porcelain tile. For dry grinding, pendulum grinders and granulators were used and silk screen decoration was performed on totally mechanized production lines.

The skill of the ceramicist was recovered, leaving Modernism behind and with it manual decoration systems and the casting of specially designed restoration and made-to-order pieces.

In this last stage there was also an increasing awareness of the concept of sustainability, which boosted the development of environmental legislation designed to save energy, and to reduce and recycle waste. The Spanish ceramic industry

was regulated by Directive 96/61/CE of the European Council, which is concerned with Integrated Pollution Prevention and Control (IPPC).

Up until 2005, Spain underwent a massive expansion in the international marketplace, almost reaching the same position as Italy, its great European competitor in the export sector, and it invested in major research and development centres.

In decoration advances in developers were achieved, leading to the development of high-technology frits with complex compositions and containing additives, including water-resistant, bactericide and self-cleaning performance enhancers, etc., or metallic finishes, including nanometric technologies, computer decoration using INK-JET or laser printing, polishers, sand-jet bas-relief work and huge advances in the superficial treatment of anti-slip floor tiles.

The regulations which differentiate products, depending on their porosity and the way they are manufactured, are applied to classify the products of this period. The pieces which we can currently find on the market are as follows:

Cladding:

- White-body majolica and earthenware tiles: reduced thickness as a result of greater compaction to 5 mm, porosity 10/15 %, manufactured by single firing with a glazed surface (BIII).
- Types of stoneware tiles: Semi-vitrified and vitrified tiles, rustic stoneware and clinker: porosity 1.5/6 % (AIIa, AI, BI and BIIa).
- Porcelain tiles: Porosity less than 0.5 %, composition: 40% clays, 40% feldspars, 10% kaolins, 10% quartz; reaching thicknesses of up to 3 mm (AI and BI).
- Some variants of porcelain tiles manufactured with special additives: porcelain body + titanium dioxide (water-resistant and bactericide: self-cleaning façades); tiles with smart properties; fibre-reinforced tiles (by means of continuous compaction) to avoid tiles falling off tall facades.
- Mural cladding: bespoke by ceramic artists recovering traditional manufacturing techniques.

Flooring:

- Vitrified floor tiles: Rustic stoneware, clinker, partially vitrified and vitrified floor tiles: porosity 1.5/6% (AIIa, AI, BI and BIIa).
- Porcelain tiles: non-glazed: polished with non-slip finishes.
- Special pieces: For finishes and trims made of different materials and for different types of mass-produced bodies for modulated floor tile finishes.

- Design pieces: Custom products made by ceramic industry craftsmen (for building projects) or competition winners and research groups sponsored by ASCER/ALICER, ITC, the University of Valencia, Jaume I University, IPC, the International University of Barcelona Ceramics Department, etc.

Current installation systems are divided into two major groups and they all meet the regulations which are in force.

- "Wet" direct adhered tile installation: the thick layer and the thin layer are maintained (UNE EN 12004). The type of joint and the materials which are used in movement and grout joints are also regulated (UNE EN 13888).

  As well as regulating adhesives, in façades above heights of 3 m reinforcement with metal or synthetic cramp irons is compulsory.

- Dry tile installation: Adhesive Manufacturers are investigating direct adhesion systems for interior wall and floor tiles with layers of synthetic rubber using double-sided modified acrylic adhesives.

  But the most widely used application is undoubtedly prefabricated systems on façades ventilated with virtually non-porous cladding: pressed or extruded flat porcelain tiles fixed to a metallic structure as part of a system which has been entirely designed by the same factory.

  Dry systems for the installation of floors, such as plastic die-cast moulds, are also being applied with fitted tiles, which can be rapidly installed, for interiors.

  In technical floors with metallic or plastic structures the same designs are applied as for tiles made of other materials, but employing porcelain tiles.

In architecture, this period is providing all manner of responses and a huge variety of possibilities to meet the needs of architectural design, so the diversity and versatility of the ceramicist can offer advantages covering everything from highly demanding functional and technical requirements to finishes of great aesthetic value, as a result of the creative input of the architect combined with the invaluable work of the ceramicist who has state-of-the-art technology at his fingertips. In this way the outer covering surrounding a building is perfectly adapted to the architectural project.

1. Convention Hall (Arata Isozaki), Nara – Japan (1992/1998): A pre-assembled modular structure encased in a ventilated façade made of a stainless steel structure with superimposed layers of mass-produced, opaque, silver grey stoneware tiles. The tile factory is in the region of Tokomane. All the building systems used in this building are state-of the-art and pre-assembled in order to accelerate execution times.
2. Art Gallery in Walsall (Caruso St John Architects), Walsall – United Kingdom (1999): This building has a modular structure consisting of cement panels with

a ventilated façade made of a stainless steel structure with superimposed layers of terracotta cast-died and made to order by a German company. This building also has a ventilated façade, like the Conference Palace in Nara, but it is located in completely different surroundings.

3. Two examples of paved surfaces in urban areas used by the general public:

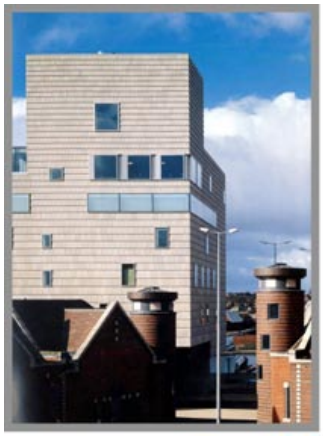
   - Diagonal Mar Park (Miralles Studio), Barcelona – Spain (2002): It is a city park which offers a paved area decorated with swathes of stoneware tiles mass-produced in 10 colours to imitate the hydraulic floor tiles from Enric Miralles' studio. Hanging from a metal structure, it is decorated with window boxes clad with a broken-mosaic designed using three-dimensional white stoneware pieces, which have been extruded, pressed and silk-screen glazed with Pop-art motifs.

   - San Vicente Street in Burriana (Arch. José Durán), Castellón – Spain, (2007): Another example of flooring in an area used by the general public, it consists of extruded stoneware pavers with grooves glazed in a bass-relief design to protect the glaze and give it anti-slip properties. It is a very colourful street of great aesthetic value right in the centre of the city.

4. Saint Catherine's Market (Miralles Studio), Barcelona – Spain, (2005): This example of a roof is a unique case of restoration. It is a multi-laminated, curved, wooden roof clad with a mosaic (pixels) of gleaming hexagonal, extruded stoneware tiles glazed in 67 colours. Seen from the air it is a true work of art right in the old part of Barcelona.

5. Conference Centre (Enrique Sobejano and Fuensanta Nieto), Zaragoza – Spain (2008): A building designed for the Expo Zaragoza 2008 exhibition with a roof made of GRC panels, with modules made of shiny extruded and glazed white stoneware pieces inserted and integrated into the panels. The modules are made up of 4 triangular pieces with silicone joints.

1. Convention Hall.



2. Art Gallery.

3. Diagonal Mar Park.

3. San Vicente Street.

4. Saint Catherine's Market.

5. Conference Centre.

3. CONCLUSIONS

The conclusions of this doctoral thesis can be summarized in the analytical points listed below:

- Evolution of the use of ceramics in Spain: The history of Spanish ceramics has gone through periods of productive expansion sustained by architectural movements, which have found it to be a language in which to express themselves, and periods in which it has been relegated to places where its use was irreplaceable. The latter have corresponded to unfavourable socio-political situations and rigorous architectural styles which have esteemed the bare structure and functional purpose of a building to the detriment of its cladding system. Fortunately, there is currently a growing interest amongst different sectors of the production process, which are motivated to develop research projects, plan future strategies and face the challenge posed by a versatile material which has proved adaptable to both tradition and the future.
- A diversity of pieces and products: Currently two broad families coexist in the market: standardized and personalized pieces. The former have reached levels that place them at the forefront of modern technology, ranging from 3 mm thick to 1m x 3 m tiles, owing to the advances achieved in compaction, which are demanding the same level of technology in installation materials: high-performance mortars with integrated modular systems for dry installation. The happy ending for this type of piece is based on the optimal interaction of the professionals who intervene in this process: the architect-manufacturer-installer-controller of the final product. Revolutionary products with solutions for trafficability requirements and new ergonomic or "flexible" designs have also appeared for floor tiles. For their part, personalized pieces have recovered an element which belongs to the Spanish tradition: three-dimensional pieces which Modernism turned to in its moment of splendour. The architect, designer and ceramicist work with them with the help of the best manufacturing and installation technologies, creating architectural works in which aesthetics is not only confined to the architectural value of a building, but is also found in pieces which have been specially designed for that building project in particular.
- Approximation to sustainability criteria: The ceramics sector has not remained detached from the problems of sustainability which are of so much concern in the times in which we live. The sectors implicated in this issue seek and demand preventive measures to ensure greater efficiency in waste reduction and the minimal use of water and energy, especially during the transport of materials. And, although the regulations in this area are still insufficient, many companies and research groups are on the look out for products with bioclimatic features, such as solar energy screens, self-cleaning properties, the bioclimatic adaptation of the home, etc.

- Spain in the international market: Although up until 1990 Italy was the leader in terms of manufacture and machinery, Spain has moved beyond this state of affairs in the tile and frit production subsectors, with Castellón as the main production centre. This has put Spain in second place in the world ranking, where it is surpassed only by China. But, as a result of the recent world crisis and the Spanish crisis in particular, production has declined an estimated 40% in the last year, with the country losing its competitive edge with respect to Italy and placing it on a par with Asian competitors, such as India. So we are left with the challenge of recovering the position we have lost and, trying not to repeat the mistakes of the past, we need to focus on the fact that we might have to reflect on what steps we should take in the future. The quality of the product Spain has achieved in recent years is indisputable and this is the starting point from which we can compete with Italy, which will always be able to rely on the manufacturing quality of its machinery.
- Ceramic cladding in architecture: Through different historic periods architecture has used ceramics as a language to express different styles. Both in Modernism and its reverence for cladding systems, and in Vitruvian rationalism and its negation of these installations - relegated to areas of the home where it has been irreplaceable and, as such, has retained its very high utilitarian value – ceramics has become the cladding system par excellence, acting like a cloak which speaks to us as if it were a layer of textured skin that protects, masks and decorates, and, when it is lacking, it entirely strips a building of all artifice.

The profound transformations which ceramics has undergone and will undergo is a subject that interests the world of architecture, serving as it does as a material for creating flat plastic art forms or shapes with a high level of precision. In its role as a competitor in an international market, Spain's potential ability to create a product with high added value that will excite the world of architecture and respond to the new aesthetic and functional trends and needs that have emerged in recent years is real and tangible. This means it is more than a mere layer of tiles and must interpret the language of new technological and environmental motivations.

And now we have reached our own times, in which we are witnessing the rebirth of this expressive language form, from the personalized and artistic three-dimensional façade to the standardized, self-supporting, ventilated façade with highly technical features. Contemporary architectural tendencies seem to be reincorporating the values of the external covering, of the language of architectural expression interpreted by the outer layer of buildings and special care will have to be taken so as not to repeat the error of saturating the ceramics market, as we have seen in earlier periods, so that artistic and plastic values can be fully integrated with the new high technology products which express the language of architectural ceramics.

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