Illuminating through Ceramics

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Rosa Urbano Gutierrez

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Illuminating Through Ceramics

is a research-led teaching project taking place within the MArch Programme of the Liverpool School of Architecture. This publication is the accompanying catalogue of the exhibition that features the students' work of the 2011-12 class.

This project forms part of the Network of Ceramic Tile Studies Departments sponsored by ASCER – Tile of Spain (Association of Ceramic Tile Manufacturers of Spain), and coordinated through ICEX, the Spanish Institute for Foreign Trade.

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View of the exhibition in the Main Hall of the Liverpool School of Architecture. © Martin Winchester.

Welcome

I am delighted that we are able to host this architectural exhibition that brings together the fundamentally important material of ceramics with the fundamentally important environmental quality of light. It is vital that Schools of Architecture play a role in applying research and innovation ideas by working with industrial and trade organisation partners to exploit exciting new possibilities. This exhibition is the product of such a collaboration and I am sure that visitors and our partners will appreciate the thoughtful approach that has been taken to produce the display pieces that are on show.

I sincerely thank our sponsors, ASCER, for their generous award of funding to undertake the investigations and design work that you will see demonstrated in our exhibition. Rosa Urbano Gutierrez, Lecturer in the School of Architecture and Researcher in Lighting and Architecture has been the driving force behind this wonderful venture, so the last words in this introduction should be a personal thanks from me to her for the strong personal dedication that she has given to this project.

Professor André Brown FRSA
Head of the School of Architecture
The University of Liverpool

Illuminating through Ceramics

Preface

It is a great pleasure to be asked to write an introduction for this exhibition. The exhibition shows the exciting potential for the use of ceramics – clays, glasses and concretes – for light redirection on contemporary facades. This exhibition adds greatly to our understanding of the use of these techniques for both light redirection and visual expression of a facade.

Until the start of the 20th century daylight was the only practical large scale light source for buildings and for this reason daylight had an overwhelming influence on the form and technology of vernacular architecture. This generally meant that buildings were shallow plan since daylight penetration rarely extended more than a few metres from the building envelope. Although the development of the electric lamp freed designers from this constraint there remains a general preference for daylight as a light source in buildings due to a number of factors related to its fulfilment of human needs. These include delivery of light of high illuminance with a spectral composition that ensures favourable colour perception; bright, visually interesting and dynamic lighting conditions; and the fact that windows also provide contact with the exterior and a view.

There are two main approaches to providing daylight deep into interiors. The first involves redirection of sunlight by adding reflective or refracting elements such as louvres or light-shelves to conventional facades. Examples from history include the Rowshan shading systems used in Hedjazi architecture, and the various forms of characteristic light-shelf from the Modern Movement. The other approach captures daylight using collector devices and transports it into buildings using some form of linear guidance system. These are of more recent development and commercially available systems depend for their success on the use of highly reflective materials, usually made of aluminium.

Both methods of daylight redirection feature in some form in this exhibition but each has very different implications for energy usage, sustainability and for integration into, and visual impact on, the host building. The major benefits of daylight guidance in use are economic – daylight displaces electric lighting – and the improvement of the interior visual environment due to daylight. The modern linear guidance systems presently on the market certainly can deliver daylight, but the results are often indistinguishable from the electric lighting systems they purport to replace. Also their extensive use of aluminium means that their embodied energy is some ten times that of comparable systems employing ceramics as the light guidance system. The linear systems also require heliostats, or other light collecting devices, and routes through a building for light transport, all of which have a major adverse visual impact. The various ceramic lattice wall systems promulgated in this exhibition, on the other hand, potentially offer controllable daylight distribution of varied patterns, good colour properties and privacy/view but with minimal impact of the interior of a building. The exhibition demonstrates that ceramic lattice walls offer daylight guidance that not only provides dynamic control of light but is also capable of enhancing the facade of a building. The next generation of signature buildings may well feature this technology.

We are reminded by Corbusier that 'architecture is the....... play of masses brought together in light'. The work in this exhibition makes the case for a considered use of ceramics as an elegant solution for delivery of that light. I commend this exhibition to you.

David Carter
Chair of Editorial Board, Lighting Research and Technology
School of Architecture
The University of Liverpool

Acknowledgements

I want to express my gratitude to the Liverpool School of Architecture for its human and physical resources, and in particular to its Head, André Brown, for making this project possible and for his unwavering support of this exhibition as I negotiated extra time, space, and most importantly, structural challenges in our exhibition gallery. In the same way, my colleagues in the MArch Programme, Jack Dunne, Peter Farral, Richard Koeck, and Robert Kronenburg, generously welcomed the project within the Studio Design Year 4 Programme.

I am extremely grateful to the Network of Ceramic Tile Studies Departments and ASCER-Tile of Spain (Association of Ceramic Tile Manufacturers of Spain), not only for receiving us into their community and sponsoring this project, but also for their exemplar initiative to engage and effectively connect the academic and industrial worlds. I also wish to warmly thank ICEX, the Spanish Institute for Foreign Trade, especially Consuelo González García and Maria Dolores Arraez Vera for coordinating that connection between the two countries, Spain and the UK, and at a personal level, for their constant encouragement and availability.

I would like to extend my deep gratitude to the many people who have collaborated in this project:

Amanda Wanner provided generous and crucial time and talent to the coordination of the ceramic production. Jenny Bevan and Wendy Lawrence contributed beauty and skills through their interpretation and materialisation of the students' ceramic designs. My thanks also to Wayne Clarke for his support in the production of the prismatic rods.

David Carter offered inestimable advice on lighting for the exhibition, and inspiring words in the foreword of this catalogue.

Antoni Cumella (Ceramica Cumella), Dusanka Popovska and Harsh Thappar (Foster + Partners) provided fundamental and stimulating lectures during the course.

Many thanks also to Alexis Harrison (Arup) for his presence at the opening and for sharing his abundant knowledge on contemporary applications of ceramics in his inaugural lecture.

Nuno Ferreira enthusiastically developed the environmental simulation of the prototypes. A big thanks must also go to Professor Barry Gibbs for introducing and supervising this work.

Martin Winchester beautifully implemented our website, catalogue and exhibition photographs.

Craig Staples, Stuart Carroll, and Ian McKnight, helped in every possible way with all the technical aspects of the exhibition production and setup.

Alex Halliwell diligently and patiently dealt with the numerous orders and forms involved in the economic and administrative sides of the exhibition. Pauline Mitchell generously helped with the inauguration preparations.

And most importantly, I am particularly indebted to all the students who have willingly explored the possibilities of designing with ceramics, making this project such an exciting one through their dedication and hard work. Three MArch students have directly contributed to the development of the exhibition materials. James Hayles produced models and the first draft of the catalogue. Aleksandar Kokai arrived at a critical moment to inject fresh energy to wrap up the exhibition. And finally, there is no question that this project would not have come together without the work produced by Rob Vasili. His creativity, energy and dedication have been instrumental to the design and building of the exhibition prototypes, website and catalogue.

Rosa Urbano Gutierrez
Lecturer in Architecture and Environmental Design
School of Architecture
The University of Liverpool

Introduction

The critical environmental impact exerted by the construction industry has triggered the search for low-impact and less energy intensive alternatives. Ceramics offer exceptional prospects in this direction, since clay minerals, the traditional ceramic raw materials, are abundant, easily available, and they are often used as found in nature with very little processing before firing.

Additionally, ceramics are very durable materials. Ceramic structures have proved to age pleasantly and accommodate environmental changes over very long periods of time. Recent research on the suitability of using ceramic tiles for covering the exterior surfaces of buildings have shown they posses exceptional stable properties: they perform as well as stone (marble and granite), and better than timber, aluminium, plastic or concrete in aspects such as bending, stain and frost resistance; permeability; linear thermal and moisture expansion; salt spray corrosion; and solar ageing.

To respond to environmental and comfort criteria, there are at present many initiatives working with energy and performance simulation tools to produce advanced engineered earthen materials for architectural applications. Recent progress on reinforced ceramic structures have made possible amazingly thin pieces that save on material. Some new products have improved their insulating properties. Other proposals offer promising functions such as the growth of living elements to eliminate pollutants from the environment, or new optical properties such as translucency or high reflectance. Despite all these developments available from both industry and research centres, so far the use of ceramics in contemporary facades shows that very little has been explored about their potentials to include the benefits of sunlight. In particular, traditional and contemporary proposals of ceramic lattice walls have investigated privacy and shading in combination with the visual effects and cultural connotations of patterns (regarding colour, texture, and geometry), but very rarely have studied the optimisation of daylight distribution. This could be particularly interesting for non-residential buildings, since amongst the different end-uses of their energy consumption, lighting causes the highest costs in terms of energy, ecological impact, and economics. In this context, it is a priority to maximize our reliance on natural lighting rather than electric lighting, by exploring different material and technical solutions.

The *Illuminating Through Ceramics* project addresses this issue by studying new concepts of sustainable ceramic facades that improve the distribution of daylight in buildings by transforming the standard ceramic lattice wall into a dynamic lighting interface. By means of light-control techniques, geometrical analysis and contemporary digital design tools, we aim to shape the ceramic surface to generate a system that captures, transports and/or deflects daylight through the building skin.

Programme

Illuminating Through Ceramics started in 2011 as a research-led teaching project taking place within the Studio Design course of the MArch programme at the Liverpool School of Architecture. The project forms part of the Network of Ceramic Tile Studies Departments sponsored by ASCER – Tile of Spain (Association of Ceramic Tile Manufacturers of Spain), and coordinated through ICEX in the UK.

In the MArch programme, students have to develop the buildings they design to a detailed tectonic resolution, demonstrating the ability to make informed decisions on structures, materials and provision of environmental services, and gain knowledge of the energy implications of their design decisions.

In the academic year 2011/12, students were asked to design a small Free Secondary School in Liverpool, following a green agenda which prescribed that the building itself had to be perceived as a science lab in line with its environmental manifest. Within this framework, and organised in small teams of 3 people, students had to deepen their architectural proposals by designing either a ceramic light-deflecting piece or a ceramic daylight collector as part of their buildings' facades. Given two particular sites in Liverpool as fixed scenarios with specific daylighting conditions, they had to explore the form of the ceramic pieces in order to capture and distribute daylight inside their buildings.

The assignment required:

> Understanding and using parametric and algorithmic design.
> Utilising CAD/CAM techniques for ceramic materials.
> Understanding the basics of daylighting design.

The course was complemented by specialised lectures on ceramic materials, daylighting technologies and environmental and parametric design. In particular, between the 5th and 6th of December 2011, our two invited speakers instructed and inspired us with their working methods through the presentation of examples of contemporary architecture. Antoni Cumella offered an overview of the superb ceramic production of his artistic workshop, providing details about different ceramic materials and techniques; Dusanka Popovska & Harsh Thapar from Foster + Partners provided an enthusing exposition of their innovative approach to performance driven design.

The students produced thirteen proposals, ranging over a variety of light-control strategies: one natural chandelier, one performative shading facade, one light-deflecting rod screen, two systems of light-shelves, two systems of light-deflecting louvres, two rotating and mobile curtains, one light-transporting ceiling, two screens of vertical shading fins, and a dynamic shading ceiling.

The ceramic design proposals were collected and exhibited at the Liverpool School of Architecture, from 7th February to 30th June 2013. This catalogue and the *Illuminating Through Ceramics* website feature the project's process and its final results (http://www.liv.ac.uk/lsa/illuminatingthroughceramics/).

The satisfactory results together with the critical didactic benefits that this type of activity brought to the students have prompted the continuation of the project in the academic year 2012/13. In this second year, there will be again a research-led teaching project linked to the MArch programme, but this time in the format of an intensive workshop. Through lectures and practical work organised during two weeks, the aim will be to explore and define the new possibilities that computational design, environmental simulation and digital fabrication can bring to the world of ceramics. The first part of the workshop will be dedicated to the exploration of new possible geometries and their associated performances for ceramic products, while the second part will be dedicated to the construction of mock-ups and validation of performances.

The ultimate goal of the *Illuminating Through Ceramics* project is to reflect on materiality and tectonics as an instrument to promote ideas and develop new design methods. As an exploration of the relationships of materials to the advancement of architecture, this work entails a considerable amount of experimentation and has to allow for the possibility of mistakes as a necessary part of the learning process. In this sense this project represents a unique opportunity that allows the students to be exposed to critical pedagogical processes, such as product design and fabrication techniques, designing from materials and daylighting strategies, and most exceptionally, to gain experience with full-scale construction and become involved in industrial and professional perspectives and environments.

Through the development of all these activities, we wish to manifest the School's interest in the cultural and environmental concerns of our contemporary society, as well as present to the public our endeavours in scholarship and design creativity.

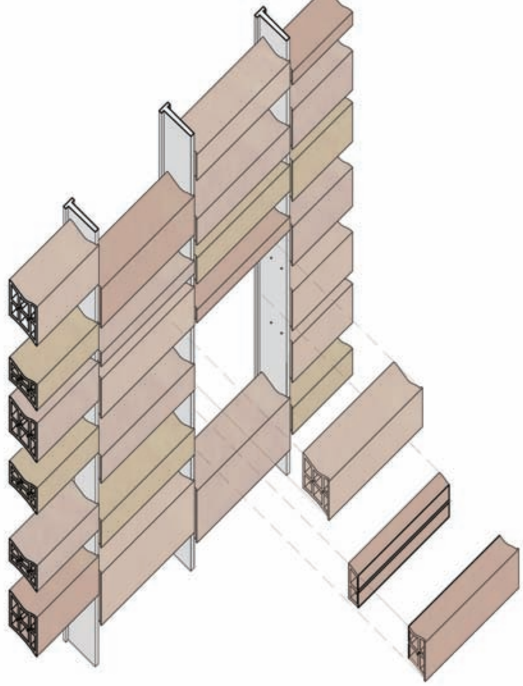
Rosa Urbano Gutierrez

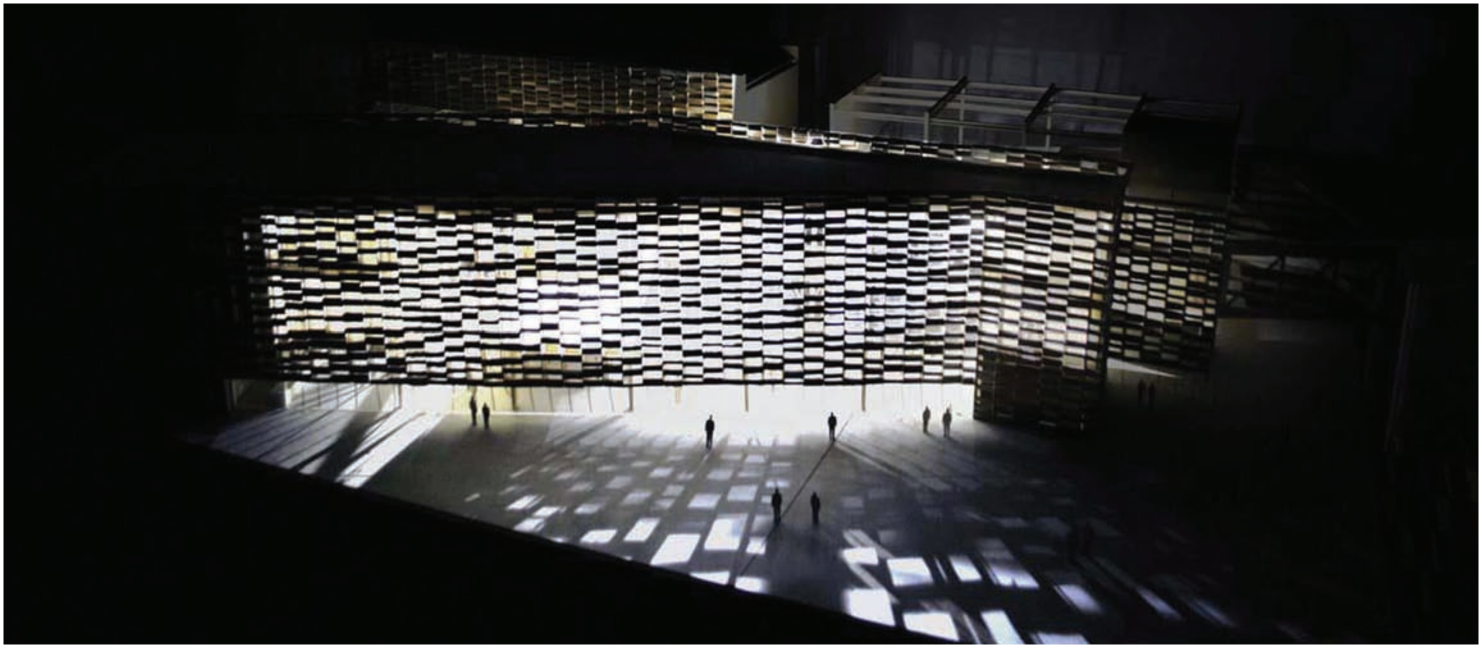
Designs

Team 1
Modular Light-Shelves

David Parry,
Jason Stewart,
Katherine Strange

The double facade incorporates external ceramic elements that act as modular light-shelves. The angled surface of the top of the shelves helps to redirect light into the internal spaces. The array of different angled surfaces in conjunction with the diverse dimensions of the ceramic pieces prevent a one dimensional light display occurring. Furthermore, the use of different coloured reflective glazes gives a more playful aesthetic to the facade, which breaks up what would otherwise be an expanse of curtain glazing. It also provides a colourful phenomenon in the interior of the building. Light studies have been produced to create a profile that allows for a powerful penetration of natural daylight.



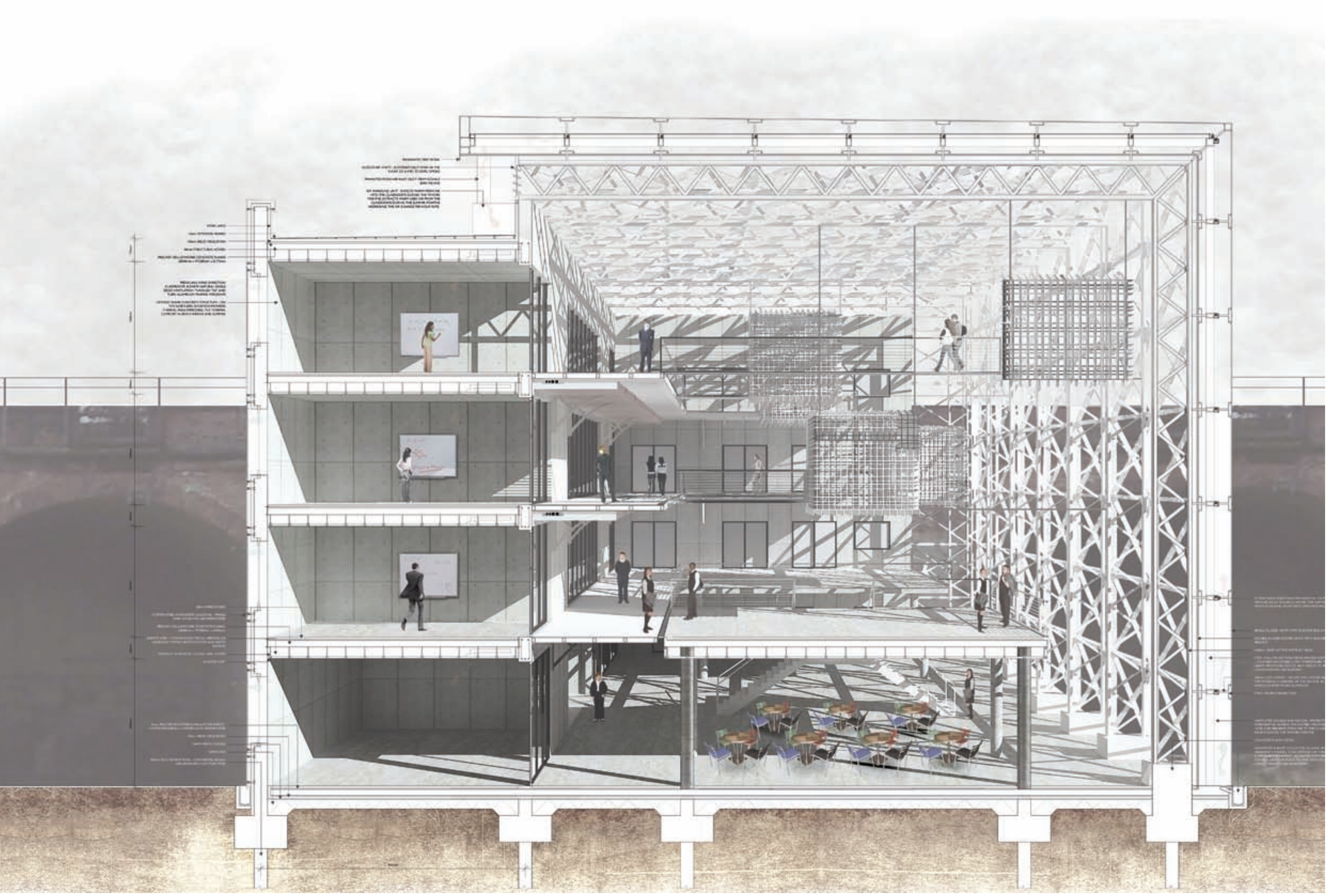


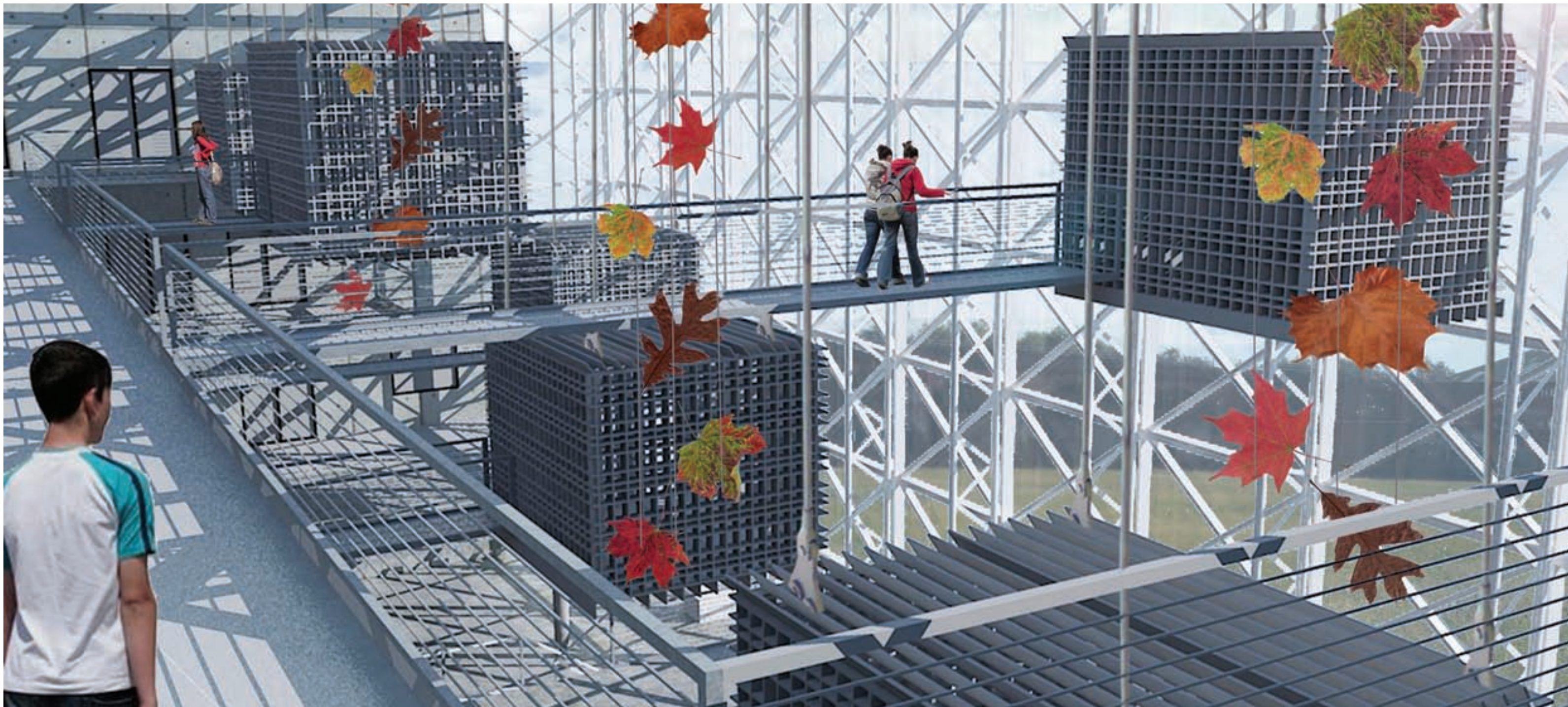
Team 2

Ceramic Lanterns

Amy Ellis-Taylor,
Emma Smith,
John Watling

This project proposes the use of ceramic clad 'pods' hanging in the atrium space. These pods act as student 'break-out' spaces, for study or teaching. The ceramic louvres clad the whole envelope of these pods, and are backlit with an array of coloured LED's that filter and project the internal light towards the open environment of the atrium. The screened light here is used as a means to show occupancy as well as a to provide a powerful articulated atrium with the image of the ceramic lanterns 'floating' in the space.

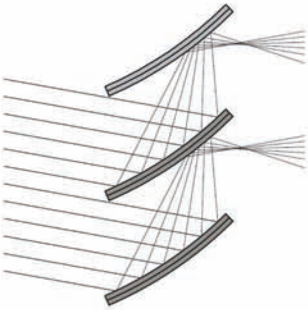


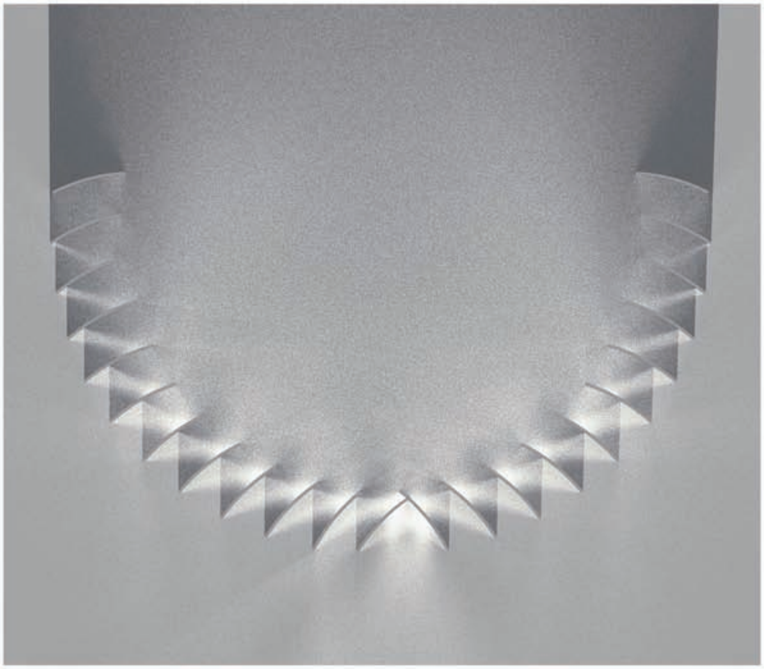


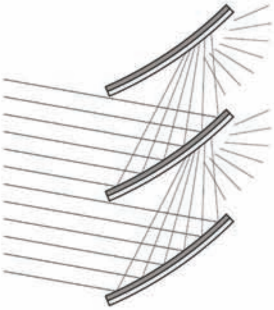
Team 3
Hydroponic Chandelier

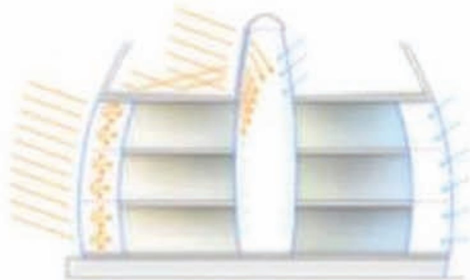
Loren Durkin,
Adrian Lombardo,
Zara Moon

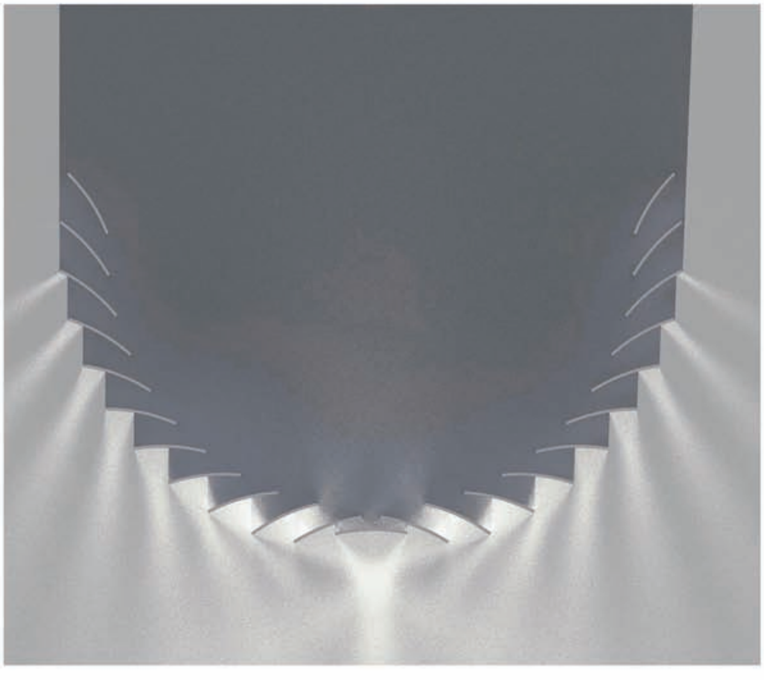
The *Hydroponic Chandelier* is a complex organic structure forming a ceramic tubular chandelier that distributes light and captures and channels rainwater, which allows the growth of plants thanks to a hydroponic system. The daylight is filtered and reflected down the ceramic surfaces, the falling water, and the translucent leaves of the plants, creating a sophisticated light-pipe that projects constantly-changing light patterns in the courtyard of the building.

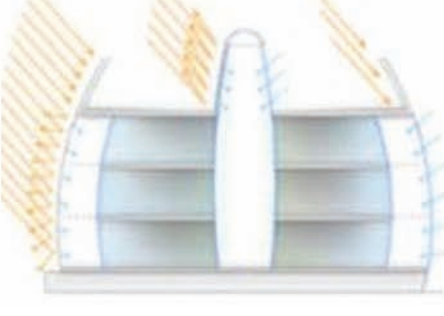






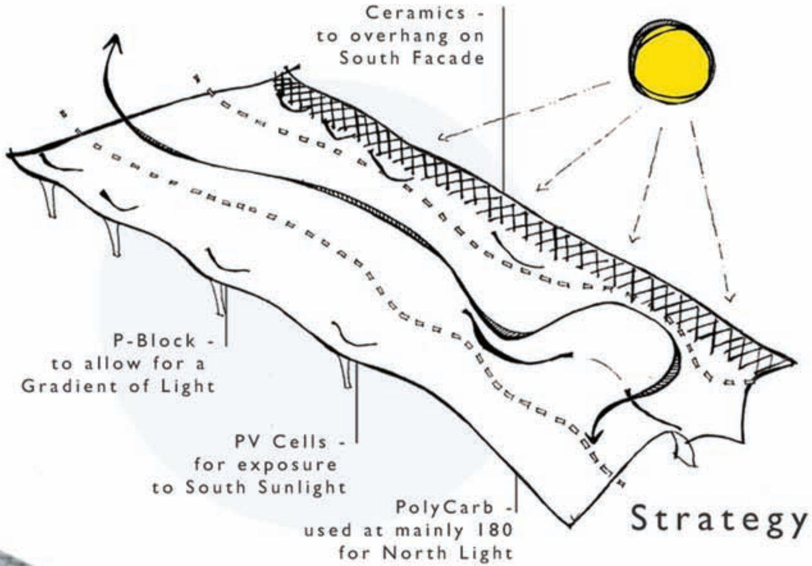


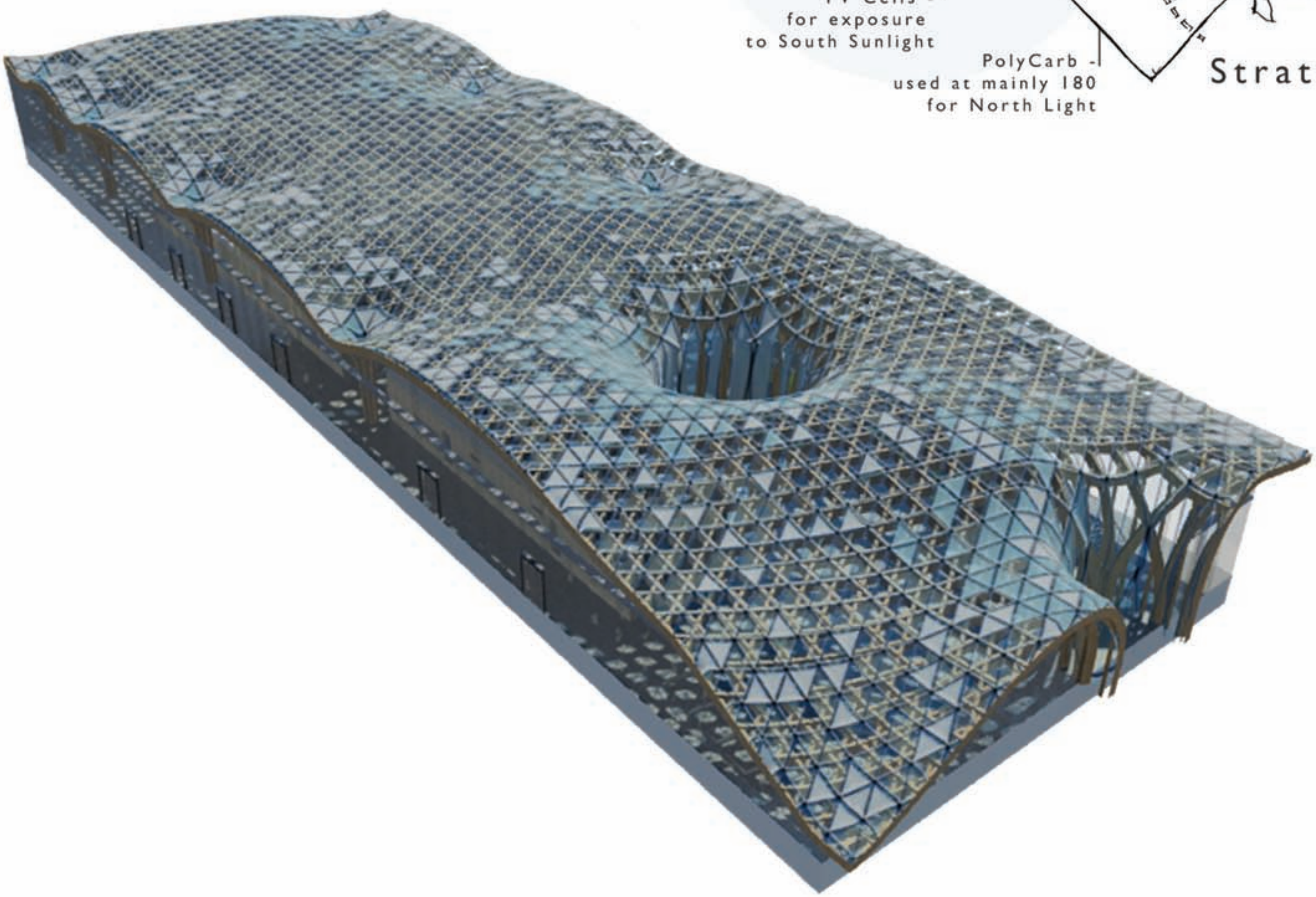


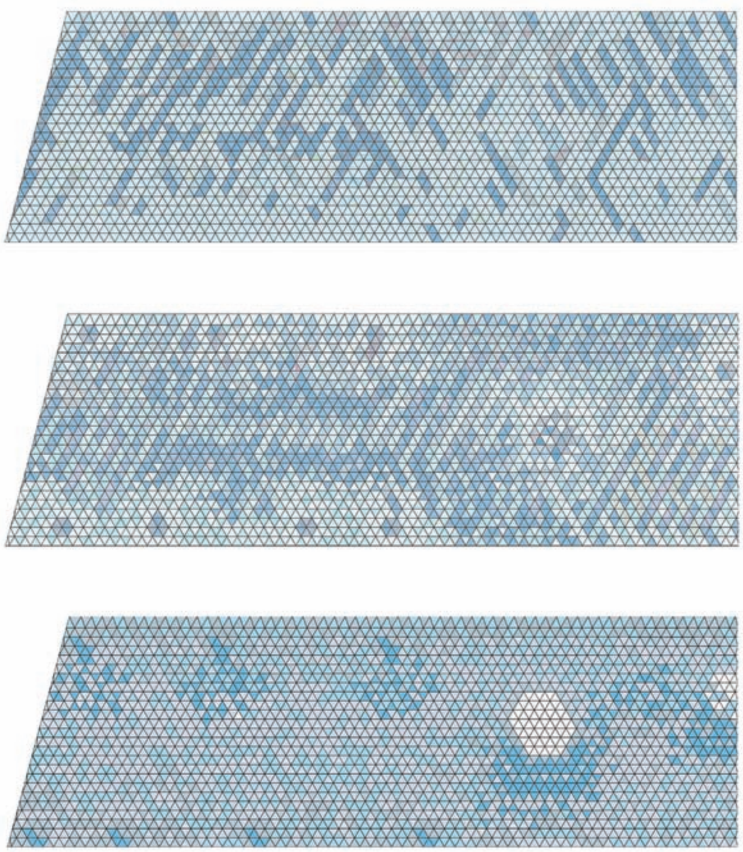


Team 4
Adaptable Ceramic Shading

Jenna Fife,
Georgina Holden,
Robert Novelli

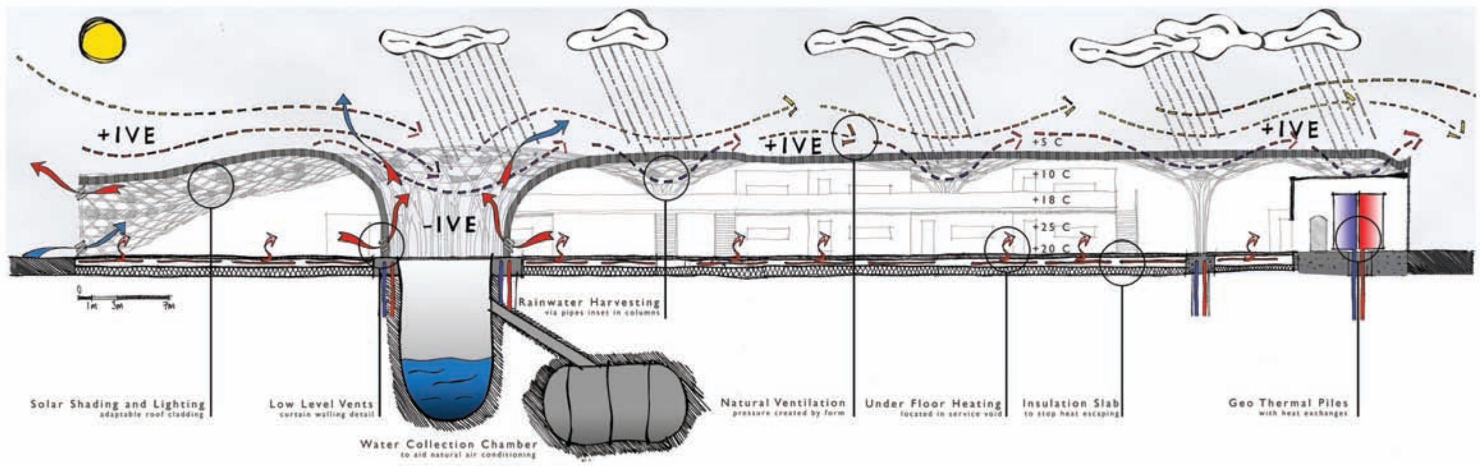






Studies in Pattern, Orientation + Form

The *Adaptable Ceramic Shading* forms part of the buildings geodesic roof, as an integral environmental strategy that combines several technologies. The rational grid of the roof's structure allowed for a tiling pattern to admit light that floods into the building in a dynamic fashion. The array of reflective and translucent ceramic tiles, combined with transparent glazed panels creates a wide range of lighting patterns that change with the movement of the sun.

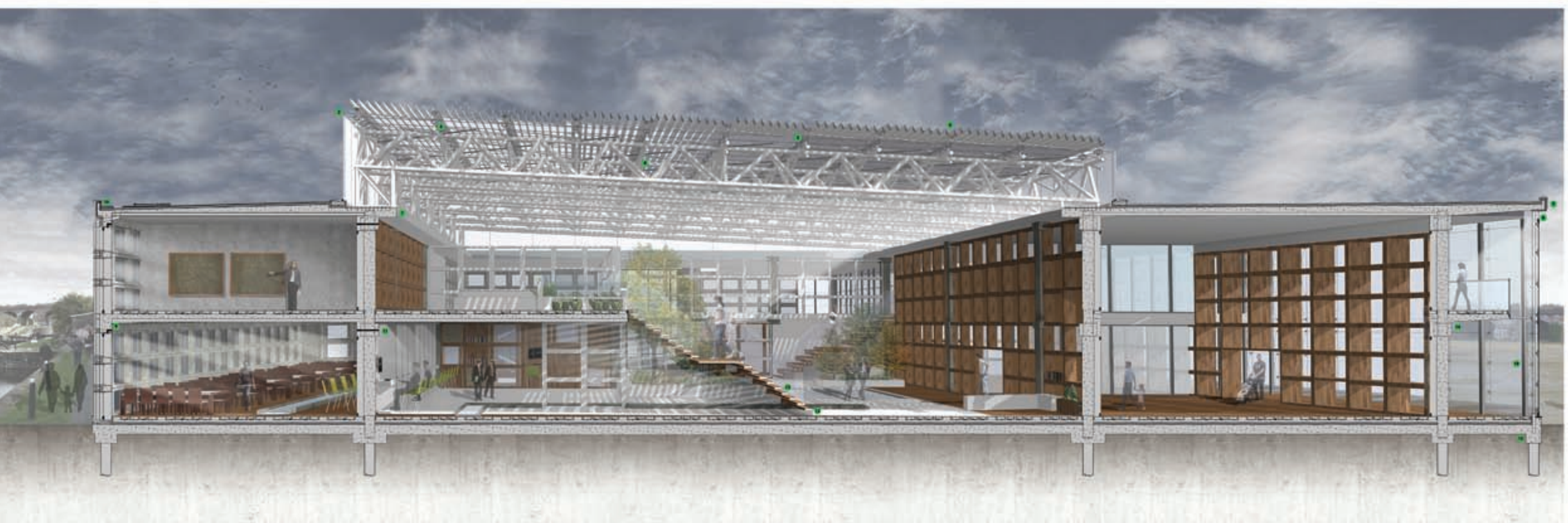


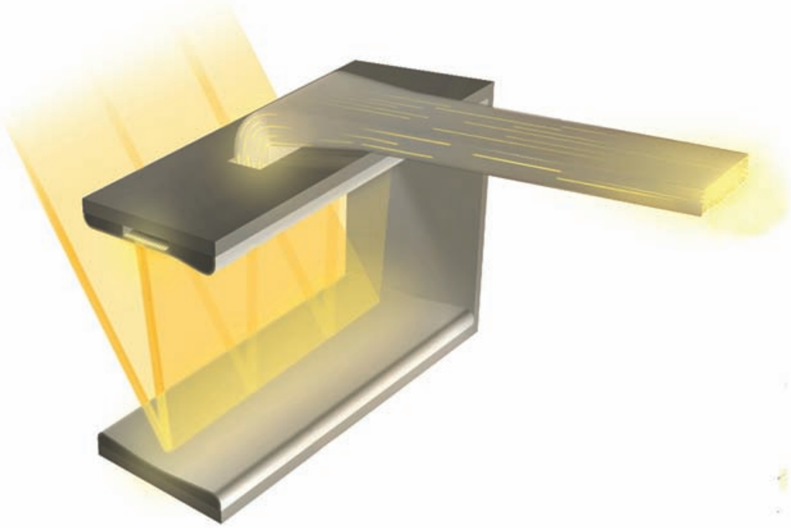
Team 5

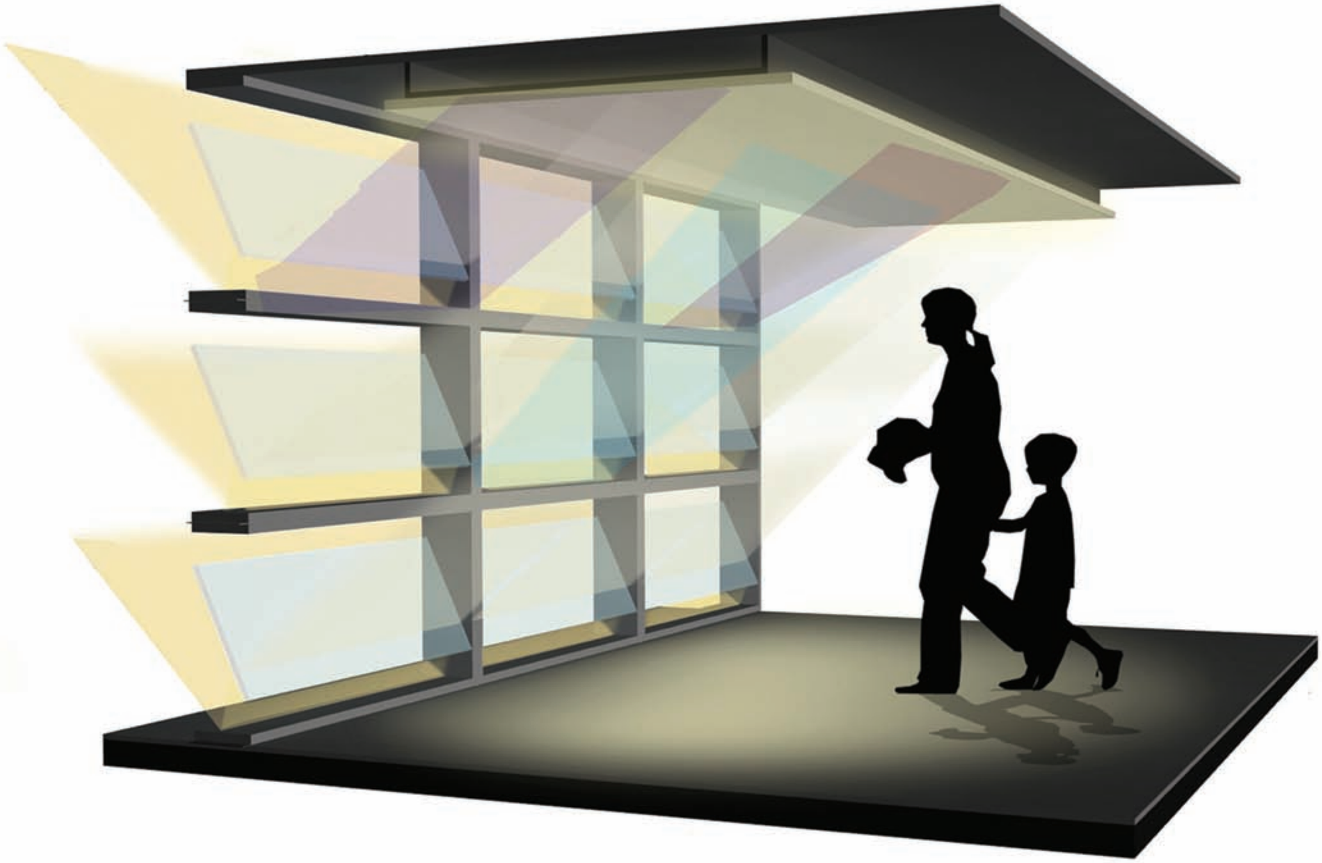
Lighting Surfaces

Serena Cardozo,
Ryan Jones,
Li Yin Lim

The rational facade of the building contains ceramic components with a prismatic surface that captures and reflects light into the interior spaces. The ceramic reflective surfaces are strategically inserted on the transoms and mullions of the glazing. Once the daylight is inside, reflective panels on the interior ceilings help to distribute light further into the building, producing a bright day lit interior



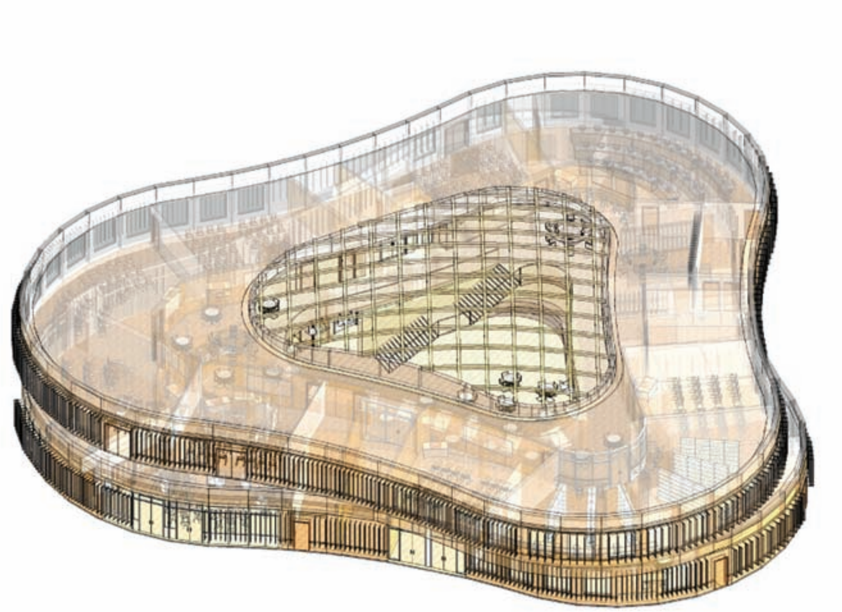




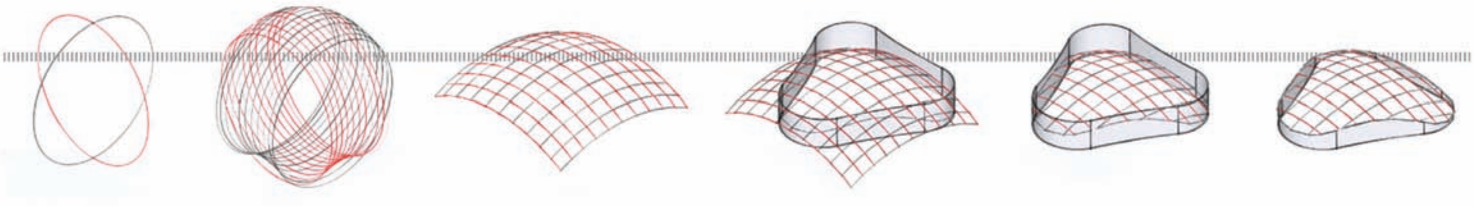
Team 6

Dynamic Ceramic Ceiling

Ashley Crane,
Hannah Dockerty,
Tim Mitchell



The *Dynamic Ceramic Ceiling* is made from a series of moveable petals that cover the central atrium space of the building. The petals sit within a gridded frame, and were intended to be mobile as to control the quantities of daylight entering the internal spaces as well as controlling solar gain. The petals exhibit a delicate variety of textures as well as light transmission patterns, ranging from complete opaqueness, to diverse degrees of translucency, to complete transparency in specific points of the surface. The differential light performance of this material, together with the various opening positions of the petals, provides an adaptable daylighting system with a rich palette of light configurations.

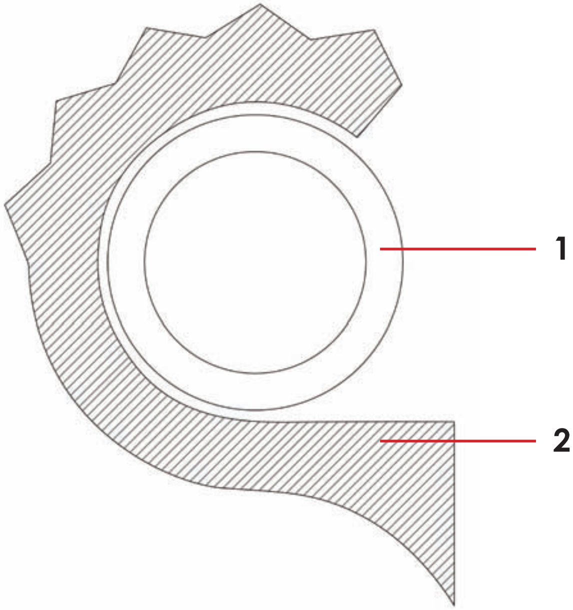


Team 7

Prismatic-Rod Screen

Pritpal Chana, Sam Goldby, Pradumn Pamidighantam

The ceramic prismatic rods are envisioned as a movable light-redirecting system working in conjunction with solar collectors. The balance between solar shading performance and maintaining views is key to the design, where the screen makes up half of the double facade. During the winter months, it is planned to pump water through glass tubes that would have ceramic profiled shields to reflect light into the spaces behind the louvre system. The water pumped through the tubes would gain heat from the sun and transfer the heat gained into the under-floor heating system. Once developing the concept the team then started to experiment with the form of the louvre itself with the aim to produce maximum efficiency between solar shading, heat penetration to the glass tubes and the relationship between the louvres.



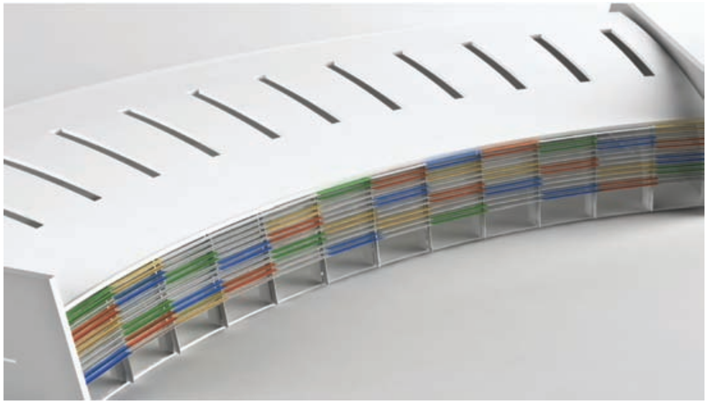
1 - 21mm Glass Tube with 5mm Thickness
2 - Ceramic Profiled Shield for Glass Tubes

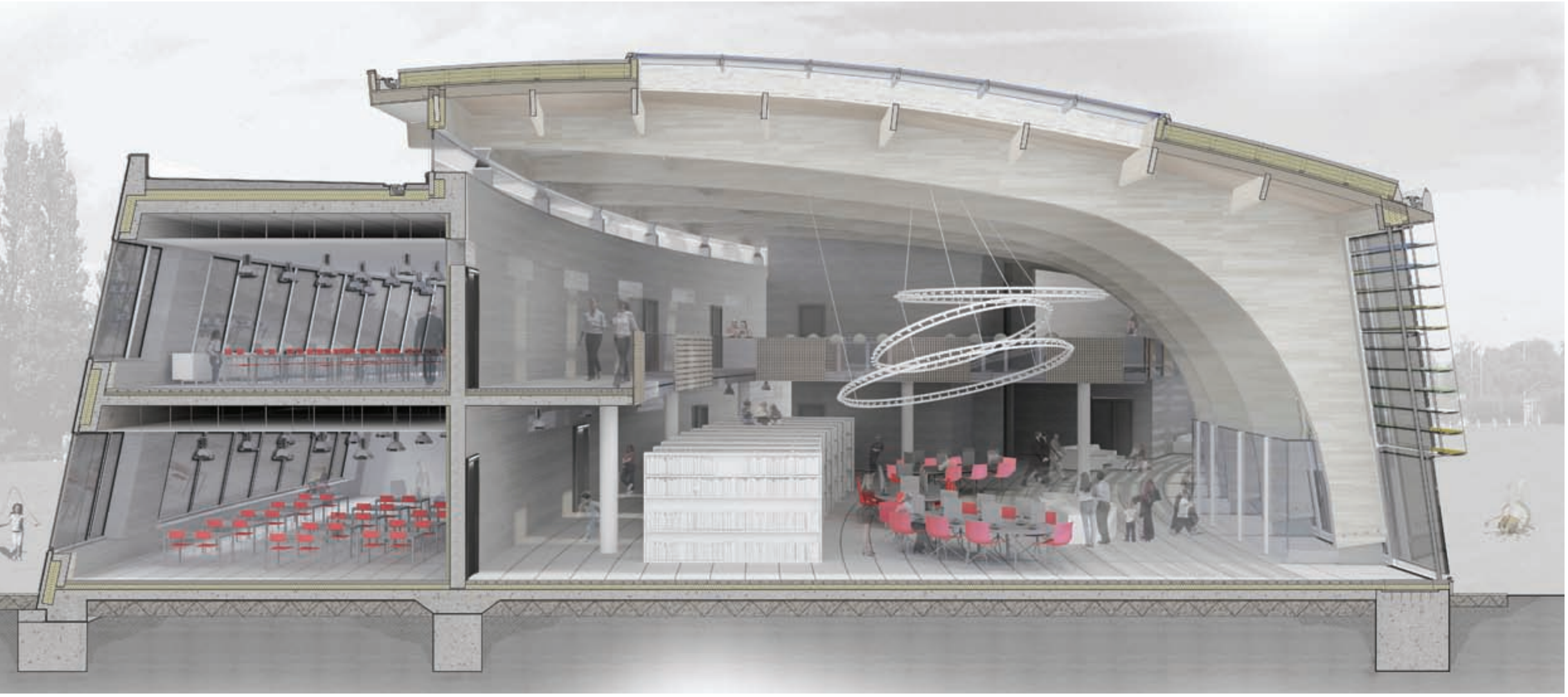
Team 8

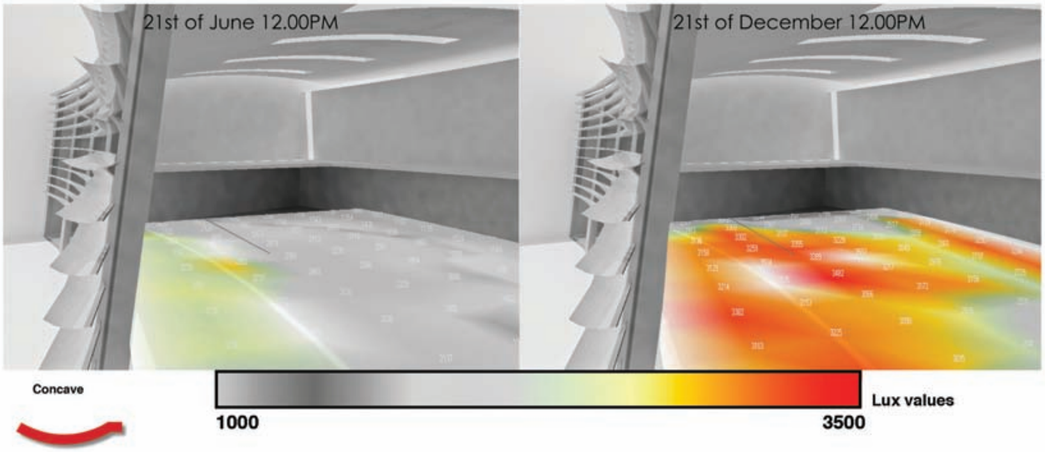
Concave Ceramic Louvres

Joe Diaz,
Benjamin Gregory,
Mikael Pedersen

A set of colourful concave ceramic louvres clad the convex facade of the curved building. Light studies have been performed to select the best profile to avoid excessive solar gain and to maintain comfortable natural daylighting levels. Coloured glazes add a playful finish to the facade, as well as providing colourful effects as light bounces into the internal spaces.



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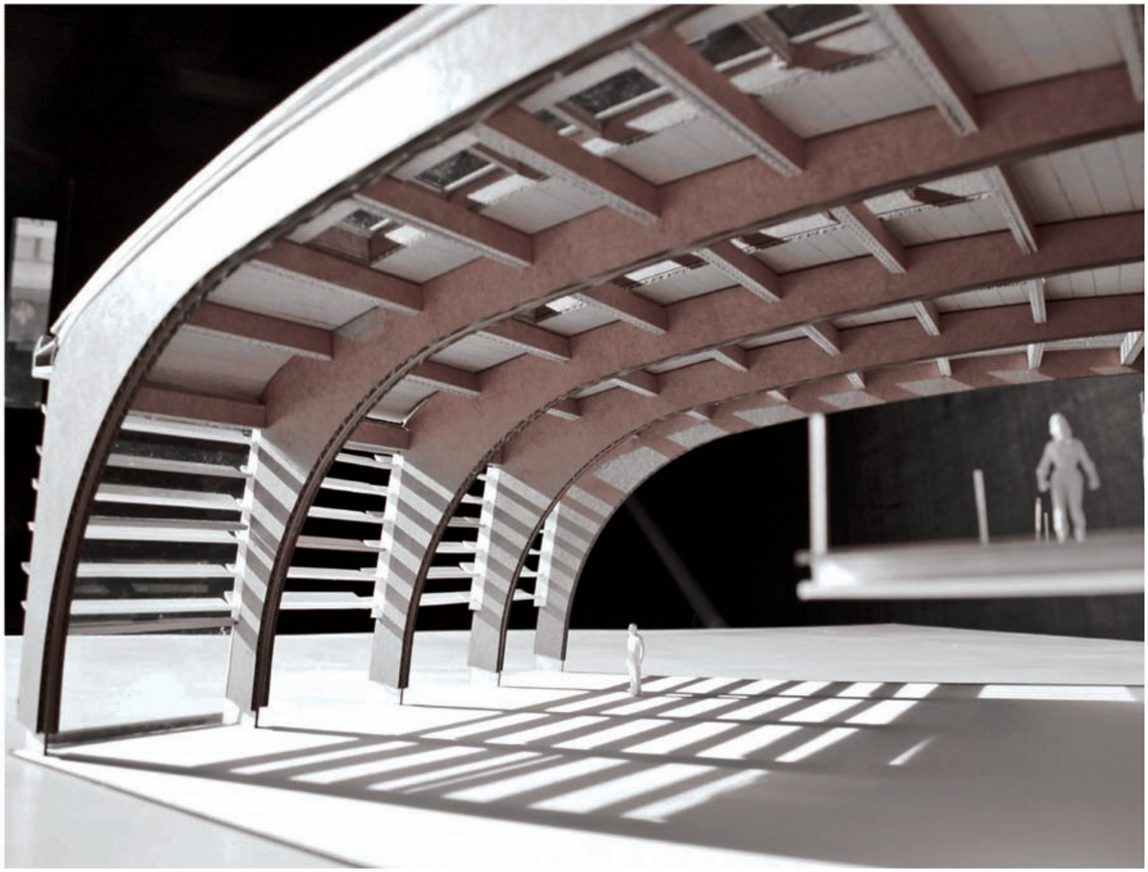
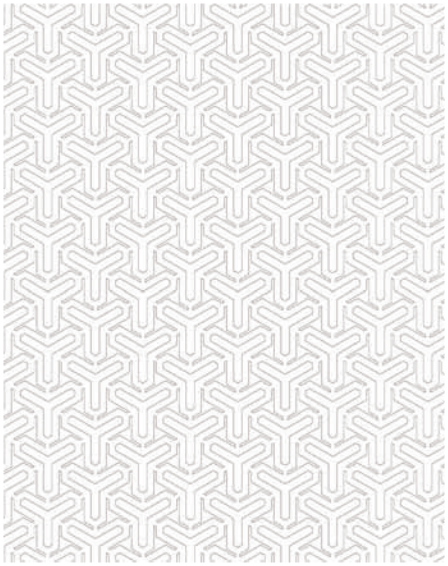


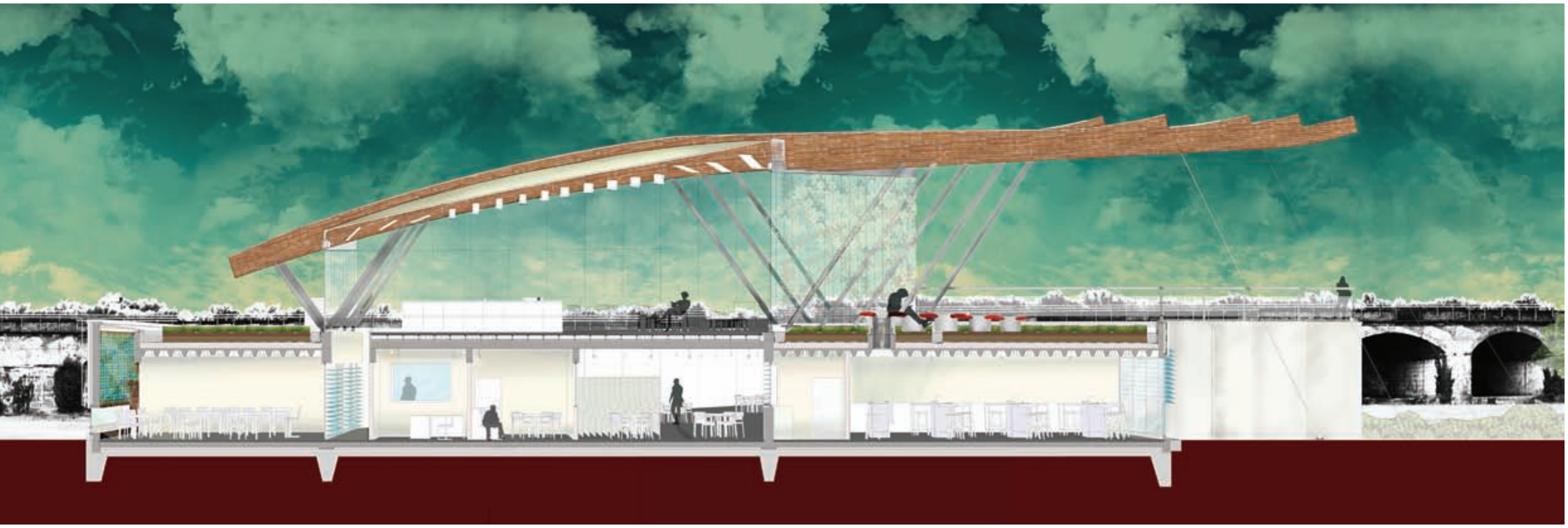
Team 9

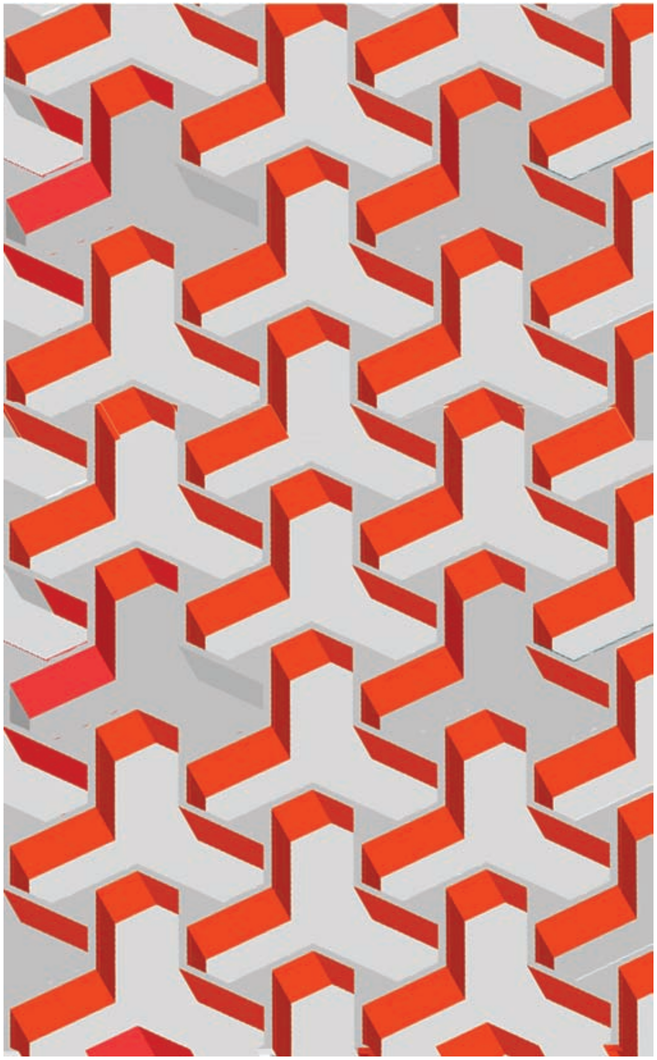
Modulating Lattice Wall

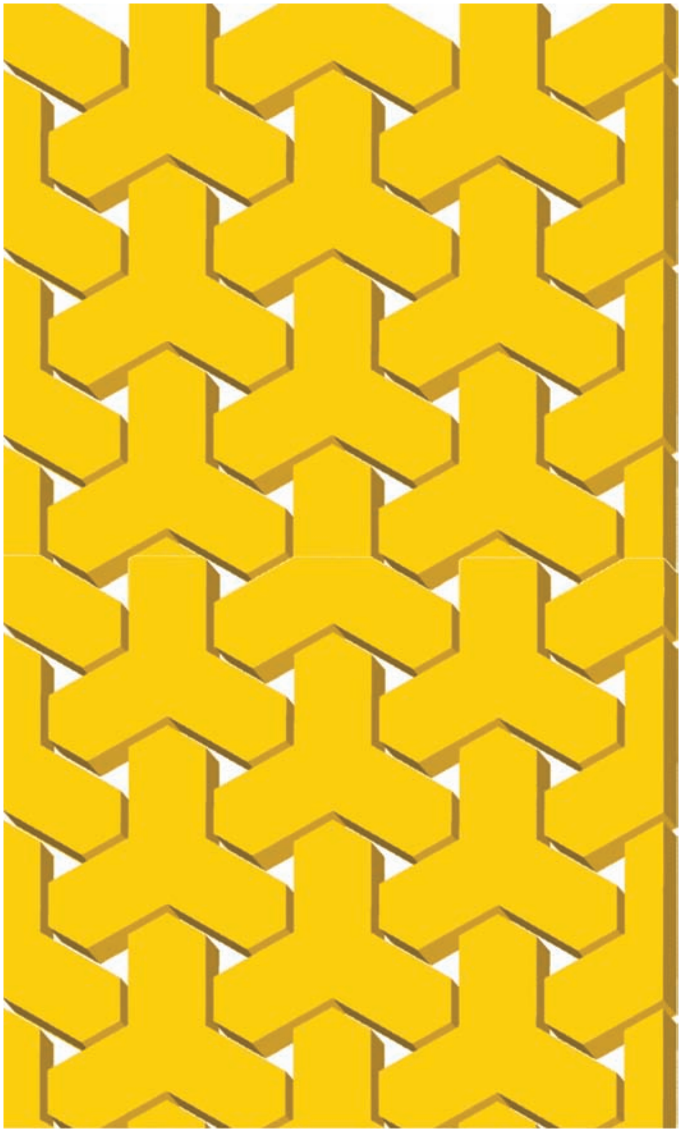
Senna Al-Bachari,
Catherine Howe,
Alexandra Roberts



This project proposes a facade composed of 3-legged flat ceramic profiles that conforms a rhythmic lattice wall. The geometry of the delicate silhouettes of the hollow ceramic pieces conform an arabesque surface that projects an intricate configuration of light and shadow. The surface is composed of hollow and solid pieces, randomly placed within the envelope, which contributes to a higher diversity of light-control and privacy according to the building's internal uses.



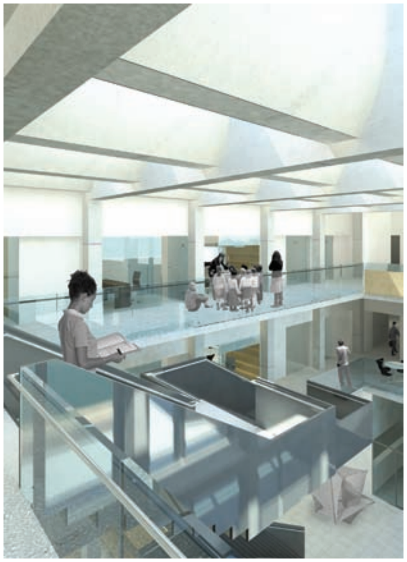




Team 10
Vertical Ceramic Fins

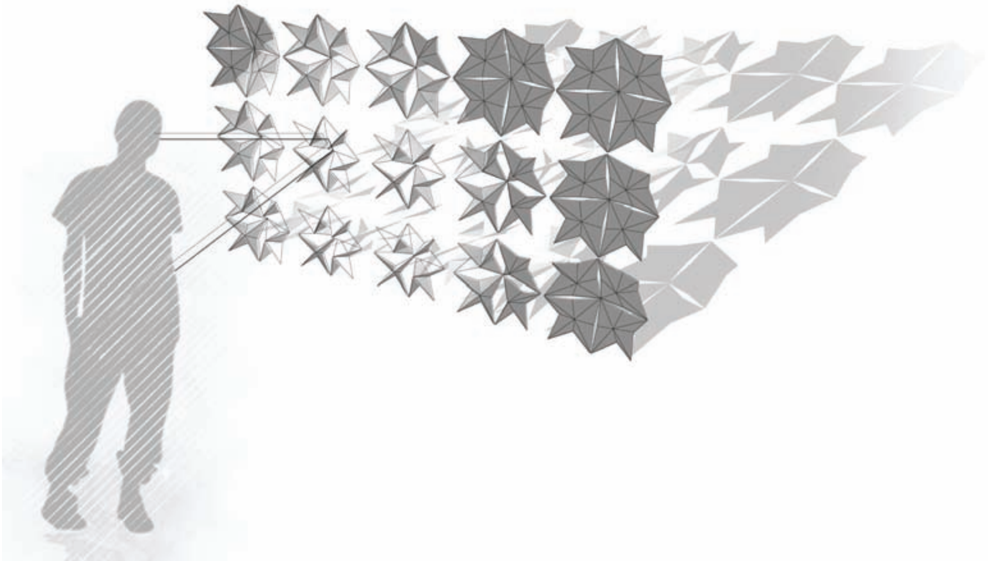
Joseph Aniedu,
Katie Hope,
Paul Wynn

Vertical ceramic louvres control light accessing the internal spaces. The static and rational nature of the screen produces a patterned array of shade and light that matches the rational composition of the building. The proposal also implements glazed ceramic surfaces to enhance the penetration of light into the building. These surfaces sit around the transoms and mullions of the windows as well as the internal surroundings to the roof lights to provide a powerful and dynamic illumination from above.

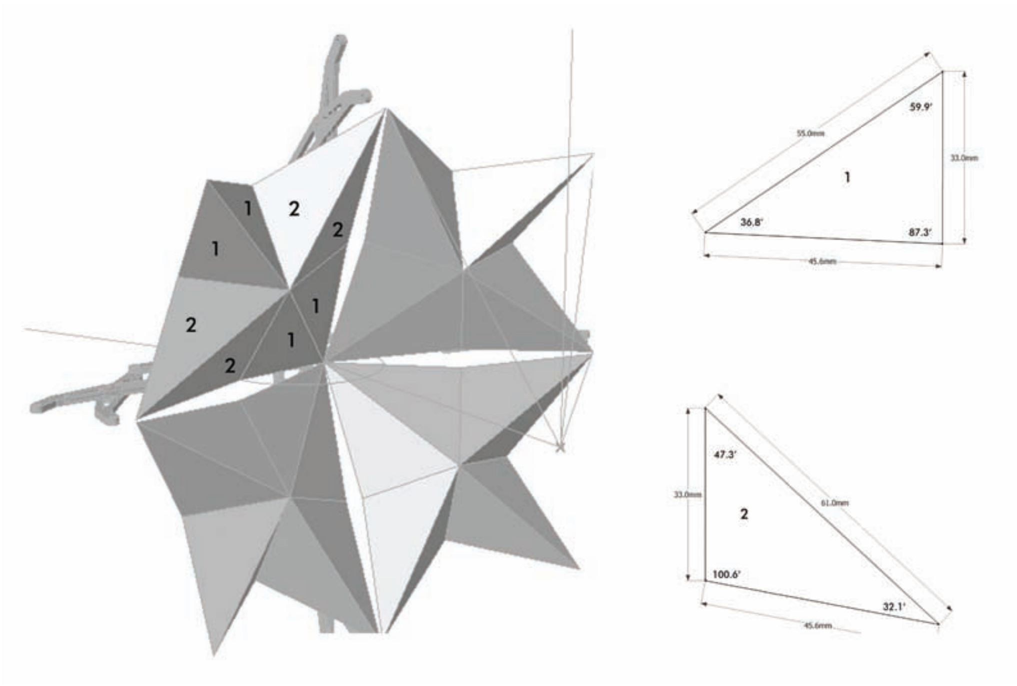



TOBACCO
WAREHOUSE

Team 11
Performative Ceramic Surface
James Fosbrook,
Adam John,
Oliver O'Niell



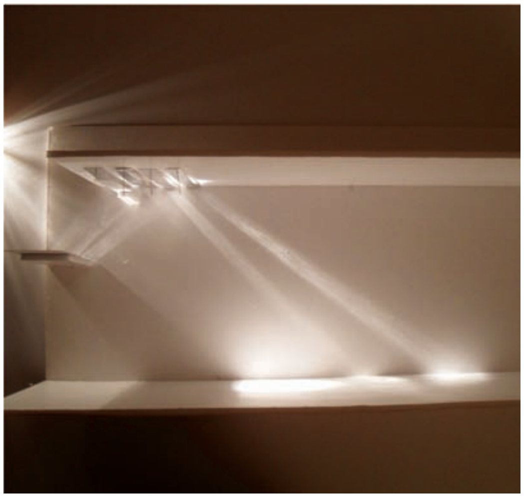
The glazed facades are backed by an array of actuated solar shading devices that respond to both occupant and environment. The responsive performative ceramic surface controls light and the dynamic nature of the surface produces a wide range of lighting patterns. Two types of ceramic triangles conform the topography of the variable surface, structured in square modules of 32 triangles each, which creates an operable cluster that opens and closes in a variation of degrees.



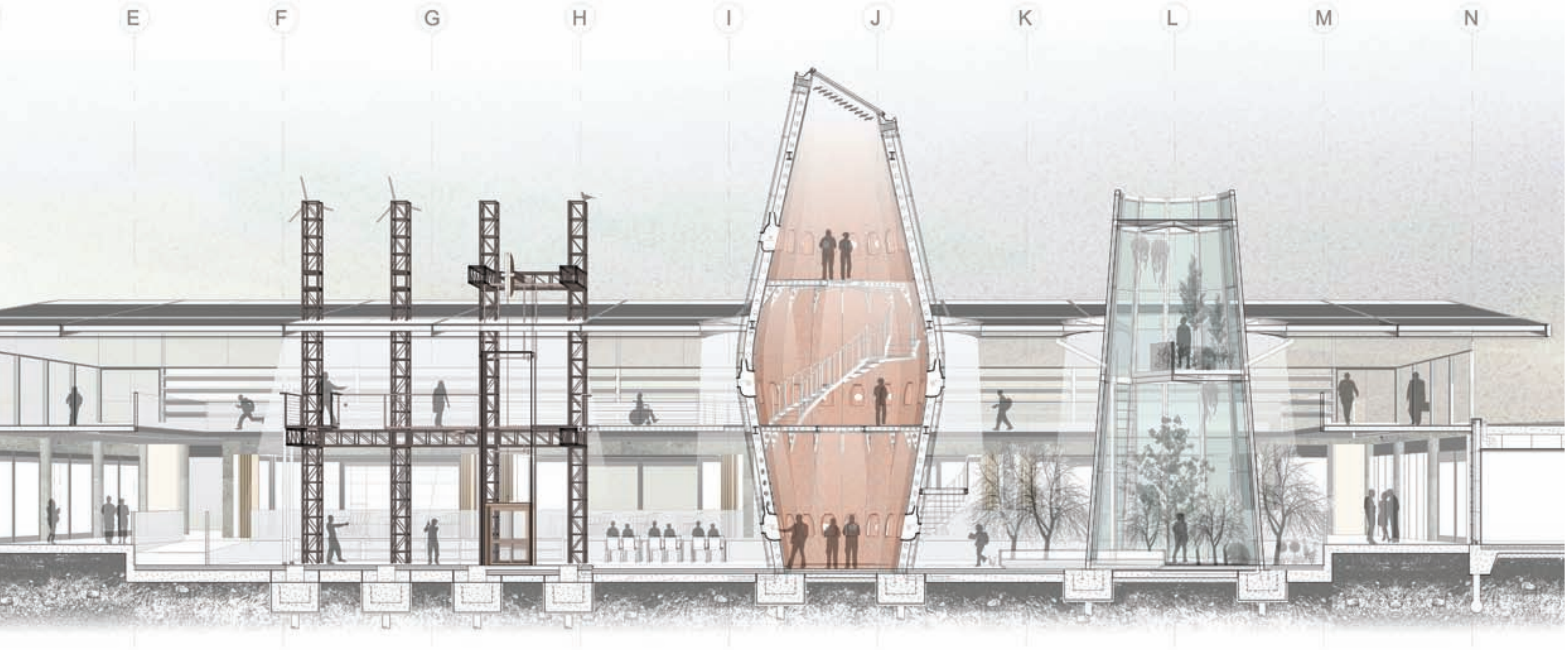
As well as this primary function during times of occupancy, the solar shading responds uniformly to regulate solar gain from this South facing glazed facade. The adaptive performance of the surface provides a refined controllable shading structure that offers a smooth graduation of internal illumination.

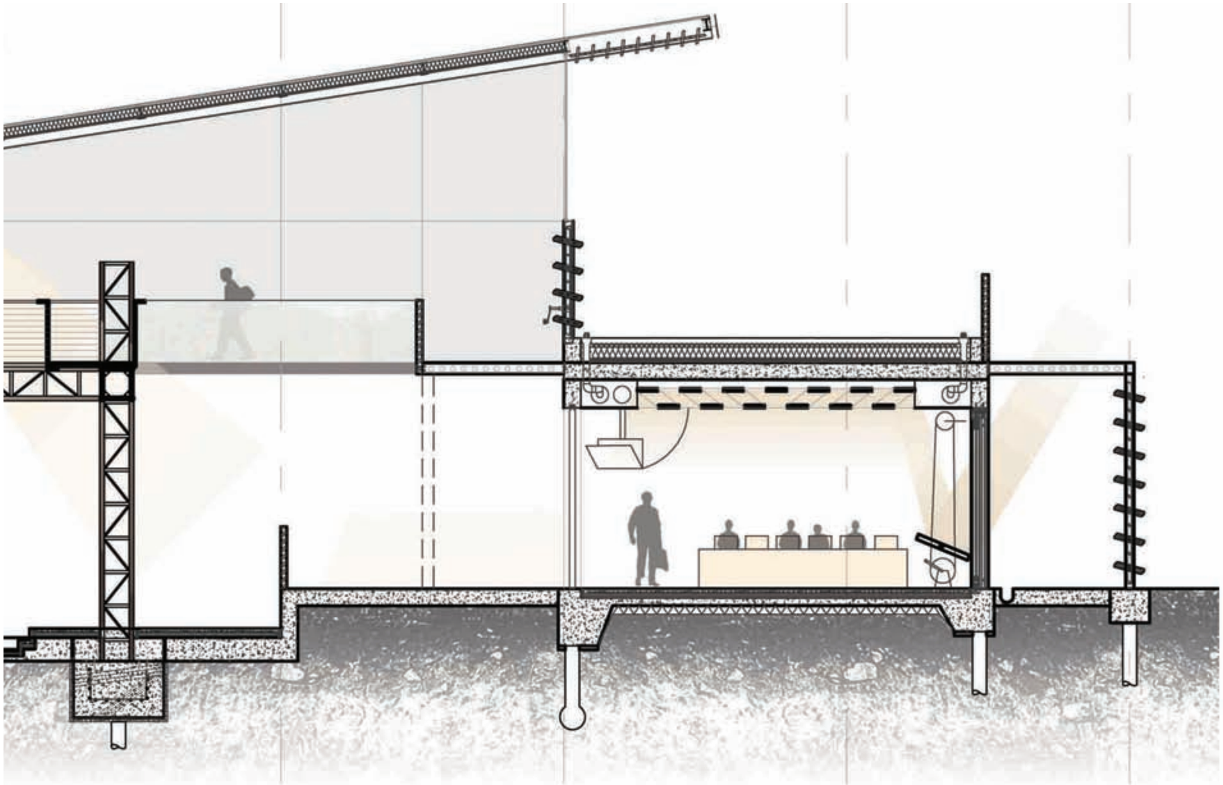
Team 12
Undulating Light-Transporting Ceiling

Chantelle Arnold,
Nikita Butler,
Robert Child



The *Undulating Light-Transporting Ceiling* redistributes natural daylight deep into the classrooms. A succession of narrow reflective ceramic strips that cover the whole width of the classroom forms the topography of this performative ceiling. Each of these strips is bent in particular areas forming a differential surface that combines flat and bent zones, which makes the reflected light travel along the ceiling. The undulating nature of this ceiling produces a progressive scale of light, filtering down to a subtle quality of natural light.

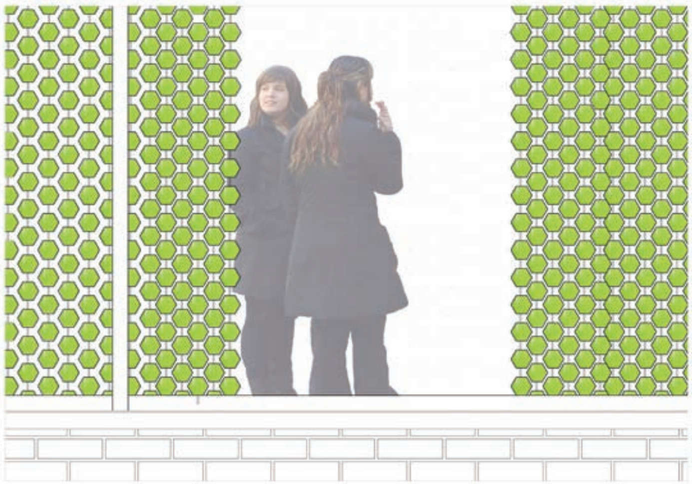




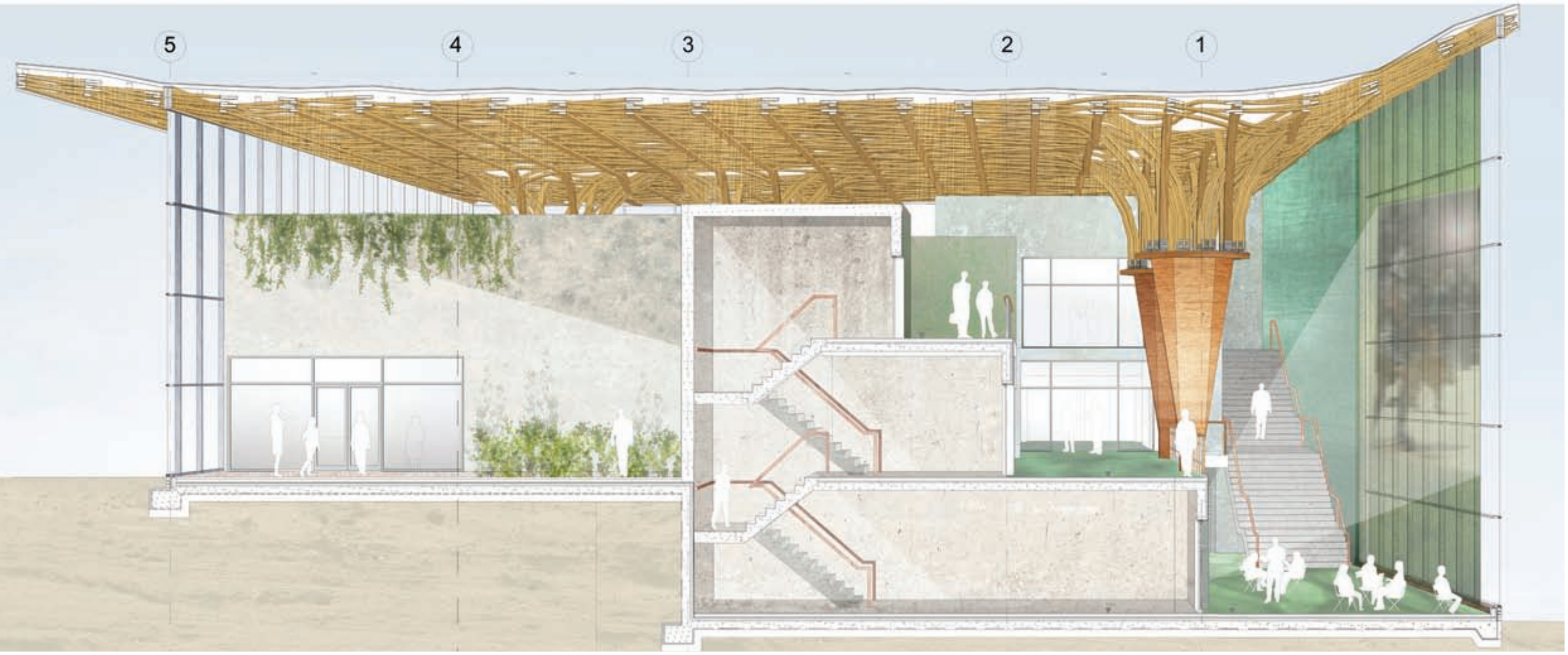
Team 13

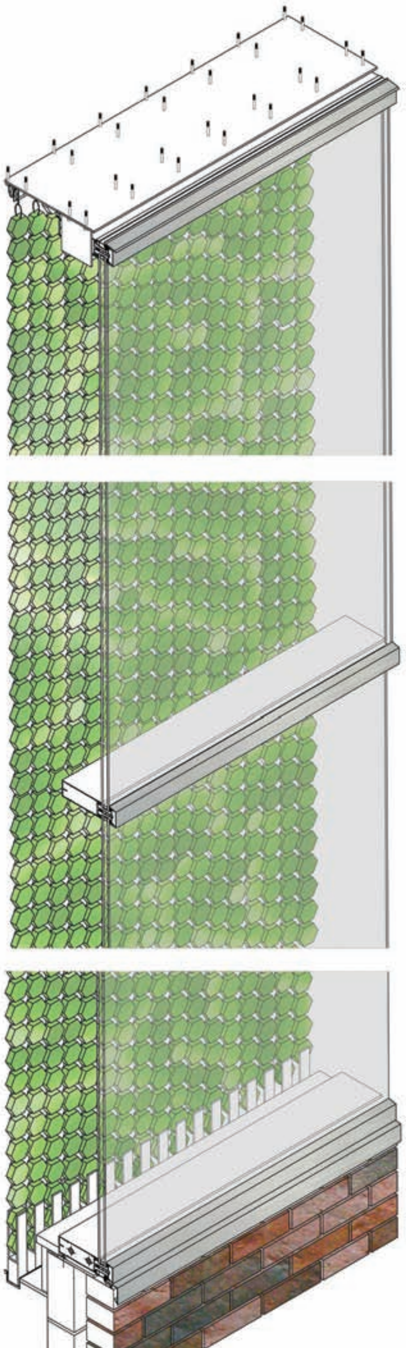
Tessellating Hexagonal Curtain

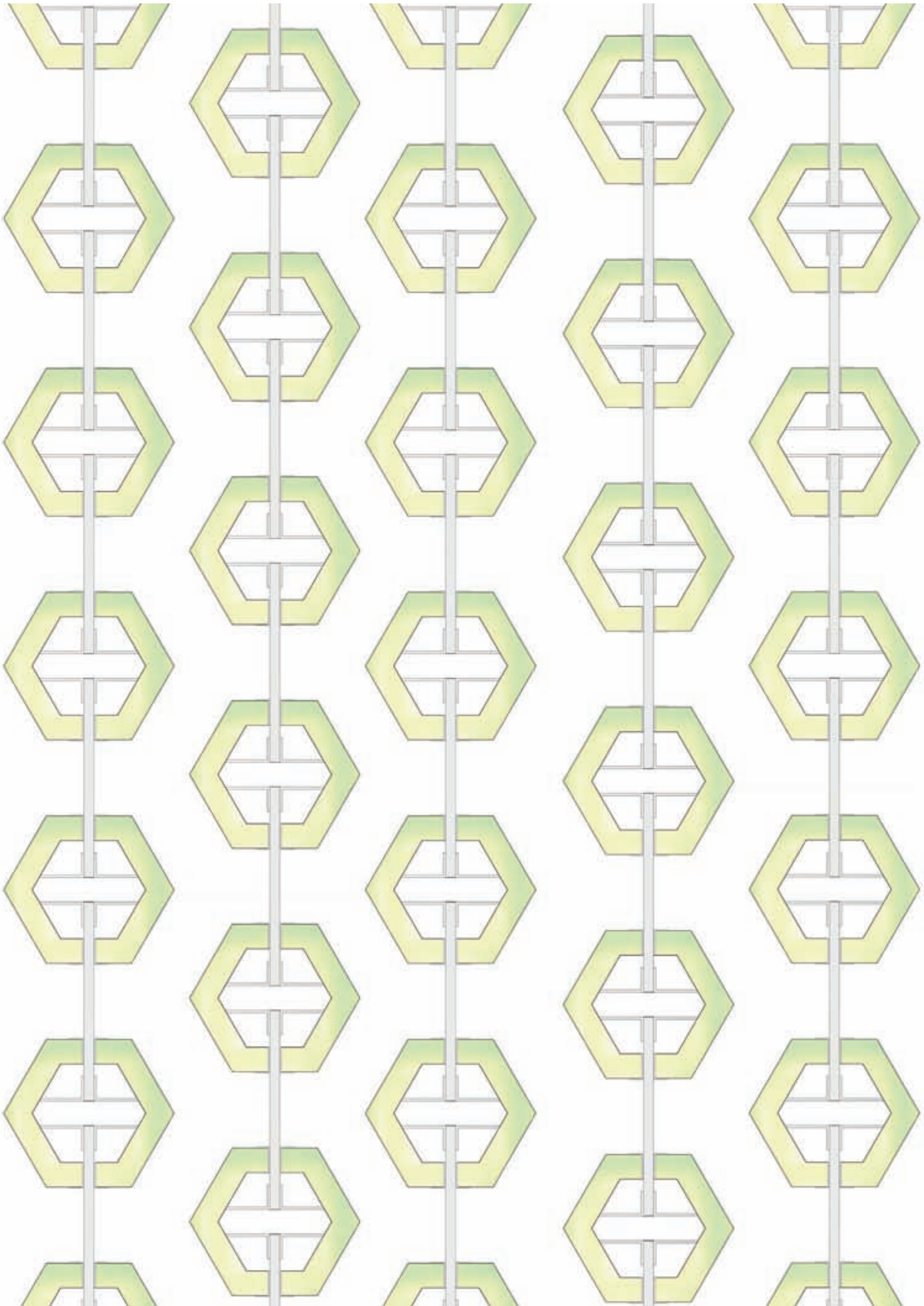
Oliver Clucas,
Robert Vasili,
Alastair Wake



Alternating vertical alignments of hexagons, which are connected to vertical metal bars using a revolving fixing, form the daylighting curtain. Each column of hexagons is independent and suspended from a rail that runs along the entire glazing, allowing its movement and therefore the provision of shade or daylight by concentrating or spacing apart these elements in a particular area of the glazing. This horizontal flexibility in conjunction with the rotational movement of the hexagonal pieces allow for a plastic and fine modulation of the natural illumination. The curtain is also intended to be used as a screen for digital media projections when it is fully tessellated.







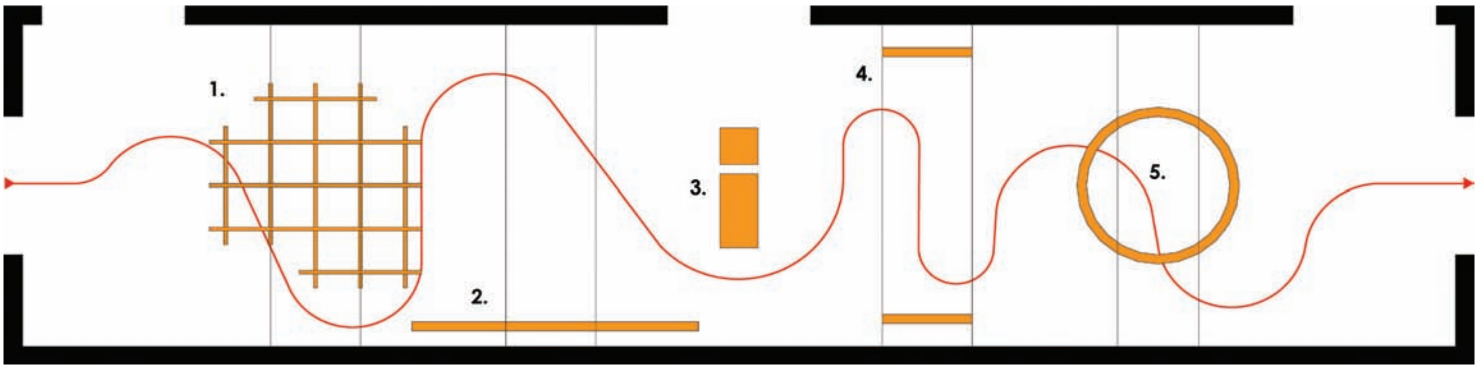
Prototypes

Exhibition

The *Illuminating Through Ceramics* show displays visuals of the thirteen proposals, and prototypes of five of them built at full scale and performing within a light-immersing scenario in the Main Hall of the Liverpool School of Architecture. The selection of ceramic prototypes for the exhibition was based on diversity criteria in terms of both form and light performance. These prototypes are being tested under different conditions of illumination, unit and cluster geometry, and building position. This is also a fundamental stage to analyse their mechanical performance, and its architectural integration and feasibility, in terms of manufacturing complexity and costs.

The exhibit, hence, is conceived as an opportunity to use a real space as a case study and a laboratory for new applications of ceramic designs for daylighting purposes. Through the planning of different *mise-en-scenes* with these designs, it is possible to understand not only their possibilities in the generation of the architectural envelope itself, but also to show the impact of the light performance projected on the space. Towards this end, a lighting setup is incorporated to reveal the variety of ways in which these systems perform and are perceived, which generates a tactic itinerary provoking a specific contrast of daylighting concepts.

Exhibition Layout



1. Dynamic Ceramic Ceiling 2. Tessellating Hexagonal Curtain 3. Performative Ceramic Surface 4. Prismatic-Rod Screen 5. Hydroponic Chandelier

Prototypes

To allow for a sensory experience of the exhibit, all the installations are suspended in the gallery. The objective is to offer the visitor a spatial itinerary to discover the sensual materiality of ceramics in combination with the sequence of light patterns. The main structure, a system of tie bars installed three and a half metres high, is designed to allow the articulation of five areas, so each of the five installations enjoys its own independent performative space. Five separate sets of bars, wires and fasteners compose the secondary structure of each of the five ceramic installations, which are then hung from the main structure.

The goal of the lighting set up is to test and explore the light performance of the ceramic designs. To recreate the dynamic nature of sunlight, each of the five ceramic installations will be illuminated using at least two different lighting conditions. A set of M35 LED lamps will be strategically displayed, projecting light with different angles of incidence on the ceramic devices. The light performances of the proposed daylight-systems for different climate conditions have been previously assessed through software simulation. The purpose of that analysis is to estimate illuminance (light levels) and daylight factors of the different devices compared to the performance of a clear double-glass facade. A room of 12m x 6m x 3m was chosen to carry out the simulations, corresponding to the typical size of a classroom. The values of illuminance and daylight factor were calculated for a horizontal grid set at 70 cm above the floor in order to correspond to the standard desk height. The location of the virtual room was set to the southern part of the UK with coordinates 51°N, 0°W. The time chosen for the maps shown in this catalogue was 12.00 am of 1st April under an overcast sky (considered a worst-case scenario). The vertical daylighting devices were simulated taking the whole surface of the double glass facade. In the case of top lighting systems, either punctual or surface installations were considered, depending on the design’s character and the type of light performance.

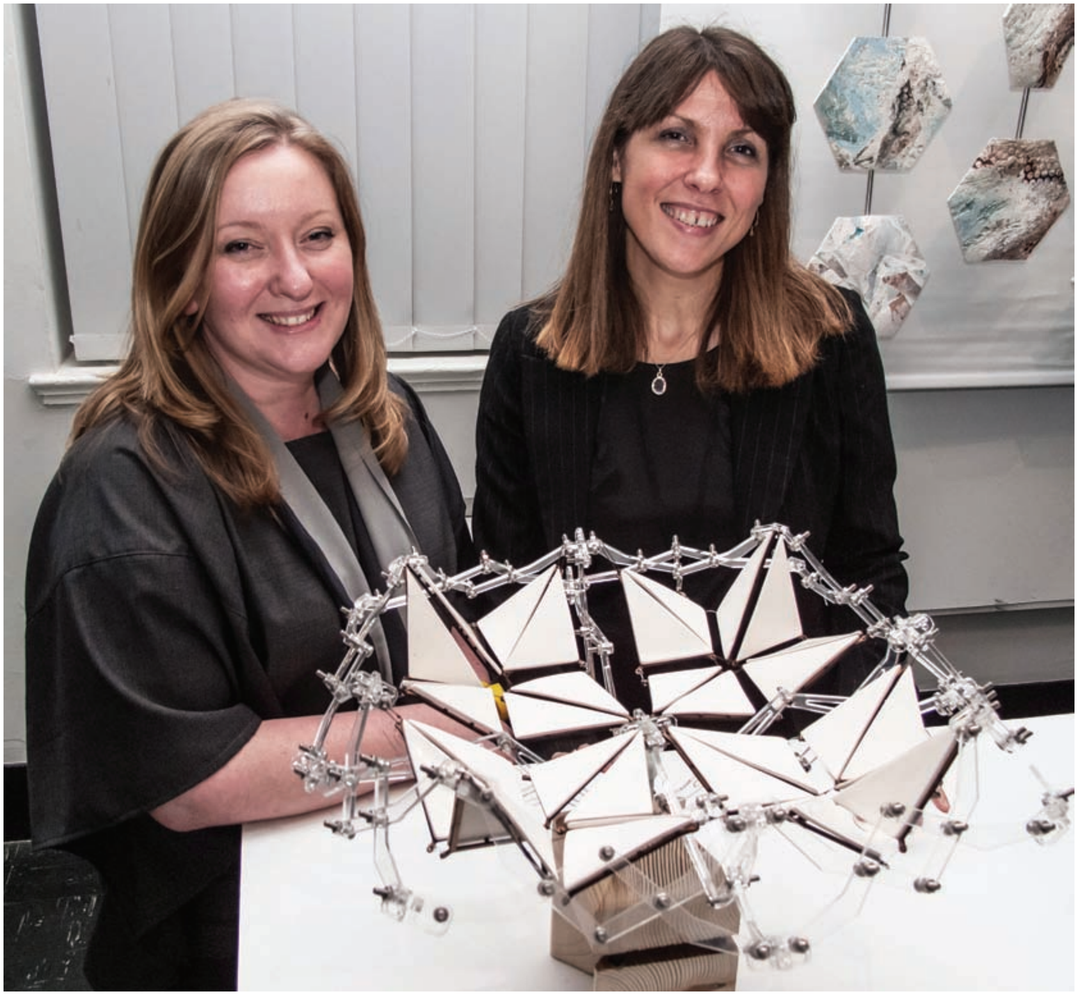
The show opens with the *Dynamic Ceramic Ceiling* designed by Ashley Crane, Hannah Dockerty, and Tim Mitchell (Team 6, Year 4 students), a regulating shading system for glass domes. Oliver Clucas, Robert Vasili, and

Alistair Wake (Team 13, Year 4 students) designed the following installation of the exhibit, the *Tessellating Hexagonal Curtain*, a shading screen that modulates sunlight and privacy by sliding and/or rotating its hexagonal ceramic units. In the third lighting scenario, the *Prismatic-Rod Screen* designed by Pritpal Chana, Sam Goldby, and Pradumn Pamidighantam (Team 7, Year 4 students), explores the redirection of light towards the bottom of the room. *The Performative Ceramic Surface* designed by James Fosbrook, Adam John, and Oliver O'Neil (Team 11, Thesis students) is the fourth light performance of the show, based on the sensorised adjustable openness of a kinetic surface. And finally, the last protagonist of the ceramic light-interacting itinerary is the *Hydroponic Chandelier* designed by Loren Durkin, Adrian Lombardo, and Zara Moon (Team 3, Year 4 students), an organic light pipe that channels daylight down into the core of the building.

General view of the exhibition in the Main Hall of the Liverpool School of Architecture.
© Martin Winchester.

From left: Jenny Beavan, Ceramics Artist; Pradumn Pamidighantam, MArch student; Amanda Wanner, Ceramics Coordinator; Rosa Urbano, Project Leader; Alexis Harrison, Senior Designer at Arup London; Wendy Lawrence, Ceramics Artist; Andre Brown, Head of the Liverpool School of Architecture; Tim MItchell, MArch student; and Rob Vasili, MArch student and Research Assitant.
© Martin Winchester.

Images of the exhibition during its inauguration.
© Martin Winchester.



Amanda Wanner and Rosa Urbano. © Martin Winchester.

Ceramic Prototypes

The ceramics production for the exhibition has been commissioned to a professional team coordinated by the architect Amanda Wanner, and developed with the ceramics artists Jenny Beavan and Wendy Lawrence.

In the realisation of every design, there is always a challenging transition from the design idea to its materialisation. In our case, this being our first experience in designing environmental ceramic components for architecture, it has been particularly demanding, yet an exciting didactic journey, to find the compromise between keeping the spirit of the design ideas and resolving the practical issues around their production under very tight timescales. These difficulties are not limited to this experimental project and can be mirrored within the world of construction, where artists and architects work together and where the timescales, pragmatics and logistics of creating a building can sometimes be at odds with the time that artists need to experiment, create prototypes, realise their aspirations and ultimately generate elements of a building. To this end, the enthusiastic spirit and professional attitude of the ceramics team have been instrumental to bring the project to an excellent ending.

As an experienced architect, Amanda has worked with many different groups of people to translate their ideas and aspirations into built forms. Engaging with artists, community groups and people with special needs, she has already encountered some of the practical problems of bringing together different requirements within the construction process, and this has seen her generate work, which is embraced by all involved in the construction process. As experienced artists, both Jenny and Wendy have developed their original and distinctive approaches to their respective ceramic work throughout their professional career, and whilst both of them are visibly inspired by nature, they work in a somewhat polarised manner to generate very different conceptual and visual approaches to their ceramic pieces. This biomorphic inspiration is an added value in favour of the integration of the ceramic pieces in proposals of sustainable architecture.

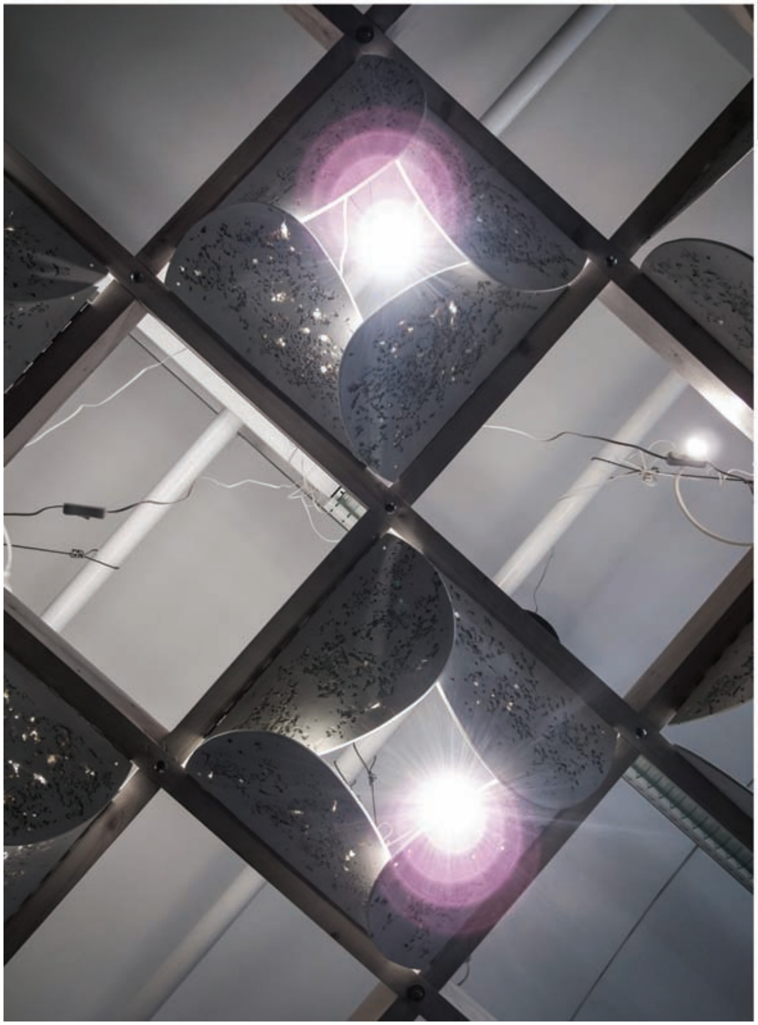
The delicate techniques developed in white china clay by Jenny belie the realities of working the clay and passing it through a series of membranes and textures to generate pieces that are imbued with vernacular combustible and non-combustible materials. Her current work could be seen to reference the rugged coastland close to her studio whilst evoking a delicacy and vulnerability that is ever present on the moors directly surrounding her studio. This dichotomy of strength and delicacy and her use of embedded surface texture, seemed to be perfect to interpret the lightness and differential transmission of light needed for two of our installations: the movable petals of the *Dynamic Ceramic Ceiling* and the rotating and sliding hexagons of the *Tessellating Hexagonal Curtain*.

For the *Dynamic Ceramic Ceiling*, Jenny has produced twenty four movable petals made of high-fired white porcelain. These petals (40 cm long, 28 cm high, and with a maximum thickness of 0.3 cm) exhibit a delicate variety of textures as well as light transmission patterns, ranging from complete opaqueness, to diverse degrees of translucency, to complete transparency in specific points of the surface. The differential light performance of this material, together with the various opening positions of the array of petals, provide a highly adaptable daylighting system generating a rich palette of light patterns.

Conceptually, Jenny surrounded herself with biological references and living materials that she experimented with to generate her understanding of the word ‘petal’ and to explore how she might interpret this within each of the pieces. In order to achieve a surface that was lightweight, flat, thin and strong she made samples, which contained varying quantities of paper pulp to clay slip mixed with combustible materials such as petals, seeds, and grasses. She produced sixteen different proposals for the petals, which sought to achieve the visual delicacy and light transmission qualities needed whilst maintaining the flatness required to generate an operable component. The incorporation of the paper pulp (which burns out during the firing process) and the high firing temperature ensured that the petals had the necessary strength.

Production process of the *Dynamic Ceramic Ceiling* ceramic components. © Jenny Beavan.

View of the *Dynamic Ceramic Ceiling*. © Martin Winchester.

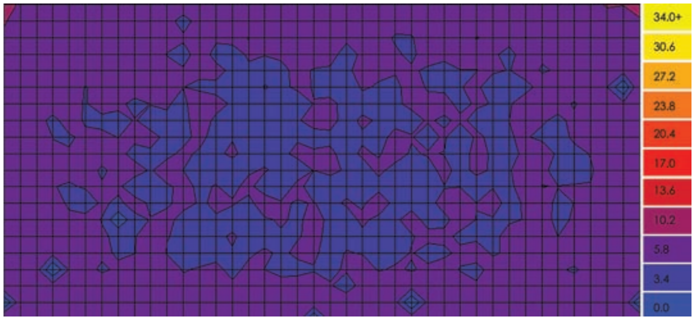


Left: view of the *Dynamic Ceramic Ceiling*. Right: ceramics artist Jenny Beavan, who produced the ceramic pieces for this prototype, is conversing with MArch students Tim Mitchell and Ashley Crane, designers of this proposal. © Martin Winchester.

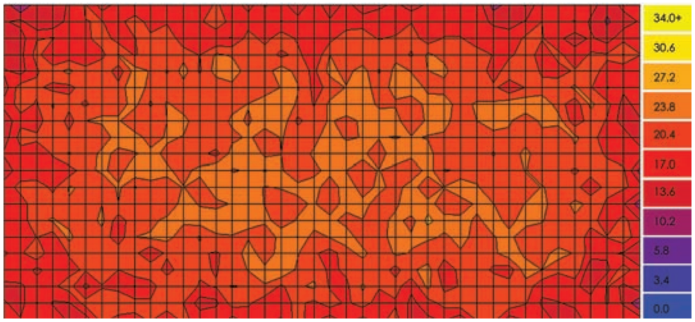
Lighting Analysis of the Dynamic Ceramic Ceiling

Illuminance (light levels) map generated for the *Dynamic Ceramic Ceiling* when the bidimensional array of ceramic petals that cover the entire ceiling's surface area are open at 0°, 45° and 90°. The screen was designed to prevent direct sunlight from entering the space, control glare, and produce a uniform distribution of light throughout.

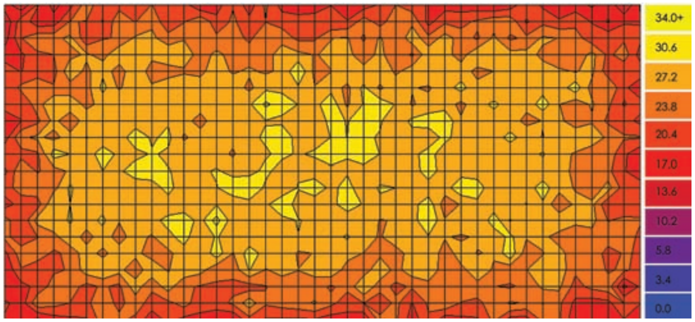
Daylight Analysis
Daylight Factor
Contour Range: 0.0 - 34.0 %
In Steps of: 2.0%
© ECOTECT v5



Ceiling closed



Ceiling closed 45°



Ceiling open 90°

Jenny has also produced the twenty three rotating and sliding hexagons that compose the *Tessellating Hexagonal Curtain*. These hexagons (30 cm diameter) are made following a stratification process in which again, the clay is manipulated through a range of physical processes of collage and decollage with found textures, combustible materials, and 'reclaim' off-cuts from the shaping process. This layering of processes gives the porcelain a heterogeneous internal porous structure that permits the differential transmission of light. Alternating vertical alignments of hexagons, which are connected to vertical metal bars using a revolving fixing, form the daylighting curtain. Each column of hexagons is independently suspended from a rail that runs along the entire glazing, allowing its movement and therefore the provision of shade or daylight by concentrating or spacing apart these elements in a particular area of the glazing. This horizontal flexibility in conjunction with the rotational movement of the hexagonal pieces allow for a plastic and fine modulation of the natural illumination.

Conceptually for this piece, Jenny was concerned with the notion of a 'curtain' and its ramifications; bridges, barriers, thresholds, concealment, container and contained, but ultimately a dividing device that separates the actor from the audience and the resulting liminal space which acts as a bridging device. Each hexagon was made using a 'slip' of porcelain, paper clay and fine molochite which was poured onto a set of specially formed plaster batts. Each piece was individually painted using locally sourced minerals before combustible materials were added to generate a pattern of texture and forms that passes along the curtain. Before bisque firing, non-combustible materials were added and textures imprinted into the surface and each of the individual slabs were rolled to the correct thickness. The hexagons were then cut from these three dimensional canvasses and the 're-claim' was carefully configured to make new canvases which act as visual connecting pieces between the hexagons. The pieces were bisque fired at 1240 degrees before more glaze and glass were added and re-fired at the same temperature.

Production process of the *Tessellating Hexagonal Curtain* ceramic components. © Jenny Beavan.

View of the *Tessellating Hexagonal Curtain*. © Martin Winchester.

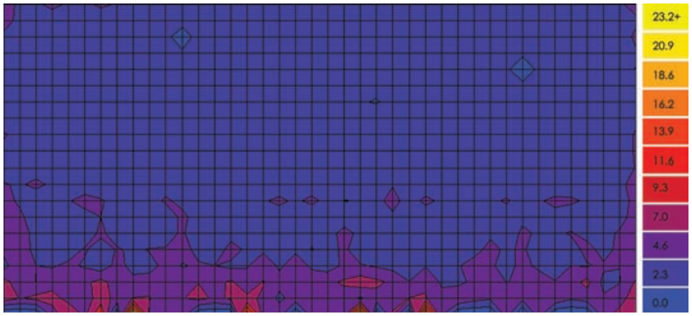
Rob Vasili, one of the designers of the *Tessellating Hexagonal Curtain*, with Jenny Beavan and Amanda Wanner, producers of the ceramic hexagons. Below: two positions of the rotated hexagons.
© Martin Winchester.

Lighting Analysis of the Tessellating Hexagonal Curtain

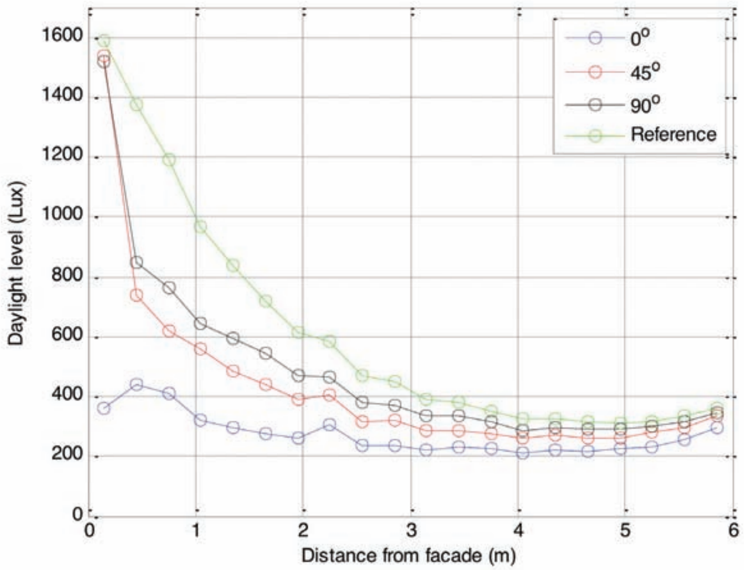
Illuminance (light levels) map generated for the *Tessellating Hexagonal Curtain* when the hexagonal units are rotated at angles of 0°, 45° and 90°. The screen was designed to prevent direct sunlight from entering the space, and to control privacy and glare. The filtered rays produce a plastic pattern of traveling sunlight patches, detonating visual interest throughout the area, and allowing the experience of time.

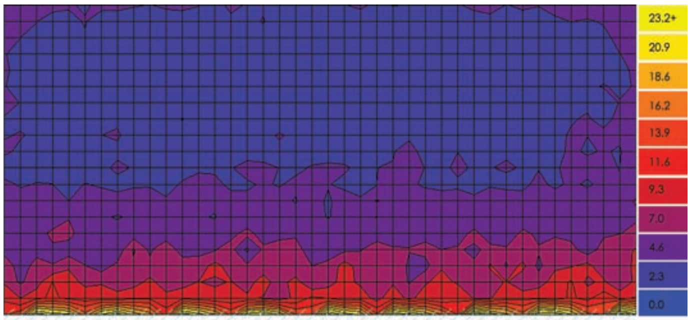
Graph showing illuminance in relation to distance from the facade for the 3 simulated rotated angles (0°, 45° and 90°). Reference conditions refer to the levels obtained considering the window facades without the respective screen.

Daylight Analysis
Daylight Factor
Contour Range: 0.0 - 23.2 %
In Steps of: 2.0%
© ECOTECT v5

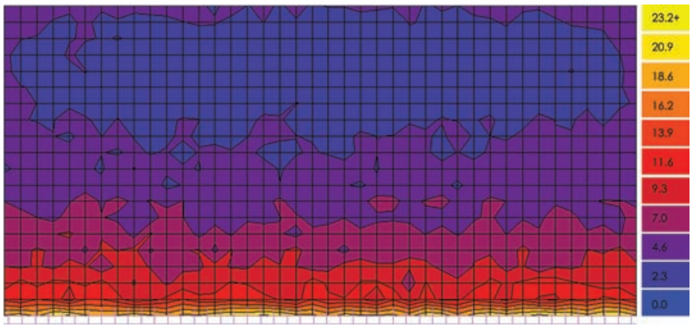


Hexagons closed





Hexagons open 45°



Hexagons open 90°

The visual and textural richness of Wendy's geological narrative, expressed in her pieces through the use of scale, deeply incised organic geometries, intensified colours and multi-fired layers of glazes, seemed most suitable for the elaboration of three of our installations: the *Prismatic-Rod Screen*, the *Performative Ceramic Surface*, and the *Hydroponic Chandelier*. Wendy works in a highly intuitive but controlled manner, exploring the density, texture, and composition of the clay through physical manipulation and pounding of the clay, in ways that mirror the physical geological processes that inspire her. She surrounds herself with objects, textures and materials gathered from her travels and immerses herself within these textures whilst she works. The resulting pieces do not copy the natural textures she values, but evoke the qualities and forces that have created them.

The *Hydroponic Chandelier* is a complex organic structure forming a ceramic tubular chandelier that distributes light and captures and channels rainwater, which in turn allows the growth of plants thanks to a hydroponic system. The daylight is filtered and reflected down the ceramic surfaces, the falling water, and the translucent leaves of the plants, creating an active light-pipe that projects constantly-changing light patterns in the courtyard of the building. Once the concepts and constraints of the piece were discussed with Wendy, she moved quickly to the clay to generate textural responses that could be experimented with under different lighting conditions to ascertain which of the textures would be the most successful. From the five samples generated, two textures were chosen and made into working prototypes. Each of the fifteen organic tubes that represent a section of this structure in the exhibit is made through an elaborated process. First, slabs of clay are rolled out using a slab roller. The slabs of clay are then rolled around a tube of the desired diameter and then joined to make a long cylinder. The surface is then smoothed using a smoothing kidney shaped tool to even the surface. The 'strata' pieces are then scored using a knife and carved into using turning tools. Once the work is leather hard it is then carved into using a wire brush to soften the lines.

The pitted pieces are also achieved using turning tools of a variety of scale, width, size and are carved into the clay at angles and worked over each pitting. Once finished in clay state, the pieces are fired to 1000 degrees. Wendy used eight different engobes (a very matt surface similar to a slip but contains more glaze). These engobes were applied by spraying at different angles to achieve contrast and to create change in colour as you move round the piece. The sheer size of the pieces necessitated the use of a large walk-in kiln and the pieces were packed horizontally in the kiln, propped on tiny pieces of kiln shelf with a layer of kiln fibre to stop piece sticking to shelf, and fired to 1180 degrees.

Production process of the *Hydroponic Chandelier* ceramic components. © Wendy Lawrence.

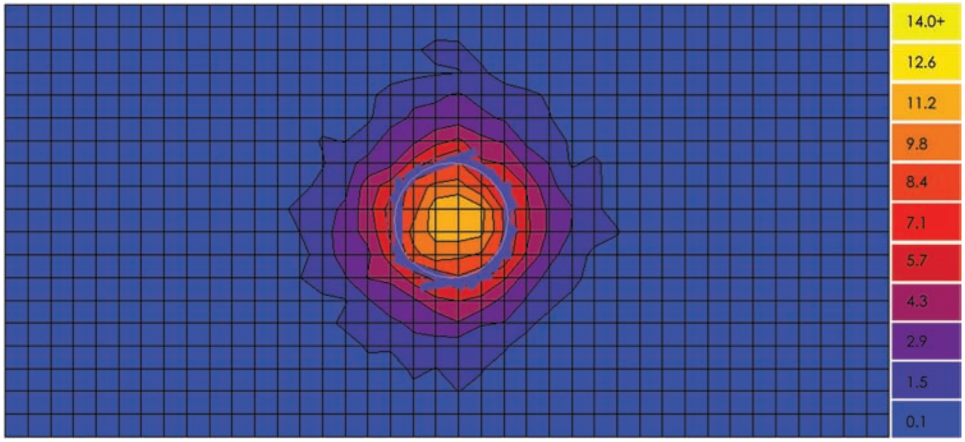
General view of the *Hydroponic Chandelier*. © Martin Winchester.

Two views of the *Hydroponic Chandelier.* Top right: Zara Moon and Adrian Lombardo, designers of this concept, with Wendy lawrence, producer of the ceramic components for this prototype. © Martin Winchester.

Lighting Analysis of the Hydroponic Chandelier

Illuminance (light levels) map generated for the *Hydroponic Chandelier* installed in the centre of the standard room. The device generates a bright spot on the floor that will travel around the room following the sun course, activating the space and providing a feeling of transience.

Daylight Analysis
Daylight Factor
Contour Range: 0.0 - 14.0 %
In Steps of: 2.0%
© ECOTECT v5



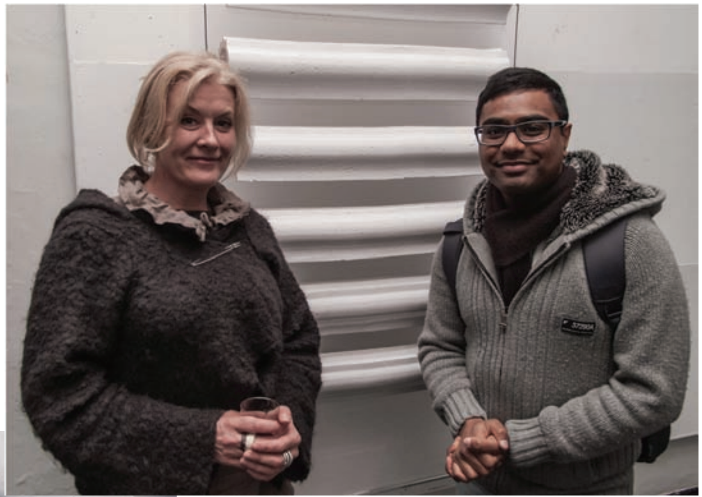
The ceramic prismatic rods are envisioned as a movable light-redirecting system working in conjunction with solar collectors. Each of the ten rods that compose the *Prismatic-Rod Screen* (10 cm diameter, 70 cm long) is extruded. To do so, a die or template is made from a piece of wood or metal, which is attached to the base of the extruder. This acts as a template to create the form from clay and is formed from a crank clay body. The pieces are made by wiring clay straight from a bag and pushing clay into the extruder. Once the extruder is full, the handle is pushed down forcing the clay through the die or template. In this case the pieces were formed by a vertical extruder and therefore had to be supported by a weight at the correct height to stop the extruded clay from sagging and bending from its own weight and plastic consistency. The extruded clay is then dried gently and evenly using a blowtorch to aid the drying process and to stabilize the clay.

Once leather hard the clay form is then shaped and refined by hand and allowed to dry slowly. The extruded forms are then bisque fired to 1000 degrees. Once biscuit fired the sides and edges are sawn to achieve precision ceramic edges. Each rod had white or black high gloss earthenware glazes applied with an air fed spray gun then fired to 1050 degrees. With these two colours we wanted to test two performances: glossy white for improving the reflective performance of the prismatic surface, and black for optimizing the heat collection of the solar system.

The extrusions created for this installation have stark visual differences to the techniques that Wendy has explored throughout her career so far, but the pieces retain similarities through their boldness of form, visual presence, and through the physical processes and strength necessary to manually extrude the forms, and the sheer weight of the resulting pieces.

Production process of the *Prismatic-Rod Screen* ceramic components. © Wendy Lawrence.

Two views of the *Prismatic-Rod Screen*. © Martin Winchester.

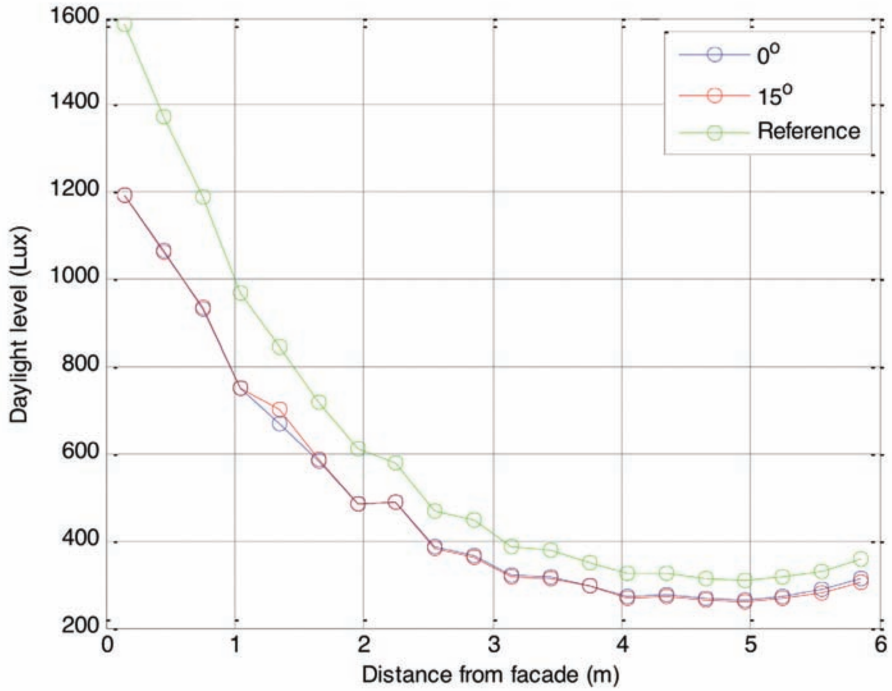


Top right: Prad Pamidighantam, one of the designers of the *Prismatic-Rod Screen*, with Wendy Lawrence who produced the ceramic rods for this prototype.

Left: perspective of the prismatic blind.

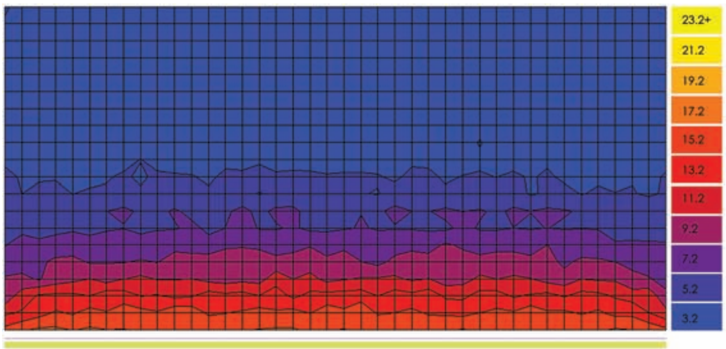
Lighting Analysis of the Prismatic-Rod Screen

Illuminance (light levels) map generated for the *Prismatic-Rod Screen* when the prismatic ceramic shells are rotated around each individual horizontal axis at angles of 0° and 15°. The screen was designed to deflect light deep inside the room, providing a better distribution of daylight and allowing for seasonal adjustments.

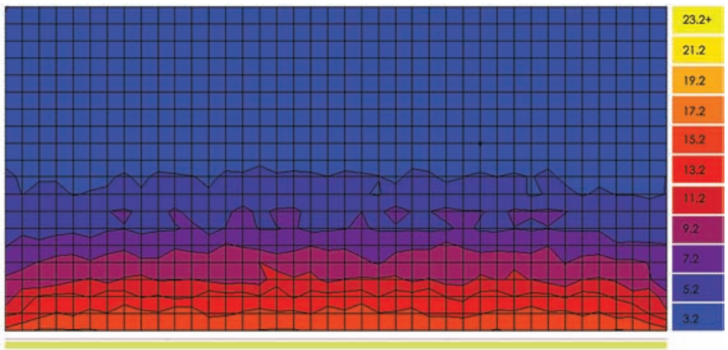


Daylight Analysis
Daylight Factor
Contour Range: 3.2 - 23.2 %
In Steps of: 2.0%
© ECOTECT v5

Graph showing illuminance in relation to distance from the facade for the 2 simulated rotated angles (0°and 15°). Reference conditions refer to the levels obtained considering the window facades without the respective screen.



Rods 0°



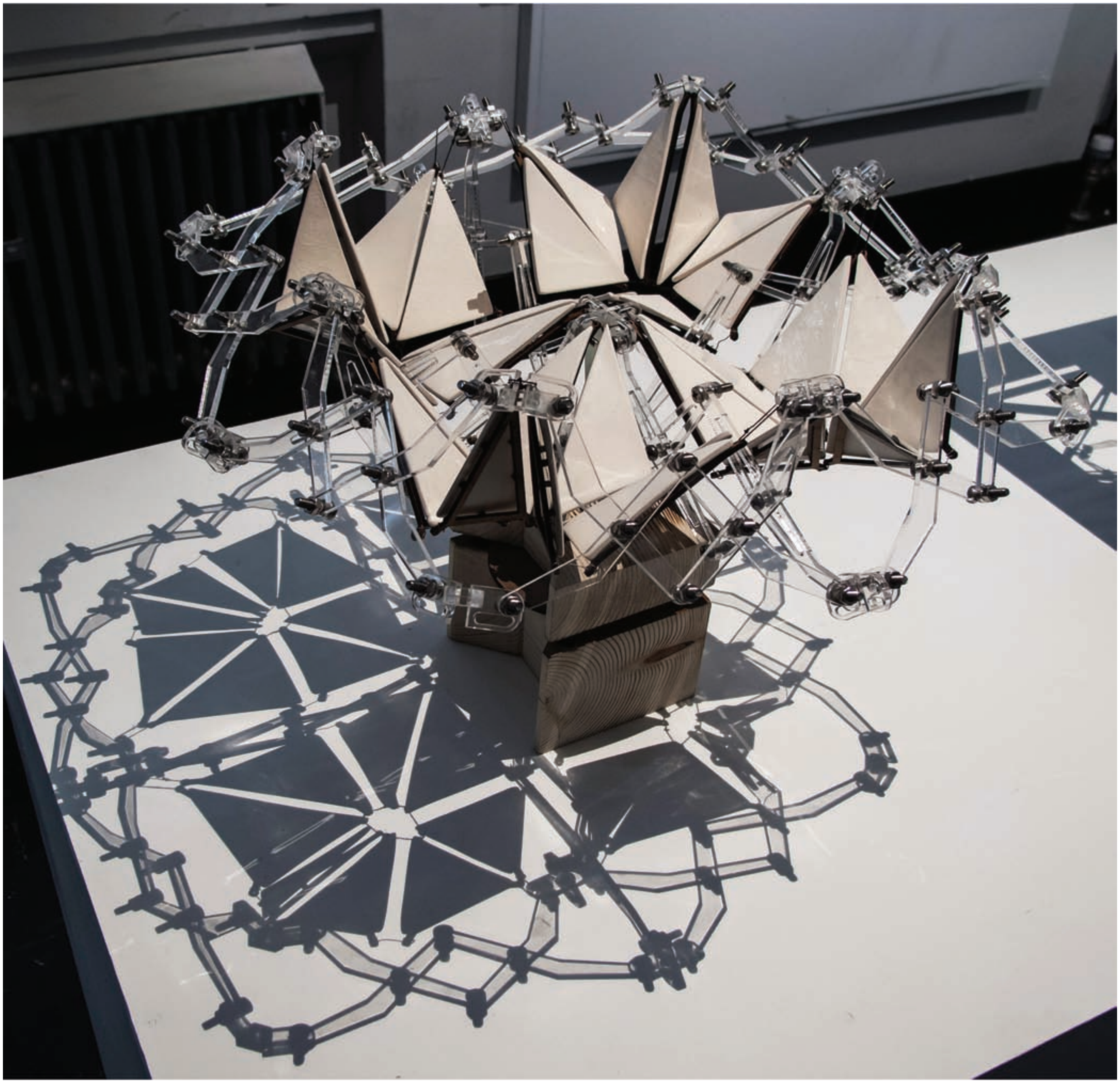
Rods 15°

Whilst having developed a distinctive visual language and methodology, Wendy is always open to new directions in her work. The deeply incised textures that she is known for, have recently been taken in new directions and she has been experimenting with a new body of work in which glazes are applied to a flat surface and built up in thick layers before firing at varying temperatures to generate a surface depth and texture within the glaze itself.

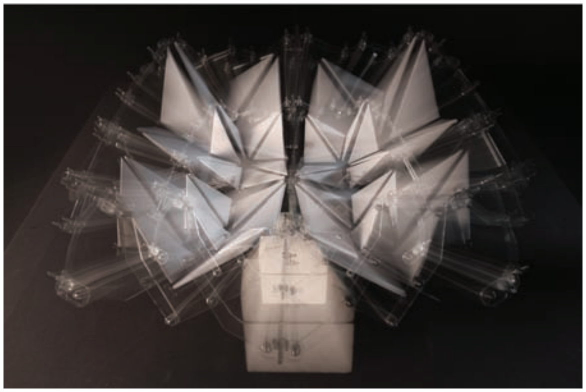
For the *Performative Ceramic Surface*, Wendy is producing thirty two movable triangles that are composed to make one of the modules of the surface, whose movement is possible thanks to two different triangular shapes (110 x 66 x 91.2 mm and 122 x 66 x 91.2 mm, 3 mm thick). Each triangle is made of slabs of thin porcelain clay that are cut using a template. Once the porcelain is leather hard the sides of each triangle are sponged to soften the edges, and then the pieces are glazed to obtain reflective surfaces.

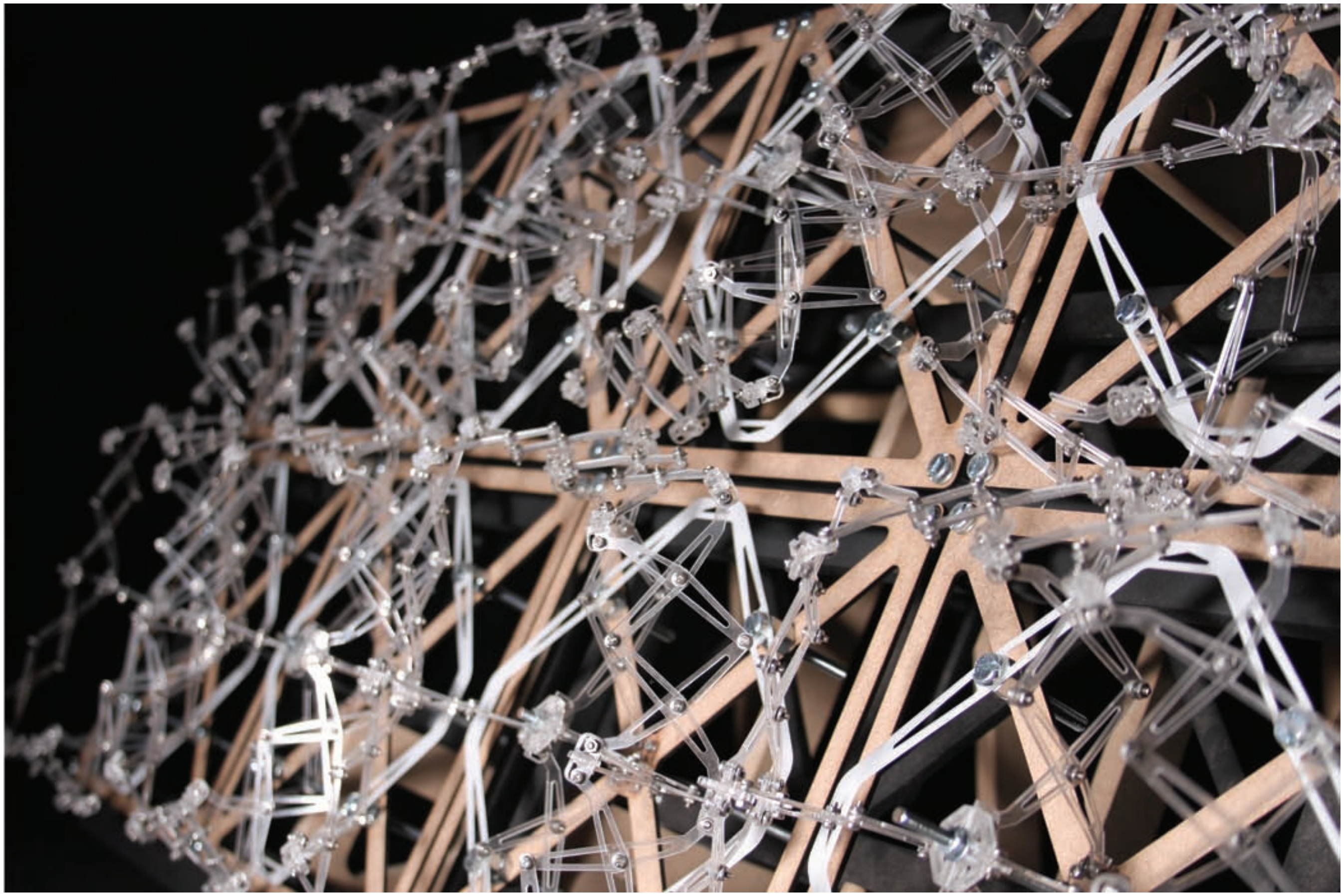
The ceramic surface is attached to a structural base of modular squares that hold the articulated arms whose back and forth movement opens and closes the triangulated surface. The adaptive openness of the surface in conjunction with its reflective treatment provides a refined controllable shading structure that offers a smooth graduation of internal illumination.

Production process of the *Performative Ceramic Surface* ceramic components. © Wendy Lawrence.

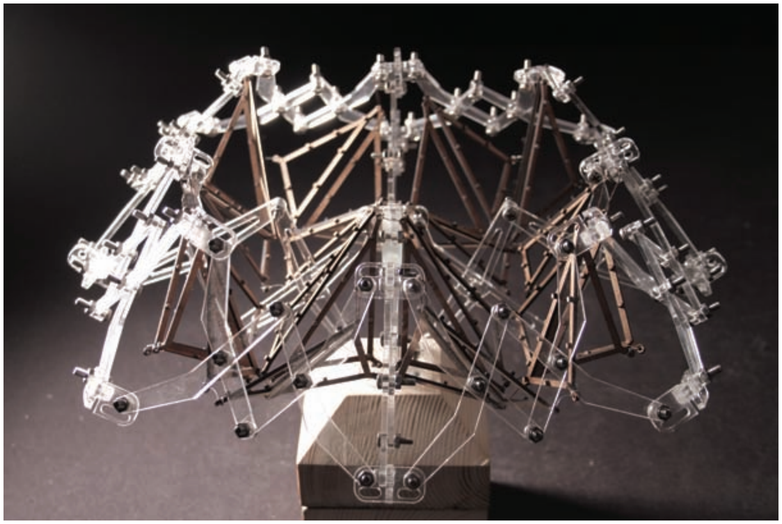


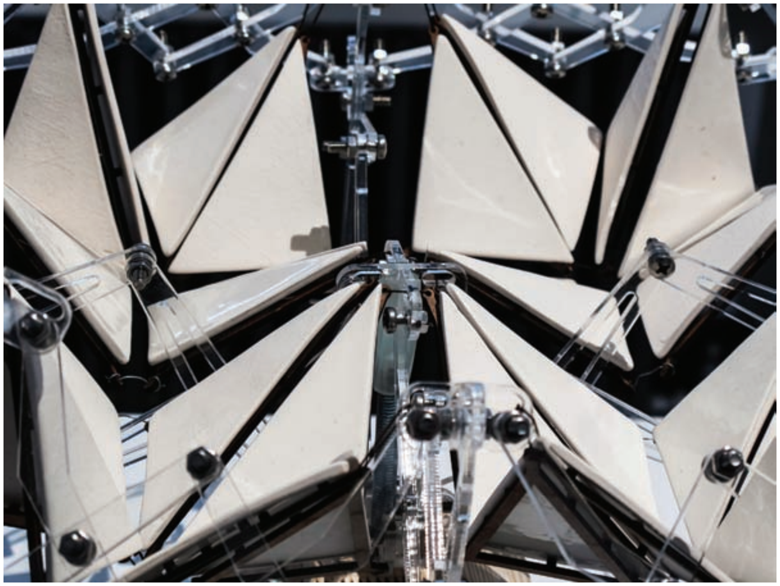
General view of one actuator of the *Performative Ceramic Surface*. © Martin Winchester.





Structure of an array of actuators without the ceramic surface and image of one actuator in movement. © Alex Kokai.

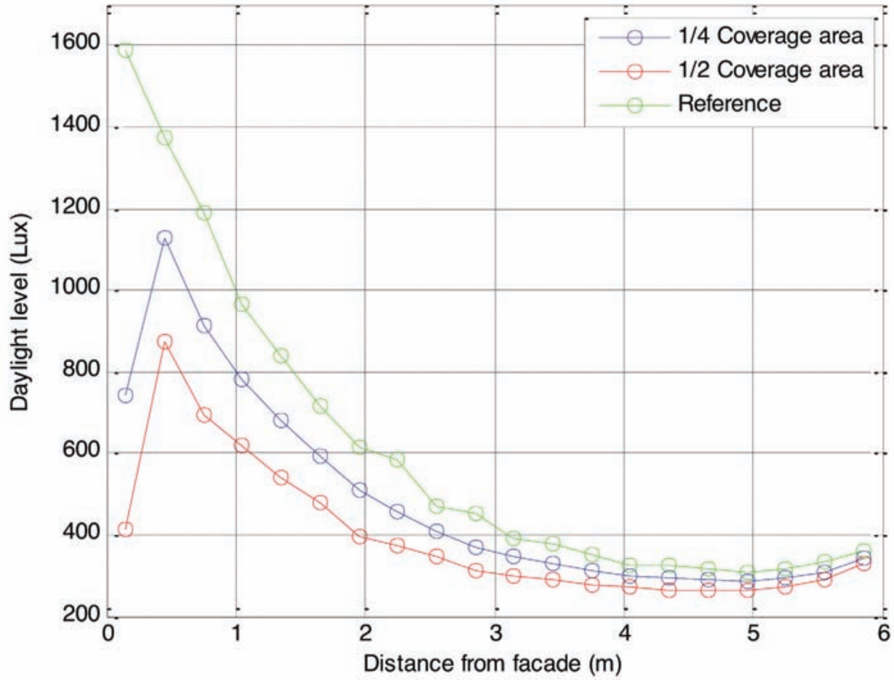




Images of the construction of the prototype of one actuator of the *Performative Ceramic Surface*.
Top right: Alex Kokai working on the School's workshop. © Alex Kokai & Rosa Urbano Gutierrez.

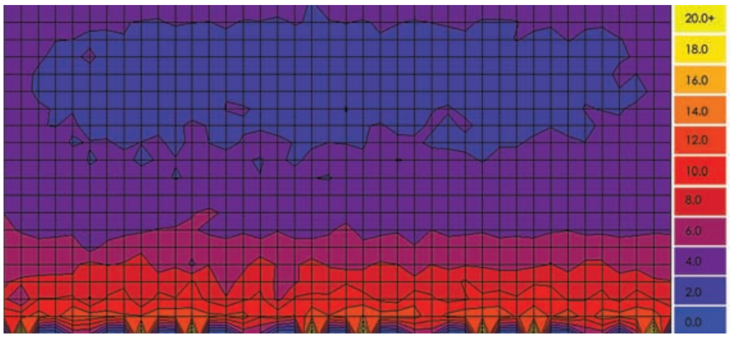
Lighting Analysis of the Performative Ceramic Surface

Illuminance (light levels) map generated for the *Performative Ceramic Surface* when the kinetic units are open covering ½ and ¼ of the facade's surface area. The screen was designed to prevent direct sunlight from entering the space, and to control privacy and glare. The filtered rays produce a plastic pattern of traveling sunlight patches, detonating visual interest throughout the area, and allowing the experience of time.

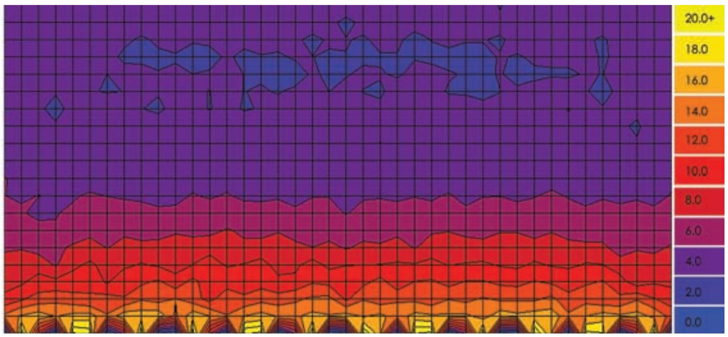


Daylight Analysis
Daylight Factor
Contour Range: 0.0 - 20.0 %
In Steps of: 2.0%
© ECOTECT v5

Graph showing illuminance in relation to distance from the facade for the 2 simulated positions, covering ½ and ¼ of the surface area. Reference conditions refer to the levels obtained considering the window facades without the respective screen.



1/2 Facade coverage



1/4 Facade coverage

These five ceramic installations generated by two ceramicists have allowed an insight into many different forms of ceramic production and treatment. The creation of the different pieces has involved extrusion techniques, slip casting techniques, slab building and carving, and it has employed very different clay bodies in order to explore how these different materials will react under different lighting conditions. Final finishing of the pieces have also explored very varied techniques, from the spraying of the high gloss glazes and matt engobes to the hand application of delicate glaze washes, inset materials and melted glass.

All of the pieces have been fired at different temperatures as required by the different clay bodies along with the structural qualities needed, and the kilns themselves have, through necessity, varied greatly from large scale commercial walk-in kilns to small scale sample kilns. The exploration of these processes and the photographic mapping of every stage of ceramic development have generated a visual resource for everyone involved.

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