engineered transparency
INTERNATIONAL CONFERENCE AT GLASSTEC

GLASS | FACADE | ENERGY

JENS SCHNEIDER
BERNHARD WELLER
EDITORS

TECHNISCHE UNIVERSITÄT DARMSTADT

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Foreword

Dear Reader.

The international conference engineered transparency takes place for the first time from 29-30th September 2010 in Dusseldorf. As an additional event within the glasstec, you will find here a unique forum of specialised discussion between architects, engineers, researchers, façade engineers and the glass industry. The local vicinity to glasstec enables the outstanding opportunity of obtaining comprehensive information by visiting this conference and the trade fair. The glasstec is the worldwide leading trade fair of glass, glass production, glass mechanical engineering and glass handcraft with more than 1000 exhibitors from more than 45 countries.

The papers of the keynote-speakers introduce the proceedings. They give an inspiration to glass, architecture, present innovative glass constructions, latest technical developments and outstanding projects. Furthermore, damages on glass structures and the conclusions of evaluating them are presented and discussed. As representatives of leading engineering offices they provide examples in glass constructions for future inspirations.

Afterwards you will find approximately 60 session papers about the current knowledge in the field of structural glass, structural design, architectural design, fixings and fittings, built projects, composites and coatings as well as solar technology. Thereafter the papers of all poster presenters follow. All these papers gives you the opportunity to learn more about glass constructions after the lectures. We hope that our efforts in providing the right layout of this proceedings contribute to the pleasure in reading this book.

The organisation team of engineered transparency thanks all contributors to the conference. Our special thanks go to the keynote-speakers as well as all the other presenters. Furthermore, we thank the members of the scientific committee for the professional support, the supporting organisations of the conference and of course all participants.

Prof. Dr.-Ing. Jens Schneider
Technische Universität Darmstadt

Bernhard Weller

Prof. Dr.-Ing. Bernhard Weller
Technische Universität Dresden

Perceptual effects of overlapping curved glass

Paulo J. S. Cruz*, Fred A. Veer[a], Paulo L. L. Carvalho[b]

* School of Architecture, University of Minho
Campus de Azurém, 4800-058 Guimarães, Portugal
pcruz@arquitectura.uminho.pt

[a] Faculty of Architecture, Delft University of Technology
[b] School of Architecture, University of Minho

Abstract

The application of glass in contemporary architecture explores perceptual phenomenon that intentionally change the way we experience space. SANAA's recent work uses glass in a radical way, proposing a renewed approach to transparency. The Toledo Glass Pavilion, with most spaces defined by glass walls, presents an intense visual experience. The overlapping of glass produces perceptual effects that vary according to depth and lighting conditions. This paper proposes an alternative reading of these phenomena, beyond its aesthetical delight, based on contemporary artistic practices.

Keywords: Curved Glass, Overlapping, Perception, Transparency, Reflection, Atmosphere

1 Introduction

The German Pavilion for the 1929 Barcelona International Exhibition is considered one of the most important pieces of modernist architecture. It was the first time that Mies van der Rohe introduced the "free flowing space" using walls as isolated planes. These walls were arranged asymmetrically, with space around them, but always orthogonally, in order to accentuate the perspective.

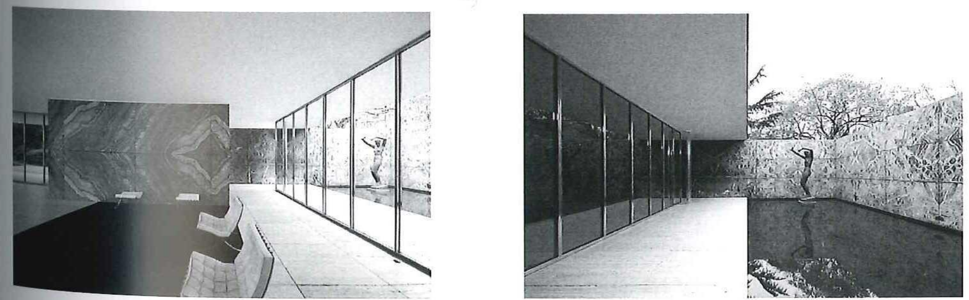

Figure 1: German Pavilion for the 1929 Barcelona International Exhibition interior view (a) and exterior view (b).

The intention was to project the interior spaces to the surroundings, dissolving the boundary between inside and outside (Figure 1a). In the meantime, on the opposite direction, the continuity from exterior to interior space is blocked. The glass planes are opaque due to the mirrored treatment, duplicating the view of the surroundings (Figure 1b).

This space construction and architectural language, determined an approach towards transparency polarized in the two possible opposites when using glass: total transparency and opacity. This building is representative of the modernist context in which was created and had a decisive influence in the work of several generations of architects. Meanwhile, in recent years we are witnessing different approaches to transparency, not only in architecture but also in the visual arts.

2 Soft reflections

"SANAA is widely considered the inheritor of Miesian transparency" (Colomina [1]). The recently open Toledo Glass Pavilion confirms this statement. In a city once considered a major centre of glass production, this pavilion realized the challenge of building an extension of the existing museum using glass in a radical way. It was materialized by defining most of the spaces using glass walls. The program to be hosted by the pavilion, although not very complex, consisted of spaces with very different characteristics: five exhibition spaces, two glass fabrication hot shops, a multipurpose room, a café and other auxiliary spaces. The great thermal amplitude caused by the ovens inside the hot shops and the exterior climate, determined an inventive solution: the creation of a "buffer space". A temperature controlled and ventilated 800mm airspace, only accessible for maintenance and cleaning that ended up evolving all the interior spaces. This way, each interior division is defined by an autonomous glass wall (figure 2a). The result was a duplication of layers that, despite suggesting a complex solution, led to a simple organization of the program, as desired by the architects: "The important thing for us was that each space, each functional space would be outlined on the plane by one line"(Cortés [2]).

The interior lines are composed of two glass sheets of 8mm with PVB interlayer and the exterior lines are composed of two 10mm sheets also with PVB interlayer, without any coatings, silkprints or insulated glass units. Both lines are made of low-iron annealed glass, selected for its optical clarity and flatness, curved with varying radii. The glass panels are frameless and the joints are occupied with a translucent extruded feather gasket (Simmons [3]). This way, the material optical features became more refined, which combined with the overlapping of glass layers, allowed reflections to come into play. In Colomina's words "in such space walls are not optical barriers, but optical intensifiers" (Colomina [4]). When looking through the multiple glass defined spaces, accounting to the depth and illumination conditions, the view can be transparent or, which turned out to be more interesting, a series of soft reflections (figure 2b).

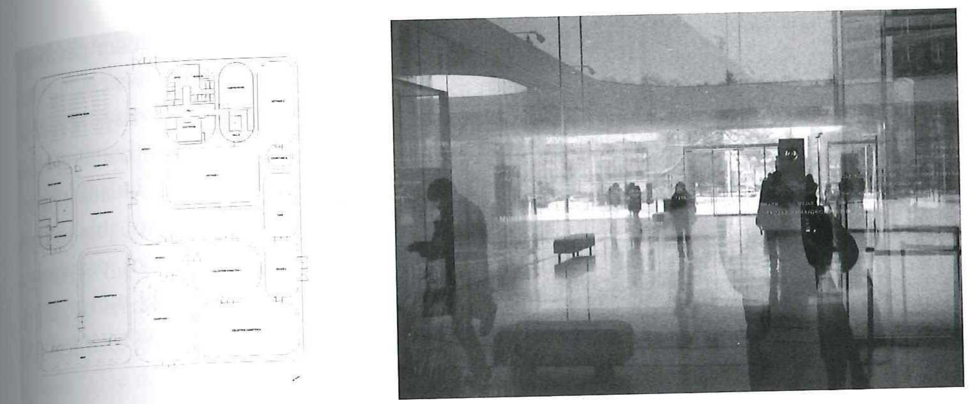

Figure 2: Toledo Glass Pavilion plan (a) and soft reflections in the glass walls (b)

In the 1980s, Dan Graham started an intense instigation of the human perception through his artworks. He built a series of glass-steel pavilions, with diverse shapes form circular, triangular, rectangular, using in many cases *two way mirror glass*: "The inside and outside views are both quasi-reflective and quasi-transparent, and they superimpose intersubjective images of inside and outside viewers' bodies and gazes along with the landscape" (Graham [5]).

Figure 3: Dan Graham photographing his "Two adjacent pavilions", 1982 (a) and people experiencing "Half Square, half crazy" pavilion, 2004 (b)

In the "Two adjacent pavilions" (1982) (Figure 3a) Graham placed two square pavilions close to each other, both with the same size but little differences in reflectiveness, so that the effect could be maximized. Meanwhile in the "Half Square, Half Crazy" Pavilion (2004) (Figure 3b), he uses curved glass to induce distorted views of the surroundings and the people observing. Both pavilions were intended to be observed from the outside as well as from the inside: "People entering or observing Dan Graham's pavilions are able to look at a specific site and their place within it. Any change in the lighting conditions, provokes a change in the relative reflectivity or transparency of the pavilions' two way mirror glass, putting the relationship between people and their surroundings into constant flux" (Pimlott [6]).

3 Atmosphere effect

Overlapping of layers and curved surfaces co-exist in the Toledo Glass Pavilion, but in a never seen scale. Some diagonal views along the building cross more than 15 layers of glass! Walking through the building, the perception of spaces starts to be characterized by an overlapping of soft reflections that with the increasing of intensity, becomes more and more saturated, leading to a kind of crystallization of the view, thus creating an intense atmosphere effect. (Figure 4),

SANAA pursued in many previous projects this atmosphere effect, using materials such as metal meshes, polycarbonate, acrylic or glass. This tendency has clear roots in the Japanese culture, in which materials like translucent paper or wooden lattice were ancestrally employed as lightweight mobile partitions to define space and create "an atmosphere that is perceived sensually, with the senses" (Nishida [7]).

Figure 4: Atmosphere effects inside the Toledo Glass Pavilion

SANAA is looking for a sensual perception of space, ephemerally influenced by light, but could this "atmosphere" be more than a motif for aesthetic delight? If we derive once again to contemporary artistic practice, we can find an interesting answer to this question: "The atmospheric pressure of Eliasson's work is such that it demands the visitor's engagement beyond that of a mere onlooker" (Frichot [8]).

Olafur Eliasson is a Danish-Icelandic artist known for developing works of art that challenge the nature of human perception. He often uses light, shadows, color, water, wind, or fog to create specific atmospheres in order to charge space with a sense of tangibility. His ultimate goal is to create a strong relationship with the viewer, inviting him to become a "user". He describes it as a process of "negotiation", an active engagement between user, the work and the time and space that both inhabit: "...if I have a sense of the space, I feel the space is tangible, if I feel there is time, I also feel that I can change the space" (Schmidt-Garre [9]).

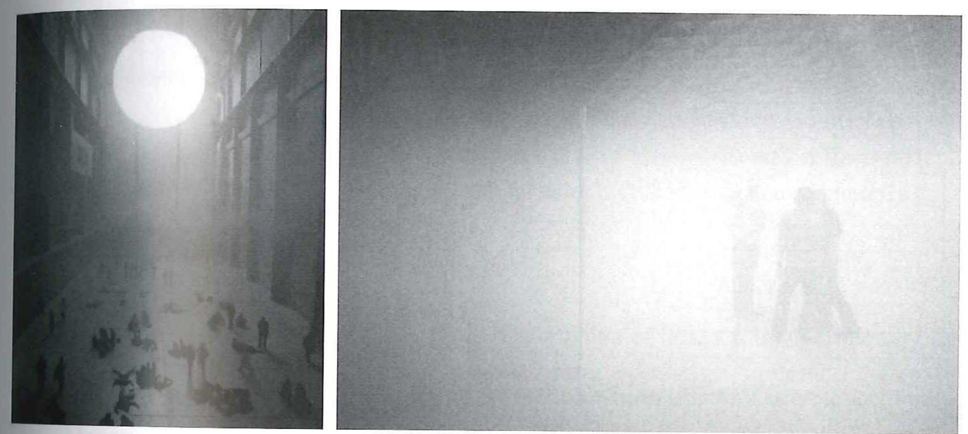

Figure 5: "The weather project" installation, 2003 (a) and "Your atmospheric colour atlas" installation, 2009 (b)

In "The Weather Project" (Figure 5a) an installation for the Turbine Hall of the Tate Modern in London, Eliasson imbues the space with a fine mist, covers the ceiling with mirrors and places a semicircular disc made of hundreds of mono-frequency lamps, creating a duotone landscape. The engagement was established when people felt comfortable to the point of lying down on the ground and producing images of themselves in the mirrored ceiling by moving their bodies. In the "Your Atmospheric Colour Atlas" installation for the 21st Century Museum of Contemporary Art in Kanazawa (Figure 5b), Eliasson fills the space with fog and illuminates it by a series of RGB (red, green, blue) lights. It creates a multicoloured atmosphere that was responsive to human action, since the RGB light mixed and changed value when bodies moved through space.

4 Tactile experience of vision

Since 1996, the Mies van der Rohe foundation invites different plastic artists and architects to develop an original installation, regarding the Barcelona pavilion (Figure 1a and b). These short-term interventions must be conceived as lightweight and contribute with an original interpretation of the pavilion itself. SANAA was invited to propose an installation that was to be open to public from November 2008 until January 2009.

The authors proposed, among other possibilities, the creation of transparent curtains, and to do so, they decided to use an acrylic spiral. They imagined an installation that would leave: "the existing space of Barcelona Pavilion undisturbed. The acrylic curtains are standing freely on the floor and shaped in a calm spiral. The curtain softly encompasses the space within the pavilion and creates a new atmosphere. The view through the acrylic will be something different from the original, with soft reflections slightly distorting the pavilion" (Sejima and Nishizawa [10]).

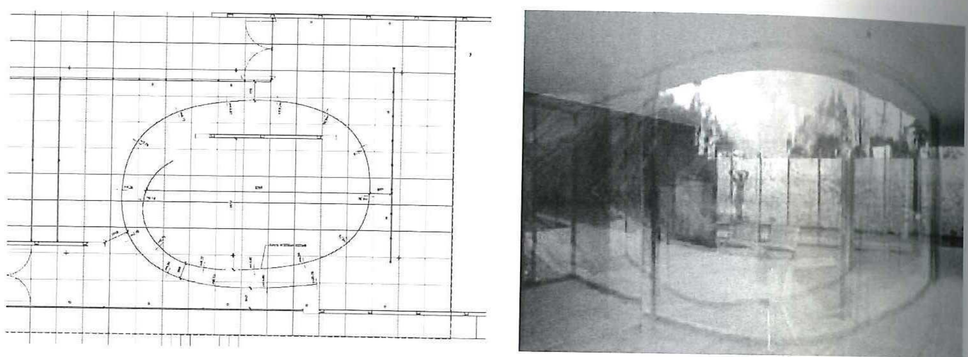

Figure 6: Plan of the SANAA Installation in the Mies van der Rohe Pavilion in Barcelona (a) and internal view (b)

This proposal, simple in its arrangement and materiality, establishes a strong confrontation with the previous order. The clarity and precision of the original pavilion visual organization, is completely disturbed (contrary to what the authors humbly claim), with the inclusion of overlapped and slightly distorted images of the surroundings and of the actual planes that define space. The spiral shape is not innocent. Besides allowing a structurally autonomous constructive solution, without needing an auxiliary element, it contrasts decisively with the orthogonality of the asymmetric planes. If in the original pavilion we had the "free flowing space", with the introduction of the acrylic spiral we now have a "condensed space". A space that is simultaneously open and enclosed. The result is, as we have seen in the Toledo Glass Pavilion, an overlapping of layers that, accounting to depth and lighting conditions produces a series of soft reflections until an atmosphere effect is

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29 and 30 September 2010

created. In fact, "after centuries of architecture organized by the straight lines of viewing eye, we now have an architecture formed by the soft distortions of the gaze, a more tactile experience of vision" (Colomina [11]).

5 Conclusions

Today we experience new and improved kinds of transparency that deviate from the modernistic approach determined by the opposites of total transparency and opaqueness. The Toledo Glass Pavilion by SANAA presents a holistic resolution of glass that explores, with great sensibility, the challenge of defining spaces with glass walls. The overlapping of glass panels produces soft reflections, determined by depth and lighting conditions. Previously, Dan Graham's *two way mirrored glass* pavilions were created as devices for people to look at their place in a specific site, ephemerally influenced by lighting conditions. But the scale to which the overlapping of glass is performed in the Toledo Glass Pavilion, depending on the intensity of reflection and distortion, leads to a kind of crystallization of the view, creating an intense atmosphere effect. Similarly, Olafur Eliasson, proposes atmosphere effects beyond its aesthetical delight, aiming to create a strong engagement with the viewer and inviting him to participate in the space production. SANAAs installation for the Barcelona pavilion summarizes in a simple yet (un)clear way, the result of this contemporary vision of transparency that starts with soft reflections and culminates with an atmosphere effect, proposing a "more tactile experience of vision".

6 Acknowledgement

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8 Image credits

Figure 1a: http://www.flickr.com/photos/mb17chung/2594901069/

Figure 1b: http://www.flickr.com/photos/vanneste/2419709782/

Figure 2a: *Engineered Transparency – Visual and Spatial Effects of Glass*, 2010, 25.

Figure 2b: http://www.flickr.com/photos/thegoatisbad/2275542244/

Figure 3a: http://www.minusspace.com/wp-content/uploads/2009/06/whitney-graham.jpg

Figure 3b: http://www.bv33.com/schede/08_graham/e-graham.html

Figure 4a: http://www.flickr.com/photos/item_view/239363400/

Figure 4b: http://www.plataformaarquitectura.cl/2007/02/09

Figure 5a: http://reclamationproject.wordpress.com/2009/09/04/

Figure 5b: http://www.olafureliasson.net/exhibitions/your_chance_encounter_31.html

Figure 6a: *Sanaa, Kazuyo Sejima Ryue Nishizawa,* 2010, 13.

Figure 6b: *Sanaa, Kazuyo Sejima Ryue Nishizawa,* 2010, 17.

Membranes vs. glass - recent innovations from the world of foils and textiles

Jan Cremers*

* Director Technology / Hightex GmbH
D-83253 Rimsting
www.hightexworld.com / jan.cremers@hightexworld.com

Abstract

Besides glass, a variety of other translucent and transparent materials are just as highly attractive to architects: plastics, perforated metal plate and meshing, but maybe most of all membrane materials which can also withstand structural loads. Earlier applications of textile materials have served the purpose to keep off the sun, wind, rain and snow while offering the advantage of enormous span widths and a great variety of shapes. The development of high performance membrane and foil materials on the basis of fluoropolymers, e.g. translucent membrane material such as PTFE-(polytetraflouro-ethylene) coated glass fibres or transparent foils made of a copolymer of ethylene and tetrafluoroethylene (ETFE) were milestones in the search for appropriate materials for the building envelope. The variety of projects that offer vastly different type and scale shows the enormous potential of these high-tech, high performance building materials which in its primordial form are among the oldest of mankind. Their predecessors, animal skins, were used to construct the very first type of building envelopes, namely tents. Since those days, building has become a global challenge. Usually building structures are highly inflexible but long-lasting and they account for the largest share of global primary energy consumption. It is obvious that the building sector has to develop international strategies and adequate local solutions to deal with this situation. Principally, building envelopes as facades or roofs are the separating and filtering layers between outside and inside, between nature and adapted spaces occupied by people. In historic terms, the primary reason for creating this effective barrier between interior and exterior was the desire for protection against a hostile outside world and adverse weather conditions. Various other requirements and aspects have been added to these protective functions: light transmission, an adequate air exchange rate, a visual relationship with the surroundings, aesthetic and meaningful appearance etc. Accurate knowledge of all these targets is crucial to the success of the design as they have a direct influence on the construction. They determine the amount of energy and materials required for construction and operation in the long term. In this context, transparent and translucent materials play an important role for the building envelope as they not only allow light to pass through but also energy. [1-4]