



# **Glazed Architectural Ceramics in Public Spaces**

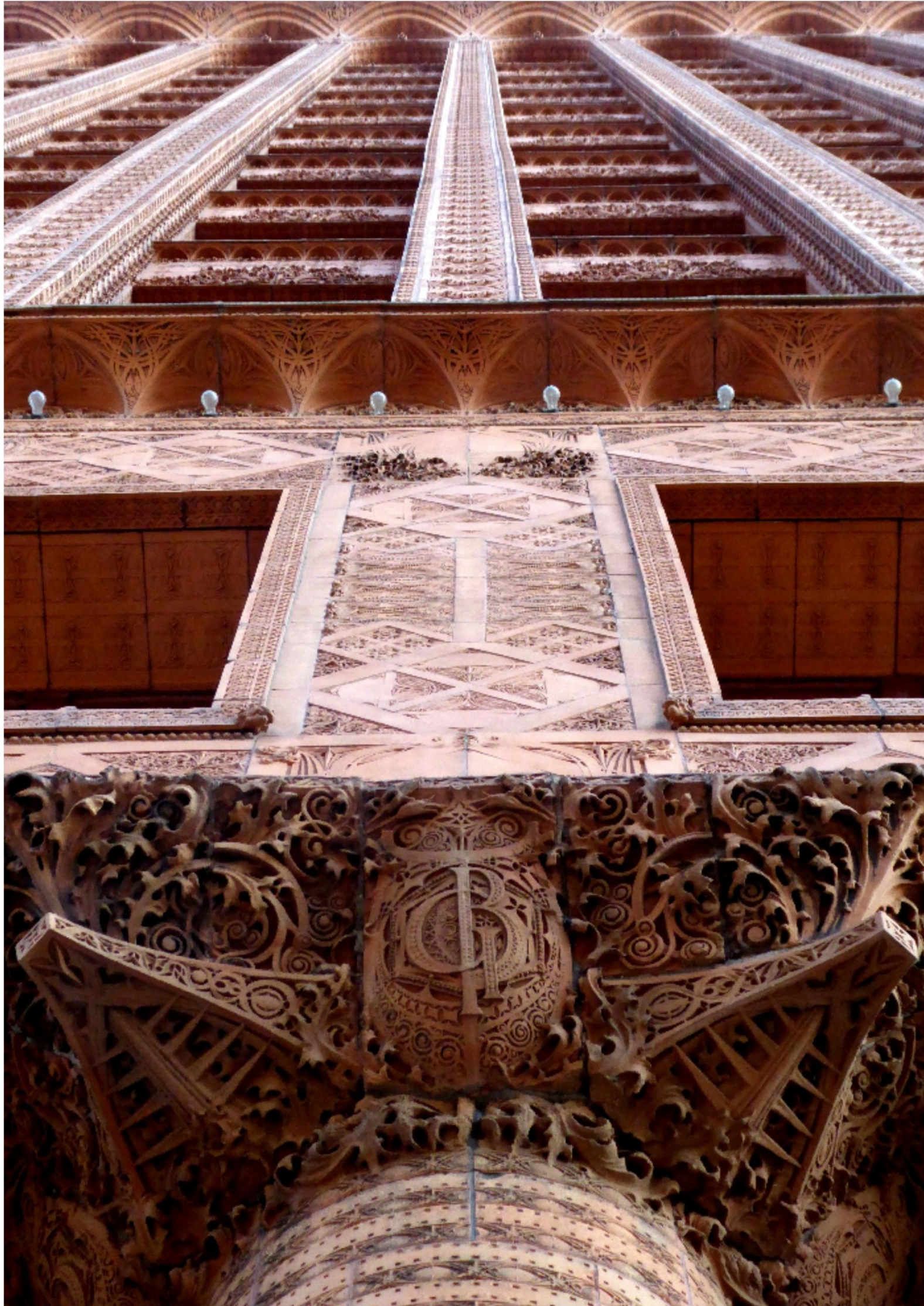
Lessons from the Netherlands, USA and Hungary

Maria Gasparian

2016

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## BIOGRAPHY

Maria Gasparian is a practicing architect, she recently graduated with distinction from the MA in Ceramic Design course at Central Saint Martins College of Art and Design in London.

As an architect Maria worked on a number of high profile mixed-use developments and public spaces in the UK and Russia. Other architectural projects included smaller scale educational, healthcare and residential schemes.

Her MA project on ceramic design “Colour Ceramic City” addressed issues of neglected spaces in cities and how tactile and colourful ceramics can transform these by engaging with people. The project was awarded the Unilever Sustainability award and Mullen Lowe Nova Runner up Prize for design innovation (2016).

Maria’s current multidisciplinary practice combines architecture, art and design with a particular focus on the integration of ceramics on an architectural scale in buildings and public spaces. The aim is to provide multisensory experiences through tactile and coloured ceramic interventions such as street furniture, decorative surfaces and elements for landscaping and buildings that will create unique, socially inclusive and engaging public spaces.

The aim of the Winston Churchill Fellowship was to research the application and manufacturing of glazed architectural ceramics abroad, in order to raise awareness of architectural ceramics among designers and clients, contribute to the built environment and public realm through ceramic design and stimulate ceramic manufacturing in the UK.

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## EXECUTIVE SUMMARY

The focus of my Fellowship was to research the best practice of application, design and manufacturing of decorative architectural ceramics in the USA, Hungary and the Netherlands. The research was initiated by my previous architectural practice and research for my MA in Ceramic Design (2016).

### The Research Questions:

- Where have ceramics been used historically abroad?
- What are the advantages of ceramics?
- How are architectural ceramics incorporated into contemporary buildings and spaces?
- What effect do decorative ceramics have in the built environment and public spaces?
- What are the relationships between designers, architects, artists and industry which lead to successful projects?
- Which manufacturing methods are used abroad and how do these compare to the methods currently used in the UK?

### Major Findings:

- Currently there is growing interest and demand among architects and designers to use architectural ceramics in the built environment.
- There is a large demand in the building industry worldwide for natural and sustainable building materials that can provide customised, individual solutions.
- The best projects both historical and contemporary were achieved through collaboration between artists, architects and industry.
- The early involvement of material specialists such as artists, designers and engineers is crucial for successful outcomes.
- Collaboration between industry and educational institutions is instrumental for innovation and high tech solutions.
- Prototyping facilities and medium sized manufacturing facilities are valuable resources for developing new products and testing ideas.

### Recommendations:

- Local Authorities and private developers should encourage the use of architectural ceramics in public spaces, buildings and landscaping.
- Architects and designers should work collaboratively with material specialists and industry when designing and specifying architectural ceramics.
- Incorporation of craft skills into industrial processes should be encouraged.
- Setting up and development of medium-size manufacturing and experimental facilities should be supported and encouraged by industry and the government.



## INTRODUCTION TO THE PROJECT

The term “Architectural ceramics” traditionally related to a range of products such as covering bricks, chimney pots, roof tiles, wall tiles, floor tiles, and terracotta and faience facings. Today the term is used for a large spectrum of decorative clay products, systems and artwork used both in interiors and exteriors of buildings as well as in public and private spaces.

Ceramics have a long relationship with people and cities. Fired clay is one of the most long lasting man-made building materials. The longevity of glazed ceramics makes them sustainable. Ceramics are both functional and decorative, being waterproof, fireproof, frost-resistant when fired at a high temperature and virtually maintenance free. They weather and age gracefully and the colours of the glazed surfaces do not fade with the passing millennia.

During the past few years in the UK there has been increasing interest in glazed architectural ceramics among architects and designers. This is linked to such factors as the building boom in the UK and a need for sustainable materials that are high quality.

However, in spite of the many advantages of the material, architectural ceramics are used very little in the UK.

What are the underlying reasons for this? Is there a misconception among clients about the values of the material that makes it difficult to commit to? Or are there other factors that make it hard to supply architectural ceramics?

**Aim: To identify best practice of application and manufacturing of architectural ceramics abroad with the view to implement the findings in the UK.**

### Objectives:

- Identify and analyse successful examples of architectural ceramics in historical and contemporary public spaces and buildings abroad.
- Examine traditional and contemporary manufacturing methods and techniques in Europe and the USA.
- Identify various types of manufacturing facilities: factories, workshops, innovation hubs, individual artists and compare these with relevant facilities in the UK.
- Explore successful relationship between clients, architects, artists and industry.

### Approach and Methods

The objectives of my project were achieved through:

- Literature review and desk studies followed by visits to museums and ceramic collections.
- Extensive photographic surveys at all visited locations.
- Recorded interviews with manufacturers, design practitioners and artists.
- Attending a collaborative workshop with an interdisciplinary team of professionals.
- Primary research through observation and interviews with various stakeholders.
- Visits to manufacturing facilities and workshops to study different production methods.

## Historic Overview

Researching the historical use and manufacture of architectural ceramics helps us to understand the potential and opportunities that existed and their relevance to practice today.

During the late eighteenth and nineteenth centuries manufacturing of brick and other clay products became a very important industry in the UK and in Europe because of industrialisation and the rapid growth of large cities. Because of the high demand for bricks and tiles, mechanised manufacturing methods were developed in factories at that time. (Hamilton, 1978).

Some people reacted against industrialisation and mass production. At the beginning of the 20<sup>th</sup> century individuality, decorativeness and the quality of the built environment were some of the major principles promoted by architects and designers. In Britain, the Arts and Crafts movement advocated social change by promoting high quality housing for the working class. Similar principles were followed in the Netherlands by the Amsterdam School movement. At the turn of the century, Art Nouveau in France and Belgium, Secessionism in Austria and Hungary and the Modernista movement in Spain produced brilliant examples of ceramics in buildings, street furniture and landscaping.

However, in the mid-20<sup>th</sup> century the use of glazed ceramics went into decline in the UK, across Europe and in the USA. There were a number of reasons for this, including financial market instability and the increased use of concrete that was associated with Modernism in art and architecture. Compared with ceramics, concrete has a much lower initial cost, but it weathers and ages badly. One can see evidence of this in the concrete buildings from the 1960s and 1970s, in which the concrete surfaces have seriously deteriorated and become discoloured.

During that time decorative terracotta and faience went out of fashion and, as a result, manufacturing also shrank. In the UK successful manufacturers bought out their competitors, which led to a reduction in the variety of products that were available (Hamilton, 1978). For example The Royal Doulton ceramic factory which was founded in 1815, originally produced tiles, terracotta detailing and glazed sculptural elements, as well as tableware. Since 1956 Royal Doulton have produced tableware only.

Similarly the De Porceleyne Fles factory in Delft in the Netherlands produced most of the architectural ceramics in the Netherlands at the turn of the century which were exported to the USA and Britain. The De Porceleyne Fles factory stopped architectural ceramic production in the 1960s and currently manufactures tableware decorative and tiles only.

However, within the last few years due to increased demand, factories such as Royal Tichelaar in Makkum in the Netherlands and the Darwen Terracotta factory in the UK have fully dedicated themselves to the production of architectural ceramics.





## Contemporary Context

In the past ten years growing interest in ceramics as a building material has catalysed research and technical developments in the field. If earlier glazed ceramics were used in buildings mostly as a protective layer, today these are considered for many other functions.

Contemporary industry has the advantage of versatile computer-controlled kilns. Modern glazes have unique qualities and can be self-cleaning and pollution-reducing. Advances in technology such as material research, digital fabrication and robotics allow for the development of a multi-functional external ceramic layer that is also aesthetic.

Potential uses of ceramics include microclimate control by moisture, heat and sound transfer, as well as sunlight control.

To produce individuality in the built environment there is a need for custom-made design and manufacturing solutions. Understanding the principles of contemporary manufacturing techniques is crucial for designers who are engaged in designing ceramic elements, particularly if they want to explore new possibilities.

Many of the processes used to form ceramic products can be adapted at different stages relatively easily to create custom made elements. Clay in a plastic state is relatively easy to manipulate by stamping, bending and slumping. However, post-firing customisation is also possible by drilling, scoring and cutting. The latter allows for more precision.

During my Fellowship I visited major ceramic manufacturers, smaller workshops and experimental facilities to understand manufacturing techniques and best practice used at these facilities. I also interviewed individual ceramic artists, architects and designers to learn about mechanisms for the production and application of architectural ceramics.

# 1. Total Work of Art

## Lessons From The Netherlands





The Netherlands, much like Britain has a large amount of natural clay and hence has a huge heritage of bricks, tiles and glazed ceramics in multiple applications. Dutch bricks have been imported to Britain since the 17<sup>th</sup> century and can be seen in many Georgian buildings. Even today large amounts of standard bricks as well as glazed products come to Britain from the Netherlands.

In search of the integration of ceramics in buildings and spaces I travelled around the country and visited Amsterdam, The Hague, Delft, and Rotterdam and Roermond.

In the early 20<sup>th</sup> century the Amsterdam School movement lead by architects Michel de Klerk, Piet Kramer, and Johan Melchior van der Mey created a new expressive style, the aim of which was to create Gesamtkunstwerk (Total Work of Art), a German word used to describe a joint product of multiple disciplines.

In response to the rise of mass production very much like today, the 19th century saw a renewed interest in traditional craftsmanship all across Europe including the Netherlands. The artists and architects of the Amsterdam School shared this interest, and also believed that *beauty should not be restricted to the elites in society, but instead should be used to improve all of society.*

The artists of the Amsterdam School often combined traditional crafts with new processes: concrete construction with brick facades, the use of hand blown as well as factory produced sheet glass and the combination of iron produced by smiths with that made in foundries. Applied arts were embraced as a way to bring beauty to the general public on a large scale, and often a work would have two versions: for example, an expensive version of jewellery made of silver as well as a simpler and less costly version made of tin. (Exhibition in Het Schip housing complex, 2016)

Architects worked in close collaboration with sculptors and other artists and produced some of the best examples of social housing commissioned by housing associations. Their idealistic aim was to develop high quality housing that would improve the lives of the working class. These ideas were influenced by international movements of the time including the Arts and Crafts movement in Britain.

**Het Schip** housing complex presents one of the best examples of the creative and innovative application of bricks and roof tiles using various bonds and mortar joints. The development involved collaboration with artists and sculptors in particular with Amsterdam's municipal sculptor Hildo Krop who created many significant buildings in Amsterdam and around the country. Many of his satires, sea monsters and mythological creatures adorn bridges and buildings in Amsterdam.

After the First World War, to cut costs and provide large amounts of housing, development plans for housing were rationalised and architects concentrated their efforts on designing street frontages and producing expressive detailing for archways and towers on major intersections and corners. Many sculptural interventions were introduced at the entrances to the buildings.

As Hendricus Theodorus Wijdeveld, the editor of the journal *Wendingen* said at the time: *"The house has been overcome; the street has been invented"*.





***The Shipping House, 1916.***

**Architects:** Johan van der Mey, Michel de Klerk, Piet Kramer

In 1912 six shipping companies commissioned the design of the façade and shared offices for their head office building. This was the first building to be constructed which manifested the ideas of the Amsterdam School of architects. Stained glass in the interior, wrought iron detailing and hundreds of terracotta and stone sculptures built into the façade covering the reinforced concrete core, made the building into true *Gesamptkunstwerk*.



## ***Tuschinski Cinema, 1921***

**Architect: Heyman de Jong**

Combination of Art Nouveau, Art Deco and Amsterdam School styles were used to create the expressive front facade. The façade is decorated with high fired glazed ceramics produced by the Koninklijke Porceleyne Fles factory in Delft.

### ***Lessons***

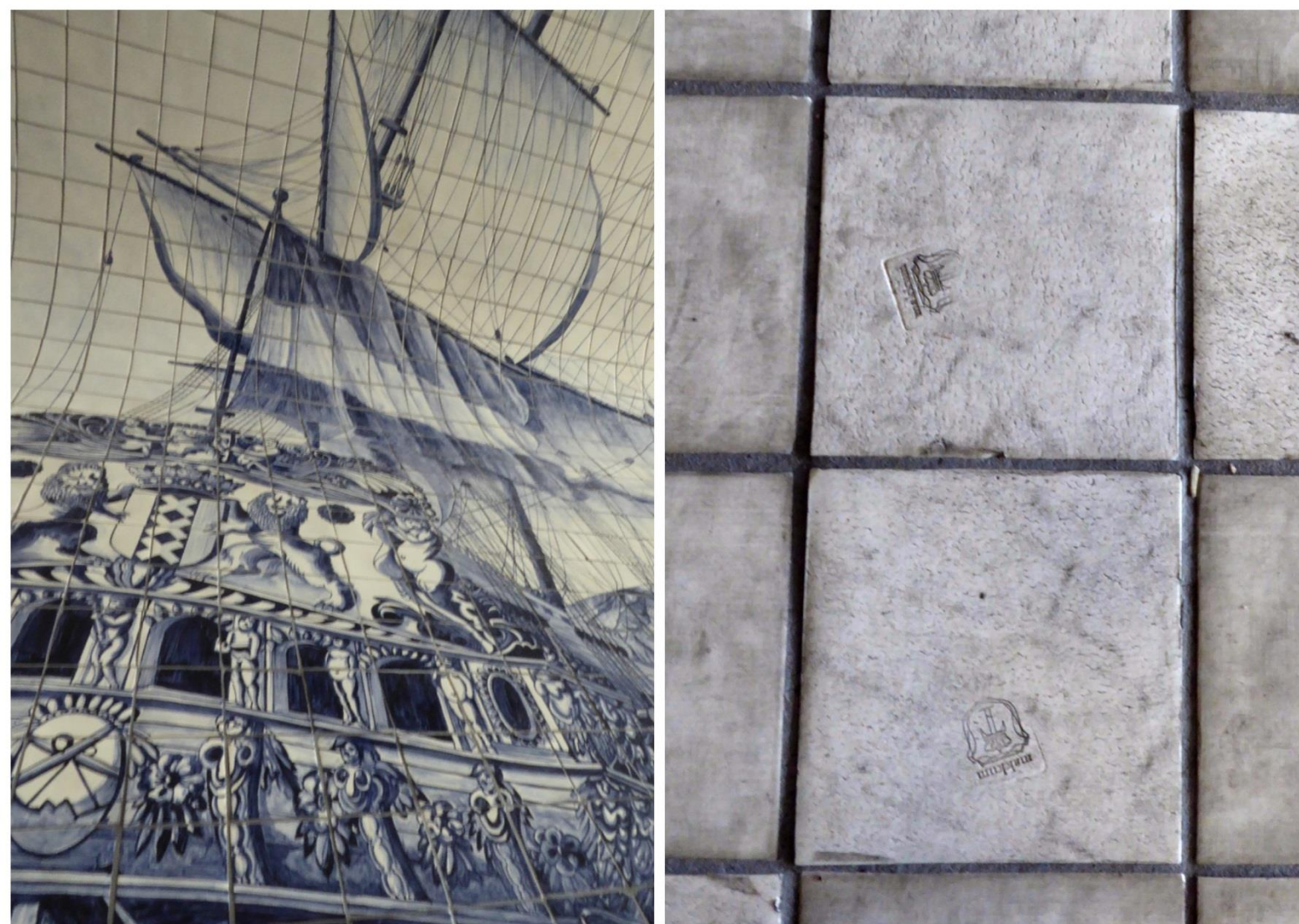
*Today the overload of virtual experiences, alienation of people and lack of sensory experiences brings the importance of craftsmanship and hand-made back into focus.*

*With the housing shortage and rapid growth of residential developments in Britain at present, there is a need for creative design solutions to create contextual, site specific buildings and spaces. There are many lessons we can learn from architecture in the Netherlands and particularly the Amsterdam School that can be used in Britain, such as the creative use of ceramics in buildings and the integration of art into the streetscape to create unique architecture and public spaces.*

## 2. Contribution to the Public Realm

Creating Unique Buildings and Spaces





Architectural ceramics, being a clay product integrate well into the built environment. Ceramics are the most long-lasting man-made material, carry cultural references from many civilizations and are both functional and decorative. Appropriately integrated into urban fabric, ceramic elements significantly contribute to place making.

Successful public spaces have been discussed by many, including William Whyte (1980) and Jan Gehl (2011). Henry Shaftoe (2008) notes that creative and multi-sensory designs are crucial elements for successful public spaces. Juhani Pallasmaa (2005) claims that material and sensory experiences in cities enable people to better relate to their surroundings and each other. It has also been argued that ceramics have a sensory connection with people (Rawson, 1971).

Evidence-based researchers such as Roger Ulrich (1984) and Ivonne Jewkes (2016) have identified factors affecting peoples' wellbeing and behaviour in various contexts such as healthcare and prison spaces. The effect of colour and texture on humans has also been extensively researched.

One of the tasks that I set for my Fellowship was to see examples of ceramic interventions in cities that improved the environment and made a positive change to the spaces where they were used. I examined both historic and contemporary examples.

***Cuyperspassage Bicycle and pedestrian tunnel, Amsterdam Central Station, 2015***

**Architect: Benthem Crouwel**

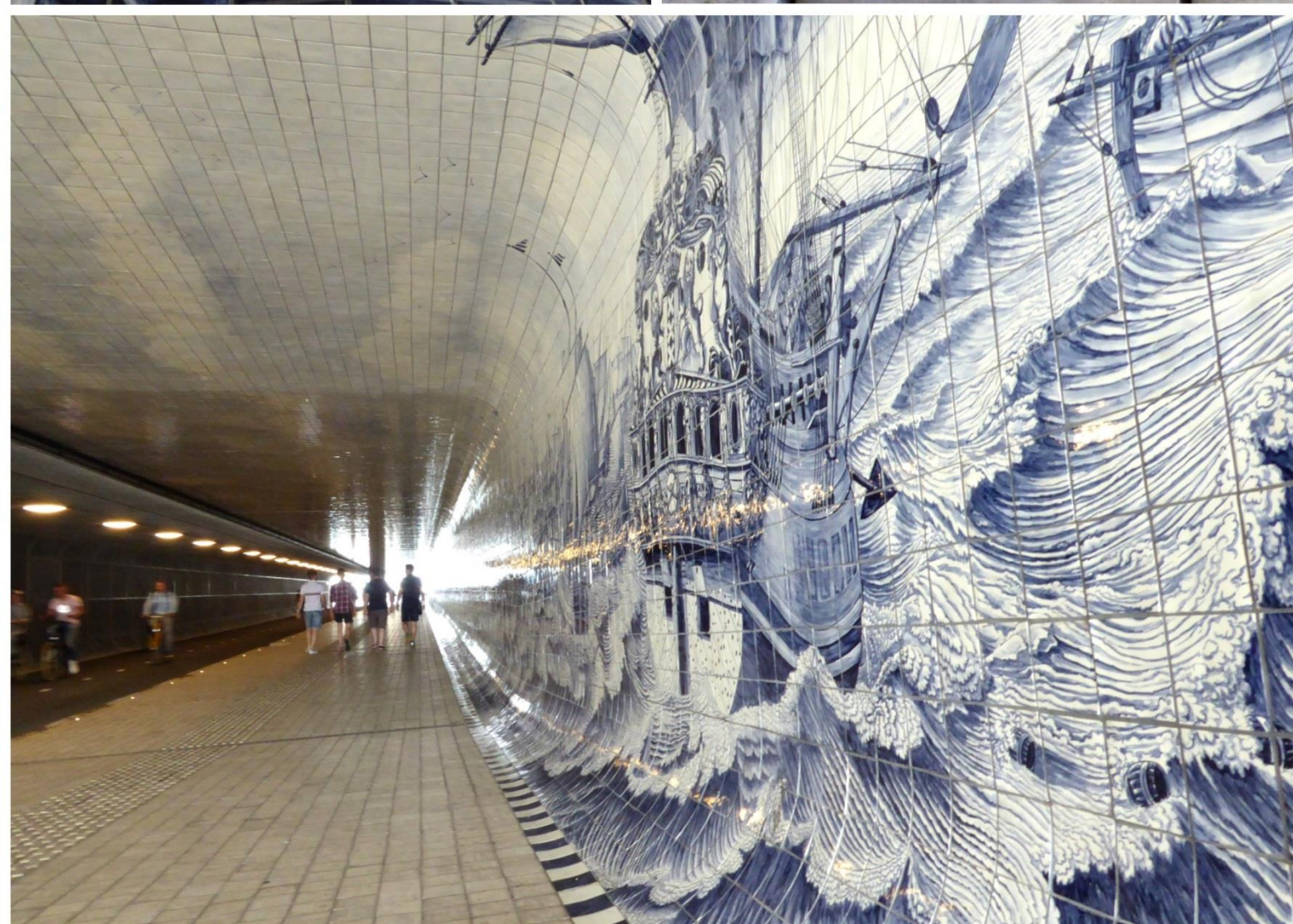
**“Delft Blue” mural by Irma Boom Office.**

**Manufacturer: Royal Tichelaar, Makkum.**

The pedestrian and bicycle tunnel runs under the Central train station in Amsterdam, connecting the old city centre and the river front. The wall on the pedestrian side of the tunnel is covered with hand-painted blue and white glazed tiles.

A large seascape painting inspired by traditional Dutch warship battle scenes was created by artist Irma Boom in collaboration with the Royal Tichelaar Makkum factory. Production of the 46,000 hand-painted tiles took several years.

The choice of hand-painted tiles and traditional themes show the importance of cultural references and values for enhancing public spaces.





The city of Delft in the Netherlands has been home to the Porceleyne Fles Factory (Royal Delft) has produced traditional “Delft Blue” porcelain ware since 1653. The factory also produced architectural ceramics until the 1960s.

In 2011 the “Delft Ceramics Route” was introduced in the city linked with the Focus in Terra 2011 exhibition. White and blue glazed brick pavers were introduced into the dark brick-paved streets linking various ceramic highlights in the city. The word "earth" written in several languages referred to the material that is the basis of all ceramics. The route is now a permanent part of the city fabric. The Humtunnel - bicycle and pedestrian Underpass forms part of the Ceramic route.

**Humtunnel, Bicycle and Pedestrian Underpass**

**Client: Municipality of Delft**

**Artist: Marta Nagy, 2013**

As part of the Ceramic Route project, the Municipality of Delft announced a competition for the renovation of an existing bicycle tunnel to address the issue of graffiti and advertising papers being illegally applied to the walls of the underpass.

The Hungarian artist Márta Nagy was commissioned to produce the artwork for the tunnel. Ceramic artwork called “Garden” was applied to both sides of the tunnel and was inspired by the 1652 city plan, celebrating the canals and gardens of the city.



*"I wanted to create something different from traditional "Delft Blue" that is present everywhere in the city" notes Marta.*

Strong geometrical design using textured undulating bricks was envisaged to be different from "familiar" blue and white pallet.

Various patterns were achieved by a combination of repetitive brick elements. Abstract "tulip", "butterfly" and "rose" were highlighted by gold and silver colour accents. The artist notes that gold and silver metals are precious for many cultures and by introducing colour accents into the surface of the wall, extra value was added to the space.

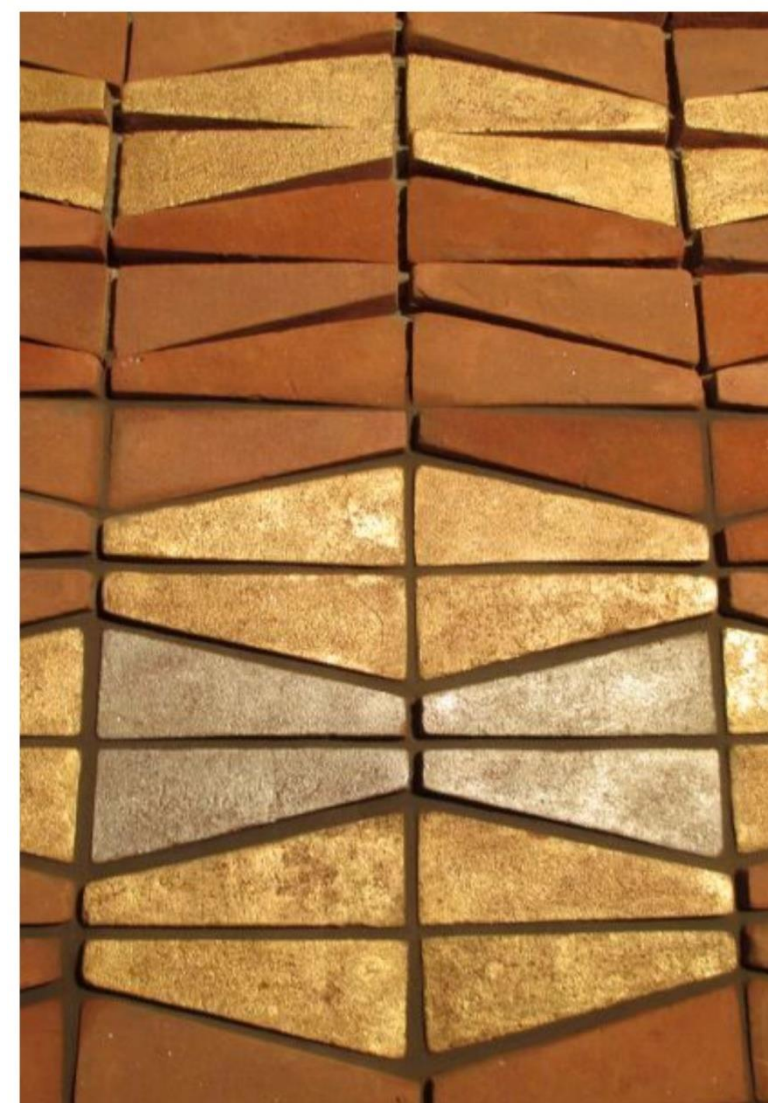
The richly textured hand-made bricks were individually made by pressing the clay into wooden moulds. A linear arrangement was created considering the visual impact on cyclists.

The raised surface of the bricks made fixing advertising posters very difficult. At the same time the strong regular pattern of the design made graffiti visually ineffective.

### *Lessons:*

*A tactile surface and warm natural colours of the brickwork in combination with special accents contributed to the creation of a very comfortable and friendly space and completely transformed the underpass.*

*I visited the underpass three years after it was completed. The underpass was very clean and the walls were in the same condition as they were when first completed. This example demonstrates how ceramic art and design can positively affect the environment and effect peoples' behaviour.*



## Sea View Hospital, Staten Island, New York City, 1913

The former tuberculosis hospital in Staten Island incorporates a unique example of application of ceramic tiles within the façade. The design of the hospital was exemplary at the time and reflected high aspirations both in spatial design and choice of materials.

Designed by the American architect Rimond F. Almirall in 1905, the hospital opened in 1913.

The hospital was commissioned by the municipal government as part of the social urban reform movement at the end of the 19th century and was conceived as “a hospital for all classes”. This was in response to the overcrowding of the industrial city and the spread of infectious disease such as influenza, scarlet fever and tuberculosis in particular.

The hospital was designed to be located within nature, with plenty of sunshine and fresh air. The revolutionary treatment used here at the time made the hospital one of the best in the world. Antibiotic treatment for tuberculosis was successfully introduced for the first time in 1952 at Sea View Hospital.

The location and design of the hospitals and the choice of materials reflected a growing awareness of bacteria and infection, sterility and cleanness. Ceramic tiles were included as they were considered a hygienic and healthy material for hospital construction. In *Tile and Walls for Hospitals* publication (Associated Tile Manufacturers, 1915) tiles were promoted for being non-absorbent, non-porous, and “filthproof”.

The “Sectile” style (irregularly cut) ceramic tiles were imported from the Netherlands and produced by Joost Thooft and Labouchere (1700-1930), the predecessor of De Porceleyne Fles manufacturing in Delft. The tiles were made for exterior application, fired at high temperature and had a dense stoneware clay body. The reasons for using Dutch tiles for the building are unknown, but it has been speculated that a competitive price together with a perception of European products being superior to their American counterparts could be the reasons.

A two meter deep ceramic frieze, installed under the eaves, runs along the 100m perimeter of four pavilion buildings and forms a band of colourful decorated surface. Figures of doctors, nurses, and children made out of irregular shaped tiles are incorporated together with high relief scallop shells and medallions showing the Red Cross, the American flag and other imagery. (Figure x). Ten different coloured glazes were used in the composition. The background was covered by gold metallic glazes that would have originally shone brightly in the sun. The lustre glazes, however, were affected the worst by the weather.

Regrettably, the buildings have been abandoned since the 1970s and have been deteriorating slowly. The roof detailing failed, the majority of the copper flashings and downpipes were stolen which exposed the ceramics to direct water ingress. In spite of this, the tiles have withstood the test of time remarkably well.

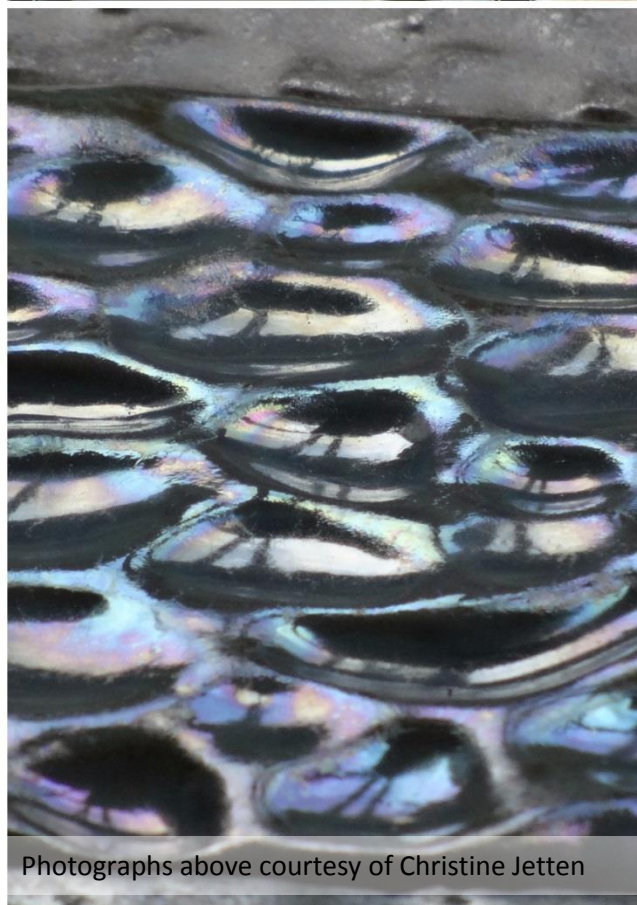
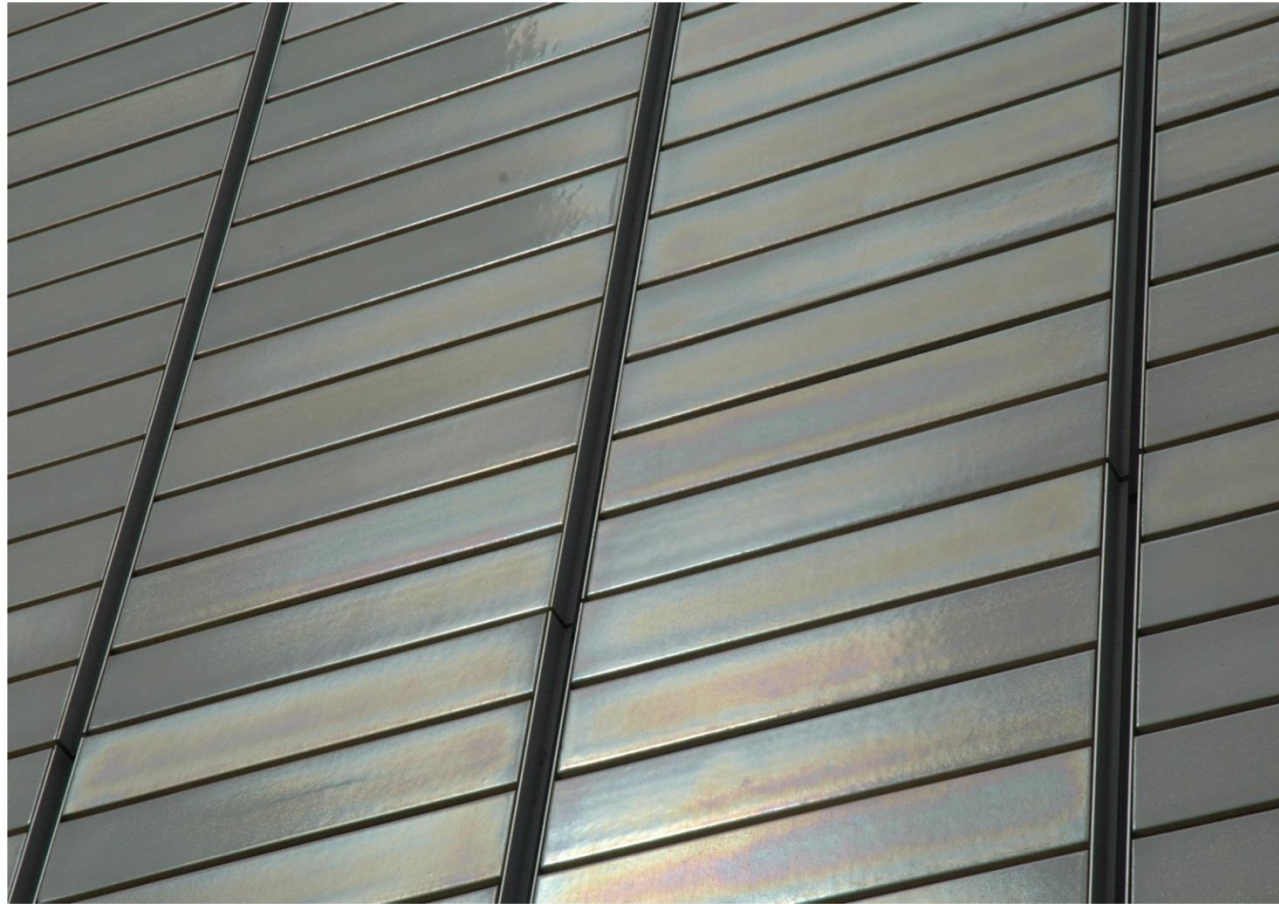
Ironically, the discovery of revolutionary treatment for tuberculosis in 1952 meant that patients could be treated in other hospitals around the city. Since then the Sea View hospital has served as a facility for geriatric care and a nursing home. The open air pavilions subsequently became abandoned.

### *Lessons:*

*The relevance of this case study is applicable to the healthcare sector in the UK today. Considerable amounts of money are spent in the UK to introduce art into hospitals in an attempt to avoid an “institutional” feel, create positive distraction and hence improve wellbeing. Many evidence-based studies have been carried out on the effect of colour and the importance of the quality of outdoor spaces and links with the nature. (Ulrich, 1986)*

*One of the possible ways to contribute to healthcare design for both exterior and interior spaces is to incorporate ceramic surfaces and detailing as these combine functional qualities such as durability, low maintenance and hygiene with durable colour and opportunity to introduce textures and that can affect peoples’ mood and psychological and physical wellbeing.*

### 3. Artists' Collaborations



Photographs above courtesy of Christine Jetten





Many successful projects that included the innovative use of ceramics had artists collaborating with the architects and manufacturers.

One of the objectives of my Fellowship was to understand the relationship between the clients, designers and manufacturers that ensured the successful results.

### Studio Christine Jetten

Dutch ceramic artist and glaze specialist Christine Jetten explains her collaboration with architects and industry.

Jetten works with architects, providing specialist knowledge for the creation of unique ceramic facades. Developing custom-made glazes for new build and reproducing glazes on restoration projects, she explains the possibilities and material qualities to architects.

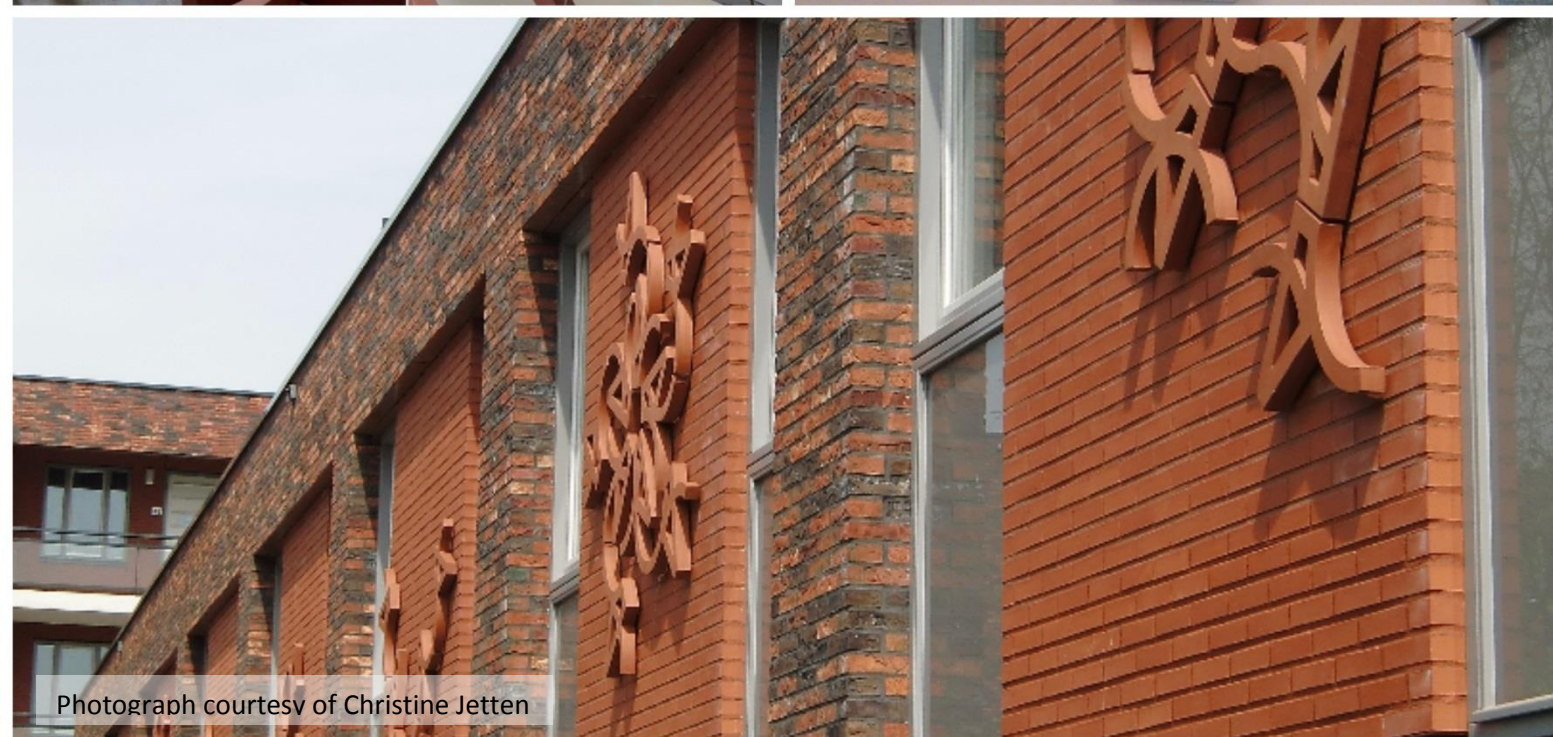
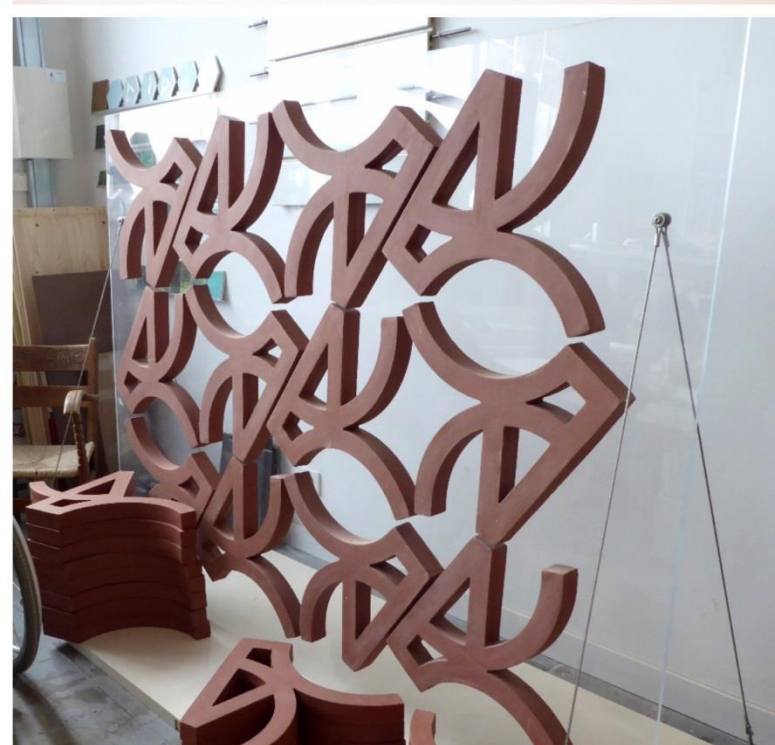
*"I help to generate new ideas about how to use clay and glaze especially in building designs. I often develop a range of glazes based on the architect's needs."*

When a glaze is chosen, Jetten produces glaze samples for the bidding process so that the architects can give the manufacturers a clear idea of what is required.

*"In addition I assist the architect in dealing with other various aspects of the ceramic industry. For example, if a manufacturer needs assistance matching a glaze I have developed, they can consult me."*

Jetten collaborated with international architectural firms to use ceramics in façades and interiors. Based in 's-Hertogenbosch in The Netherlands, she has worked on developments in London, Beijing, New York, Las Vegas, Fort Lauderdale and Delft.

She also acted as a production supervisor and as an intermediary between architects and ceramic manufacturers such as NBK in Emmerich, Germany, Koninklijke Tichelaar in Makkum, Holland, and Boston Valley Terra Cotta, USA.



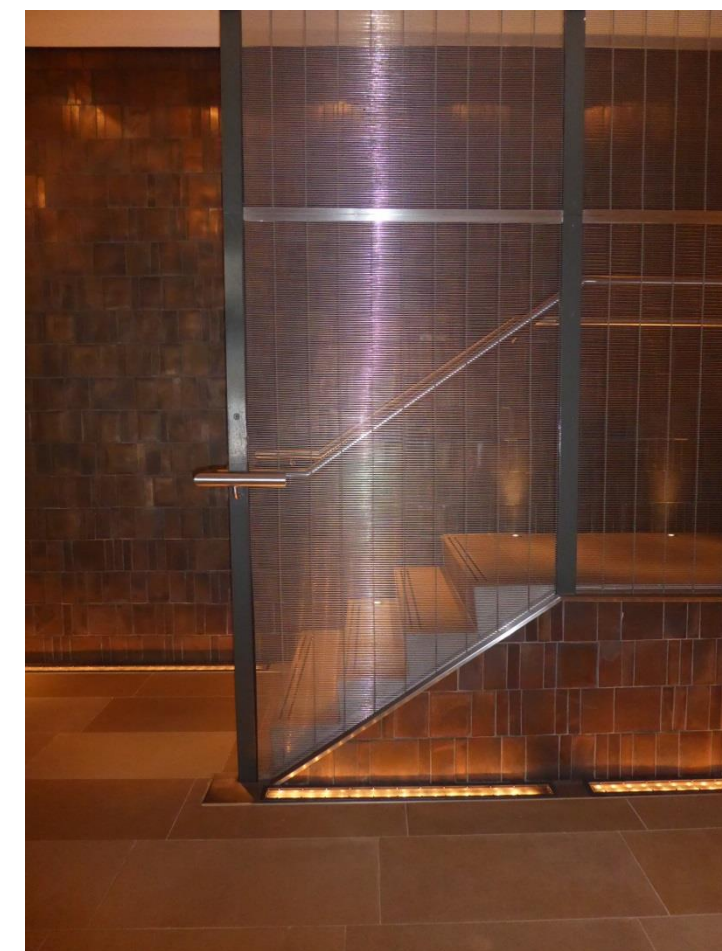
Photograph courtesy of Christine Jetten



### Luxury apartment building, Davies Street, Mayfair, London.

Another successful project with KPF architects was a luxury apartment building in London. The exterior uses ten shades of unglazed terra cotta cladding that relates to the prevailing colours of the surrounding Victorian buildings. Jetten worked closely with the manufacturers to create various shades of the clay body to match the surrounding context.

The interior in both the lobby and the hallway were covered by custom made tiles glazed with a bronze metallic glaze produced in collaboration with Royal Tichelaar in Makkum. These provide a sense of handcrafted quality adding value to the building.





Holland House, City of London



## AIG Real Estate Investment Corporation Headquarters, City of London.

Working with Kohn Pedersen Fox (KPF) architects, Christine Jetten developed glazes for the AIG Real Estate Investment Corporation headquarters building in the City of London.

The project was inspired by the historic context of the area and an iconic building in the vicinity of the new development. The ceramic façade of Holland House that was designed by the famous Dutch architect H. P. Berlage and manufactured by Royal Delft in the Netherlands in the 1930s was an inspiration for the client.

Christine Jetten was engaged in the project for her expertise in ceramic glazes to recreate an old glaze recipe used by the Royal Delft factory.

The challenge was to produce the mottled effect of the old existing hand-made tiles using modern, high-tech equipment.

The research and testing to achieve the desired effect took several months in collaboration with the ceramic manufacturer.

With the commitment of the client to the material and support from the architects and the manufacturer a very successful result was achieved.



AIG Headquarters, City of London



### ***Lessons:***

*Commitment of the client, early involvement of the material specialists, collaboration between the architect, artist and the manufacturer are essential ingredients for high quality results.*

## Struktuur 68

A unique example of collaboration between artists, architects and ceramic specialists is the Atelier Struktuur 68 ceramic making facilities located in The Hague.

Tucked away in a narrow street in the centre of The Hague, this workshop has a history of almost 50 years of collaborating with over 200 artists including some famous artists in post-World War Two Europe.

Established by Jacques van Gaalen and Henk Trumpie in 1968, the Atelier started in response to a demand among visual artists for monumental colourful ceramic work for public spaces.

Originally the founders ran the Atelier while working at the Experimental Department of the Porcelyne Fles factory in Delft.

Other existing manufacturing facilities at the time were not able to provide the expertise for the artists. Even today it still proves to be difficult to incorporate individual artistic quality into a large scale industrial setting. Artistic experiments are time consuming, expensive and therefore are not viable for the industry.

Because of its specialist set-up and existing facilities, Struktuur 68 supports craft making, collaborative processes and experimentation. The studio specialises in the manufacture of large sculptures in public and private spaces for both interiors and exterior spaces.

Many projects that Struktuur 68 was involved in take their origin from the ideas of the Arts and Crafts movement that influenced the style of applied art in the Netherlands in the 1900s.

The socialist movement in the Netherlands at that time had a great effect on “community” based art in paintings and sculptures for public buildings. Integrated works of art were applied to public buildings, housing projects, squares and bridges. It was believed at the time that “improved aesthetics” and well-made industrial products would influence the spiritual levels of people and improve quality of life.

Ceramics played an important role in this community-based art. The mural by Jan Toorop in the Beurs van Berlage is a good example of the beautiful integration of ceramics within brickwork, glazed bricks and tiles. Many well-known ceramics factories in the Netherlands facilitated similar interventions.

After the Second World War an experimental department of Porceleyne Fles provided facilities for artists like Karel Appel, Dick Elffers, Maurits Escher among others to produce artwork in buildings. The Danish “Cobra” movement artists also collaborated with other European ceramic factories such as Sevres in France and factories in Italy and Germany.

The workshop provides making facilities for creating large scale sculptural ceramic works. Examples of their work can be seen in many public spaces and buildings in the country. Art for “community” that began in 1900 still exists, however it is now called “art for public spaces”.

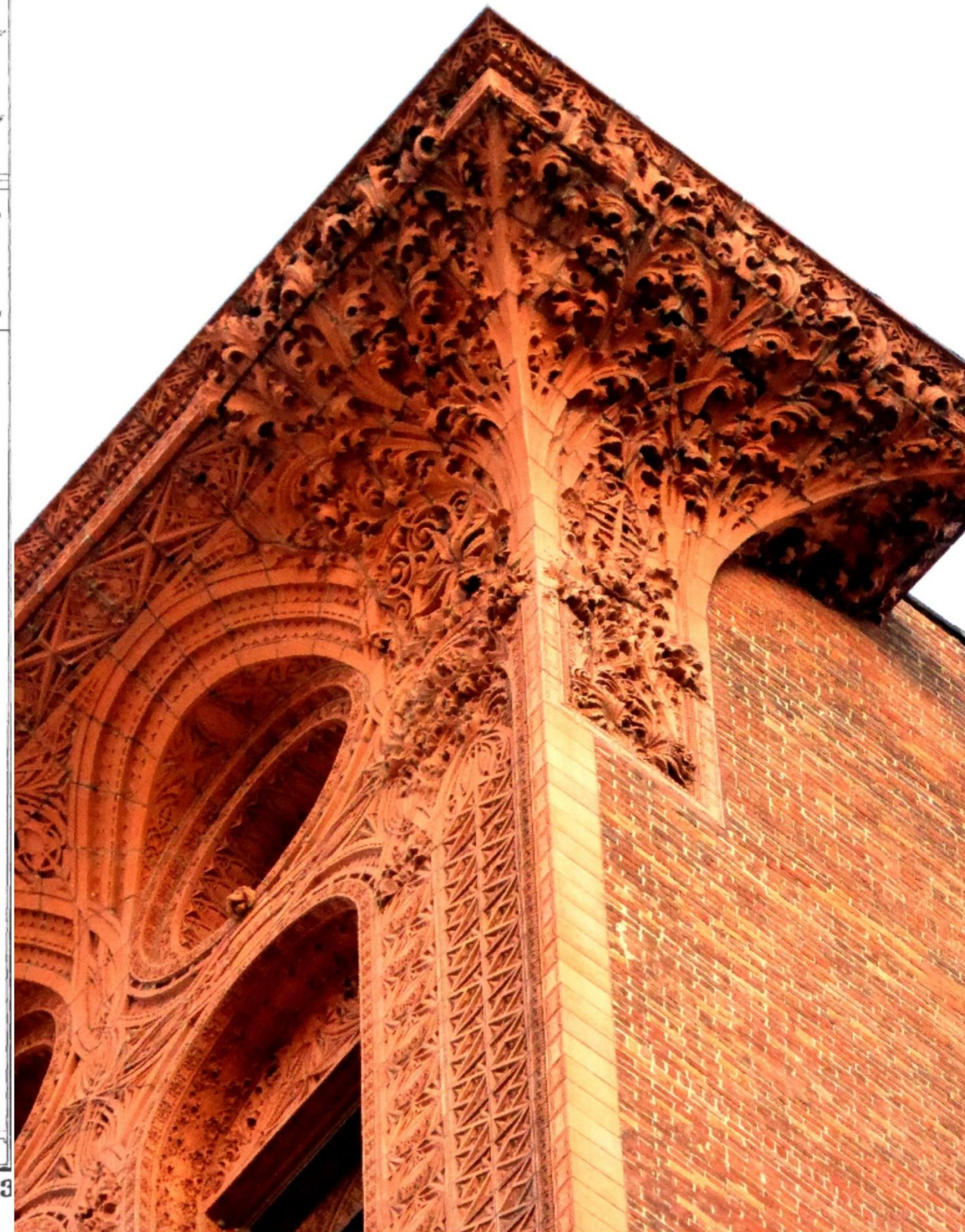
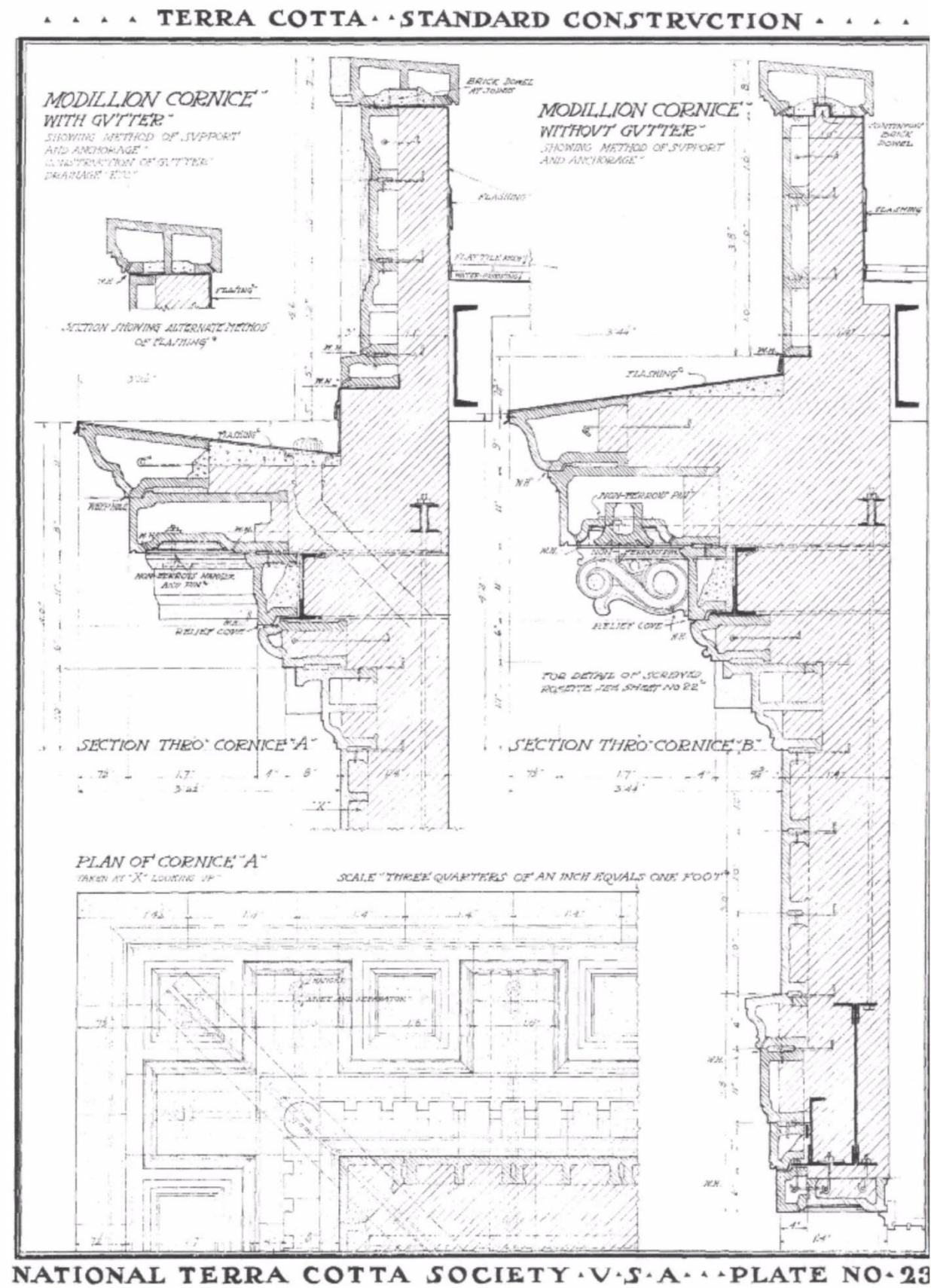
### *Lessons:*

*Medium sized ceramic workshops and production facilities are instrumental in allowing for experimentation and creative work to be produced on a large scale. These facilities provide ceramic specialist knowledge as well as a place for developing and testing creative ideas for artists and architects. Here ceramic and visual artists and architects are able to produce work on a larger scale and are supported by craft specialists with in-depth knowledge of the material.*



## 4. Manufacturing of Architectural Ceramics

### Traditional and Innovative





Visits to various manufacturing facilities both traditional and innovative illustrated the range of possibilities and opportunities for the production of architectural ceramics. Below is a short description of traditional making techniques that are still used in most manufacturing facilities.

### ***Hand Press***

This traditional forming method is used for sculptural pieces, particularly ones that contain intricate detailing or details with undercuts. Plaster moulds that are the negative of the finished piece are filled by hand with soft clay. The moulds are made up from several pieces held by straps. Lately rubber or silicone moulds have been used for forming intricate shapes. Soft clay is pressed against all faces of the mould to a set thickness. Internal webs are formed to provide stability for the walls during drying and firing. The plaster dehydrates the clay, allowing the piece to hold its form when released from the mould.

### ***RAM Press***

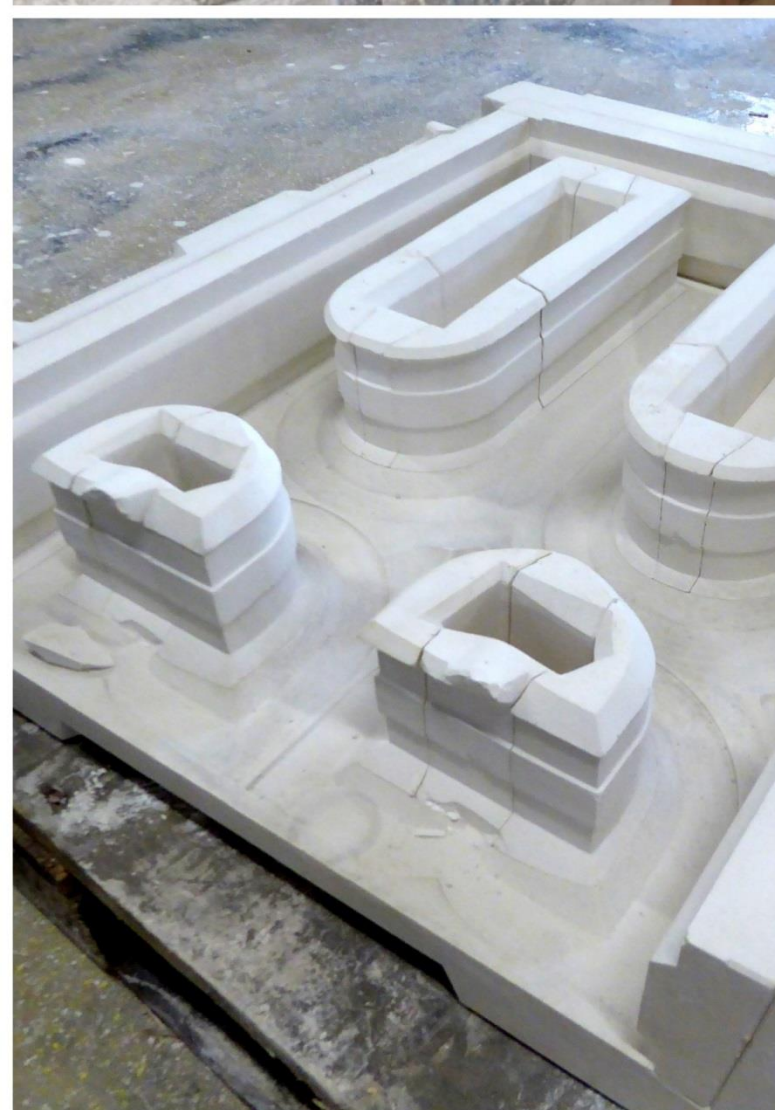
Pieces made using a hydraulic press are not generally as sculptural as those made by hand pressing. However like hand pressing, this forming method does not allow for undercuts to be included in the die. Soft clay slug is placed on the die and hydraulically pressed into the form. Air forces water in the plaster die to the surface, releasing the piece from the mould.

### ***Extrusion***

The extrusion forming method is used for the production of linear profiles when a large quantity of repetitive elements is needed. The clay is forced through a steel die, forming a hollow cored or solid unit. The profiles are cut into the required length, taking into account clay shrinkage. Die profiles can be customised to produce various outlines. Rain screen facades are made using profiles of extrusions and most bricks are produced using the extrusion method.

### ***Slip Cast***

Slip is a liquid clay body that is poured into a plaster mould and left for a specified period of time to form an inner core. As in hand pressing, the plaster begins the dehydration process, drawing the water out of the liquid clay suspension and causing drying clay to build up on the sides of the mould. Once the desired wall thickness of the finished piece is achieved, the extra liquid clay body is poured out from the mould and the piece is allowed to dry further before being released from the mould. This forming method is particularly suited for pieces with fine ornamentation and units that need to be hollow for anchoring such as balusters.





### Advanced Technology

Technological advances allow for a dramatic change in manufacturing processes that affect time and quality. 3D printing and 5 axis CNC milling can create elaborate shapes that would be difficult to produce by hand.

Hand Pressing and Slip Casting processes require moulds to reproduce the original. Traditionally these were made by hand and have been cast off an original that was also produced by hand. Today it is possible to create a mould without a physical original model by creating a computer generated model and milling it out using a CNC router.

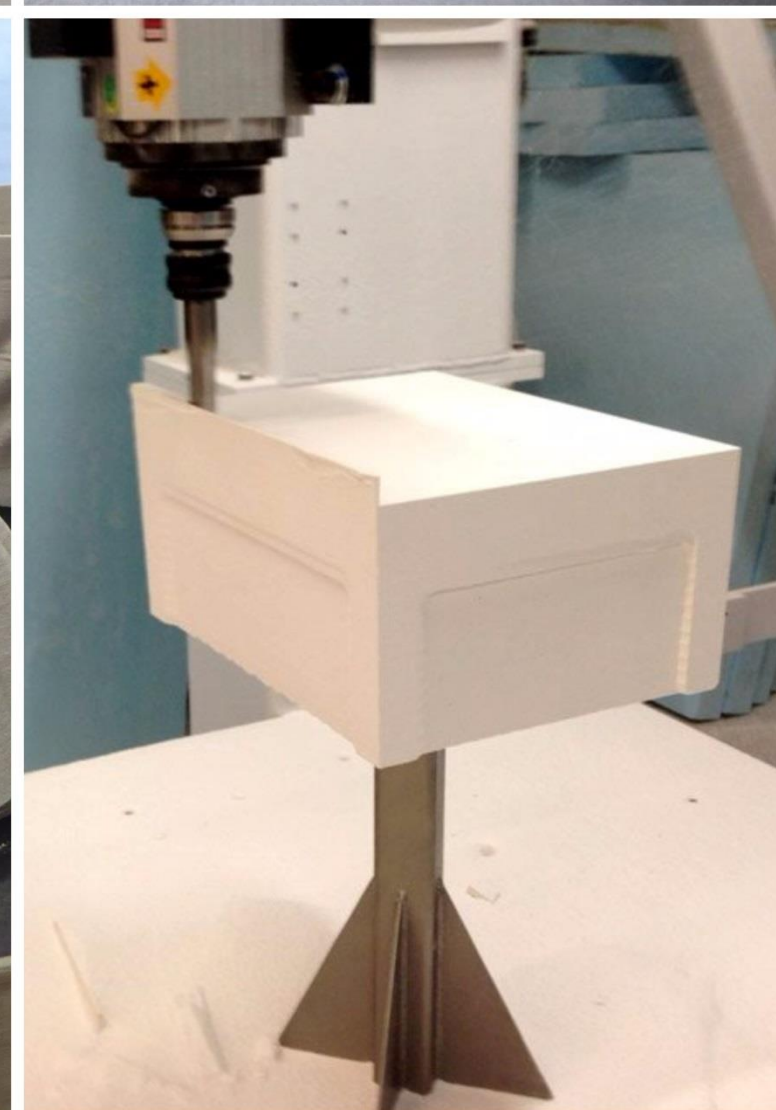
The latest additive technology such as 3D printing allow for direct fabrication during which all preliminary stages such as model/mould/casting are omitted completely and the clay objects are printed from a computer generated model. However currently this technology is applied only in prototype labs and experimental facilities.

Meanwhile, large unfired clay structures are produced for experimental housing in hot countries. (<http://www.iflscience.com/technology/3d-printer-uses-mud-natural-fibers-make-homes-impoverished-areas/>. Accessed: 8 May 2017)

Some of the most creative examples of the use of architectural ceramics in buildings today use a combination of traditional and innovative production methods.

I visited factories in three countries to establish the manufacturing methods and how these can be used to create innovative products. The factories included major ceramic manufacturers such as Boston Valley Terra Cotta in the USA, Royal Tichelaar Makkum, St. Joris brick factory and Rodruza brick manufacturers in the Netherlands, and the Zsolnay factory in Hungary.

Below is a table showing the production methods used at these factories.



Manufacturing Processes in Factories Visited

Manufacturers	Processes								
	Hand-made models	Digitally made models	Hand-made moulds	Digitally made moulds/ wire cut/CNC Router	Hand-pressed/ Slip-cast products	RAM-pressed products	Extrusions	3D Printing/ Direct manufacturing	Frost Resistant Glazes
Boston Valley Terra Cotta, USA									
Royal Tichelaar, Makkum, The Netherlands									
Zsolnay Factory, Hungary									
St. Joris Keramische Industrie, The Netherlands									
Ibstock Brick, UK									
Darwen Terracotta, UK									



Photograph courtesy of Royal Tichelaar Makkum

The following case studies illustrate how traditional, innovative and a combination of both methods were employed for particular projects resulting in stunning outcomes.

### Royal Tichelaar Makkum, the Netherlands

Royal Tichelaar Makkum is the oldest company in the Netherlands making ceramics. Established in 1572 as a brick factory, ceramic production included tableware and traditional tiles and remained as a family business until recently.

Linked to growing demand in recent years, the factory has almost totally dedicated itself to the manufacture of architectural ceramics. Traditional forming and painting technics are still used in the factory to produce decorative earthenware and tiles. However, the majority of the workload at the factory is dedicated to custom made ceramics for architectural projects.

Several iconic buildings were produced in collaboration with internationally renowned architects. A few buildings and interventions for public spaces were also produced in collaboration with artists. Slip-casting, extrusion and press-moulding are among the techniques used in production.

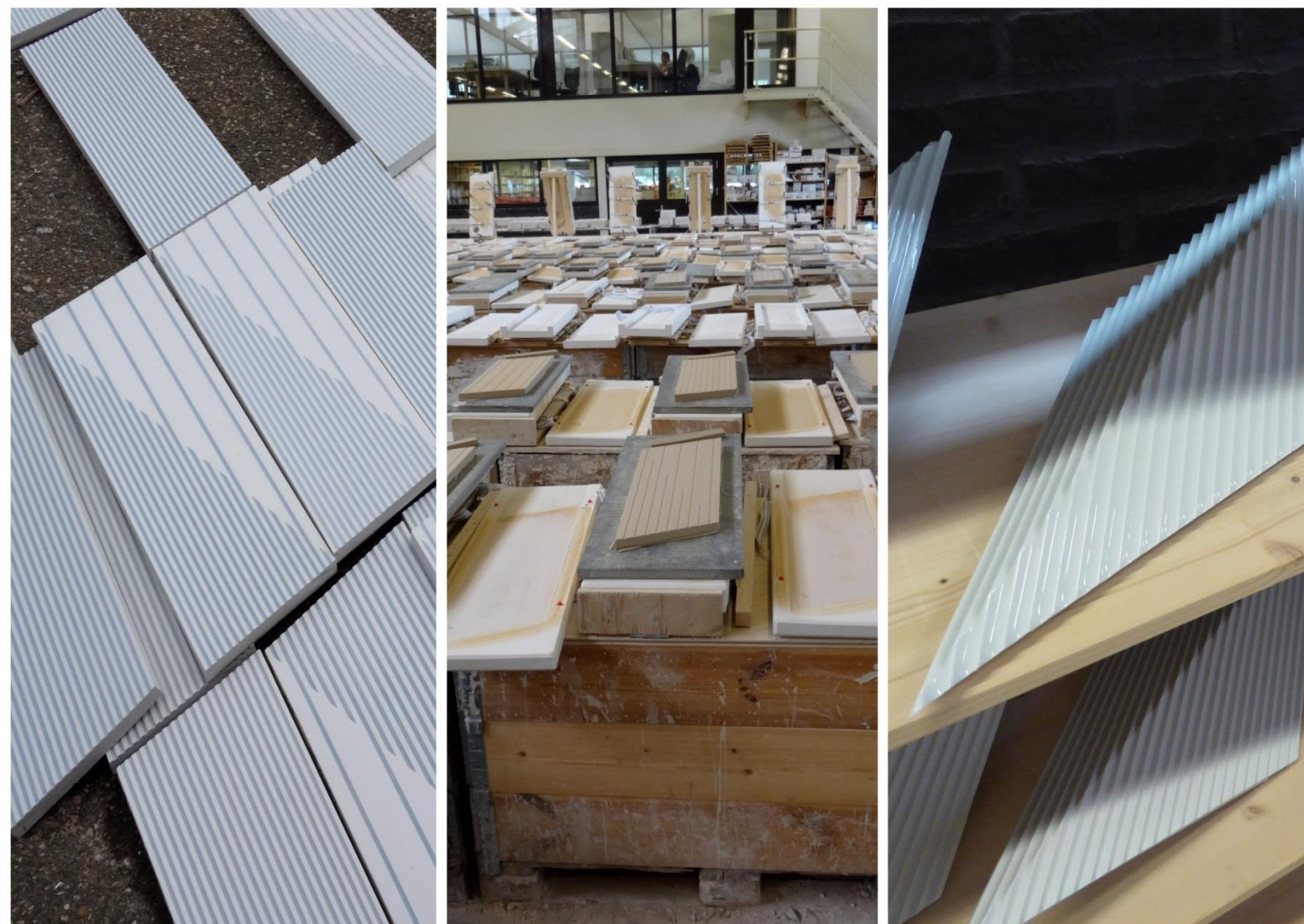
The company provides a wide range of glazes that can be used indoors and outdoors and which can be applied to tiles, extruded and sculptural elements.

### Victoria and Albert Museum, London New courtyard, exhibition space and café. Amanda Levet Architects (AL\_A)

Due for completion in 2017.

The Exhibition Road entrance, courtyard, cafe and an underground gallery for temporary exhibitions. This will be the first courtyard in the United Kingdom to be tiled in porcelain. This choice of material is a specific response to the original building and the collections, which include numerous striking examples of 19<sup>th</sup>-century decorated ceramics. (<http://www.tichelaar.com/projecten/victoria-albert-museum2>, Accessed: 08 May 2017)

195 x 558 mm Slip-Cast Porcelain Slabs, frost proof for outdoor floor and roof application, partially glazed by hand. The tiles are produced using traditional slip-cast techniques.



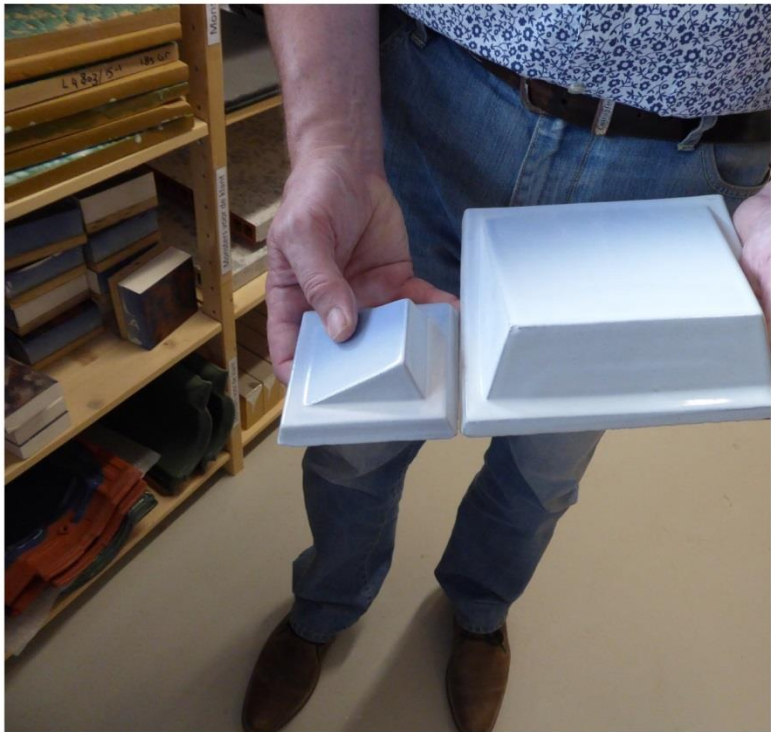
**Extension to museum de Fundatie, Zwolle**  
**Architect: Bierman Henket Architects**

**2013**

In 2011, Royal Tichelaar Makkum developed and manufactured ceramic cladding for an elliptical extension to the roof of the existing 19<sup>th</sup> century building of the museum.

The organically shaped three-dimensional ellipsoid called 'The Eye', has been designed to contrast the original Neo-Classical building.

Two sizes of wedge shaped elements of cladding were produced using the RAM pressing technique. The extension was to blend with the sky. White glaze with light blue accents reflecting the light and sky was developed for the cladding providing the desirable effect.



## St. Joris Keramische Industrie b.v.

The St. Joris factory, located in the South-East of the Netherlands is Europe's biggest producer of glazed bricks. Established in 1923, the factory switched its focus to the development of glazed ceramic products after the Second World War. The factory produces a large selection of glazed bricks, blocks, wall copings and window sills.

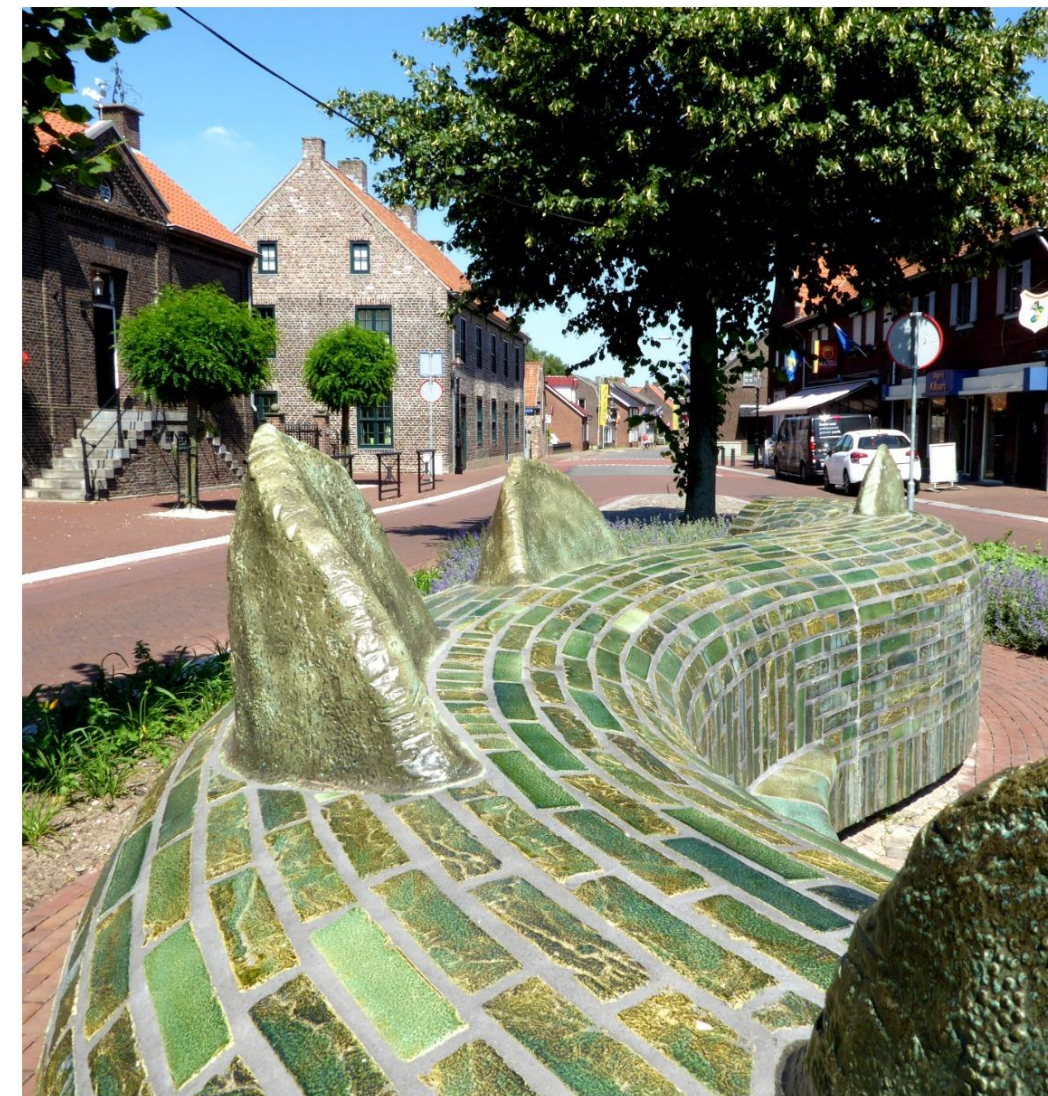
Currently 80% of the production of the factory consists of bricks developed for specific projects and 20% standard glazed window sills. St Joris factory exports bricks to the UK, the USA, Belgium and other European countries including Russia.

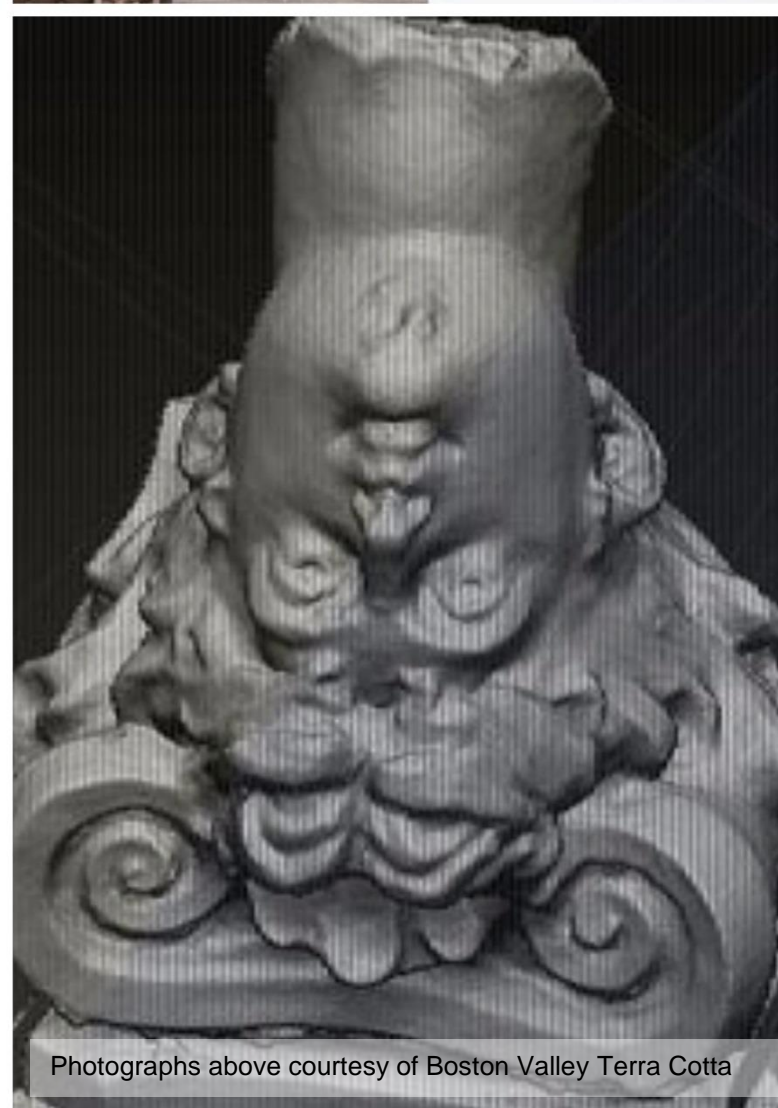
The bricks are formed using both hand craft and mechanical techniques such as extrusion and RAM pressing. All bricks go through a single firing process with temperatures up to 1200 °C that makes them frost and heat resistant.

German Westerwalder light coloured clay is used for the bricks which allow the vibrant colours of the glazes to be well seen.

Much experimental work takes place at the factory's laboratory to develop various colours and surface textures. Experimental products include glazes which glow in the dark.

In the 1960's the factory collaborated with artists and sculptors who used the facilities to produce sculptures and pieces of public art. Many examples of these collaborations adorn spaces and buildings in local towns. The company worked with many renowned Dutch and British architects to create unique facades and elements for landscaping. In the UK, projects included West Hampstead Station, the Emirates Stadium and the development on Black Friars Road in London and more recently the Bus Station in Stoke on Trent. St. Joris works in partnership with local brick companies in various countries.





Photographs above courtesy of Boston Valley Terra Cotta



## Boston Valley Terra Cotta factory, New York State, USA

Boston Valley Terra Cotta (BVTC) is one of the leading ceramics manufacturers in the USA. Combining technological innovation and contemporary methods of production with traditional craft methods makes the factory unique.

BVTC is a family owned business that started in 1981. However the original factory has produced ceramic products since 1889.

Initially most production was focused on historic restoration projects. However in the last decade this has changed and new build projects form about 50% of the factory's production (Interview with B. Pottle, 2016).

Terracotta forming methods used in the factory include traditional hand pressing, slip casting, hand finishing and decorating. Cutting edge technology such as a 5-axis CNC router for model making, laser cutting, overhead lifting devices to transport units around the factory as well as the use of bar code scanners to track every unit through the factory.

### Reconstruction jobs

Reconstruction jobs are a good example of how state of the art digital tools are used in combination with hand finished detailing to produce replacement elements for buildings.

Digital scanners are used to survey the original ceramic detailing that needs to be reproduced. 3D digital models are then generated using photogrammetry technology. Next, a physical model is created, scaled up from the original, taking into account shrinkage of the clay. The model is milled out of foam using a CNC router. Less complex models can be produced from foam using a wire cutter that is cheaper and quicker to operate. The accuracy of digital scanning and laser cutting increases the quality and consistency of replacement block fabrication.

3D scanners and 5axis CNC cutters dramatically reduce the production time for several labour-intensive stages of production. A model-making process that would have taken a master sculptor days or even weeks to make is made over night. An important consideration is also the light weight of the foam model which would be very heavy if made of clay. This facilitates movement of the products around the factory.

At the next stage, plaster moulds are prepared by hand and cast off the machine-made model. Dried plaster moulds are filled by clay slip and released after a set time to create the reproduced detail.

Depending on the complexity of the job, clay elements are either sprayed with glaze or decorated by hand. The restoration of Childs Restaurant in Coney Island is a good example where roundels and elaborate detailing were finished and painted by hand, as variations of four colours had to be matched to the original. The medallions were reproduced by a 5-axis CNC router.

### Collaborations

BVTC has formed partnerships with local universities such as the University of Buffalo and Alfred University that provide mutually useful relationship. Universities provide fresh ideas, experimentation and knowledge of latest technology. This can be tested and applied to the current manufacturing processes at the factory. On the other hand the factory provides experience based opportunities for young design professionals. Students of the University of Buffalo work with the factory creating a direct impact on production. Some of them join the company after graduation.

BVTC collaborated with ceramic artist Christine Jetten to develop glazes for some of their projects.



## ARCH Design Lab

ARCH Design Lab was formed at the factory to allow custom made architectural elements to be produced at, or near, catalogue mass produced cost. 3D parametric CAD/CAM (Computer Aided Design/ Computer Aided Manufacturing) technologies are used to provide “mass customization” in architectural fabrication.

The workflow begins early in the design process by producing 3D drawings.

From the start of the project, the experienced team of modellers, mould makers, extrusion designers and operators, detailers, colour and glaze experts, are producing “design for manufacturability”. In addition to traditional techniques a laser cutter, large 5-axis CNC machine and a complete suite of architectural and digital sculpting programs are used to create custom exterior and interior elements, as well as architectural sculpture.

### Architectural Ceramic Assembles Workshop (ACAW), August 2016.

During my Fellowship I was invited to take part in the ACA Workshop organised by Boston Valley Terracotta.

The focus of the Workshop was to explore Bioclimatic Ceramic Systems for the built environment. Specialists from various backgrounds engaged in ceramic design, such as façade engineers, ceramic artists, architects and educators were invited to work collaboratively during the weeklong workshop. The workshop included an introduction to manufacturing techniques at the factory, visits to architectural projects and daily lectures by professionals to explore the potential of ceramics.

A significant portion of the workshop was allocated to working collaboratively in teams to explore innovative design applications for ceramics and their potential of bio-climatic functions. This included understanding how new technologies impact the production and performance of large-scale ceramic applications.

### Ringling Museum’s Asian Art Study Centre Centre for Asian Art at the John and Mable Ringling Museum of Art (2016) Architect: Machado and Silvetti Associates

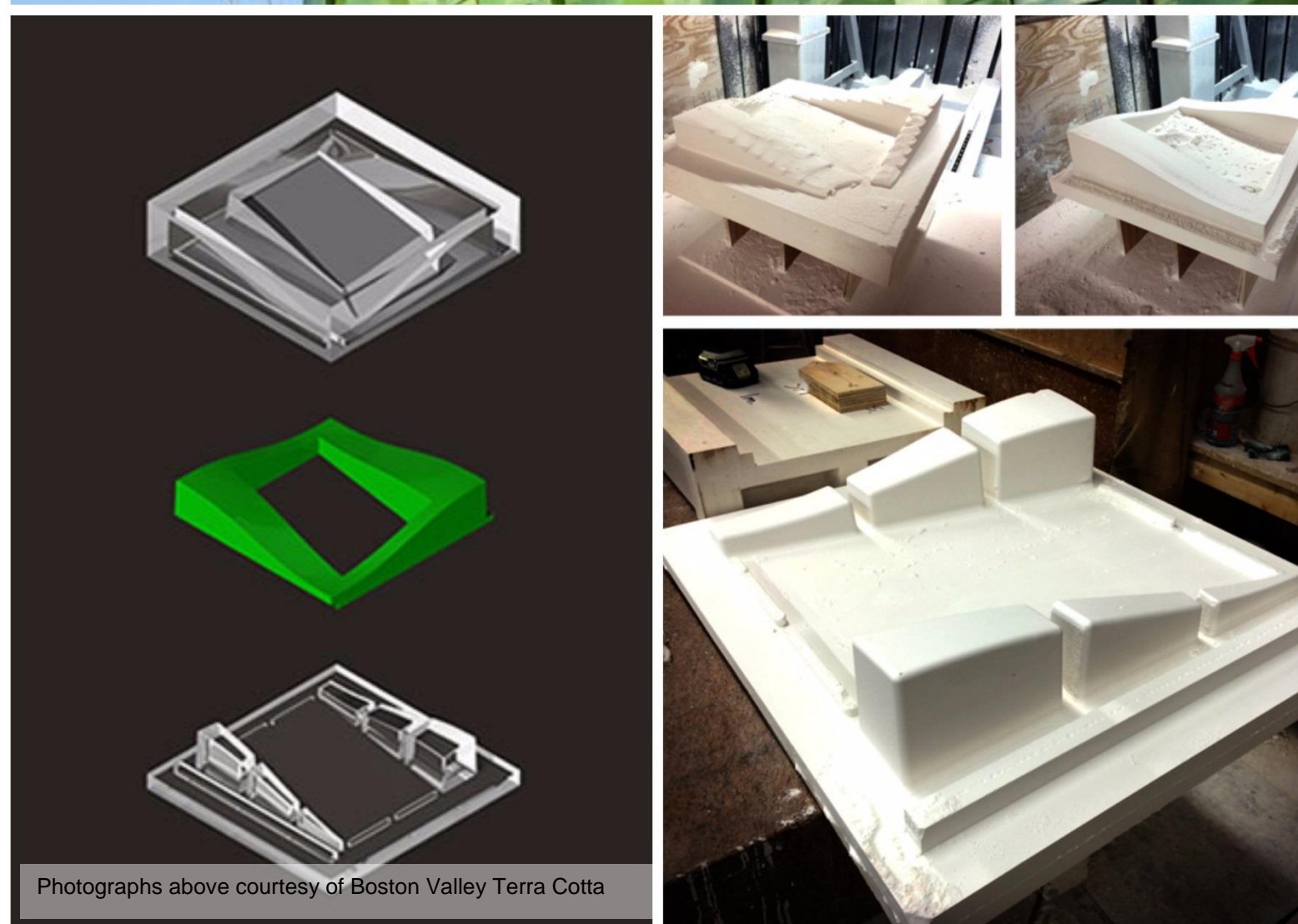
A new building for the Ringling museum in Florida was designed and clad by bright-green glazed curved units. The architects explain that the colour of the façade was chosen because of the green tile in Chinese architecture and gardens, and the green jade sculptures that are part of the collection.

The three sizes of the tiles were determined by the fabrication process.

Most of the tiles were hydraulically RAM-pressed. The corner conditions were individually made to fit particular locations. These were implemented by a combination of hand-pressed and slip-casting.

The making process involved a digital realization of the form using 3-D software and was prototyped using the 5-axis mill at Boston Valley.

The factory team created plaster moulds from the milled model for all three manufacturing types on this project. This combined manufacturing methods allowed for precision in the geometry of the façade.



Photographs above courtesy of Boston Valley Terra Cotta

## Innovative Hubs and Experimental Facilities

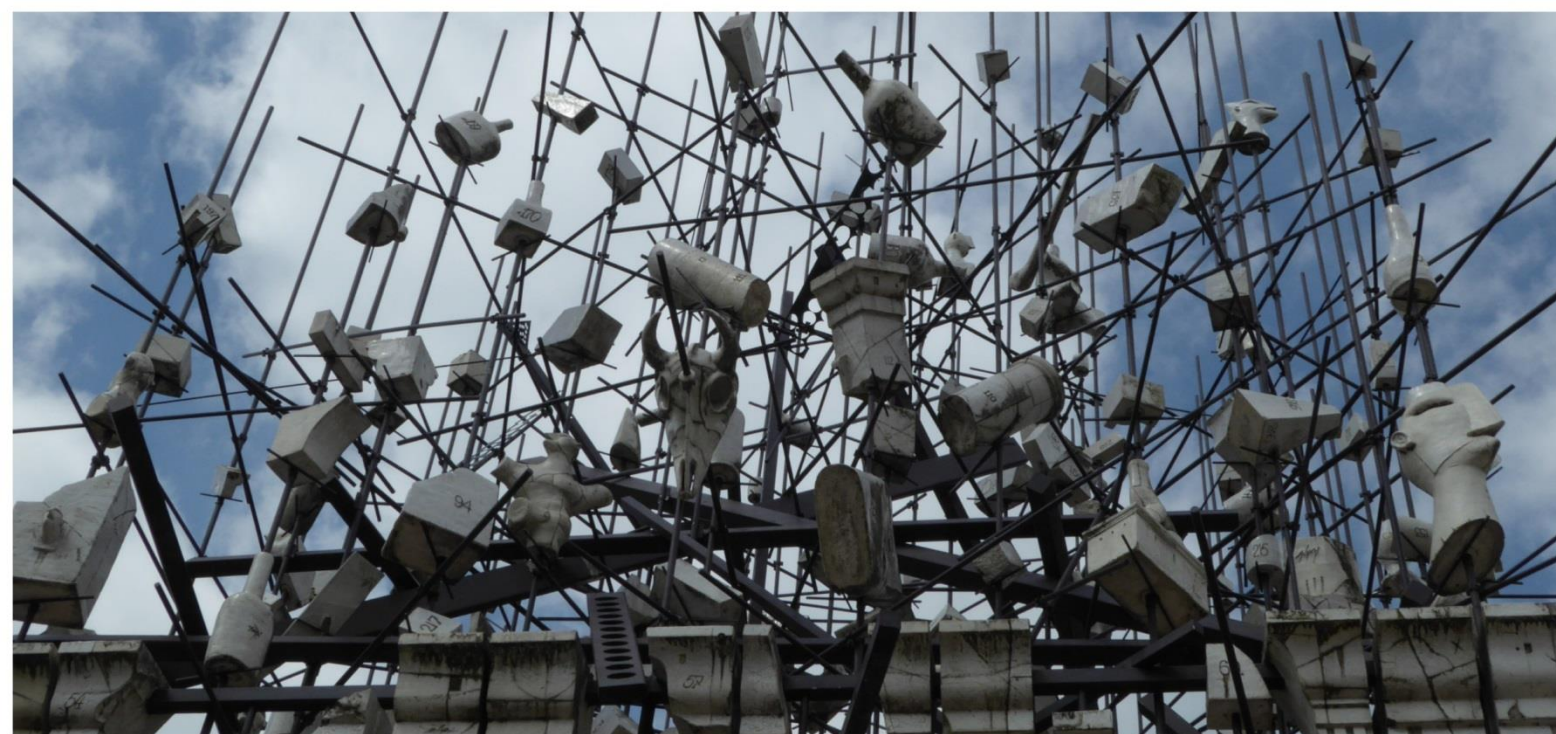
Much of the technical innovation and experimentation for ceramic applications is being carried out at the Universities, often with support from industry. There are examples of these both in the USA and Europe. Several university architectural departments, such as Cornell University, University of California, Berkley and Harvard Universities run experimental material and 3D Digital Labs.

Alongside these, there are also independent innovative hubs that provide valuable facilities for architects, designers and artists to experiment and develop new ideas.

An example of such a facility is the **European Ceramic Work Centre (EKWC)** in 's-Hertogenbosch in the Netherlands.

This is an international workplace where artists, designers and architects can explore the technical and artistic possibilities of ceramics. The centre operates artist-in-residence facilities, and attracts artists, designers and architects from all over the world. Interestingly, most participants have not worked with clay before.

The residency programme is usually three months long and can be either individual or project-based. The facilities accommodate up to 45 people and include studios, living space, state-of-the-art equipment that includes large kilns and CAD/CAM machinery that is supported by experienced staff. A 3D Milling machine and 3D clay printer can be used for production.



## 5. Lessons in History

### Zsolnay Porcelain Manufacture



*"I always want to replace the good with the better"*

*Vilmos Zsolnay*





The end of the 19<sup>th</sup> century and the beginning of 20<sup>th</sup> century produced some of the most notable architectural examples of the use of architectural ceramics in Europe. Many buildings in the Austro-Hungarian Empire were adorned with brightly coloured roofs and façade elements.

Zsolnay Porcelain Manufacture, the factory producing these architectural ceramics has dominated the market in Europe since the 1880s, winning prizes at world exhibitions in Paris and Milan.

At that time as well as producing a wide range of decorative tableware and sculptural ceramics the Zsolnay factory was involved in the reconstruction of many Neo-Gothic historic building in Hungary. The factory produced roofs tiles, gargoyles and other architectural decorations.

In early 1880s a material called “Pirogranite” was developed at the factory. This frost-resistant stoneware material enabled ceramic elements to be used externally and in exposed conditions providing extraordinary longevity. For the development of porcelain glazing technology, Vilmos Zsolnay, the owner of the factory at the time was awarded the French Legion of Honour in 1878.

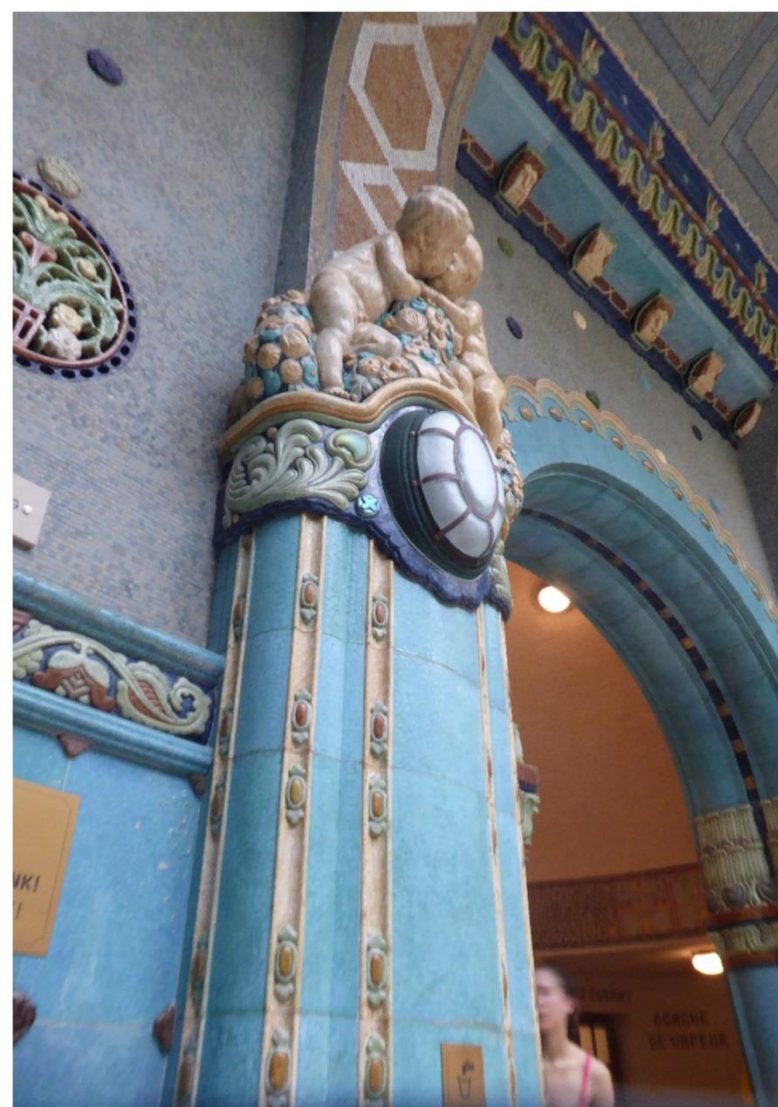
Vilmos Zsolnay worked with Lajos Petrik, the Principal of the Industrial School of Budapest, and Vince Wartha, a Professor at the University of Technology to develop innovative glazes and materials. Together they produced a unique iridescent lustre glaze called Eosin. The reduction lustre glazes originated from Persia in the 8<sup>th</sup> and 9<sup>th</sup> centuries. These were used in Italy and Spain in the 14<sup>th</sup> century and were rediscovered in Europe in the 19<sup>th</sup> century. The name of the glaze derives from the Greek “Eos” (the goddess of dawn), in reference to the vivid red colour of the end-product. Eosin has been used in architectural detailing that can be seen in many Art Nouveau buildings in Budapest and elsewhere in Hungary. It adds a jewel-like quality to the buildings.

Many artists and designers worked at the factory and created some wonderful art work using the eosin technique. The glaze is still used today for decorative ceramics. The technology for making this colourful and iridescent glaze is a closely guarded secret to this day.

The factory employed and collaborated with many talented designers that created a number of iconic designs through the decades. Many famous artists participated in the work of the factory, such as József Rippl-Rónai, Ferenc Martyn, Victor Vasarely, Ödön Lechner.

Currently the factory is involved mainly in restoration jobs as well as producing decorative vessels and sculptures.





## Gelert Thermal Baths, Budapest

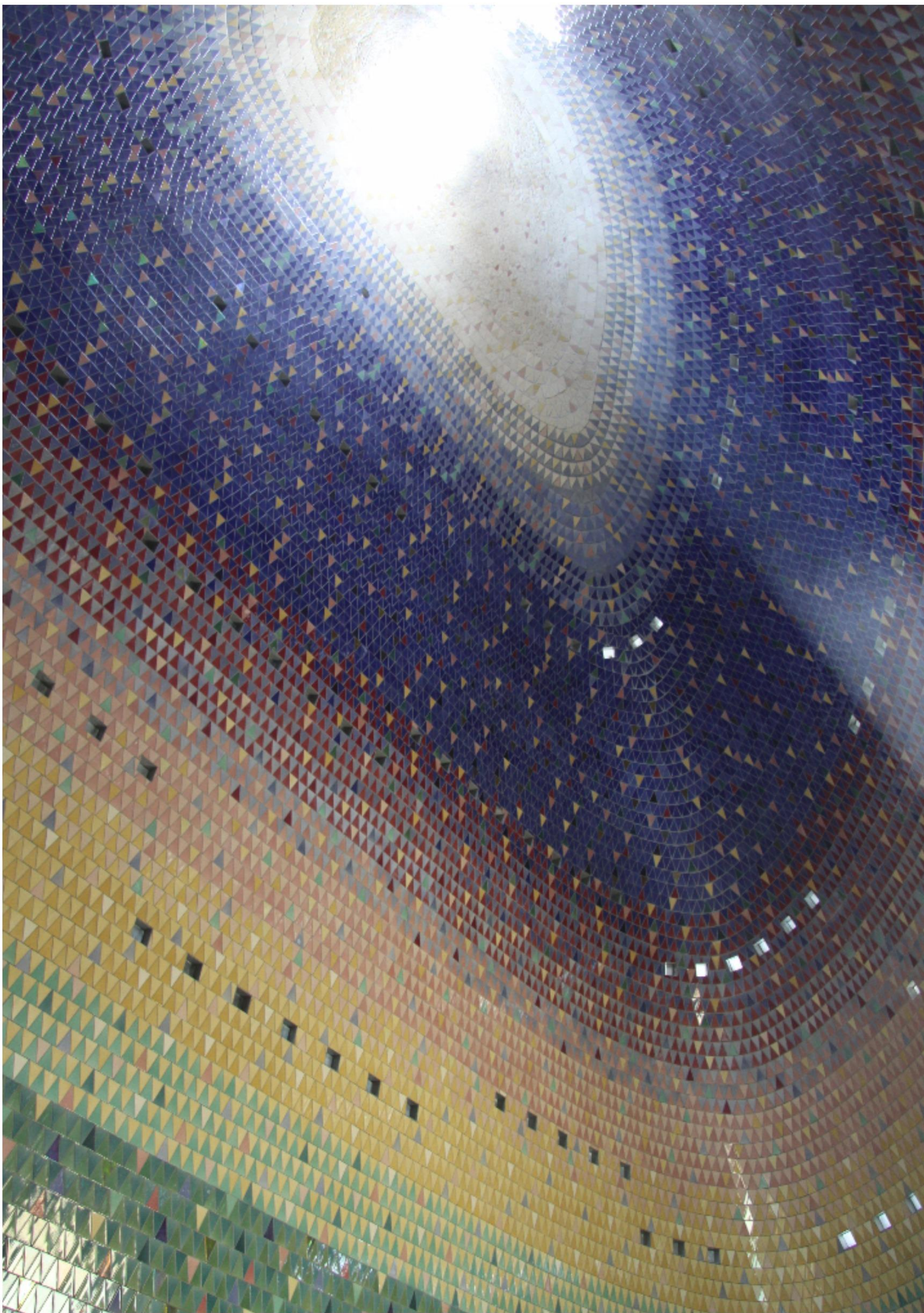
Gelert Baths, built between 1912 and 1918 are a great example of Secessionist architecture in Budapest.

In this public building architectural ceramics fulfil a functional role combined with exceptional aesthetic qualities. The overly decorative surfaces and lavish detailing of the baths create an amazing atmosphere.

The longevity of ceramics has been tested here. For the past one hundred years the glazing covering the benches, walls, fountains and horizontal surfaces have been subject to extreme conditions, such as hot and high in minerals water.

The colours of the ceramics kept their vibrancy, and although some of the architectural elements need attention, the majority of the surfaces are in a good condition.





## Library in Pécs, Beehive.

**Architect:** Torok es Balazs Epiteszeti Kft

**Artist:** Marta Nagy

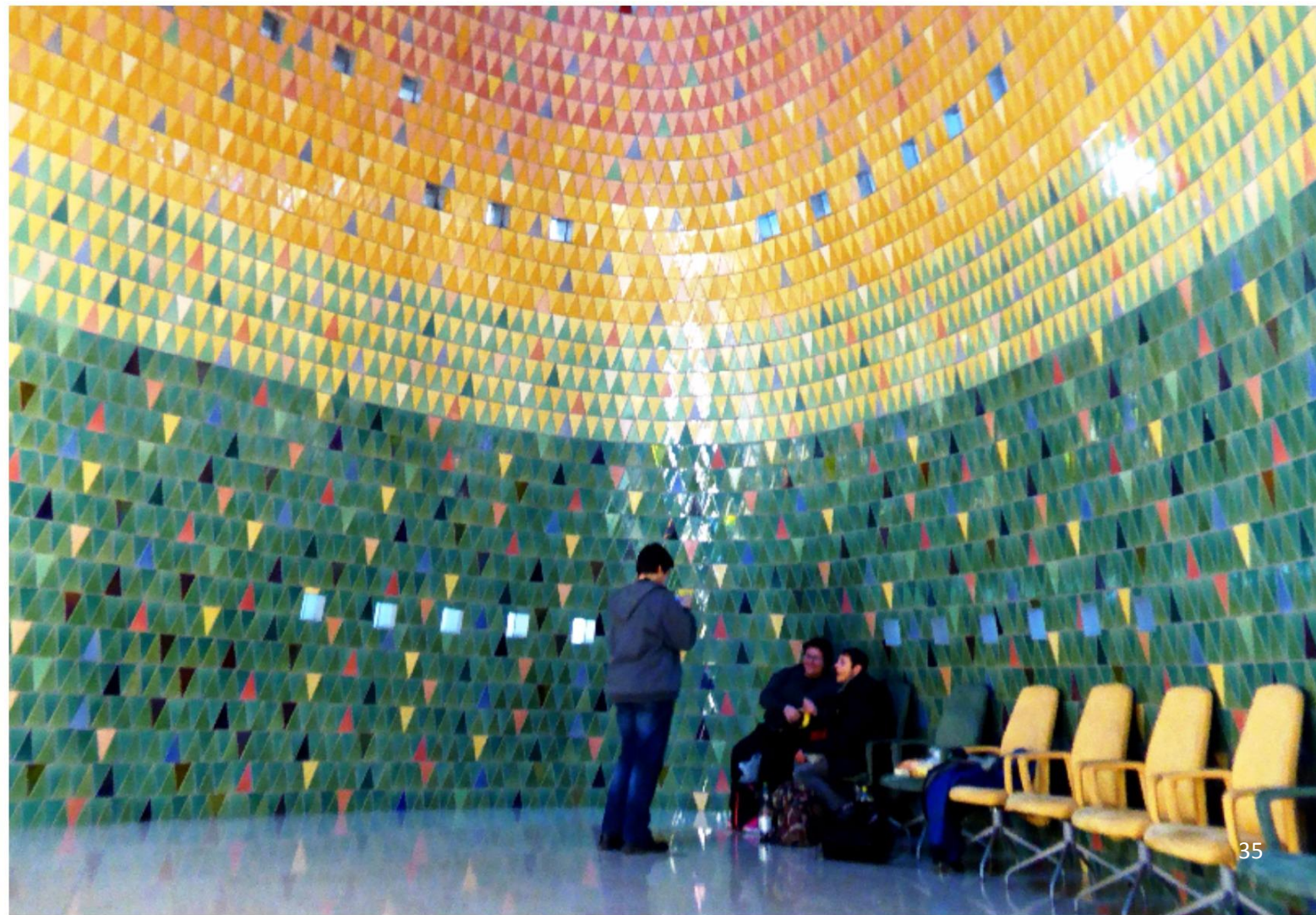
One of the latest architectural projects of the Zsolnay factory was created in collaboration with the ceramic artist Marta Nagy.

“The Beehive” is the foyer space in the centre of the Library in Pecs and is conceived as an organic, pebble-like form. A mosaic rainbow of glazed ceramic tiles lines an interior of the irregular dome.

A series of small windows and a circular skylight puncture the curving tiled surfaces. The artwork is called “The Universe” with various layers graduating from earth to the sky.

Iridescent tiles introduced at particular intervals within the colourful bands create playful accents within the ceramic surface.

The light penetrates the dome through the aperture above creating dramatic visual effect.



## FINDINGS

- Currently there is a growing interest and demand among architects and designers for the use of architectural ceramics in the built environment.
- There is a large demand in the building industry worldwide for natural and sustainable building materials that can provide customised, individual solutions.
- Custom solutions for buildings are made possible through collaboration between architects, designers, engineers and industry.
- Large tile and brick manufacturers appear inflexible when it comes to introducing custom-made elements within their production. This arises from the high cost of setting-up and tooling of the processes used in these factories.
- While large manufacturers have the advantage of cutting edge technology, links with other industry partners and collaborations with designers and architects are crucial.
- Craft makers and smaller workshops are more accommodating but lack the resources to develop new products and scale up.
- Medium-sized manufacturers and workshops are the most flexible and open for collaborating with architects and designers.
- Collaboration between industry and educational institutions is instrumental for innovation and high tech solutions.
- The best projects both historical and contemporary were achieved through the involvement of artists, architects and industry.
- Early involvement of material specialists such as artists, designers and engineers is crucial for successful outcomes.
- A special role is provided by innovation hubs which provide facilities for experimentation and the development of new products and techniques as well as encouraging ceramic artists to produce project specific work. Some of the outcomes of the work produced in these facilities have the potential to feed into industry. A similar role is fulfilled by university departments developing relations with factories.
- Robotics and digital fabrication facilitate mass customisation and allow for the creation of high quality products, applications and are crucial for the future development of architectural ceramics.

## RECOMMENDATIONS

- **Local Authorities should encourage the use of architectural ceramics in public spaces.**

Ceramics are an ideal material to be used outdoors - they are sustainable, weather-proof, long-lasting, robust and maintenance free.  
Ceramics combine function and décor. These express identity and collective memory for many cultures. Designed for local communities and sites, ceramic interventions can bring human values and engage with people.
- **Private developers should consider using architectural ceramics for buildings, street furniture, landscaping and as a valuable and sustainable alternative to wood, stone, metal and glass.**

Ceramics add vibrancy and uniqueness to landscapes, buildings and public spaces.  
Textured and coloured ceramics used in the built environment can provide multi-sensory experiences and improve environments at work, leisure and healthcare spaces.  
Ceramics are ideal for the integration of art in buildings and spaces. Decorative elements seamlessly integrated in the brick and masonry fabric of buildings can be formed in murals and sculptures bringing value and creating unique buildings.
- **Architects and designers working collaboratively with material specialists should design and specify architectural ceramics.**

Currently with the use of modern technology custom-made cladding can provide individual solutions for facades. This can provide sustainable systems for the building envelopes and landscaping.
- **Artists and ceramic designers should be encouraged to work in collaboration with architects, engineers and industry.**

The use of industry expertise as well as engineering knowledge are crucial for scaling up the ceramic elements and placing them in the public realm.
- **Collaborations should be encouraged between clients, architects, artists and industry.**

This can be facilitated through workshops, seminars, symposia and residencies organised by any of the stakeholders.
- **The incorporation of craft skills into industrial processes should be encouraged by Design and Craft Councils.**
- **Setting up and development of medium-size manufacturing and experimental facilities should be supported and encouraged by government and industry.**

These facilities allow for flexibility in production, technical innovations and experimentation to be incorporated into the production process and open new opportunities for manufacturing.

## DISSEMINATION PLAN

### Presentations

In May 2017 I gave a talk about my Fellowship at the “Ceramic and Champaign” event at ARUP Consulting Engineers, London. The event was organised to raise awareness of advantages of architectural ceramics among the architects and developers.

I plan to give talks at Central Saint Martins College of Art and Design, and the Royal College of Art, London.

I plan further presentations at architectural firms to promote the use of ceramics in buildings.

### Report Distribution

I will be distributing my report to relevant organizations in the UK including:

Arts Council England, Design Council, Crafts Council UK, Tiles and Architectural Ceramics Society, Central Saint Martins College of Art and Design, Royal College of Arts, University of East Anglia, Clayground Collective, ARUP Consulting Engineers, Kate Malone Ceramics, Cultural Strategy Group for London, New London Architecture, Brick Development Association, Ibstock Brick Plc, Wienerberger AG, AJ Specification Magazine, Ceramic Review Magazine.

I will also distribute my report to all contacts in the USA, the Netherlands and Hungary which include: Studio Christine Jetten, Royal Tichelaar Makkum, St. Joris Ceramics factory, European Ceramic Work Centre, Boston Valley Terra Cotta, University at Buffalo, University of California, Berkley, Friends of Terra Cotta Inc., Zsolnay Factory, Marta Nagy and the University of Pecs, Faculty of Music and Visual Arts.

### Website and Blog

I will upload the report and a selection of photographs from my travels to my website: [mariagasparian.co.uk](http://mariagasparian.co.uk)

### Social Media

I will also post pictures from my Fellowship on social media:

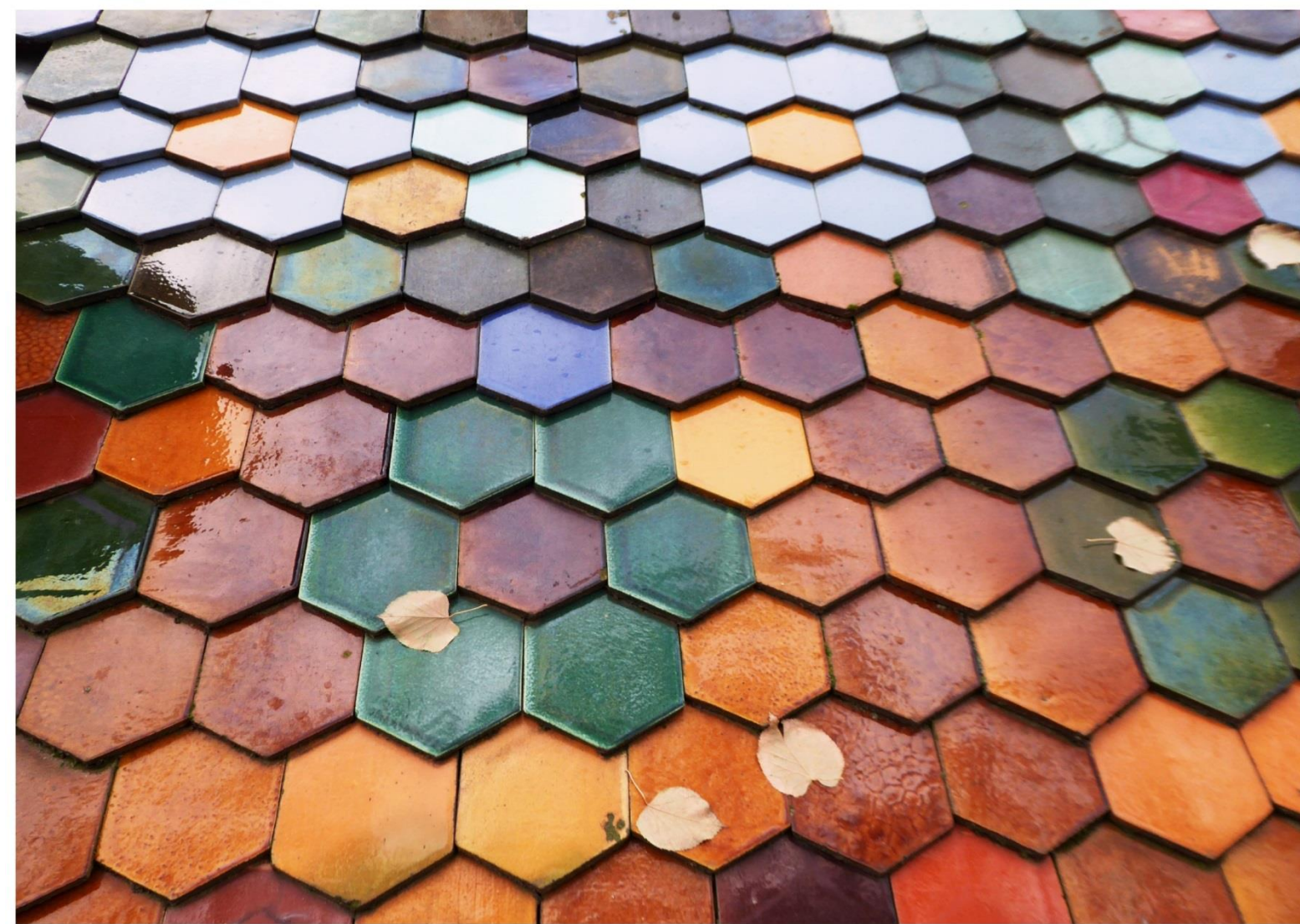
[www.twitter.com/mggasparian](https://twitter.com/mggasparian)

[www.facebook.com/ mariagasparianstudio](https://www.facebook.com/mariagasparianstudio)

[www.instagram.com/mggasparian](https://www.instagram.com/mggasparian)

### Further research

I will continue the research that I have started during my Fellowship to Doctoral Research.



## APPENDIX

### BIBLIOGRAPHY

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## ORGANISATIONS AND PLACES VISITED

### THE NETHERLANDS

#### Factories and workshops:

Royal Tichelaar, Makkum  
St Joris Keramische Industrie b.v., Beesel  
Rodruza Brick factory  
Christine Jetten Studio, 's-Hertogenbosch  
Cor Unum, 's-Hertogenbosch  
De Gruyter Fabriek studios, 's-Hertogenbosch  
European Ceramic Work Centre, EKWC, 's-Hertogenbosch  
Struktuur 68, the Hague  
Royal Delft, Koninklijke Porceleyne Fles, Delft

#### Architects offices:

Molenaar and Co Architects, Rotterdam

#### Universities:

Gerrit Rietveld Academy of Art and Design, Amsterdam

#### Museums and collections:

Stedelijk Museum of contemporary art and design  
Royal Delft Museum  
Ship house museum  
Kroller-Muller Museum and sculpture garden, Otterlo  
Jachthuis Sint Hubertus, Otterlo  
Gemeentemuseum, The Hague  
Mauritshuis museum, The Hague

### USA

#### Factories and workshops:

Boston Valley Terra Cotta Factory, New York  
3D Lab University of California, Berkley

#### Universities:

University of Buffalo, New York  
Berkley University, California

Artist's studio:  
Susan Tunic, New York City

#### Museums and collections:

MoMa, New York  
Whitney, New York  
Art institute in Chicago

#### Architects offices

Morris Adjmi Architects  
KPF Architects

### HUNGARY

#### Factories and workshops:

Zsolnay Porcelain Factory, Pecs  
The International Ceramics Studio (ICS), Kecskemet  
Sandor Dobany Studio  
Marta Nagy Ceramic Artist

#### Universities:

University of Pecs, Faculty of Music and Visual Arts.

#### Museums and collections:

Museum of Applied Art, Budapest  
Mucsarnok, Budapest  
Gyugyi Collection, Pecs  
Zsolnay Ceramic Museum, Pecs  
Margit Kovacs Ceramic museum, Szentendre.  
ICS Ceramic collection, Kecskemet

#### Links to websites and organisations:

<http://bostonvalley.com/>

<http://www.christinejetten.nl/>

<http://www.data-clay.org/>

<http://www.dobanyporcelan.hu/dobany-sandor/>

<http://www.icshu.org/facilities.html>

<http://molenaarendco.nl/>

<http://www.nagymarta.hu/>

<http://www.preserve.org/fotc/>

<http://www.royaldelft.com/menupage.asp?pageid=22&lang=1>

<http://www.stjoris.nl/en/>

<https://sundaymorning.ekwc.nl/en/>

<http://www.tichelaar.com/>

<http://www.transartists.org/air/european-ceramic-workcentre>

***All photographs taken by Maria Gasparian unless otherwise stated.***

