Material sensibility - Iteration of work on the effects of material experimentation

Astrid Piber
UNStudio, Stadhouderskade 113, PO Box 75381, 1070 AJ Amsterdam

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Abstract

Ludwig Mies van der Rohe entered the Berlin Friedrichstrasse competition with an unprecedented proposal for a steel-framed tower encased in glass in 1921, significantly earlier than his skyscraper designs of the late 40s and 50s. Innovative application and use of materials have since lead to visionary design ideas that in turn have triggered building technology to advance and to facilitate the production of innovative architecture.

In contemporary architectural practice the relationship between experimentation and physical implementation has become more immediate, propelling the design processes. Within these processes the idea of making (manufacturing) has transformed in relation to architecture and working with 1:1 mock-ups during the design process has become the status quo.

Explored during several façade projects at UNStudio[1], the making of experimental prototypes and the endeavor to achieve an enduring material sensibility has lead to improved design processes. User comfort and energy performance are key-parameters in defining the physical determination of our built environment. The adaptation of existing facades coupled with the need to regenerate in a sustainable manner, in order to both improve the performance of buildings as well as to create individual façade expressions, initiated within the work of UNStudio an iterative approach to façade solutions. Various forms of prefabrication engage simultaneously with the design and the production process and provide important feedback when designing climatic, lighting and material effects.

Introduction

New production methods developed by the building industry have specifically influenced each architectural project, whilst higher requirements and standards have added to the functional complexity of design. Environmental conditions have raised awareness of the deployment of resources and simultaneously created architectural solutions which effect wellbeing. With these requirements and capabilities the role of architects is also changing constantly. While in modern architecture experimentation in exhibition and house projects generated new possibilities for the building practice, in an age of digital production - alongside a geometrical and spatial determination - an understanding of material sensibility becomes critical. Although potentially simulated with highly developed software programs, the effect of material combinations can only be understood when experienced in reality. In practice the design process has to engage in the production of 1:1 mock-ups and utilize these to ensure the optimization of the design.

At UNStudio, based on the objective to understand this changing role[2], methods and approaches have been developed which regard physical experimentation as an integral part of the design process. During the lecture at the GPD 2009 focus is singularly placed on façade development, with the design and realization of a façade project becoming itself the territory of experimentation. Reviewing the design process from computer model to physical model to 1:1 mock-up and back again has lead to realized projects in which the design process has constantly been evaluated and refined.

Experimentation in architecture design

In contemporary architectural practice the relationship between experimentation and physical implementation has become more immediate, propelling the design processes. Within these the idea of making (manufacturing) has transformed in relation to architecture and working with 1:1 mock-ups during the design process has become the status quo. Certainly this has lead to design processes where engineering and technical considerations feed back on the design of projects. However, what has become critical for the practice is the cross-fertilization of ideas and techniques from one project to another. The argument here is that through practicing in 1:1 scale material sensibility has become a critical instrument in the design process and that such experimentation has always been part of the building process and as a result has triggered the design thinking process.

Throughout the twentieth century in particular a chain of technical developments can be traced back to the design process. Often a 1:1 structure was first built and tested in an exhibition project or in houses, projects which allowed the architects to experiment and which in turn became a laboratory for their ideas. However, such projects also resulted in some the most influential structures in modern architecture, such as the 'Glasshouse', Bruno Taut's pavilion for the glass industry in the German Werkbund exhibition of Cologne of 1914, and the L'Esprit nouveau Pavilion in Paris from 1925, designed by Le Corbusier and Pierre Jeanneret among others.[3] Ludwig Mies van der Rohe entered the Berlin Friedrichstrasse competition with an unprecedented proposal for a steel-framed tower encased in glass in 1921, significantly earlier than his skyscraper designs of the late 40s and 50s. After submitting the photomontage of the Glass Skyscraper on Friedrichstrasse, also Mies van der Rohe found the potential for experimentation in real scale in projects like the 'Glas Raum' - a project that was commissioned by the German Glass Industry to display their products - or the German Pavilion for the Barcelona International Exhibition in 1929.[4] In his canonic houses, such as the Villa Tugenhat, he was able to experiment with new materials like glass and was thereby able to achieve the transparency he was aiming for.

Innovative application and use of materials have since lead to visionary design ideas which in turn have triggered building technology to advance and to facilitate the production of innovative architecture.

Iteration of work on the effects of material experimentation

At UNStudio parallel design processes and evaluation in theoretical writings and manifestos have been a continuous undertaking of the firm since its outset. Both of these processes feed back on each other and both fields of thinking have evolved simultaneously, thereby distinctively impacting 'The

Figure 1:

Façade, La Defense Office Building (Almere, the Netherlands) – Design: UNStudio, photograph: Christian Richters

Figure 2:

View from inside, La Defense Office Building (Almere, the Netherlands) – Design: UNStudio, photograph: Christian Richters

Figure 3:

La Defense Office Building (Almere, the Netherlands) – Design: UNStudio, photograph: Christian Richters

Making of Architecture' at UNStudio. This I would not define as the mere production of buildings, but moreover as the knowledge produced through practicing architectural design. When reviewing then a series of projects and tracing how this knowledge evolved throughout, the reciprocal relationship between design and building can on the one hand propel ideas and on the other produce a final product which is as true as possible to the initial design.

Already during the nineties UNStudio was recognized for its design processes which have always been based on knowledge generated through analytical understanding and an intuitive proto-functional approach;[5] the modes of producing architecture have constantly evolved. While in the earlier days of the studio these strategies were applied to planning and infrastructure works, more recently this evolved into the use of prototypical 'Design Models',[6] which similarly incorporate the constraints of building practice as starting parameters.

At UNStudio unprecedented material effects and atmospheres have been designed to express the building's day and night time appearance and to facilitate different perceptions of the building from various viewpoints. A re-occurring potential for experimentation has been found within the theme of façade design. The physical boundary of a building establishes the relationship between the internal and external parameters inherent in any project. Different façade designs at various locations lead to solutions which do not rely on standard façade systems, but which instead are designed uniquely for individual projects. The intricacies of the various elements in the façade, applying unprecedented material combinations and integrating lighting have lead to aesthetic effects. The engineering of these facades however has very much focused on the functional, climatic and fabrication aspects. Through understanding the possibilities of the 'making' the architects involved in the design of these projects could follow their underlying enduring vision. In the following I would like to trace the development of facades in two different projects and explain the effects on current design processes.

Galleria Department Store, Seoul, South Korea (2003-2004)

Situated prominently in the Apgujeong-dong district, one of the trendiest commercial districts in Seoul, the design objective for the Galleria Department Store, as put forward by the client, was to transform the store 'from novel to noble', becoming more 'luxurious' while remaining 'hip and unique'. The exterior renewal was completed only nine months after the first design meeting with the client and soon became a distinct landmark in Seoul.

The initial idea of 'magnetic geometries' was interpreted in parallel with computer animations, where circles would be packed on the façade surface, and with physical models consisting of buttons made from mother-of-pearl, bought at the market next to the studio's headquarter in Amsterdam. The investigation into the lamination process for the façade panels for the La Defense Office Building (Almere, the Netherlands), in collaboration with 3M had just reached the final stages of becoming patented, while the search for the most suitable iridescent foil for the façade disks on the Galleria was just starting. Glass samples with a diameter of 80 centimetres, laminated in Europe with a thin layer of foil covered with PVB foil on one side of the disc, were taken by plane to the client meetings in Seoul. Simultaneously the same foil was laminated by a Korean manufacturer between two glass discs, each 6mm thick. Initially problems were encountered with shrinking and melting of the foil, but a solution was found by means of sealing the edges of the discs which would also prevent delamination over time. The various samples were tested under daylight conditions at a position similar to that at which they would be applied to the new façade. The different type of foil applied would reflect altering colour ranges and let the façade appear in varying ranges, but also the glare of the different foils under extreme sun conditions differed depending on the applied foil. To prevent such strong light reflection from having an adverse effect on the adjacent busy traffic route, the outer glass surface was sandblasted slightly, with the result that it became 'milky'

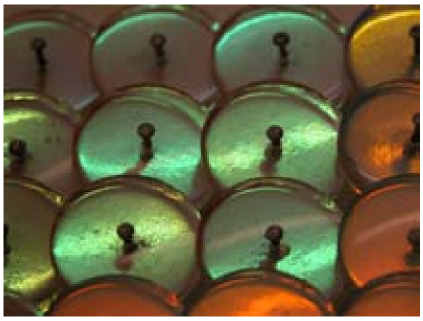

Figure 4:

Study model

Figure 5:

Glass sample with colour changes due to iridescent foil

and spread the light evenly across each disc. Still, during the daytime situation the array of the 4330 glass discs offers constant colour changes in the perception of the façade.

Whilst during the day the façade has the appearance of a facetted skin, at night the aim was to de-materialize the discs with light and create a continuous display across the whole surface of the building. This 'screenplay' was designed cooperatively by UNStudio and ArupLighting, and was developed with a similar methodology. Simulated in the computer, built in a 1:10 model and included in the 1:1 test mock-up on site, the LED lighting was developed in parallel with the architecture. While the architects would engineer the facade's back structure and consider the most effective positioning of the tripod substructure and the glass fixtures, the lighting designers were customizing a design for an LED fixture - to be known as raindrop - watertight and equipped with a lens to illuminate each disc from within the narrow gap between the building's new skin and the existing concrete structure. The evaluation on the mock-up during the night time, with different combinations of foil and glass surface treatments, lead to the decision for the inside oriented glass surface to be sandblasted also, in order to catch the light and illuminate the whole disc. Depending on the number of layers of laminated foil the iridescent film was made of, the colour changes would be different and the lighting colours would be complemented or suppressed. Nevertheless, the character of the glass disc skin is different from the principle technologies used in screens, since whatever visual information is projected onto the discs will be transformed due to the material conditions of the glass disc and foils. At night time the façade is not a projection screen in the conventional sense, but instead interacts with the projected information. Additionally, by placing an LED-light source behind each of the glass discs and by controlling the lights digitally one by one, the possibilities to manipulate color and light emission become endless.

Star Place, Kaohsiung, Taiwan (2006-2008)

A private developer, enthusiastic about the effects created in the Galleria project, commissioned UNStudio to design their new luxury shopping plaza in Taiwan. On a very strategic plot in the city of Kaohsiung the design of the façade and interior should generate an even more dynamic building. Based on previous designs by the architectural firm of Dynasty Design Corp and HCF Architects the massing of the twelve storey building was maximized towards the curved outline of the nearly triangular building plot, creating a large and unobstructed frontage oriented towards the recreational park and a major roundabout junction in the city. The architects of UNStudio were intrigued by the inward curving geometry of the front façade. One of the initial ideas for the design was to cut cylindrical shaped façade elements along this curvature, but these were later substituted by linear lamellas and vertical fins. The swirling façade organizations would follow the rotation of the circulation space; the interior layout is organized around a central void space, with escalators spiraling upwards. This vertical movement is connected with the façade geometry and, when perceived from the outside, is transparent and creates yet another radiant dynamism.

The deep sunscreen façade is characterized by a prominent pattern consisting of horizontal, aluminum-faced lamellas and vertical glass fins. In addition to breaking up the scale of the building and framing the outward views at each level, the deep façade also functions as a sunscreen and weather barrier. The façade depth varies according to location and in relation to the program. The contrasting effect between the curtain wall glazing and the façade pattern was defined both geometrically and by its technical constraints. The curtain wall is the outer skin and follows the concave shape of the 51.30 meter high façade. The curtain wall glazing is a low-E coated glass with a dark-brown tint, while the fins are made of laminated, low-iron glass for extra clarity. The proposed application was determined through in depth material testing, where we used different glass types, frit types and patterns and evaluated these under day time and night time conditions. As the lighting was supposed to cause the fins to glow, the material parameters of the chosen glass had to comply with these demands at all times. The dot frit patterns, the arrangement of dots, a possible gradual change in size of dots and whether they would be applied on the outside layer of the fins or in-between the two layers of glass was tested step by step. Applying color to the frit in combination with the glass type was also reviewed at one stage. Low-iron glass was chosen because with

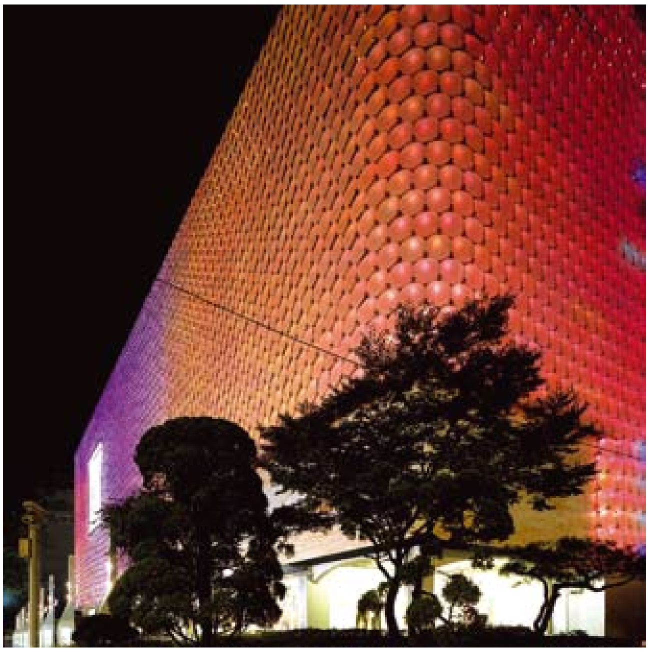

Figure 6:

Galleria Department Store (Seoul, South Korea) – Design: UNStudio, photograph: Christian Richters

Figure 7:

Interior circulation diagram of Star Place, UNStudio

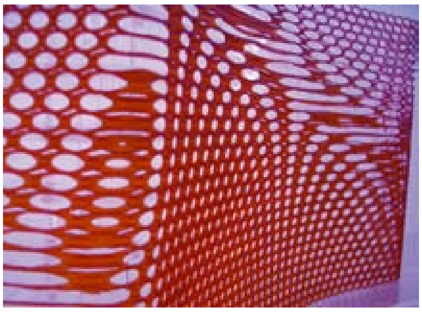

Figure 8:

Conceptual model, UNStudio

Figure 9:

Façade mock-up of Star Place facade

this glass the spread of light was the most effective. A diagonal arrangement of dots to both outer layers of the glass resulted in the furthest spread of light within the glass fins, which average a height of one meter. From further away the horizontal lamellas and vertical fins were designed to appear uniform in color, forming elements of one continuous white frame. Similarly the size and spacing of the white dot frit had to be chosen so that the dots would be minimally perceptible when viewed from inside.

The lighting concept of the glowing fins required us to integrate fixtures and technical equipment into the facade structure. The optical effect is achieved by the depth embedded in the façade motif, overlaid with a fluid layer of changing hues and tones. The dots on the laminated glass fins pick up the colors distributed by LED-lights which are integrated on the underside of the fins. The minimized light fittings contribute to the luxurious appearance of the façade and were achieved by working in collaboration with the designers from ArupLighting, for whom creating an energy efficient solution was an obvious prerequisite. In parallel with the material tests various options for LED light sources were reviewed. ArupLighting designed a combined optic of a condenser lens just above the LED and a linear fresnel lens to distribute the light evenly across the entire length of the glass panel. The lighting fixtures were manufactured by the local company AOP, who had already collaborated with the lighting designers and architects during the design phases, to achieve the most elegant and effective solution. Their production methods could therefore be considered when designing the lighting fixture which was integrated with the glass holding fixtures. Highly experienced e:cue programmers, Lightlife (Cologne,Germany) carried out the control system programming based on fluent lighting scenarios choreographed for different seasons and events.

The project was completed following two years of cooperative planning. During the design development several models and mock-ups were produced. First in the offices in Amsterdam, and later a 1:1 'model' was constructed at the location in order to test all possible combinations of material finishes, glass, frit, color and lighting. Following this review further development to the fixtures and glass treatments lead to a material mock-up being produced during the tender stage. This was tested under extreme wind conditions and evaluated based upon its performance in accordance with the design. During all of these reviews the design and product drawings were adjusted and fine-tuned to achieve the proposed effect. The varying measurements of the façade elements and glass and lighting fixtures were controlled by UNStudio's parametric model. All data

Figure 10:

Star Place (Kaohsiung, Taiwan) – photograph: Christian Richters

Figure 11:

Star Place (Kaohsiung, Taiwan) – photograph: Christian Richters

Figure 12:

Star Place (Kaohsiung, Taiwan) – photograph: Christian Richters

from the aesthetical, structural and lighting elements was interconnected whereby design changes and variations to the pattern could instantly be outputted from the design models for manufacturing.

Material sensibility in current façade design projects

Developed on the basis of the experimental approach applied in Seoul and Kaohsiung, we are currently designing another fully glazed, illuminated façade for a large scale department store in Korea. In this case, due to the partially double layers of glass, the façade depth can act as a temperature barrier. This cavity is connected to the public spaces arranged on different levels around the central void with its skylight. Depending on the orientation of the façade the elements employed to protect from direct sunlight vary. Large scale models for this project were done much earlier in the studio in Amsterdam, in order to get a realistic impression of the optical pattern that is created by overlaying vertical and distorted lines.

In another project in China two 250m tall tower facades follow the transformative nature of the project. Based on optimizing WWR and relating the façade organization to the mixed-use program, vertical façade panels are designed which follow the twisting tower geometry. They vary in size, depth and orientation according to their location within the building. Through partially allocating 'winter gardens' we can significantly improve the energy performance and increase the residential quality.

Summary

Explored during several façade projects carried out by UNStudio, the making of experimental prototypes and the endeavor to achieve an enduring material sensibility has lead to improved design processes, where information from mock-up testing is intrinsically linked to the optimization of the design. User comfort and low energy performance are key-parameters in defining the physical determination of our built environment. The adaptation of existing facades coupled with the need to regenerate in a sustainable manner, in order to both improve the performance of buildings as well as to create individual façade expressions, has initiated within the work of UNStudio an iterative approach to façade solutions. New forms of prefabrication engage simultaneously with the design and the production process and provide important feedback when designing climatic, lighting and material effects. Modeling effects in digital and physical models is almost routine now. We have learnt from experience that each design process requires an individual approach and many decisions. Therefore the sequences of operations and evaluation points of models and material effects become critical design moments at a much earlier stage than in conventional design processes.

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4 Ibid. pp.9
5 Greg Lynn, 'Forms of Expression' in: El Croquis, Ben van Berkel 1990-1995, pp. 16-31
6 Ben van Berkel, Caroline Bos, UNStudio Design Models, Thames and Hudson, 2006