Studio Anne Holtrop

ETH Zürich

HS22

MATERIAL GESTURE:

GLASS

Tokujin-Yoshioka, KOU-AN GLASS TEA HOUSE, Japan 2011

photo Kuniharu Uchida

CONTENTS

DESIGN STUDIO

When we take all aspects of the material into consideration – the geology, the sourcing, the industry, the different properties, the craftsmanship, the specialised techniques and the cultural significance – we can deploy the full potential of the inherent qualities of the material itself and our way of working it in what we call MATERIAL GESTURE.

In this design studio, you will define your gestures of making and working with material(s) through research and experiment, and in response to the topic of the studio. You are required to produce an architecture that results from your specific engagement with the material and the spatial condition you construct with it. The architecture that results from this approach does not reference or represent something, but simply attempts to exist as a physical spatial reality in its own right.

Your research should be supported by the knowledge made available by our studio, and engaged through you with the use of available resources and facilities at departments of the ETH and from external specialists / fabricators.

Throughout the whole semester, and for your final presentation, we require that you work with physical (fragment) models of your building in the actual material(s). It is important, in this design studio, not to make a complete building, but to show and support the found values of the material engagement in a spatial way, based on the full potential of the inherent qualities of the material itself and your way of working it.

MATERIAL GESTURE: GLASS

"Any work of architecture which does not express serenity is a mistake. That is why it has been an error to replace the protection of walls with today's intemperate use of enormous glass windows"
—Luis Barragán in The Architecture of Luis Barragán, 1976

Glass is the miraculous material that allows sunlight and the surrounding environment into space. Thanks to the technological advancements in modern steel and concrete construction, this material has continuously acquired presence and relevance in the buildings we inhabit. Being very malleable in its viscous state, its properties can be strongly manipulated and its intrinsic fragility has become questionable as it can also be an insulating and load-bearing element. The float glass process is responsible for 90% of today's flat glass production, but other techniques such as blowing, casting, thermoforming and stretching into fibres, offer endless possibilities. We will approach the historic evolution of glass with a wide lens, from the first evidence of use dated 1.5 million years ago, as blades formed from naturally occurring volcanic Obsidian glass. We will go on to study its cultural origins in Syria and Egypt, and its import to Europe and beyond. Glass moved into the discussion of architecture during the modernist period, seen as a symbol of purity and renewal, and has only grown in architectural curiosity since. From an artisanal perspective, we will study its range of chemical compositions when melted, and the techniques used to deliver colour, pattern and texture when manipulated into form; working to discover new material gestures of glass in architecture.

The focus of this semester is to challenge the possibility of glass as a building material, questioning its predominant architectural use as a pictorial frame. Miesian architecture can be understood as the merging of the modernist constructional logic of the frame with the romantic pictorial instrument of framing; expanding the gaze on the exterior site and allowing a connection to the landscape. This speaks in stark contrast to the writings of Beatriz Colomina on Adolf Loos, where she details his aversion to transparency, believing instead that the purpose of a window is purely to let light in.

This semester, we will study the dialectics surrounding glass transparency, the frame, and site to reimagine what can be gained and achieved with glass as a space-defining material.

Studio Anne Holtrop

ASSIGNMENT

In this studio, we work in a workshop and laboratory-like setting where you research, design and test the proposed material. The material and the ways of making are not a presentation outcome of the design studio but rather, an integral part of a process of working, researching and designing.

There is no given program for the space. This can be chosen at any time in the development of your project and should support the spatial and material conditions that you have set out.

For the final presentation, you are required to make a physical model of your work, or a fragment of it, in a scale of 1:15. The model should show the material and the gestures (the ways of making) and the specific spatial conditions it constructs. This is the key element of your presentation,

along with samples of the material research and test models. You are required to display the material gesture research, drawings of the project and photos of the model alongside your model on portrait A2 sheets.

The A2 material will be collected in print and digitally in PDF format for the material gesture archive. A semester result book will be made after the presentation. From a selection of a maximum of three projects, the models and material research will be crated and archived for future exhibitions.

SCHEDULE DESIGN STUDIO HS22

INTRODUCTION
Sep 20 & 21

On the first day, we will give an introduction to MATERIAL GESTURE and the specific topic of this design studio, glass.
Members of the team and experts Remco Seibring and Philip Ursprung will give lectures and at the end of the session, you will choose the fields you want to engage with and make groups based on affinities of your shared interests.
On the second day, we will travel to Basel to visit Glassworks Matteo Gonet, after which you will briefly introduce yourselves and your individual practices.

FIRST REVIEW
Sep 27 & 28

RESEARCH AND FIRST EXPERIMENTS
(with assistants)
Experiments with the material and ways of making. Some first architectural spatial elements, think of a column, a room, a window, a floor,

a roof, a wall, etc, should be made in a scale of 1:15 and should relate to the material engagement. In this review, your material research will be discussed, and you will have to present the sources and the specialists / ETH departments involved that are essential for your research. The material research and experiments are documented through photography, material samples, writing, and drawing. During these days Rena Giesecke will give a lecture on the digital materiality of glass architecture, and take the studio on an introductory visit to the glass kiln positioned at the chair of Digital Building Technologies at the ETH.

STUDIO WEEK 3
Oct 4 & 5

(with assistants)

SECOND REVIEW
Oct 11 & 12

(with Anne Holtrop, assistants and guests Marta Armengol and Ate Snijder)
You will be required to present your group research and your individual architectural spaces that fully exploit the material gesture in a spatial way. We will discuss the architectural articulation and cultural significance in relation to material research and ways of making. After the reviews both Marta Armengol and Ate Snijder will give a short introduction to their practices.

STUDIO WEEK 5
Oct 18 & 19

(with assistants)

SEMINAR WEEK
Oct 24 – 28

STUDIO WEEK 7
Nov 1 & 2

(with assistants)

THIRD REVIEW
Nov 8 & 9

SPACE AND CONSTRUCTION
(with Anne Holtrop, assistants and guests Emmanuel Barrois, Armin Linke and Dima Srouji)
In this review, we will elaborate more in depth the construction techniques and applications that you will develop out of your material research and their spatial consequences. You will be required to present your projects through architectural drawings – floor plans and sections – and first detailed construction drawings. After the reviews Emmanuel Barrois will give a lecture on his workings with glass.

STUDIO WEEK 9
Nov 15 & 16

(with assistants)

STUDIO WEEK 10
Nov 22 & 23

FOURTH REVIEW
Nov 29 & 30

STRUCTURE
(with Anne Holtrop, assistants and guests including Mario Monotti and Remco Seibring)
We will continue our discussion of the previous reviews and aspects of your work together with the structural aspects, construction techniques and organisation.

STUDIO WEEK 12
Dec 6 & 7

(with assistants)

STUDIO WEEK 13
Dec 13 & 14

(with assistants)
Layout and presentation reviews.

FINAL PRESENTATION
Dec 20 & 21

(with Anne Holtrop, assistants, guest Christian Kerez, and further guests TBC)
You will work on the final presentation with an exhibition of the final models, material samples and A2 drawings and photos.

EXPERTS

MARTA ARMENGOL

Marta Armengol is an architect formed in ETSAB (Barcelona). In her work, through various disciplines such as architecture, design, installations, and sculpture, she plays with experimentation, and works in research and conceptualization of spaces and objects, using errors and material possibilities rather than searching for definitive solutions. She works with the materials out of which we construct our surroundings, and opens up new spaces within a world we thought we had defined. She believes that it is by mixing the boundaries between architecture, design, and scenography; between installations and sculpture or between the practice and research of architecture itself; that new ideas and innovation flourishes. She has exhibited her work at Palais de Tokyo in 2015, Dutch Design Festival in 2018 and Matadero de Madrid in 2019. She is also co–founder of the Cierto Estudio, and member between 2015 and 2017. During this period of her life the studio had different recognitions: Special Mention at Solvia Innova Prize 2014, Shortlisted at Solvia Innova Prize 2015, was awarded with two Premis Ajac X 2016 in Unbuilt Work + Furniture and more recently, in 2017, with the First Prize for the Masterplan and construction of a social housing building in Plaça de les Glòries, Barcelona.

EMMANUEL BARROIS

Glass is for Emmanuel Barrois a way of life, a place of freedom, a vocation born from a chance encounter. While shooting an assignment on the preservation of heritage and artistic crafts, he met a glassmaker and discovered a fascination for light, colour and the art of physically defying the material. As a self-taught man, in the 90s he began to learn glass work by restoring stained glass panels from cathedrals and abbeys. His intention is not so much to rediscover the gestures of the past, but rather to feel how the glassmakers of the 13th century created the architecture of their time and invented their modernity. The dialogue with the architect Claude Parent in 2000, followed by his collaboration with Paul Andreu, were decisive encounters that enabled him to precise his vocation and to understand the need, in his own words, to “constantly call into question, to establish the principle of discomfort as a rule”. In 2010, Emmanuel Barrois was appointed Master of Art Glassmaker of Architecture by the Minister of Culture and Communication. In 2013, he is promoted to the rank of Officer of the Order of Arts and Letters. Barrois has exhibited works at the Centre Pompidou, National Museum of Tokyo, National Museum of China, Galerie Nationale des Gobelins – Le Mobilier National, Tokyo Zokei University Museum, Designer’s Days, and Ecole Nationale de Beaux Arts de Paris. He has given lectures internationally at institutions including the Galerie Nationale des Gobelins, INMA, and the National Museum of Tokyo.

RENA GIESECKE
Rena Giesecke is an Architect, Doctoral Researcher and ITA Fellow at the Chair for Digital Building Technologies, Institute of Technology in Architecture at the Department of Architecture at ETH Zurich. Rena studied architecture in Germany, Japan and Austria. Her work, academic research and teaching activities revolve around rethinking construction through new technologies, robotic fabrication, 3d printing, and material research. She has worked on a range of construction projects that employ digital fabrication for concrete and glass.

CHRISTIAN KEREZ
Christian Kerez was born in 1962 in Maracaibo (Venezuela). After his studies at ETH Zurich, Kerez worked in the field of architecture photography. In 1993, he opened his own studio in Zurich, Switzerland. Christian Kerez has been a visiting professor in design and architecture at the Swiss Federal Institute of Technology, ETH Zurich since 2001, an assistant professor since 2003 and as a full professor for design and architecture since 2009. In 2012 he held the Kenzo Tange Chair at Harvard University Graduate School of Design, Cambridge. Kerez has been officially invited for the exhibition at the Swiss Pavilion at the 15th International Architecture Exhibition – la Biennale di Venezia in 2016.

ARMIN LINKE
Armin Linke (b. 1966, Milan) is a photographer and filmmaker combining a range of contemporary image processing technologies to blur the border between fiction and reality. Linke indagates the formation – so called Gestaltung – of the natural, technological and urban environment in which we are living. Armin Linke's oeuvre – photographs and films – function as tools to

become aware of the different design strategies.
Linke has served as a research affiliate at the MIT Visual Arts Program, guest professor at the IUAV Arts and Design University in Venice, and professor for photography at the Karlsruhe University for Arts and Design. Currently Armin Linke is guest professor at ISIA, Urbino (IT) and artist in residence at the KHI Kunsthistorisches Institut in Florenz.

RITSUE MISHIMA

Ritsue Mishima was born in 1962 in Kyoto, Japan. She moved to Venice in 1989, and began visiting the glass workshops of the Murano islands. Mishima collaborated with the glass artisans there since 1996. In 2001, she was awarded the Giorgio Armani prize for Best Artist at Sotheby's Contemporary Decorative Arts Exhibition held in London. She makes large, organic glass forms often inspired by nature, and is one of the few artists in Venice working almost exclusively in clear glass. Mishima's major exhibitions in recent years have included the Venice Biennale in 2009, a solo show at the Museum Boijmans Van Beuningen, the Netherlands in 2011 and as part of a project, “Spring at Palazzo Fortuny” in Venice in 2014.

MARIO MONOTTI

Mario Monotti graduated from Zurich Polytechnic with a degree in Civil Engineering and subsequently, earned a PhD in Technical Sciences where he focused his research on the plastic analysis of reinforced concrete slabs. Since 2009, he has held the position of Professor of Structural Design at the Accademia di architettura in Mendrisio, Switzerland. He is also the founder and owner of the Monotti Ingegneri Consulenti SA in Locarno. His company specialises in structural design in architectural contests in the public and private sectors on national and international levels. Mario Monotti works collaboratively with young architects. His name is associated with the school of Leutschenbach of C. Kerez (European steel design award 2011), the House on Two Pillars of C. Scheidegger and J. Keller (Betonpreis 2017), the National Pavilion of the Kingdom of Bahrain for Expo Milano 2015 of Anne Holtrop, and many other project and exhibition pavilions.

DIMA SROUJI

Dima Srouji founder of Hollow Forms Studio is an architect and visual artist exploring the ground as a deep space of rich cultural weight. Srouji looks for potential ruptures in the ground where imaginary liberation is possible. She works with glass, text, archives, maps, plaster casts, and film, understanding each as an evocative object and emotional companion that help her question what cultural heritage and public space mean in the context of the Middle East. Her projects are developed closely with archaeologists, anthropologists, sound designers, and glassblowers. Srouji is currently the Jameel Fellow at the Victoria & Albert Museum and leading the MA City Design studio at the Royal College of Art in London.

REMCO SIEBRING
Remco Siebring (MSc) (1983) studied architecture at the Academy of Architecture in Arnhem. He opened his practice in 2012 after working for Sou Fujimoto Architects in Tokyo (2010 – 2011). In his work he intuitively explores the boundaries of spatial experiences, in both temporary and permanent installations and buildings. He is interested in analogue working methods and large modelmaking with a wide array of materials. He is also a tutor at the master Studio for Immediate Spaces at the Sandberg Instituut in Amsterdam. Seibring is a long-time collaborator of Studio Anne Holtrop and is currently working on a glass architecture project for the studio.

ATE SNIJDER
Ate graduated from the Architecture Master at the University of Delft. In the graduation project, under mentorship of prof. ir. Rob Nijsse, he devloped a series of shell structures with glass as the primary loadbearing material. Currently, Ate works at chair of Structural Design and Mechanics within the faculty of Architecture. As a researcher he is part of the Glass Research Group where his focus is on the structural behaviour of glass load bearing components of bridges and buildings. Within the research group he specialises in FEM modeling of stress distribution in glass, detailing of glass connections and structural design with glass. Ate also teaches the structural design component of the BSc course BK1TE2, the minor Bend & Break and mentors a small number of BT graduate students with a specific interest in structural glass design.

PHILIP URSPRUNG
Since 2011 Philip Ursprung has been a Professor of History of Art and Architecture at ETH Zürich and Designated Dean of the Department of Architecture. He earned his PhD in Art History at Freie Universität Berlin in 1993 after his studies in Geneva, Vienna and Berlin and his Habilitation at ETH Zurich in 1999. He taught at the University of Geneva, the Hochschule der Künste Berlin, the GSAPP of Columbia University New York, the Barcelona

Institute of Architecture, and the University of Zürich. Philip Ursprung served as advisor to the Swiss Federal Government as a member of the Eidgenössische Kunstkommission from 1997 to 2004. He was the president of the Fondation Nestlé pour l'Art from 2003 to 2014 and president of the Jury of Akademie Schloss Solitude in Stuttgart from 2007–2011. Since 2013 he had been president of the scientific board of Zentralinstiut für Kunstgeschichte in Munich. Philip Ursprung's research deals with the history of modern and contemporary art and architecture with a focus on North American art in the 1960s and 1970s and European architecture since the 1980s. Among other publications, he is the editor of Herzog & de Meuron: Natural History (Lars Müller Publishers, 2002).

ROGIER VAN DER HEIDE

Lighting designer Rogier van der Heide has always worked with light. In 1994, he founded his agency, a world's first: serving clients with a holistic approach to light, imagery, and architecture. When the practice got acquired by Arup, Arup Lighting grew to include over 70 lighting designers under Rogier's artistic and business leadership. In 2010, Rogier joined Philips Lighting, to lead all the design activities of the corporation as Chief Design Officer and Vice President. As a lighting designer, Rogier continues to empower clients with imaginative light. And Rogier stays connected with the new generation of designers through lectures, workshops, and talks, and as the founder of the world's largest festival of Light Art, in Amsterdam.

VISUAL ESSAY

Peter Zumthor, KUNSTHAUS BREGENZ, Austria, 1997

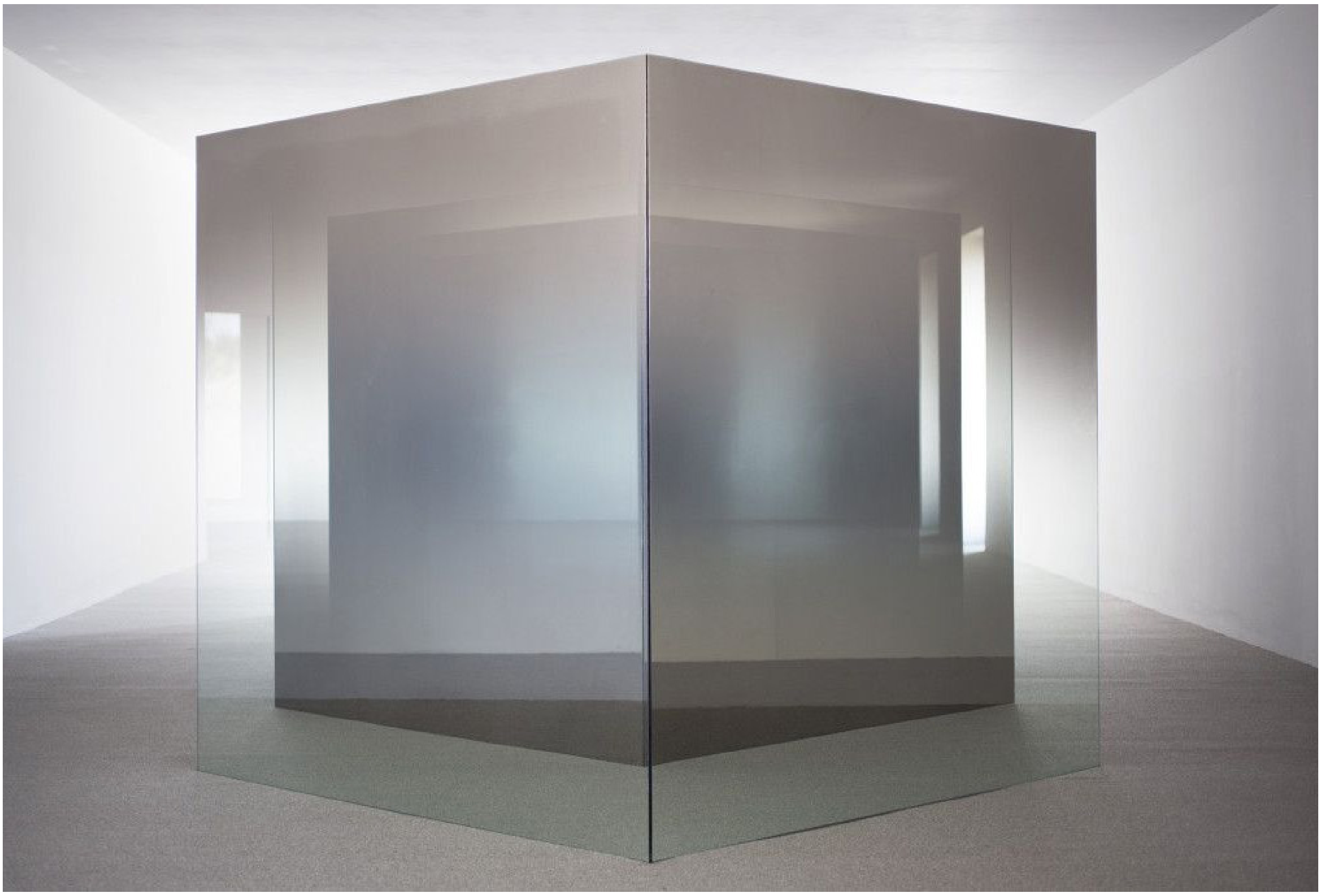
photo Benedikt Kraft

Pedro Cabrita Reis, FAVORITE PLACES NO. 3, Switzerland, 2004

photo Panayotis Voumvaks

Pedro Cabrita Reis plays with ideas about the house and the city, and the way in which they represent private and public space. He uses recycled building materials such as bricks, metal girders, doors, plaster, glass, electric cables and fluorescent strip lights, and his work often looks like a slice of an abandoned building site. Like (Siah) Armajani, he creates forms that often hide or reveal, using oppositions of transparency and opacity, light and space, and the interior/exterior dichotomy.

Sculpture Today, Judith Collins, 2007



Larry Bell, 6 × 6 AN IMPROVISATION, Marfa USA, 2014

photo Alex Marks

Bell's work has always been about exploring light and perception, as well as colors and movements on surfaces. Abolition of angle become the fundamental object of work that developed essentially from glass. In Taos, Bell invented a new process of making sublimations on glass panels using a vacuum machine he called the "Tank," which creates a void so that thin particles of metal can be deposited on the glass surface, forming remarkable puzzles of diffraction. Other methods such as photography, assemblage, and collage complete in various manners a large corpus of work. Bell continues to explore and invent new processes that remain a step that tests the limits of the machine and is deeply grounded in a certain period and landscape, capable of inspiring emotions that are quite independent of fashion. At once mathematical and sensual, Bell's work immerses us in a new dimension, one where Homo spectator becomes daydreamer. The question of The Time Machine – which is also one of Bell's unique works (The Time Machine [2002]) – makes an appropriate link to Bell's corpus, given the latter's constant probing of the limits of perception, as contained within the limits of orthonormal rules.

Peripheral perception is at the center of his researches. Glass, his favorite material, enables reflection and opacity, and allows him to invent new processes to create sculptural objects that blur the borders between painting and sculpture: "After having considered that a painting is in itself a volume, I did sculptures based on the shape of a canvas, which took the principle of a window." Doing this, Bell took a huge step beyond traditional Renaissance representative painting, which was, per Leon Battista Alberti, a window on the fiction of the world. In Bell's world, there isn't a frame on the window borders, only glass stands, like a mirror-threshold open on the world. ahead of his time and address our contemporary modes of traveling and living with screens.

Mousse Magazine, A WORLD WITHOUT ANGLES: LARRY BELL

by Marie de Brugerolle

Goshka Macuga, “DEUTSCHES VOLK – DEUTSCHE ARBEIT”,

originally designed by Lilly Reich and Mies van der Rohe, Tate Britain,

London, 2008. Photo Lewis Whyld

Herzog & de Meuron, SAMMLUNG GOETZ, Munich. Museum for a Private

Collection of Contemporary Art, Munich, Germany, 1992

Mario Merz, UNTITLED (TRIPLE IGLOO), 1984 – 2002

Photo from permanent exhibition of the MAXXI museum, Rome.

In the last decade of so, sculptors of all nationalities have been drawn to the aesthetics of the favelas or shantytowns found on the edge of cities, informal structures made from recycled material – architecture without architects. Traditional igloos provide security for their makers, but Merz's structures are unstable and insecure, and often dangerous, sometimes incorporating sheets of broken glass. He works with the emotional nature of habitation.

SCULPTURE TODAY, Judith Collins, 2007

Hiroyuki Arima + Urban Fourth, MA ATELIER AND GALLERY, Japan, 1998

photo Margherita Spiluttini

Laszlo Moholy-Nagy, STAGE SET “TALES OF HOFFMAN”

State Opera, Berlin, 1929

Roni Horn, OPPOSITES OF WHITE, 2006 – 7, Kröller-Müller Museum,

Netherlands

These two objects by American artist Roni Horn were made by gradually pouring liquid glass into a mould for twenty-four hours and slowly allowing them to cool over a period of four months. The rough sides of the objects show the texture of the moulds. The tops are smooth and shiny, because here the glass has only been in contact with the air. Depending on the viewpoint, they sometimes appear as a razor-sharp surface, or conversely as an endless depth. In this work, Roni Horn plays with the ambiguous properties of glass. It is melted and then solidified again into an apparently permanent state, but it is essentially a liquid. With this game, Horn causes the observer to become confused: it is impossible to determine the “identity” of the material with the naked eye and whether the inside of the sculpture is solid or liquid.

Kojiro Yoshiaki, HATATE #11, 2017, Loewe Foundation

“I combine glass powder with a foaming agent, such as calcium carbonate or copper oxide in a fireproof plaster mold, and then fire it for casting at around 820°C in an electric kiln. The melting glass confines the gas that the additive releases inside, and the mold is filled with foamed glass gradually – like baking bread. I open the door of the kiln to abruptly solidify the foaming glass. Although the piece cools quickly, it retains its shape, but has become a porous lump of glass with strong tensile stresses from forcibly stopping the expansion. I remove the plaster mold and fire the piece again for slumping at around 700°C. The tensile stresses are released, causing shrinking and cracking. The glass collapses under its own weight, and the spaces between the porous parts merge.”
– Kojiro Yoshiaki

Gerhard Richter, 7 PANES (HOUSE OF CARDS), 2013

Marian Goodman Gallery, London

Renzo Piano, MAISON HERMÈS, Tokyo, 2001

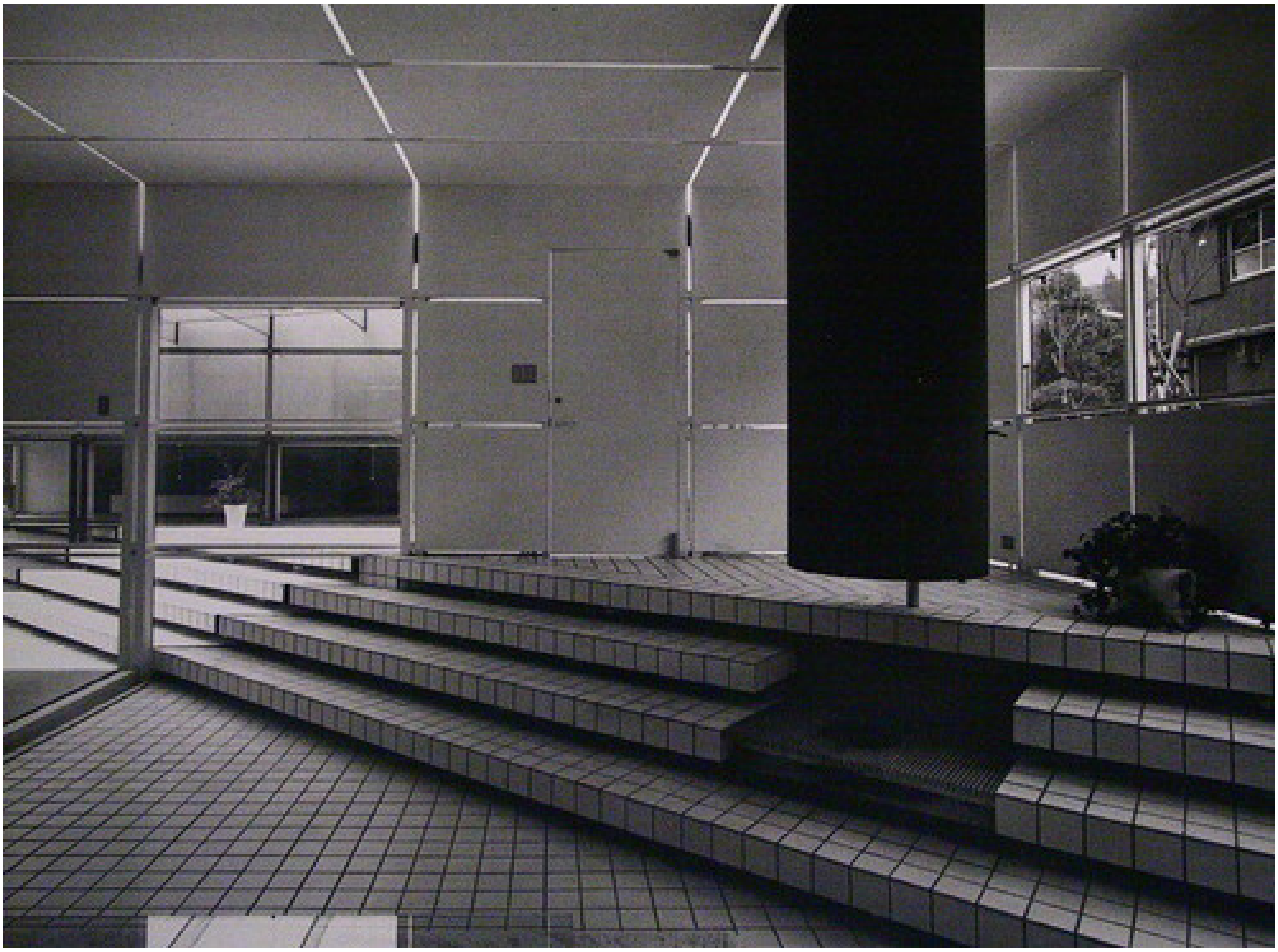
Frank Lloyd Wright, S. C. JOHNSON WAX ADMINISTRATION BUILDING (1939)

& RESEARCH TOWER (1950), USA

Borosilicate glass tubing laid up like bricks in a wall compose all the lighting surfaces. Light enters the building where the cornice used to be. In the interior, the box-like structure vanished completely. The walls carrying the glass ribbing are of hard red brick and red kasotsa sandstone. The entire fabric is reinforced concrete, cold drawn mesh used for reinforcement. (Frank Lloyd Wright, describing his technical solution in the caption of an interior photograph.) Wright defined glass as a material having two personalities, both related to the transmission of light. In his work he repeatedly exploited the potential of glass in both realms. He intensified the role of glass as an invisible material by incorporating large expanses of clear glazing and minimizing elements that define its presence. He magnified the role of glass as a visible object by assembling a remarkable variety of compositions in pieces of colored and clear glass. His challenges to the nature of glass through philosophical and practical confrontations with its various properties were limited except in certain experimental cases. The character of Wright's architecture is often defined, in part, by the unique properties of his glass, thus establishing a record of his dependence on glass to complete his architectural message. Often the expression benefits from detailing harmonious with the material but – upon occasion – confrontation with the nature of glass yields a visual impact useful to Wright's goals for the architecture.

FRANK LLOYD WRIGHT AND THE MEANING OF MATERIALS

Terry L. Patterson, 1994



Shoei Yoh, LIGHT LATTICE HOUSE, 1980

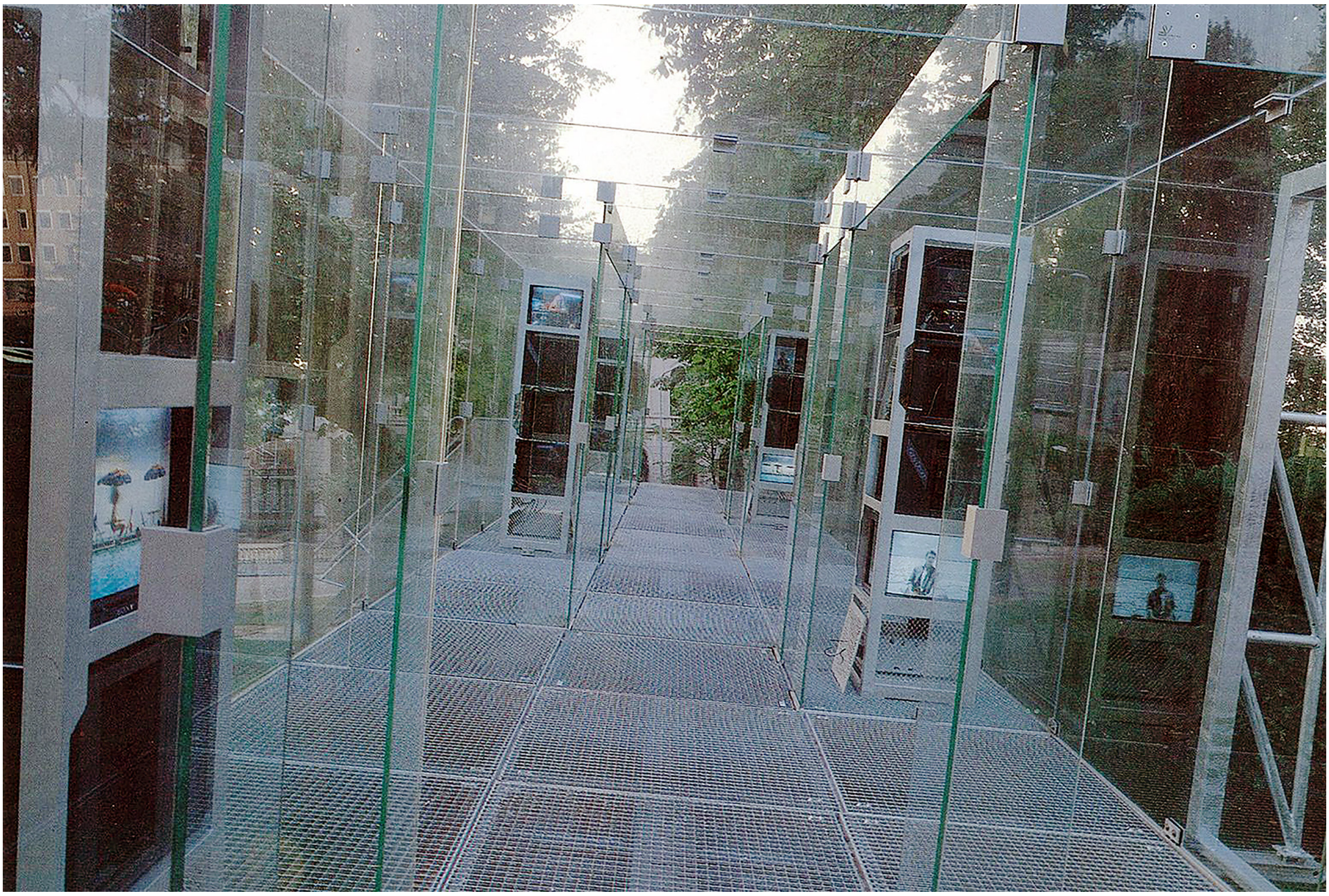
Yoh called the house a “stainless steel house with light lattice”, and grey glass was used to create a lattice of light around the insulated stainless steel panels: the light is a “negative” metaphor for the joint.

Erwin Heerich, GRAUBNER PAVILION “VITRINE”, Museum Insel Hombroich,

Germany, 1982

Tarik Hayward, SECURITY LEVEL, Swiss Cultural Center, Paris, 2018

This minimalist-looking work takes the form of a bulletproof glass, placed on the floor. In order to meet the UL 752 standard (NATO, for military use, resistance to assault rifles and small explosions), the glass is 6 cm thick. It was entirely made by the artist, in several layers of different thicknesses, alternating PMMA, polycarbonate, resin and glass. The artisanal manufacture is deliberately visible, in particular with bubbles and various marks left by the glues and resins, between the layers. This type of glass is used more and more as an element of protection in various contexts, it will also soon surround the bottom of the Eiffel Tower. It has a defensive side that stops projectiles, and another that lets them pass. Tarik Hayward chose to place the defensive face on the ground.



Bernard Tschumi, GLASS VIDEO GALLERY (presently called Tschumipaviljoen), the Netherlands, 1990. Photo Stephen Varady.

Top image: Initial video installation pictured inside the space.

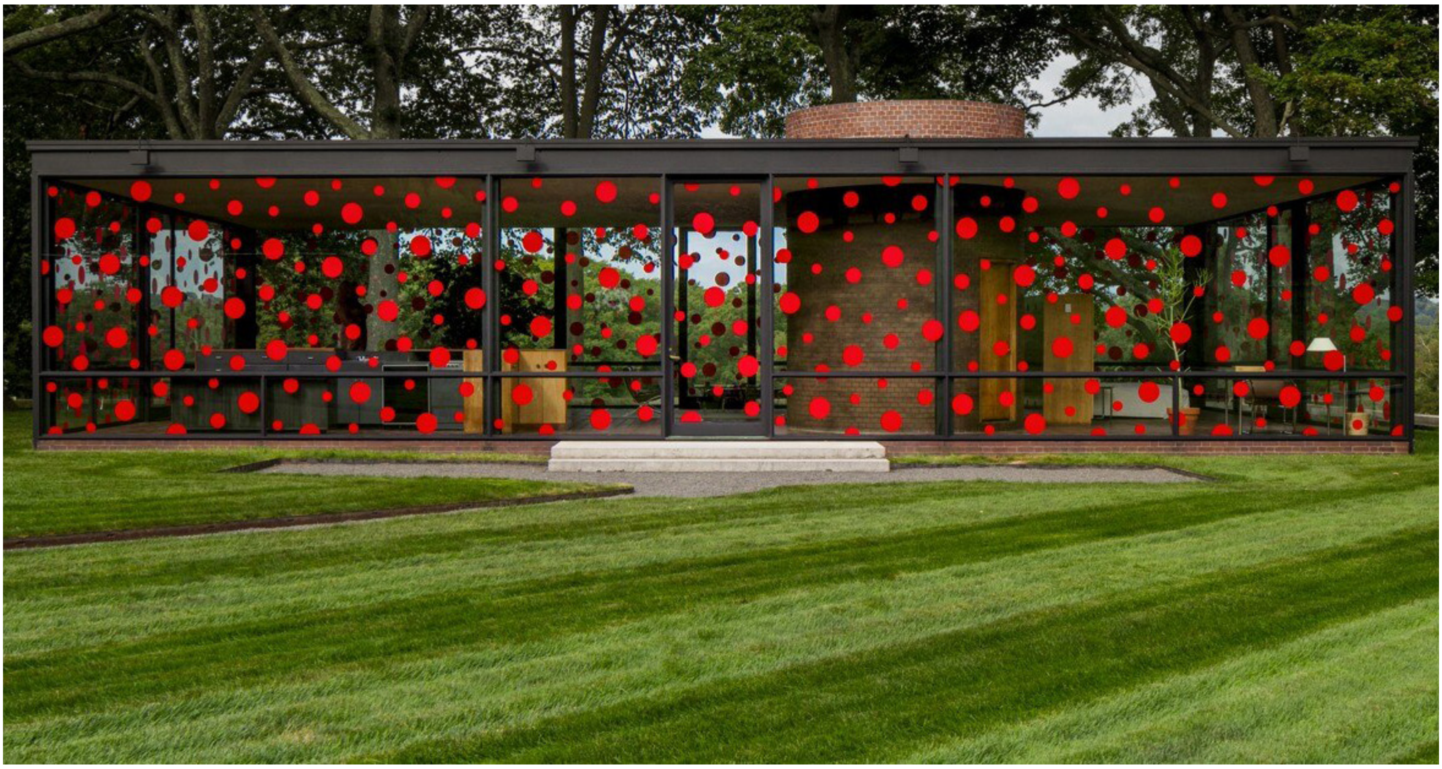
The Glass Video Gallery was commisioned by the city of Groningen and the Groninger Museum as a public pavilion for watching music videos. Situated in the center of a traffic roundabout, the regular volume of the gallery is seventy-one feet in length. Within the glass volume were six banks of video monitors. Tschumi's pellucid structure signifies the immaterial nature of video images as flickering patterns of coloured light projected onto a glass screen. The entire enclosure, including roof, sides, vertical supports, and horizontal beams, is made of toughened glass plates held together by metal clips, eliminating any substantial differentiation between structure and skin and minimising the perceptive barrier between inside and outside. Glass plates divide the actual interior of the space, multiplying layers of reflection and dissolving the solid surfaces of the glass. The lucid and rational function of glass as a building material is ultimately denied by yanking the gallery out of the Cartesian grid in which it would otherwise seem to belong and tilting it on two axes. An equivalence is set up between the glass volume of the gallery and the glass-screened video monitors, and video's function as an instrument of surveillance is inverted: the visitor to the gallery is not allowed the anonymous subjectivity of peering out of a darkened space, as in a movie theater, but is instead on view. In a transparent box, the spectator becomes spectacle, and the feasibility of a private life in a media-suffused culture is questioned. At night, the architectural volume disappears altogether, supplanted by countless reflections and incorporeal video screen images.

Terence Riley, LIGHT CONSTRUCTION, 1995

Dan Graham, A NEW WORK WITH CURVES, Massimo Minini Gallery, Italy, 2015

Tokujin-Yoshioka, KOU-AN GLASS-TEA HOUSE, Japan 2011

photo Yasutake Kondo



Yayoi Kusama, DOTS OBSESSION, 2016 at Philip Johnson, GLASS HOUSE,

USA, 1949

The insallation by Yayoi Kusama involved covering the walls with “infinity polka dots”. At the opening of the installation there was a musical performance by Carsten Nicolai, known by his stage name as Alva Noto, and Ryuichi Sakamoto. The improvised performance, rehearsed in only one day, involved using a keyboard, mixing consoles, singing bowls made out of glass, crotales, and gong mallets rubbed softly against the glass walls. It was engineered and recorded with contact microphones placed on the walls. The recording was edited and released in 2018 via Nicolai's label NOTON. A video of the performance was also filmed by Derrick Belcham and uploaded to the Glass House's official website and Vimeo.

Belcham, Derrick, Alva Noto and Ryuichi Sakamoto, Video, 26 mins, 2018,

Vimeo, the album can be listened to on Spotify

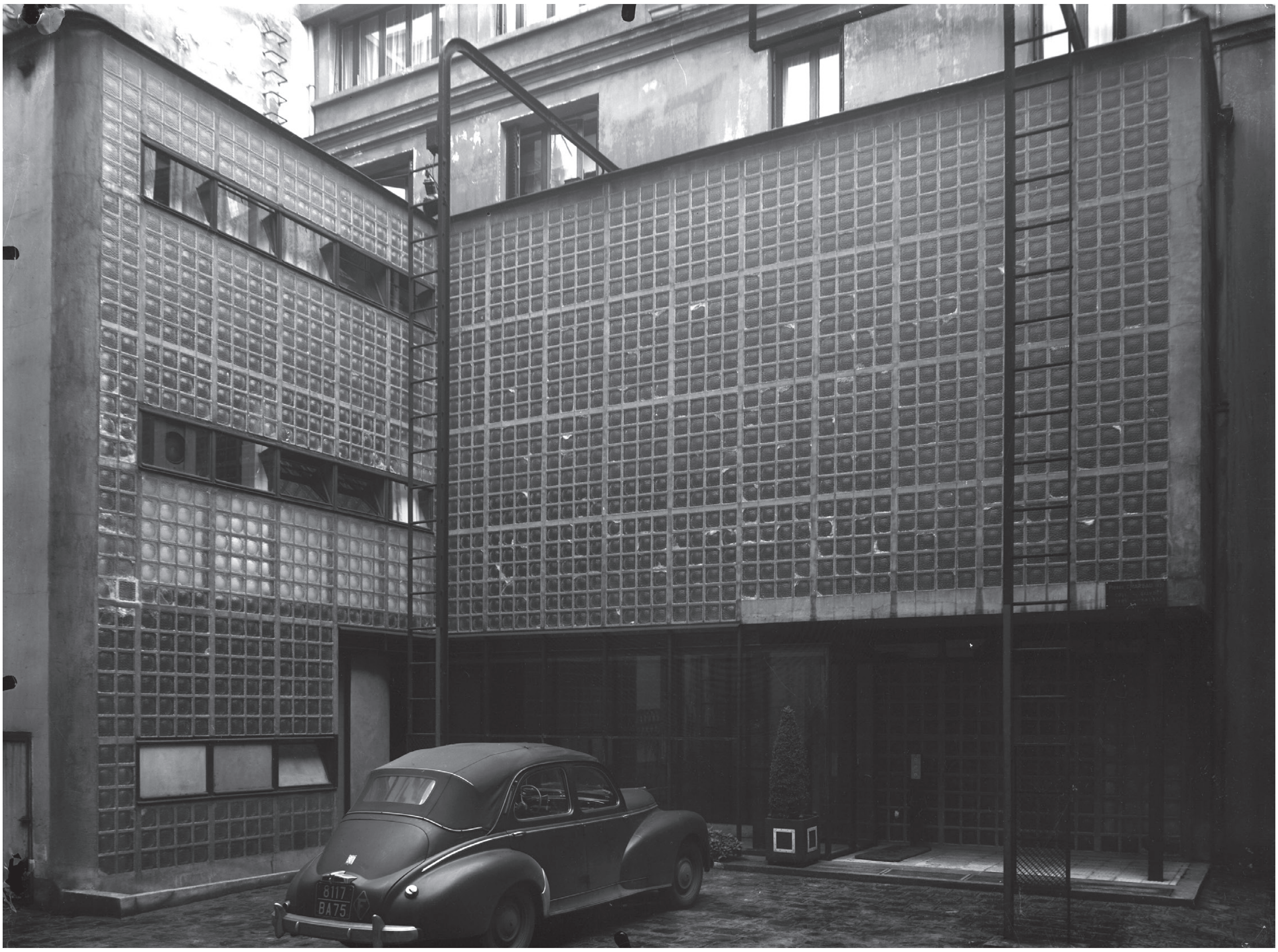
Ritsue Mishima, HALL OF LIGHT, Tokyo, 2019

David Chipperfield, MUDEC MUSEUM, Milan, 2015

Marta Armengol, TRANSICIONS, Barcelona, 2019

photo Carlota Guerrero

Facade by SANAA, LA SAMARITAINE, Paris, 2021



Pierre Chareau in collaboration with Bernard Bijvoet, MAISON DE VERRE,

Paris, 1932

Lina Bo Bardi, CASA DE VIDRO (THE GLASS HOUSE), 1951, São Paulo

photo Sekushy

Marcel Duchamp, LARGE GLASS, New York, 1923

The meaning of the objects portrayed on The Large Glass has been much interpreted. Here, I read them as a constellation of body parts, or body references, floating in three dimensions, seen as an imprint like a photograph onto the glass plane. Made from everyday and industrial materials – lead, paint, dust, silver, mercury – they are corporeal, between part-object and mechanical instruments.
The spectator looks, only to become incorporated (consumed): as the reflection from the foreground on the glass; reflected into the images already there; and as a shadow cast through the glass to the background.

Monir Shahroudy Farmanfarmaian, LIGHTNING FOR NEDA, Iran, 2009

Hiroshi Sugimoto, GO'O SHRINE, Honmura, Naoshima Island, Japan 2002

HOLLOW FORMS PROJECT: ALMOST ROMAN, Dima Srouji, Palestine, 2020

Traditional glass blowing industry in Palestine.

Rena Giesecke, BEYOND TRANSPARENCY: ROBOTICALLY ENHANCED GLASS

ARCHITECTURE, Zurich

photo Evangelos Roditis

GLASS

HISTORICAL FORMATION

TECHNICAL UNDERSTANDING
- Chemical Composition
- Secondary Processes & Applications
- Silica Glass
- Properties
- Sourcing
- Cold Working

FIVE CORE TECHNIQUES
- Glass Blowing
- Casting
- Thermoforming
- Poured glass
- Fusing

“All the dignity of colour and material available in any other material may be discounted with permanence. Shadows were the ‘brush work’ of the ancient Architect. Let the modern now work with light, light diffused, light reflected – light for its own sake, shadows gratuitous. It is the machine that makes modern these rare new opportunities in Glass.”

— Frank Lloyd Wright, lecture STYLE IN INDUSTRY, Princeton University, 1930

HISTORICAL FORMATION

The first known traces of glass use date to 1.5 million years ago in Kariandusi and other sites of the Acheulian Age, where sharp tools were found made from fractured obsidian glass. Obsidian glass naturally forms when volcanic lava solidifies rapidly. Pure obsidian is usually dark in appearance, although the colour can vary depending on the presence of impurities. The true origin of glass creation is unknown. Speculations include accidental vitrification during pottery firing, from the contact between the silica in the pottery and the alkaline ashes of the hearth. This could explain why pottery glazes were discovered before glass.

It is commonly understood that the origins of glassmaking and its industry stem from Syria, having most likely been brought to Egypt around 2000 BC, with a focus on glass bead production, to imitate

Obsidian natural volcanic glass

Glass Date Flask, Roman,
1st – 2nd century AD

Furniture inlay of polychrome glass tiles, Egypt, 200 – 100 BC

Roman Window Glass, Pompei
3rd – 4th century AD

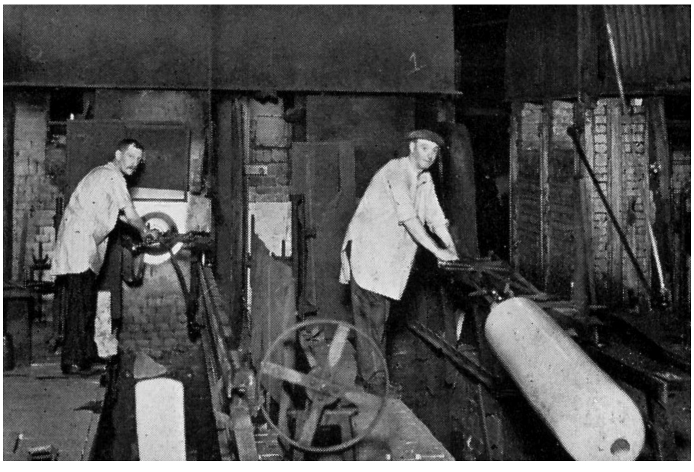
precious stones. The technique of blown glass is thought to have been invented in Sibon, and travelled to Egypt through Syria during the 1st century BC, where the technique was applied to make bottles and vessels, as well as large flat dishes; a process which later led to the invention of crown glass. The Syrians and Alexandrians were equal partners in the glass industry, the Syrians supplying most of the free-blown glassware and the Alexandrians (in Egypt) supplying the moulded, cut, and generally more decorative, glassware.

The Alexandrians had a strong trade link with the Romans who mainly applied glass for domestic purposes, such as for architectural decoration and ornaments. Window glass was first used in isolated applications such as in public baths to reduce air drafts, and not intended for transparency or view, but rather for security, insulation and natural light. Roman window glass can be placed into two distinct categories: 1st – 2nd century AD: colour blue, green or brown. 3rd – 4th century: colour pale-water green. Both types of glass were made via casting, with a maximum size of 100 × 80cm. A typical composition of Roman glass is silica 69%, soda 17%, lime and magnesia 11%, alumina iron oxide, and manganese oxide

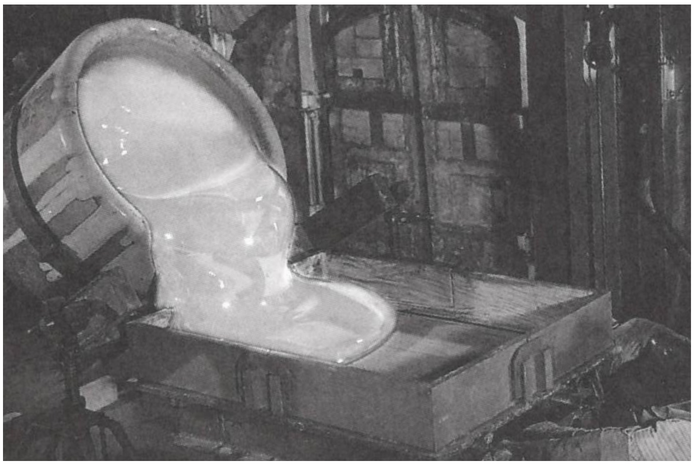
3%. The Romans were responsible for extending glass application in Western Europe.

The glass industry in Venice was established in the 10th century, moving to the island of Murano, Venice in 1291 due to fire risk. Its isolation helped develop a highly skilled and secretive trade, eventually exporting Muranese glass all over the medieval world. This new wealth brought with it advancements in proficiency and an experimental attitude. New processes included mirrors made by coating plates of glass with an amalgam of tin and mercury. A well-known glass feature in many Venetian architectures produced in Murano is the spun bullion glass fitted into frames of lead, a prequel to the development of the crown method. During the 10th century, specialisation in window glass production had developed into two main processes described below:

THE CYLINDER METHOD A ball of molten glass was gathered on the end of a blow-iron pipe and blown into a sphere which, by swinging the pipe back and forth, naturally stretched into an irregular cylinder with a domed end. The domed end was cut open, the hole widened, then pinched to provide a grip for a punty. Once the punty was attached, the cylinder was supported



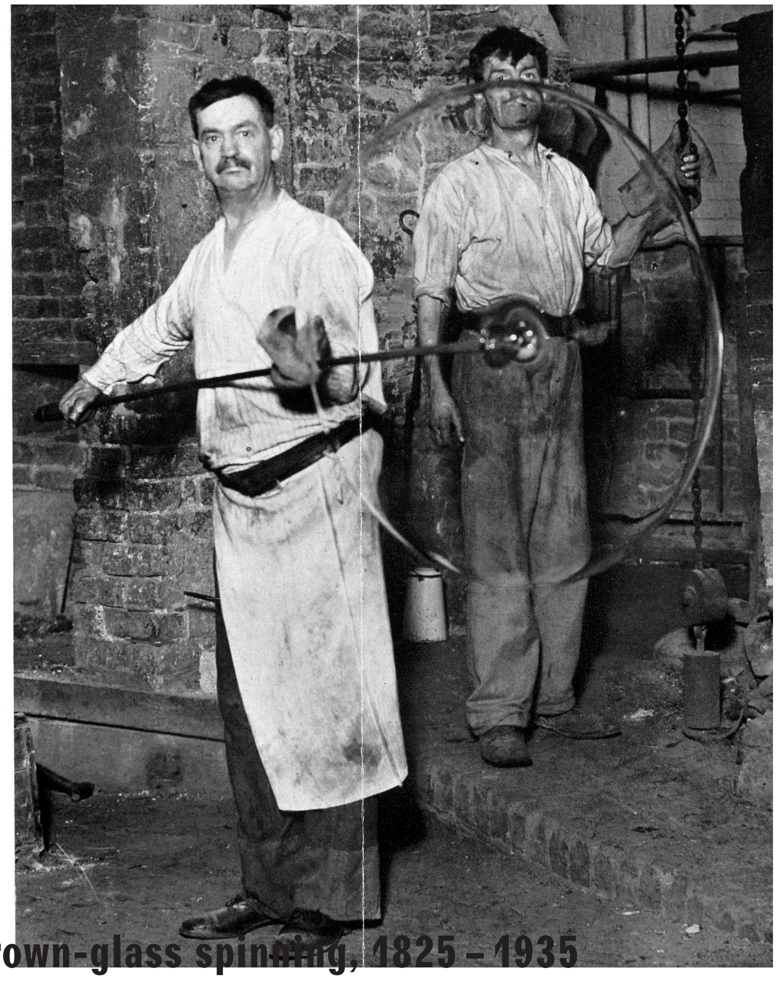
The old cylinder process of making sheet glass 1825 – 1935



Cast Plate Glass: Molten glass being poured into a frame, date unknown

at both ends. The blow-iron was then removed and the other end widened to its full diameter. Then the punty was broken off, and the pinched part re-opened. Finally, the cylinder was reheated, cut down its length and flattened into a sheet autonomously in the furnace, at times helped by running a wooden block positioned at the end of an iron rod over the glass. This method was mechanised with the invention of the machine blower by John Lubber in 1896.
THE CROWN METHOD A ball of molten glass was gathered and blown into a globe shape. The globe was transferred from a blow-iron pipe to a punty, reheated, and spun very fast to widen the hole left from the blow-iron pipe. The spinning process converted the glass from a globe shape into a disc uniform in thickness, except for the point where the punty was connected, where it formed a "bull's eye". Lamberts Glass is a well-known manufacturer in Germany that still uses these traditional methods to produce window glass today.

The first recognised glass architecture in Northern Europe was during the Gothic period, from the mid-12th century to the 16th century, utilising structural elements of arches, vaults and flying buttresses. The builders of cathedrals could build stone



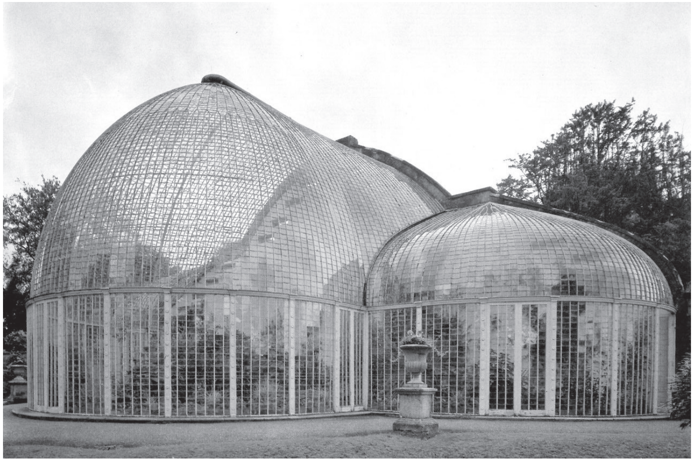
The process of crown-glass spinning, 1825 – 1935

The Five Sisters stained-glass windows, York Minster, York, 1260

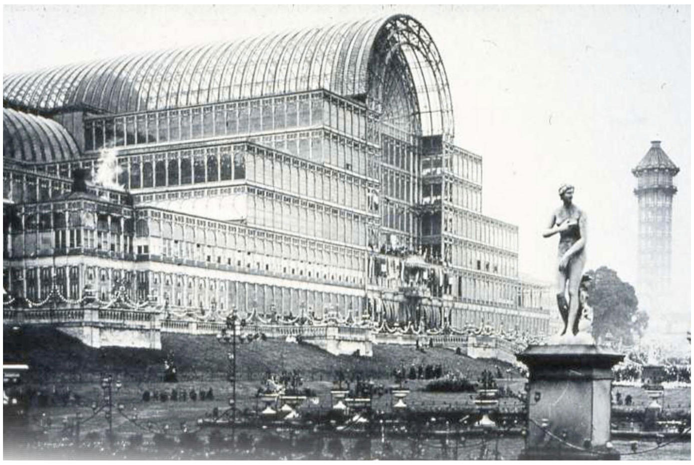
frames with very expressive structures, incorporating large openings to admit light, the problem being that glass at the time came in small pieces, thus developing the solution of pictorial stained glass veined with lead.

In Europe, early glass-making processes were held as secrets guarded by governments and traded amongst the elite. The wealthy classes' appetite worked to push creativity and developments in glass production, encouraging producers to make larger and better quality products. One such outcome was a method of casting glass called Cast Plate Glass, which was first developed in the 17th century by Louis Lucas de Nehou. The original method consisted of molten glass being poured into frames, then spread out evenly by rollers, and subsequently ground and polished. In order to grind cast plate glass, it was placed horizontally upon a flat stone table made of a very fine-grained freestone, plastered down with lime for security. It was sanded manually (and in later years via machine), first with water and coarse sand, then finer sand, until the point of using powder or smalt.

In the late-18th to early-19th century, glass production and secular use of glass increased



Speculated Architect: John Claudius Loudon, The Palm House, Bicton, England, 1820 – 40



Crystal Palace, Joseph Paxton, London, 1851

throughout the Italian Renaissance and window glass became a commodity item in Northern Europe. A new glass architecture emerged in England, with the double-hung window, leading to the development of conservatory architecture from the end of the 16th century to the middle of the 19th century.

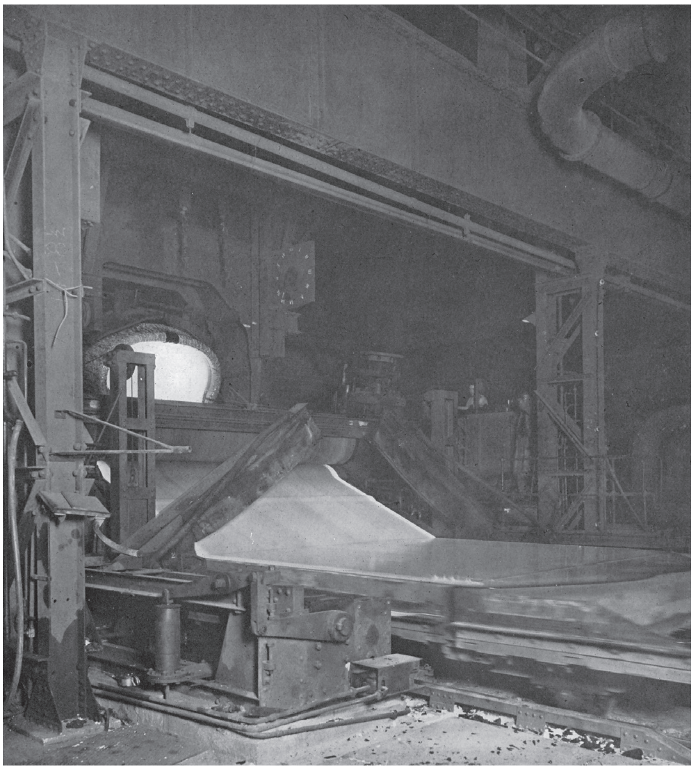
In 1886, the Swiss engineer Gustave Falconnier patented a hexagonal brick made of glass blown into a mould. This made glass insulating as well as structural, whilst still allowing light in. Glass bricks were mainly used to redirect light into dark rooms such as in basements or on ships. Structural glass façade

technology began to take form in the development of iron and glass conservatories of the 19th century, e.g. Palm House, Bicton Gardens, and especially noted with Joseph Paxton's Crystal Palace design. Conservatories in England and Europe took a dramatic departure from masonary architecture as structural iron framing systems allowed for more experimental designs. Due to rising land value and city compaction, a new architecture emerged in Chicago in the late-19th to early-20th century, recognised in the work of Louis Sullivan and William Jenney. Jenney is known for building the first skyscraper, the Home Insurance

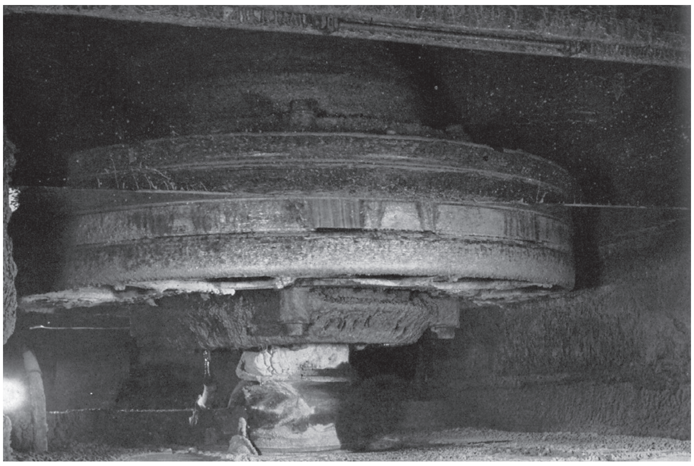
Building, in 1885. Glass sheets were used as an infill to the new multi-story steel framing systems.

In 1903, French artist and chemist, Édouard Bénédictus, invented laminated glass by accidentally dropping a beaker that once held cellulose nitrate and observing that it didn't break into pieces. The solution had formed a plastic coating around the glass so, when it cracked, it didn't shatter.

In 1914, just as World War 1 broke out, the Cologne Werkbund Exhibition opened to the public, featuring Bruno Taut's "Glass House". It was Taut's attempt to spark a new kind of architecture in glass, and its purpose was to demonstrate the potential of different types of glass for architecture. Glass was used on almost every surface. Plate glass benefited from techniques that developed after World War 1. The first development of the time was the Bicheroux process, in which glass was produced by squeezing it between two rollers prior to grinding and polishing. The result was less wasteful and proved to be a more efficient way of achieving a flat surface. The second development of the time was via the Ford Motor Company, with its interest in mass production in automotive glass.

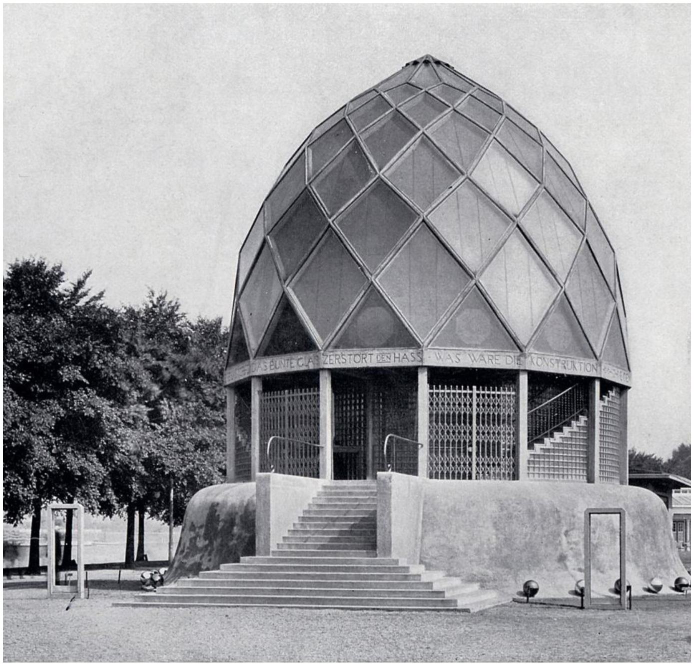


The Bicheroux Process, manufacturing rolled glass



A detail of an automated twin grinder machine, developed by Pilkington in 1938

Carson Pirie Scott store (Today the Sullivan Center), Louis Sullivan, Chicago, 1904



Glass House, Bruno Taut, 1914

Ford refined the process by inventing a continuous feed for the glass melt, rather than using pots, and mechanised the grinding and polishing process. Ford also produced a laminated safety glass introduced in ford cars in 1919. This new mechanised approach in glass production was soon picked up in England, and by 1923, experiments were taking place to try and produce plate glass using the Ford technique but in greater widths to serve the architectural industry. In 1938, Pilkington developed an automated twin grinder and polisher for architectural glass. The problems posed by the fragility of plate glass soon found a solution in the form of wire glass. Wire glass was essentially a sheet of plate glass with wire netting embedded into it. The glass could be textured and the wire netting could come in various patterns. Older forms of wire netting had an octagonal or hexagonal pattern (like chicken wire), whereas later forms had diamond or square wire patterns. In 1919, Walter Gropius established the Bauhaus, producing an architecture of glass walls for the new Bauhaus School of Art and Design, completed in 1926. The building was one of the first to utilise the curtain wall design system.

Post-World War 1, alongside the Bauhaus movement, the November Gruppe was established in Germany. A few of its members included Walter Gropius, Mies van der Rohe, Arthur Korn, Hans Richter and László Moholy-Nagy. The group inspired a new aesthetic way of thinking and compelled Mies van der Rohe to design glass towers. His first proposal came in 1919 as a competition entry, then another in 1922, which proved an incredible shift in architectural thinking, even if the glass technology to realise the projects was not yet available.

Just as plate glass became more readily available in the 1920s – 30s, so did the development of tempered glass. The phenomenon had, in fact, been known about since the Middle Ages, but as a glass-maker's game, rather than as a product. They recognised that if molten glass is dripped into water, it produces a tear drop which shatters into safe grains if the tail is broken. (Around 1870, Francois De la Bastie tried to produce a tempered glass by plunging red-hot glass into a bath of linseed oil and tallow, but the product was usually warped and hardly survived.)

In 1928, a French glass company produced "Securit" the first heat-strengthened glass. The production

Bauhaus School of Art, Design, and Architecture, Walter Gropius, Dessau, 1926

Glass brick by Falconnier

method involved the suspension of the glass in an electric furnace, followed by rapid cooling. Toughening glass, by whatever process, demands the five stages described below:

1. Forming and Working The stresses built up by heat-toughening make working on the glass post-process impossible. For this reason, edge grinding, polishing, hole formation, and cutting of any sort, must be carried out prior to toughening.
2. Washing Careful washing is essential to ensure that the glass enters the furnace clean.
3. Heating Carefully controlled heating is carried out in a furnace which is up to 80m long, heated to about 625°C. The glass is moved through the furnace over rollers and reaches the temperature of the furnace in a gradual and controlled way.
4. Quenching The glass leaves the furnace and moves into the quenching plant, which typically comprises of jets above and below the glass, blowing air at ambient temperature on to the glass surface. The higher the degree of toughening required, the faster the air flow.
5. Heat soaking After toughening, the glass is usually heat soaked at 290°C for several hours, to check the homogeneous quality of the material.

Skyscraper design, competition entry, for Friedrichstrasse in Berlin, Mies van der Rohe, 1919

The Seagram Building, Mies van der Rohe, New York, 1958

Thanks to heat-strengthening solutions, the late 1930s saw plate glass without framing widely used for shop window fronts and the curtain wall became a common design feature of many multi-story commercial buildings.

In 1952, Alastair Pilkington invented the float process, which became commercially viable in the 1960s. The float process solved a past problem of the bottom side of the glass needing to be polished. During the float process the glass is fed onto a bed of molten tin metal producing glass with a flat, smooth, and transparent surface. This allowed glass to become more economically viable and stock available, a precursor to the explosion of glass skyscrapers which dominated urban horizons in the following years.

The earliest tinted – as opposed to highly-coloured – glass used for its technical performance was the pale green glass first introduced in the USA in the 1930s. Its purpose was to reduce glare in car windscreens. Green glass is derived from reinstating the iron oxide that had already been removed in the purification process by re-adding it in very precise quantities. Iron oxide is very good at absorbing near-infrared photons,

Glass Tower by Mies van der Rohe was eventually realised in three-floor form in Foster Associates' Willis Faber & Dumas Building, built in 1975

Mies van der Rohe, Glass Tower project (view of lost model), 1922

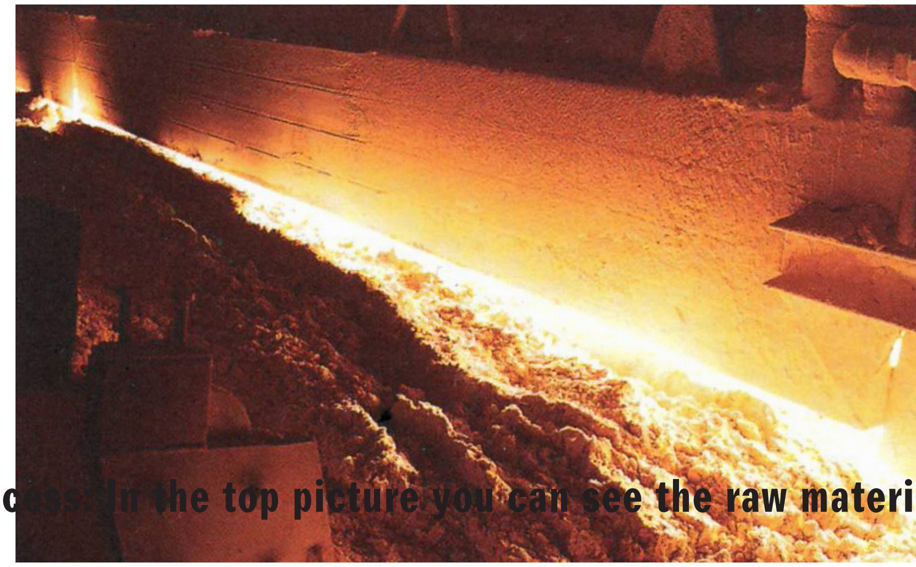
Lever House, SOM (Skidmore, Owings & Merrill), New York, 1952

reducing the transmission of solar heat. It wasn't long after that tinted glass appeared in architecture. One of the first glass skyscrapers to be built with tinted glass was Lever House, by SOM in New York, in 1952. It was made with pale green glass, allowing better solar control. The architecture was followed by The Seagram Building, by Mies van der Rohe in 1958, which was positioned opposite, and used bronze glass. On top of its heat absorption qualities, bronze glass was chosen to complement the bronze framework and façade, and varied in hue, depending on the time of day.
In the 1970s – 80s, glass atriums became an increasingly important architectural feature. Especially as the importance of energy design began to emerge. Northern climates utilised glass to enable naturally ventilated buildings with glass-covered spaces warmed by the sun. In 1980, Rice Francis Richie designed a four-way connector of glass panes, a system of spherical bearings and spring supports that connected the glass wall back to a cable truss system, itself designed to minimise the support structure. This revolutionised the idea of hanging glass walls from point fixings.

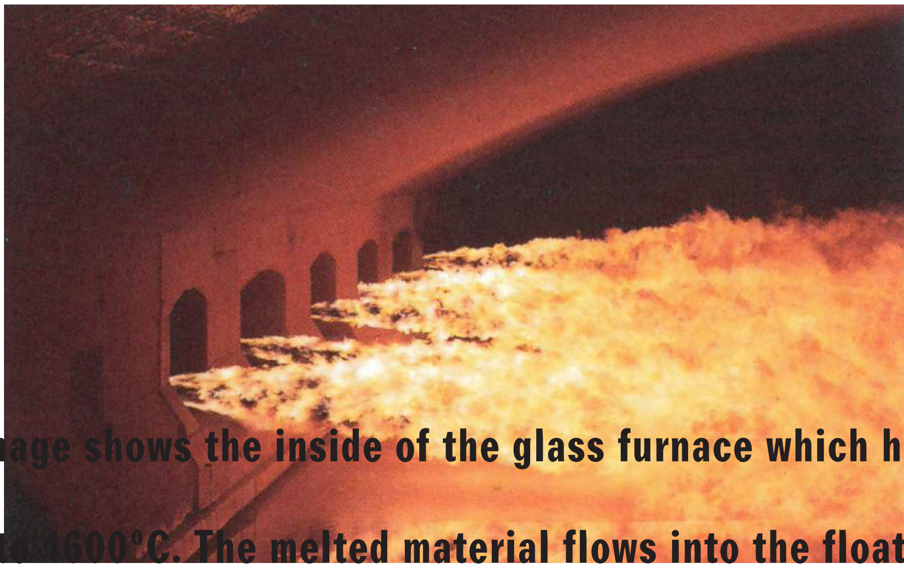
Float glass soon replaced plate glass as the process to make thick glass and by the mid-1980s, thirty years after its invention, Pilkington was producing thin sheets by the float process, thin enough to replace the material used by the automotive industry. The float process produces sheet glass by floating molten glass on molten tin, which has a much lower melt point. The process soon became fully automated (see diagram on page 86–87), lowering production costs, but the system needed to run continuously as stopping it resulted in the tin solidifying and the seizing up of the plant. However, today a new generation of short-run float plants is now in production. Another disadvantage of the float process is the time it takes to vary the colour of the glass. Tinted glass can take up to several days' worth of glass ribbon in order to achieve a uniform colour. These difficulties meant that for a building like a pyramid at the Louvre in Paris, the water-white glass was made via the old cast plate process. Today the float glass process is responsible for 90% of sheet glass production.

McGrath, Raymond, and A. C. Frost. Glass in Architecture and Decoration. Architectural Press, 1961.

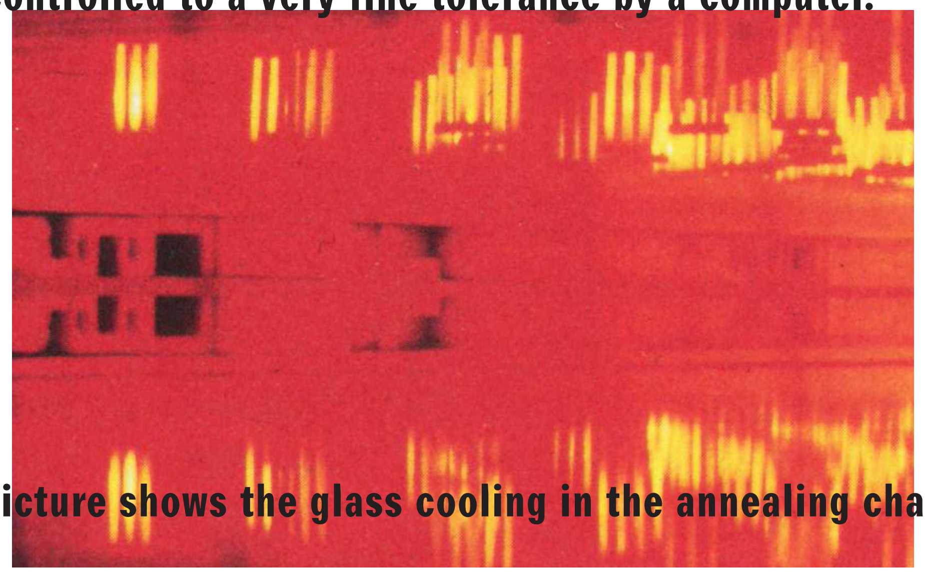
Wigginton, Michael. Glass in Architecture. Phaidon, 2004.



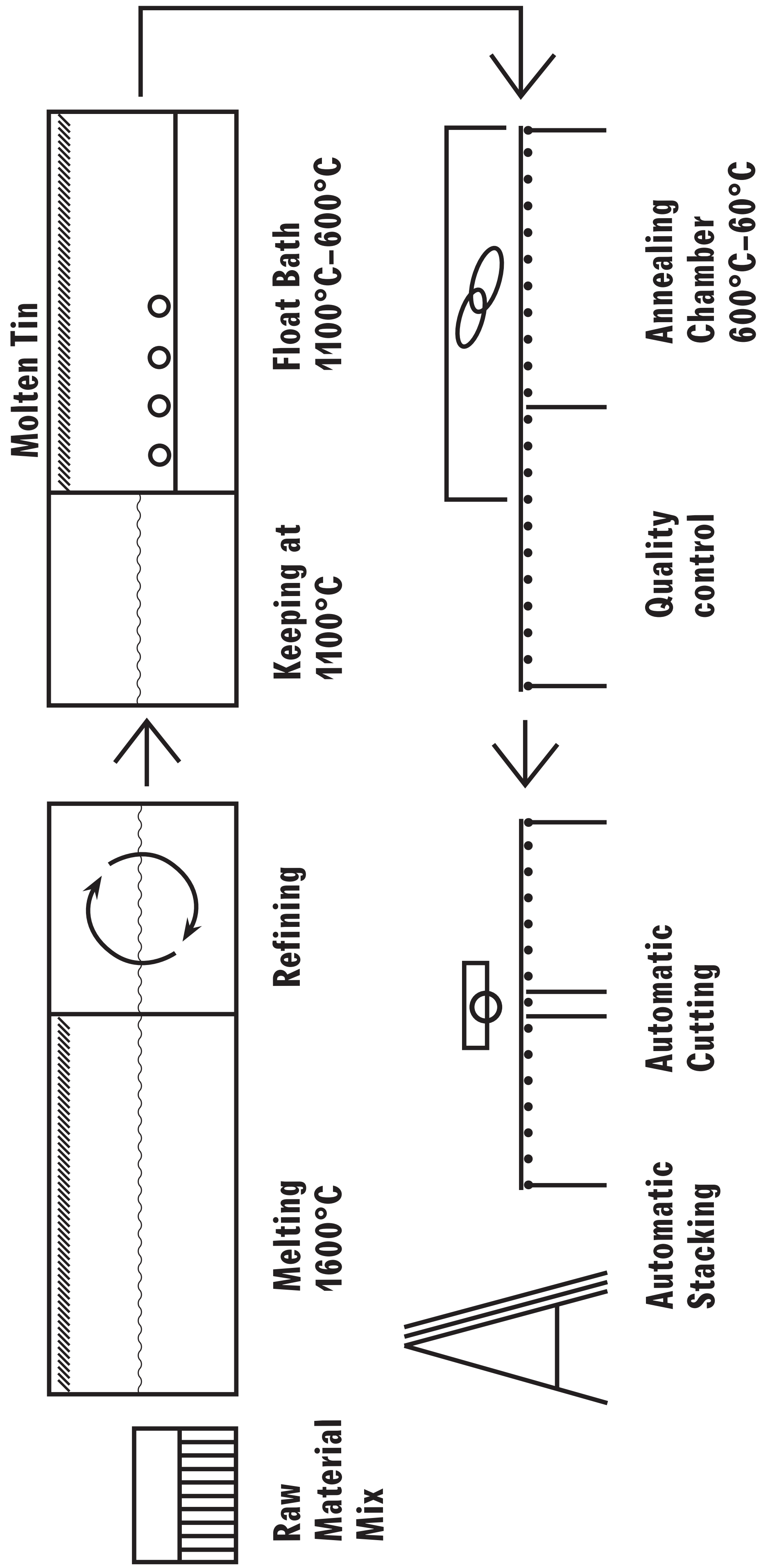
The float process. In the top picture you can see the raw materials in the hopper.



The middle image shows the inside of the glass furnace which heats the materials up to 1600°C. The melted material flows into the float bath where its depth is controlled to a very fine tolerance by a computer.



The bottom picture shows the glass cooling in the annealing chamber before processing to be automatically cut and stacked.



Automated float glass production

“Bring out the nature of the materials, let their nature intimately into your scheme.”

—Frank Lloyd Wright, Architectural Record, 1908

TECHNICAL UNDERSTANDING

CHEMICAL COMPOSITION

These are three core ingredients needed to make glass. They are mixed in the right proportions along with additives relating to the desired performance (see page 101), and with clean recycled glass. The entire batch is melted in a heated furnace before processing.

SILICA SAND

is composed of almost pure quartz grains, the primary constituent of sand. Quartz, or silicon dioxide (SiO_2), is the most common mineral found on the Earth's surface and is also found in rocks like granite, gneiss and sandstone.

CALCIUM OXIDE

is obtained by thermal decomposition of materials like limestone or seashells that contain calcium carbonate. It is generally recognised as burnt lime or quicklime.

SODIUM OXIDE

is not found primarily in nature, it is instead mostly produced through the reaction of sodium hydroxide with metallic sodium.

GLASS TYPES

SODA LIME GLASS

Soda lime is the most common glass type, its core ingredients being silica sand, calcium oxide and sodium oxide. It has a slight aqua hue and is used for sheet glass, light bulbs and containers. Soda lime glass is used in the float process to make float/annealed glass which can go on to be tempered for strength. The temperature strain point of this glass is 520ºC.

FUSED SILICA/QUARTZ GLASS

Fused silica is made from 99% silicon dioxide (SiO2). Because of this it has a high melting point, making it very resistant to thermal shock but expensive and difficult to produce as a primary melt glass. This type of glass is typically used for high technology applications like laboratory equipment. The temperature strain point of this glass is 987ºC.

BOROSILICATE GLASS

Borosilicate glass is highly resistant to thermal shock and chemical corrosion and is mainly used for lamps, laboratory equipment and domestic cooking utensils. This glass is generally supplied in a heat strengthened or toughened state.

The temperature strain point of this glass is 515°C. Fused silica and borosilicate glass are both resistant to thermal shock due to their low coefficient of thermal expansion, but fused silica is more shock and crack resistant under extreme temperature changes.

LEAD GLASS/CRYSTAL

Lead glass can have a slight green hue and has low melting and working temperatures. The quantity of lead oxide (PbO) can vary, and if above 80%, it can be used for radiation shielding. There are three primary criteria for crystal as established by the European Union in 1969: a lead content in excess of 24%, a density in excess of 2.90 and a reflective index of 1.545. Crystal is commonly used for precious glassware as it is more fragile than the other forms of glass. The usage of lead in the crystal makes the glass slightly heavier but soft and malleable, allowing it to be worked on more easily, forming more detailed patterns and designs than regular glass. Some clear crystals have the properties of reflecting light into different colours, creating a rainbow of hues.

ALUMINO SILICATE GLASS

The aluminium (Al_2O3) content of this glass is nearly ten times that of soda lime glass. Boric oxide is also present giving the glass a strong chemical durability. The most common type of glass fibre used in fibreglass is E-glass, which is an alumino-borosilicate glass.

SECONDARY PROCESSES & APPLICATIONS

FLOAT/ANNEALED GLASS

Float glass is made with soda lime glass via the float process (page 84). The glass is very flat, uniform and transparent with minimal optic distortion. Common applications include doors, windows, solar applications and shelves. It can be ultra-clear, clear, coloured, patterned or have wire set into it. It can be readily cut to size and shaped as needed, but splinters into sharp shards if broken.

HEAT-STRENGTHENED GLASS

All sheet glass including borosilicate can be heat-strengthened. Heat-strengthened glass is also known as semi-tempered or semi-toughened glass. To produce tempered glass, the cooling is much more rapid, thus creating higher surface compression. To produce heat-strengthened glass, the cooling is slower and the resultant compression in the glass is lower than fully tempered glass, but still higher than float glass, and shatters when broken in a similar way. Heat-strengthened glass is intended for general glazing, where additional strength is desired to withstand wind load and thermal stress. Heat-strengthened glass does not require the strength of fully tempered glass and is intended for applications that do not specifically require a safety glass product.

TEMPERED/TOUGHENED GLASS

The tempering process (described on page 82) increases the mechanical and thermal strength of float glass, making it historically four times as strong. Heat-strengthened and tempered glass may have glass roller wave distortion and bow caused by the strengthening process. Upon breaking, the pattern is unique in that it forms small cube-like pieces. Tempered glass cannot be worked on (cut, drilled, edge polished) after processing. Tempered glass, on the other hand, is best used for interior safety glass applications and as the façade glass for skyscrapers and commercial buildings with large windows.

LAMINATED GLASS

The basic principle behind laminated glass is its combination of glass with plastics via adhesion. There is a large range of laminated products to choose from, but the conventional manufacturing technique involves the use of a polyvinyl butyral (PVB) sheet. This sheet is sandwiched between two glass sheets and heated to 140°C with a pressure of 120 lb/sq in. The process turns the PVB into a clear tough adhesive layer. Laminated glass is five times stronger than float glass but not as strong as tempered glass. It is highly sound absorbant, and it and can be worked on after processing. Laminated glass is typically used in windows and doors requiring safety glazing, security glazing, ultraviolet filtering and hurricane impact-resistance.

MIRRORED GLASS

Until the middle of the 19th century, mirrors were made by floating glass onto tin foil coated with mercury. Then in 1840, patent silvering was discovered involving chemical deposition; a mix of silver nitrate and a reducing solution was poured onto well cleaned glass. With the emergence of thin film technology, mirrors can be made in a variety of ways, by handcraft or machine. A typical modern continuous silvering plant is an automated line of up to 100m long. A typical automated silvering process consists of: cutting > washing and polishing > tin oxide sensitising > silver nitrate coating > copper coating > drying > painting of protective coating > drying > baking at 120°C > cooling & washing. Architecturally, mirrored glass can be applied for reflective decorative purposes, such as façades. The glass can be tempered before the silvering application.

FIBREGLASS

Fibreglass is made from a drawn glass rod, usually around 0.01 – 0.1mm thick. When mixed with resins, it can be pressed into very strong complex forms with high tensile strength. The most common type of glass fibre is E-glass (Electrical/Chemical Resistance), which is an alumino-borosilicate glass and is used to make glass-reinforced plastics (GRP) and plaster. It is also commonly used in applications that require particularly high protection against acidic corrosion. In 1960, researchers identified a glass composition which was substantially resistant to the attack of alkali from Portland Cement which lead to glass fibre reinforced concrete (GFRC), a high strength fibreglass embedded in a complicated and cementitious matrix which is designed to anticipate stress behaviours. Fibreglass is widely used in bathtubs, boats, aircrafts, roofing, furniture and other form-giving applications.

GLASS WOOL

The glass used to make Glass Wool insulation is usually made from molten recycled soda lime glass dropped on to a rotating disc, or via an air stream. The glass then hardens into fibrous “wool”. fibreglass insulation takes its high thermal insulation properties from trapped air.

PURE SILICA GLASS

Silica occurs in nature as seven distinct polymorphs: quartz, cristobalite (cristobalite is found in volcanic sources almost always hosted by the natural glass rock obsidian), tridymite, coesite, stishovite, lechatelierite and opal. Quartz is one of the last minerals to crystalize from magma. Therefore, it is formed under conditions closer to present Earth-surface conditions than other minerals, which contributes to its high stability. Compared with other silica polymorphs, dense packing of the crystal structure and high activation energy required to alter the Si-O-Si bond are major factors contributing to the high stability of quartz. Quartz is present in essentially all soils and often constitutes the major portion of sand, coarse clay and silt. Opal is comprised of tiny silica spheres, formed when silica-rich water seeps into deep cracks and voids in the Earth’s crust. Opal is not uncommon, but, of these minerals, quartz is the most abundant in soil environments. Geologists examined tiny grains of the mineral zircon in samples found in Libyan desert glass, a form of lechatelierite, which formed 29 million years ago and is found over several thousand square kilometres in western Egypt, North of Gilf Kebir Plateau. Nearly pure silica, the canary yellow glass was famously used to make a scarab that is part of King Tut’s Pectoral. It has been a topic of ongoing debate as to whether the glass formed during meteorite impact, or during an airburst but the research points to the former presence of a high-pressure mineral named reidite, which only forms during a meteorite impact.

IMPURE SILICA GLASS

The first recorded use of obsidian dates to 1.5 million years ago, when it was used for prehistoric cutting instruments. In more recent times, it has been used for decorative purposes. Monuments, temples and churches throughout Asia and Europe have used volcanic rock for sculpture and decoration. Obsidian has a high silica content and is formed when rhyolitic magma with a low gas and water content quickly cools to form a solid without the time for a crystalline phase to develop, creating an isotropic glass. Natural glass objects of unknown origin were described in the tenth century in China and in the eighteenth century in Europe. Tektites have a high silica content and scientists believe that tektites are the product of a handful of the 170 terrestrial large-scale events in the geological record. Tektites have been found only in certain parts of the world, spread over large areas called strewn fields, mainly in low latitudes. The three major areas are south-east Asia (especially Thailand and the Philippines), Australasia; Caribbean-North America; and Ivory Coast, West Africa.

PROPERTIES

THERMAL CONDUCTIVITY

Thermal conductivity expresses how quickly heat is passed through a material, measured in W/m °C. The table on page 105 shows that glass is a fairly good heat insulator.

SOUND ABSORPTION

Single sheet glass is a poor sound insulator, while multiple layers and thicknesses provide good sound attenuation. Adequate spacing between layers with sound absorbing linings offer a very high level of absorption.

CHEMICAL AND WEATHER DURABILITY

Glass has a high resistance to chemical and weathering corrosion, making it a good material for laboratory or food containers where the absence of contamination is important.

DENSITY

Glass has a high density, which can aid in terms of sound insulation, but presents difficulties in handling, fixing and support due to its heavy weight.

FIRE RESISTANCE

Conventional window glass performs poorly in fire. For many years, the integration of wire as a way of obtaining structural integrity was the only way of providing resistance. Recent innovations include incorporating fire resistant interlays, which has transformed the potential of glazing as a fire barrier.

STRENGTH

Glass is a brittle material with wide-ranging strength capabilities. Materials are characterised by their elastic limit: the maximum extent to which a solid may be stretched without permanent alteration of size or shape, and their stiffness: the extent to which they resist changes of shape under stress. The diagram on page 107 shows the longitudinal elasticity, formally known as Young's Modulus (Young's Modulus is effectively the tensile stress necessary to double the length of the material involved, assuming it doesn't break). Glass has a Young's Modulus of around 70,000 MN/m^2, meaning its resistance to shape change under stress is quite good, similar to aluminium. The lack of homogeneity, or the presence of faults, in a material can significantly affect its ability to retain its shape when pressure is applied to it. The diagram shows the effect of stiffness: the resistance to a change in the length of a material when a stretching force is applied to it. The extension shown is what would occur in centimetres when a force of 0.1 GPa is applied to a piece of material 10m long. This is effectively 1000 × the reciprocal of the Young's Modulus. Glass is seen to be stiff: the problem arises as a result of its brittle nature, especially in a flat state.

HARDNESS

A mineral's hardness is a measure of its relative resistance to scratching, measured by scratching a mineral against another substance of known hardness on the Mohs Hardness Scale. The Moh scale, from 1 to 10, extends from talc (magnesium silicate) at 1 to diamond at 10. Quartz has a hardness of 7. Soda lime glass has a hardness of 5.4 – 5.8.

SOURCING

EU GLASS PRODUCTION

In the EU, Germany is the largest producer, followed by France and Italy, with Murano being one of the most highly renowned places for handcrafted techniques. This sector covers artisanal glass, container glass, domestic glass, special glass, reinforcement glass fibres and flat glass. BV Glas represents around 80 percent of the glass manufacturing companies in Germany and is a central point of contact for all questions relating to glass production. Saint-Gobain is a glass company producing and suppling window, facade, safety and decorative glass. Guardian Glass is one of the largest glass producers in the world.

bvglas.de
de.saint-gobain-building-glass.com
guardianglass.com

SILICA EXTRACTION

According to a report on the EU's list of Critical Raw Materials, published by the European Commission in 2020, the Netherlands is the largest source of silica sand in the EU (at 47% share), followed by Italy (12%) and France (8%). Although sand is a common raw material, most deposits are not pure enough for glass making. The sand deposits required by the glass industry are generally fossil beach, river, lake or wind deposit, due to their specific chemical and physical properties. Common beach sand is not suitable for the glass industry because of the presence of salt and shells, and due to the thickness of its particles. In almost all cases, silica mining uses open pit or dredging mining methods with standard mining equipment.

RECYCLED GLASS/CULLET

The use of recycled crushed glass, called cullet, as an alternative to sand as a source of silica has proved to be an efficient way to reduce CO_2 emissions from flat glass manufacturing, as the use of recycled glass decreases the melting temperature needed to melt the mix. Over the last decade, the European flat glass sector has increased the share of cullet in its batch from 20% to 26% and it is estimated that in a maximum recycling scenario, as presented in the EU's 2050 vision, an improved collection of end-of-life building glass in Europe would increase this ratio to 37%. The recycling process begins with a pre-treatment process which removes any paper or plastic using blown air. Any metal objects are removed with magnets. Next, it is sorted by colour and washed to remove any further impurities, then crushed to make cullet. From this, it can be melted and moulded into new products such as bottles and jars. Due to the permanent capacity of glass material, glass packaging can be endlessly recycled with no quality degradation during the processing and melting phases. This makes glass a genuine circular product. Container glass – including jars, bottles and other containers – cause no problems when recycled and this forms the majority of cullet. Other common glass items, such as lead crystal, ovenware and drinking glasses cannot be recycled back into flat or other soda-lime-silicate glasses.

GLASS RESEARCH AT THE ETH

ETH researchers used a 3D printing process to produce complex and highly porous glass objects. The basis for this is a special resin that can be cured with UV light. Only a few groups of researchers around the world have attempted to produce glass using additive methods. Some have made objects by printing molten glass, but the disadvantage is that this requires extremely high temperatures and heat-resistant equipment. Others have used powdered ceramic particles that can be printed at room temperature and then sintered later to create glass. However, objects produced in this way are not very complex. Researchers from ETH Zurich have now used a new technique to produce complex glass objects with 3D printing. (See page 108.) The method is based on stereolithography, one of the first 3D printing techniques developed during the 1980s. David Moore, Lorenzo Barbera, and Kunal Masania, in the Complex Materials group led by ETH processor André Studart, have developed a special resin that contains a plastic, and organic molecules to which glass precursors are bonded. The resin can be processed using commercially available Digital Light Processing technology. This involves irradiating the resin with UV light patterns. Wherever the light strikes the resin, it hardens because the light sensitive components of the polymer resin cross link at the exposed points. The plastic monomers combine to form a labyrinth-like structure, creating the polymer. The ceramic-bearing molecules fill the interstices of this labyrinth. An object can thus be built up layer by layer. ethz.ch/en/news-and-events/eth-news/news/2019/11/glass-from-a-3d-printer

COLDWORKING

Coldworking refers to processes that change the shape or surface texture of glass using tools and processes that do not rely on heat.

CUTTING & DRILLING

Many different kinds of saws are used to cut glass, but they all include a diamond coated blade which runs through water as it cuts, and acts as a coolant. Drilling or sawing glass usually creates chips on the underside. Attaching the piece to be drilled or sawn to another piece of glass, with wax or double-sided tape, minimises chipping. To drill holes in glass, a diamond coated drill bit should be used. Alternatively you can sandblast holes in glass.

SANDBLASTING & ETCHING

Sandblasting consists of spraying abrasive sand (either Aluminum Oxide or Silicon Carbide) towards the glass surface, in order to achieve a matt satin texture. A “resist” material is applied to the glass and the desired pattern or design is cut into the resist and removed to expose the part of the glass to be sandblasted. Various kinds of vinyl and rubber are available, especially for sandblasting. For small simple blasts, masking tape or painter’s tape can suffice. There are different sandblasting methods used to create different effects, such as: Surface Etching which creates a uniform texture, Shadow Etching which builds a gradient design, or Deep Carving which uses a higher pressure to create deeper etchings or reveal under layers of glass. It is also possible to etch glass using a “Glass Etching Cream”, which is acidic.

GRINDING & POLISHING

Most professional glass artisans consider the Wet Belt Sander to be the most valuable coldworking tool, alongside hand-held diamond files, which are used to reach into difficult angles. It can be used to smooth sharp edges, produce a straight edge and curve corners. Belt sanders are available in a variety that will facilitate a range of work, from slicing off large amounts of glass to applying a full polish. It is possible to use cork, diamond, felt, or silicon carbide belts on a wet belt sander. Diamond belts work fastest but are expensive. Most commonly, artisans use silicon carbide for grinding and cork or felt for polishing. In case of a larger project, a lap grinder can be used. A common order of grit to use when sanding glass starts at 80 and finishes at 600 grit. The glass can then be passed with cork, which will leave a semi-gloss finish, and finally with felt and cerium oxide to produce a complete sheen polish finish.

GLUING

Which glue to use depends on the surface of the glass. UV cure glue provides the best bond but is only reliable when used on a fully polished and clean surface. Epoxy or Silicone are better choices for a less-than-fully-smooth surface.

LOCAL GLASS COMPANIES

GLASS SUPPLIER
Glas Trösch AG, Oberkulm branch
Grosssteinengasse 1
CH-5727 Oberkulm
oberkulm@glastroesch.ch
glastroesch.com

FLOAT GLASS PRODUCTION PLANT
Euroglas S.A
Z.I. de Hombourg
F-68490 Hombourg
hombourg@euroglas.com
glastroesch.com

GLASS WORKSHOPS
Glassworks Matteo Gonet GmbH
Tramstrasse 66 (Halle 34)
CH-4142 Münchenstein
info@matteogonet.com
matteogonet.allyou.net

Niesenglass Switzerland GmbH
Eichzun 4
3800 Unterseen / Interlaken Schweiz
info@niesenglass.ch
niesenglass.ch

OFFCUT MATERIAL SHOP: COLOURED GLASS
Offcut
Hohlstrasse 418
8048 Zurich
offcut.ch

GLASS WORKSHOP, INCLUDING LARGE SCALE GLASS CASTING
(last to remain in Switzerland)
Hergiswiler Glas AG
Seestrasse 12
6052 Hergiswil am See
+41 41 632 32 32
info@glasi.ch
glasi.ch

THERMOFORMING / SLUMPING
At the chair of Digital Building Technologies our design studio has access to a small glass kiln. Please see page 104 for table on molding materials that can be used for this process.

SMALL SCALE GLASS CASTING
Kunstgiesserei St.Gallen AG
Sittertalstrasse 34
produktion@kunstgiesserei.ch
kunstgiesserei.ch

STAINED GLASS WORKSHOP
Glas Mader & Co. AG
Loostrasse 3, 8803 Rüschlikon
+41 (0)44 299
info@glas-maeder.ch
glas-maeder.ch

GLASS RECYCLING / GLASS CULLET
SPROSS
Zurich recycling plant
Hohlstrasse 330
Zurich
+41 (0)43 333 33 22
entsorgung@spross.com
spross.com

Quartz/Silica Sand/Silicon Dioxide (SiO_2)

Calcium Oxide (CaO)

Sodium Oxide (Na_2O)

Numbers in percentages %

		PbO	BaO	B_2O_3	SiO_2	H_20
Mechanical Function	Fused Silica				99.9	0.1
	Borosilicate			13	81	0.03
	Alumino Silicate		6	5	62/57	0.03
	Fluorescent Tube		0.8		71.4	0.03
	Container				72.8	0.03
Transmision Function	Lead	29/82		0.0/11	57/3	0.03
	Clear Soda Lime				73	0.03
	Green				73	0.03
	Blue / Green				73	0.03
	Auto. Bronze				73	0.03
	Arch. Bronze				73	0.03

Chemical composition of the most common glass types

Na_2O	K_2O	Al_2O_3	CaO	MgO	FeO/ Fe_2O_3	Co_2O_4	Se
4	0.4	2.5					
1	16	9	7				
15	1.7	2.2	4.6	3.9			
14.5	1.7	10.5					
4	8.5/9	1/2					
13.1/17	0/0.5	1.3	5/8.4	4/3	0.1		
15.9	0.3	1.3	6.5	3	0.5		
15.9	0.3	1.3	6.5	3	0.5	0.0005	
15.9	0.3	1.3	6.5	3	0.39	0.0008	0.0012
15.9	0.3	1.3	6.5	3	0.3	0.0040	0.0012

Molding Materials (Slumping at 675°C–800°C)

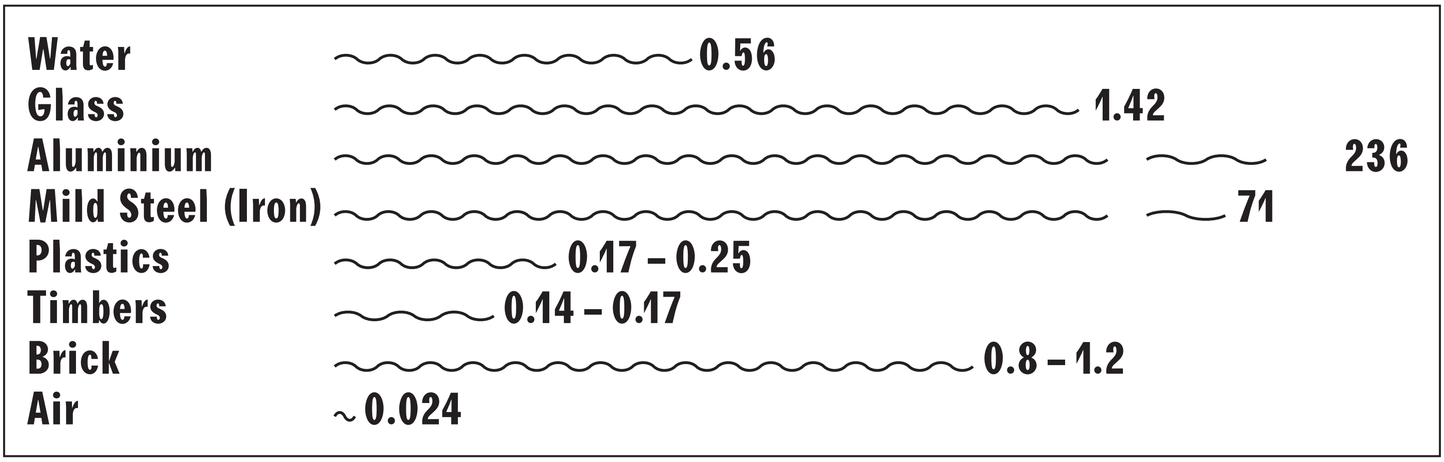
Mold material type	Preparation steps	Mold making duration	Surface properties	Module condition	Coating	Supplier/ Product
COMMON PRACTICE						
Heat-resistant plaster	Casting with mold (e.g. styrofoam, cardboard and foil, lost wax, etc.)	3 days (casting and drying)	Smooth, high-res	Custom	Bullseye Shelf Primer	creativeglassshop.ch/de
Heat-resistant concrete (Vermiculite, Fondue cement, metal reinforcement)	Casting/ forming with mold	3 days (casting and drying)	Rough, textured	Custom	Bullseye Shelf Primer	Fondue cement: imerys.com Vermiculite: perlipol.com.pl Metal mesh: Baumarkt *Watch out long delivery times!
Ceramics (custom)	Shaped by hand	3 days (casting and drying)	Smooth, depending on shaping method	Custom	Bullseye Shelf Primer	keramikbedarf.ch
Ceramics (prefab modules)	None, assembly only	None, assembly only	Varies	Rectangular or prisms	Bullseye Shelf Primer	keramikbedarf.ch
Chromsteel[1]	Assembly	1/2 day (Cutting of elements)	Smooth, edgy	Modules (pipes, profiles, meshes..)	None	Metal shop
UNCOMMON PRACTICE						
Sand	None (remove dirt)	None, only the shaping process	Smooth	Granules	None	Nature/site or water department of ETH[2]
Gravel	None (remove dirt)	None, only the shaping process	Rough, textured	Granules	None	Nature/site or water department of ETH[2]
Rocks	None (remove dirt)	None, only the shaping process	Rough, textured	Granules	None	Nature/site or water department of ETH[2]

[1] Do not use normal steel or other types of metal, also not galvanized metals (only for reinforcement not in touch with the glass)
[2] They have an amazing collection of gravel and rocks to test water flow in river beds

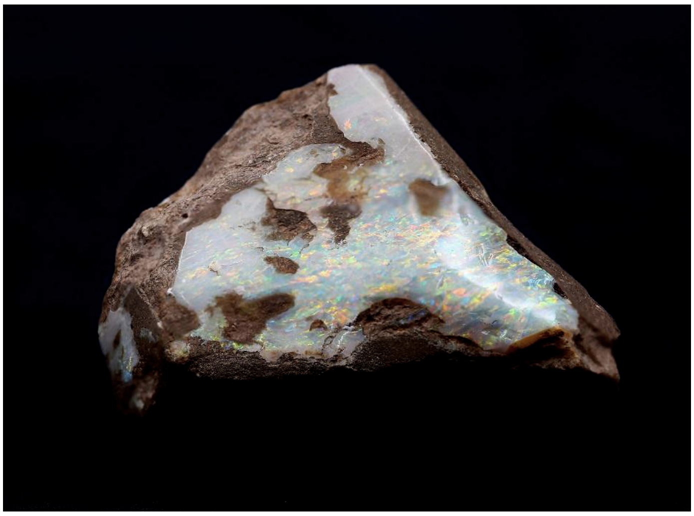
Base material/coating for kiln base plate
Glass fiber paper: creativeglassshop.ch/en/ceramic-fibres/5358-ceramic-fibre-paper-2mm-roll-20x1m.html
Bullseye Shelf Primer: keramikbedarf.ch/michel/katalog/k1/katalog_frame.asp

Blue / Green	Iron (II) Oxide	FeO
Green	Chromium Oxide	Cr_2O_3
Blue	Cobalt Oxide	CoO
Light blue	Cubric Oxide	CuO
Red	Cuprous Oxide	Cu_2O
Brown	Iron (III) Oxide	Fe_2O_3
Pink	Selenium	Se
Yellow	Uranium Oxide	UO_2

Chemical additives to achieve colour



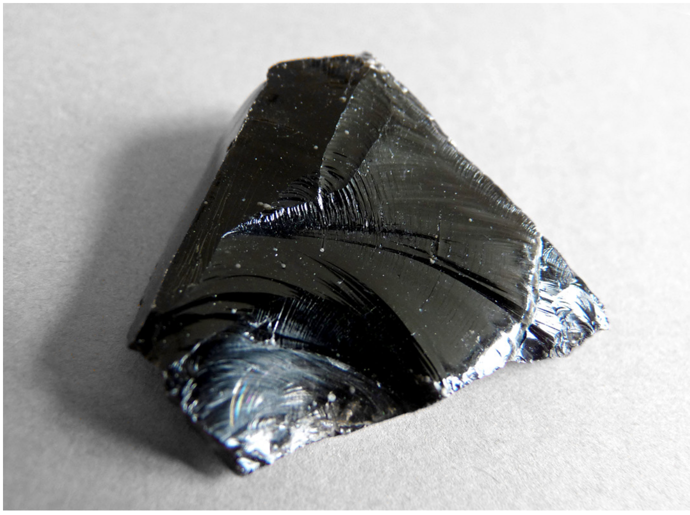
Thermal conductivity



Opal present in a host rock (pure)

Quartz (pure)

Lechatelerite (pure)



Obsedian (impure)

Tektite (impure)

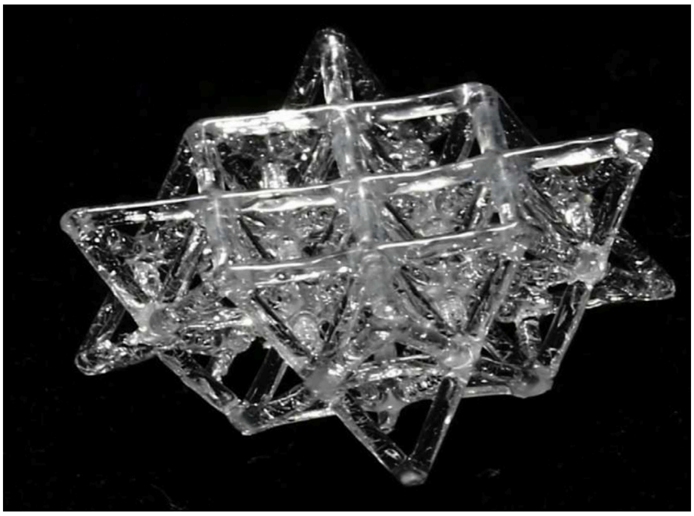
10m

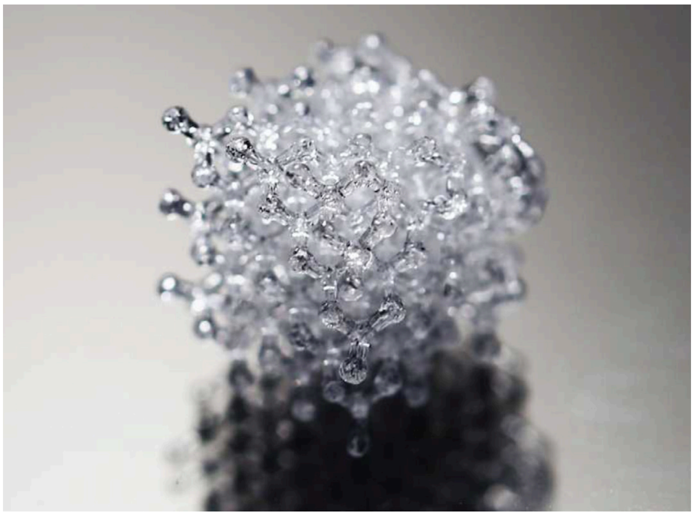
Glass	13.51 to 14.49
Aluminium	14.29
Mild steel (Iron)	4.72
Plastics	250 to 420
Timber	62.5 to 90.91

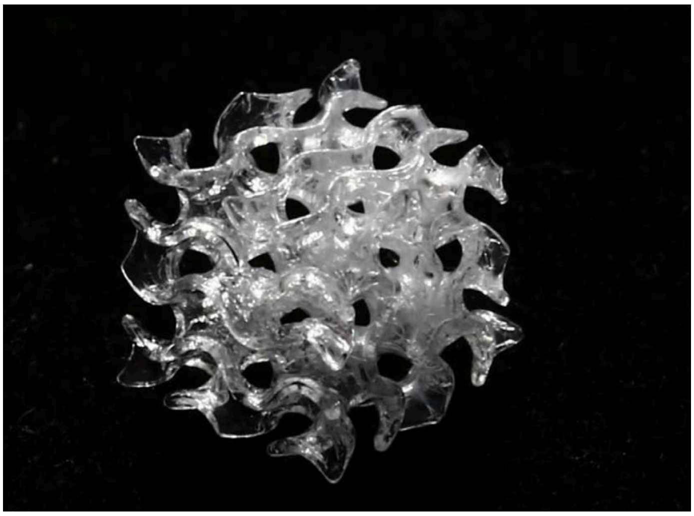
Young's Modulus: the effect of stiffness

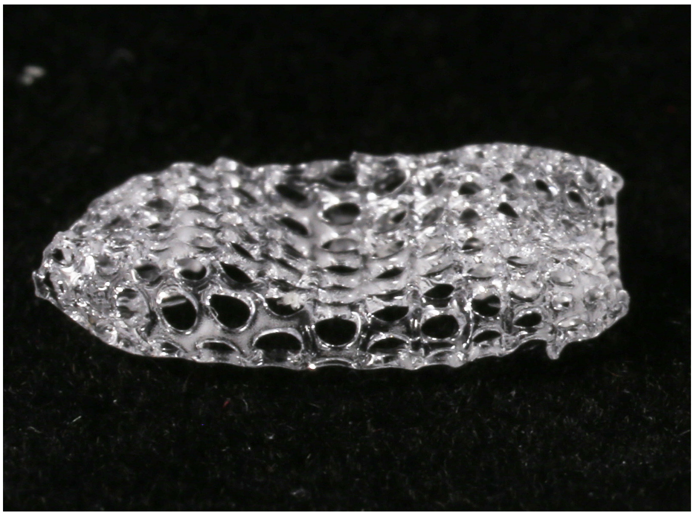

Owned by Imerys, Dordogne, France.

Silica Extraction Site









3D Printed Glass Objects (ETH)

“The history of architecture is the history of the window”

—Le Corbusier

FIVE CORE TECHNIQUES

1. GLASS BLOWING

Before starting the glass blowing process, the glass is placed in a furnace that heats it to a temperature of 1400 – 1600°C (depending on the type of glass used), making it soft and malleable. Next, the glass is gathered by inserting one end of the blowpipe into the furnace and rolling it over the molten glass until a "gob" of glass attaches to it. The next step is to roll the molten glass on a flat metal slab called a marver. The marver acts as a way of controlling the shape and temperature of the glass. The glass is taken back and forth from the marver to the glory hole, a hot chamber used to reheat the glass, in order to make it malleable again. To give the glass colour and design, the "gob" can be dipped in crushed coloured glass. After colouring, it is taken back to the marver where it is rolled again. To give the glass its final shape and size, it is blown into with a blowpipe, creating a sort of bubble of glass, and manipulated using a range of tools, such as a cast iron cupping tool, folded wet newspapers and wooden boards. To carry out this process, the blowpipe holding the glass must be placed on a steel stand. Then, the glass artist has to blow into the blowpipe while rotating it at the same time. Throughout this process, the glass needs to be continuously taken to the glory hole to be reheated because blowing it cools it very quickly. The final step is to remove the glass from the glass pipe. To do this, steel tweezers called jacks are used to separate the bottom part of the blown glass while rotating the blowpipe. Thanks to the separation with the jacks, the glass can be removed from the blowpipe with one solid tap. The last step is to take the blown glass to an annealing oven, which allows the glass to cool slowly over several hours, as it is highly perceptive to cracking when exposed to rapid temperature changes.

BLOW MOULDING A gob of molten glass is gathered onto the opposite end of the blowpipe and a little air is blown into it through the tube. This preliminary shape is then lowered into a mould and inflated by blowing until it has assumed the desired shape and pattern of the mould. The

mould may be constructed from one disposable piece, in which case it is broken off the glass piece, or it may be made from two pieces and able to open, which allows the mould to be removed and reused.

2. CASTING

KILN CASTING is the process of heating glass above or inside a refractory mould until it melts and fills the void. First, the mould is placed in a kiln and filled with pieces of glass (normally recycled glass). The furnace is heated gradually, up to 1400°C. At this temperature, the glass melts and fills the mould, and bubbles rise to the top. The furnace is then gradually cooled, over about 12 – 14 hours to prevent the glass from cracking. Once at room temperature, the mould can be removed leaving the cast which has taken the shape and texture of the mould. There are two types of moulds that can be used in kiln casting: open-faced or closed/semi-closed. When using an open-faced mould, your finished piece will be a reverse-relief, bas-relief, pâte de verre, thick-block or box castings. When using closed or semi-closed moulds, you will be able to make full sculptural pieces.

SAND CASTING When sand casting, a design is placed or carved into treated serpentine sand to create a mould. Then, using a ladle of molten hot glass, the glass is poured into the sand mould and given time to cool. Once the glass is cool to touch, the sand can be pulled away to reveal a solidified casting with a rough textural finish, which can then be polished.

LOST WAX CASTING Using this method of glass casting captures finer details. First a design is created in wax before building a mould around it. The wax can be shaped with texturing tools, in order to effectively sculpt and carve unique designs in wax. For the mould that goes around the wax, it is possible to create your own by combining equal measures of plaster and silica. Plaster gives the mould support and silica has a high refractory, so it can withstand a lot of heat. After embedding the shape into the mould mix and allowing it to set, the piece is heated which melts the wax inside, leaving a cavity inside. It is then placed into a kiln and heated, where, at the right temperature, molten glass flows from a reservoir into the mould. The critical stage of the process occurs as the glass cools and the molecules bond together and the glass anneals, which prevents possible breakage in the future. In this way, the annealing phase (controlled cooling) takes days if not weeks, depending on the size of the sculpture.

3. THERMOFORMING / SLUMPING

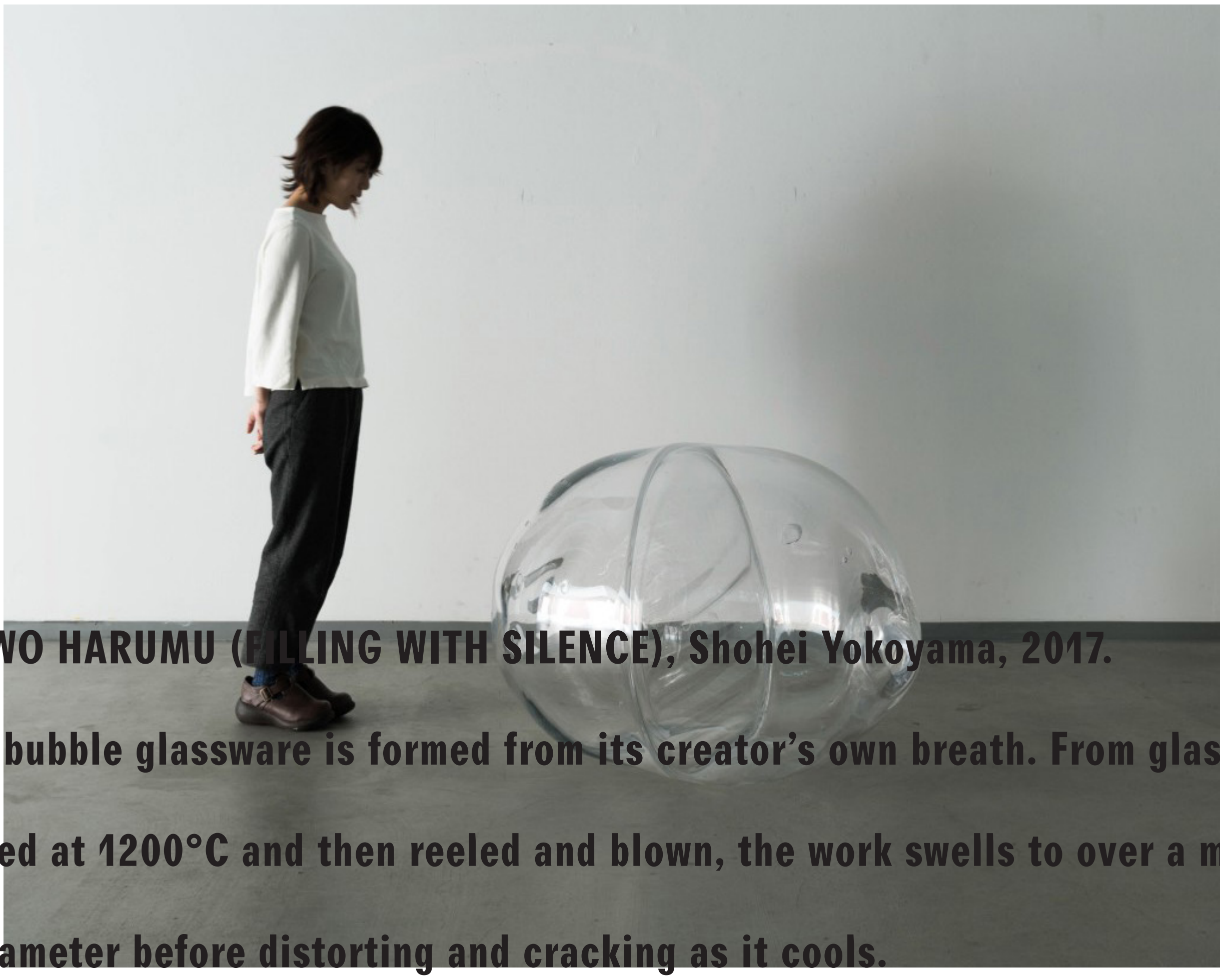
Thermoformed glass is glass that has been heated to a temperature where it becomes soft and then moulded via gravity over a shape, in order to form it and give it a texture. It is a process that is better suited for making flatter objects, such as glass countertops, tables and related materials. First, a mould is made usually in iron, stainless steel or refractory ceramic. The glass panels are then cut to a size slightly larger than the mould. Once the glass is cut, it is brought to a kiln and placed on top of its relative mould. The kiln is heated to about 843°C and the glass starts to soften thus taking the shape and texture of the mould it is placed on top of.

4. POURED GLASS

It is possible to pour glass in a range of decorative ways. One such technique is called Trailing, where the worker pours glass threads, often in a contrasting colour, around a free-blown glass shape as it spins.

5. FUSING

Fusing is the bonding of compatible glass pieces together via heat, at around 818°C, and gravity in a kiln. You can fuse stacks of glass together or glass pieces cut and placed side by side, which allows the possibility of cutting the glass pieces into intricate designs.



SEI WO HARUMU (FILLING WITH SILENCE), Shohei Yokoyama, 2017.

This bubble glassware is formed from its creator's own breath. From glass melted at 1200°C and then reeled and blown, the work swells to over a metre in diameter before distorting and cracking as it cools.

CAST GLASS TABLE, Bethan Laura Wood, produced by Wonderglass, Venice, 2020

Thermoformed black glass panelling produced by ATELIER BARROIS for

a private residence by Pierre Yovanovitch, 2018

READER

THE ARCHITECTURE OF LIGHT: RECENT APPROACHES TO DESIGNING WITH NATURAL LIGHT
Mary Ann
Steane Routledge, 2011

Excerpt of chapter 1:
Speaking of light, speaking with light.

In this excerpt Steane writes on the use of natural light and window design in the project Une Petite Maison by Le Corbusier. Examining the importance of natural light design in applying a strong orientation and involvement to the site, writing "As the windows are openings in their walls, so is the house in its site, and so is the lake in its landscape".

Chapter 1

Speaking of light, speaking with light

Le Corbusier's 'carnets de recherche patiente', *Une Petite Maison*[1] and *La Chapelle de Ronchamp*[2]

> As you can imagine, I use light freely; light for me is the fundamental basis of architecture. I compose with light.[3]

It is not easy to summarize Le Corbusier's architecture of light. Despite the fact that several of his most famous assertions about architecture concern light, he rarely discusses the topic in detail and his own photographs of his buildings are almost always in black and white. Moreover, through the course of his long career his ideas about light changed, even if its orchestration remained a central concern. This evolution was quite radical. His buildings move from a very general luminosity keyed to the tonalities of purist painting (the early houses like Villa Savoye, Villa La Roche-Jeanneret, the Atelier Ozenfant) to an approach in his late work where all the key spaces are dark (Ronchamp, La Tourette, Chandigarh), as the colours of his paintings became ever more vivid and the materiality of the buildings more attuned to the earth. In other words, while physical and spatial lightness were celebrated initially as a sign of health and modernity, his later pursuit of *l'espace indicible* prompted a bolder exploration of how shadow structures luminosity. This spectrum of design approaches and therefore of 'compositions in light' is well represented by the differences between the lighting strategies of the Villa du Lac Léman (1925, also known as La Petite Maison) and the chapel at Ronchamp (1950–1954). Fortunately, these are also projects whose design history was examined at length by Le Corbusier himself. His publication in the mid-1950s of extended photographic essays on both buildings, his 'carnets de recherche patiente' (just before and just after the 1955 publication in which the mythic themes of his late work are set out, *Le Poème de L'Angle Droit*[4]), suggest that in his mind each of these projects had a comparable significance. As documents that present the detailed analysis of his own design process in the form of an oblique yet grounded manifesto of his architectural philosophy, they would seem to provide a useful vehicle for examining his evolving arguments in light.

In the first two decades of the twentieth century the introduction of framing systems in reinforced concrete and steel meant that the use of thin, non-load-bearing external walls for masonry buildings became a possibility for European architects, even in small-scale urban projects. Not only did this dramatically change the potential appearance of a wall but also the very idea of a window. Windows no longer had to be holes in substantial walls whose size was constrained by constructional issues. Openings lost their depth and the relationship of interior and exterior was thrown into question. When whole walls could be made of glass, how an exterior view might be framed and how much light it was sensible to admit became subjects for discussion rather than assumptions based on long experience. And just as significantly the major ordering role that fenestration had previously played in masonry buildings no longer had relevance. Le Corbusier's initial reaction to this freedom of choice was to develop a vocabulary of different window shapes and sizes for different room types that reflected contemporary assumptions about what levels of illumination were appropriate in different areas.[5] While internal spaces like closets or bathrooms were frequently given roof-lights, small rectangular or square windows were used for spaces like corridors or staircases in which light levels did not need to be high. Where a greater amount of light was required, as in 'front of house' reception spaces like living rooms and galleries, and the grand domestic workspaces of Le Corbusier's laboratory-like kitchens, long horizontal windows, the famous *fenêtres en longueur*, stretched the entire width of a room. And where the highest levels of illumination were expected, *pans-de-verre*, walls entirely of glass (supplemented on occasion by additional roof-lights) were used to light entrance halls, offices and studios. Employing this vocabulary meant not only that his facades could be read but that a greater range of illumination levels and spatial moods became possible. As Le Corbusier optimistically declared, the windows of the new architecture would succeed in chasing nineteenth-century dirt and shadows away by giving access to the 'essential joys' of light, space and greenery.

In Le Corbusier's early distillation of the design principles of modernism two different perspectives on light emerge. The first of these, which concentrates on architecture as an illuminated object viewed statically at a distance, was epitomized in his messianic statement 'Architecture is the learned game, correct and magnificent, of forms assembled in light'[6]. Though less easily summarized, the second has an equally important place in his thinking: light's impact on the way buildings are encountered sequentially, as a series of visual (and ultimately tactile) experiences. The following collection of statements, first published in *Précisions* in 1930 give the best sense of this alternative outlook:

> To create architecture *is to put in order.*
> Put what in order? ... Functions and objects. To occupy space with buildings and roads. To create containers to shelter people and useful transportation to get to them. To act on our minds by the cleverness of the solutions, on our senses by the forms proposed and by the distances we are obliged to walk. To move by the play of perceptions to which we are sensitive, and which we cannot avoid. Spaces, dimensions and forms, interior spaces and interior forms, interior pathways and exterior forms and exterior spaces – quantities, weights, distances, atmospheres, it is with these we act. Such are the events involved.[7]
>
> ... Then by the opening of windows (the holes made by the windows are one of the essential elements of the reading of an architectural work), by the opening of windows an important play of secondary surfaces is begun, releasing rhythms, dimensions, tempos of architecture ... inside the house and outside.[8]
>
> Consider then the capital importance of the point where you open a window; study the way that light is received by the walls of a room. Here, in truth, an important game of architecture is played, on this the decisive architectural impressions depend.[9]

The first perspective makes light integral to the 'viewing' of building, implying that architecture can be visualized as a set of stable heroic forms in the universal illumination provided by a Beaux-Arts rendering of strong sunlight. The second reveals a much more practical, engaged position, and suggests instead that how light is handled is key to the architect's role as choreographer of events which decide the 'distances and atmospheres', the 'rhythms, dimensions and tempos' of everyday life. Here it is the significance of the dynamic play of real light to the unfolding of a building as a lived *promenade architecturale* that is given prominence. Light is something to be structured rather than accepted as a given. As an evocation of design thinking (the exploration of relationships in light) rather than an assertion about ideal form, it is perhaps sensible to consider his subsequent declaration, 'As you can imagine, I use light freely; light for me is the fundamental basis of architecture. I compose with light',[10] as a bridge between the two positions.

Une Petite Maison

First published in 1954, *Une Petite Maison* outlines the history of the small house Le Corbusier constructed for his parents on the northern shore of Lake Léman between 1920 and 1925. The embeddedness of the house in its site, both locally and with respect to the wider topography, and its measured orchestration of daily and seasonal life are the key themes of the book, and themes to which the lighting strategy is intimately linked.

The windows of La Petite Maison

A tightly dimensioned rectangle 4m × 15m, the plan of the house is centred on a long horizontal window, 'the primary actor of the house',[11] which commands a view southwards over Lake Léman towards a range of Alpine peaks. As Le Corbusier explains, it is this window that both orders the spatial field of the *plan libre* and keys it to the landscape and its glittering light: 'One single window 11 metres long unites and lights all the elements, making the majesty of the magnificent site enter into the house: the lake with its movement, the Alps with their miraculous light.'[12] For him this window marries the house to the landscape because it structures the view: throwing into prominence the landscape's major horizontal, the line where lake and mountain meet. In working out its section and choosing its dimensions he points out that the framing of the view, the moderation of natural light and aspects of the building's theatre of occupation have been considered together (reference is made to the rhythm of the mullions, sill and lintel height, the size of the opening lights, the inclusion and careful placement of a curtain rod and an exterior roller-shutter). The important role it plays in structuring daily life is given further emphasis in the only double-page spread of the entire book, an image which focuses on its provision of side-light for the main dining table[13] (*Une Petite Maison*, pp. 32–33) and in two of the drawings with which the book ends. The first of these locates the dining table in front of the view (*Une Petite Maison*, pp. 70–71, the view south across the living room), while the second, which focuses more strongly on the distribution of light and shadow, locates the public reception spaces of the living room and the guest room in front of the lake and its light (the view east down the living room, *Une Petite Maison*, pp. 72–73). In a sense, what Le Corbusier seems to be arguing throughout is that the house is the space of this window, or perhaps more precisely, the careful layering and sequencing of space and light it determines.

Of course the project does have other windows, both in the house and the garden, and the book makes clear that their place in the scheme of things also matters. A range of rectangular openings, they may be divided into five groups as follows:[14] an upper clerestory window and a glazed door in the house's short eastern facade; a series of windows in the northern and western facades that share the same sill and lintel heights as the main *fenêtre en longueur*, a group of three small lower-level openings to the *cave*; a number of roof-lights of more or less prominence in the diminutive landscape that is the building's planted roof terrace; and the 'windows' in the garden walls. Of these groups, only the third is not given an explicit role in the argument.[15]

The first of these other windows to receive comment is the clerestory of the guest room. Located above the main soffit beside a raised section of sloping ceiling, the lantern it creates is the only disruption of the section's orthogonal geometry. Pointedly, it is the 'awakening' it achieves in capturing morning sunlight that is emphasized. Below it stands the glazed door that links the garden room and the living space of the house. While not singled out in the text, the fact that in the promenade described by the photographs the reader enters and leaves through this 'back' door, suggests its pivotal significance to Le Corbusier. The drawing of the house's end wall (the view from the garden room, *Une Petite Maison*, p. 67) depicts it as part of an extended threshold that structures the transition between interior and exterior, one element of a small theatrical setting[16] whose use as an alfresco dining space is confirmed in the photographs entitled 'The door onto the garden, three steps, shelter' (Fig. 1.8).[17]

As it turns out, the apparently insignificant windows to the *cave* structure one of the book's most enigmatic and critical images. Entitled 'Architecture', this photograph depicts a corner of the garden (*Une Petite Maison*, p. 38 [Fig. 1.7]). On a sunlit gravelled surface a rustic bench is aligned with the white wall of the house, a wall in which two low horizontal openings are visible. The top surface of the bench leads the eye towards a shadowy stair that climbs upwards in the space between the corner of the house and an ivy-covered wall. It is an image that can be read in two ways. First, as a visual statement comparable to that about the significance of the curtain pole, Le Corbusier is reiterating that architecture locates the theatre of everyday life, giving it an appropriate human scale (dining, conversing, or in this case, sunbathing). Secondly, the role light plays in the composition is important. The view is on the diagonal, a *veduta per angolo* towards a corner of the house that juxtaposes a lit wall with a shadowy stair, and, by implication, the brightness of the terrace with the darkness of the *cave*. As a summation of the project it states the house as a structured route, a sequencing of settings, between the enclosure and shadowy coolth of the womb-like *cave* and the extensive light, space and greenery of the roof terrace. While it is possible that for Le Corbusier the image asserts that the introduction of light into darkness is an archetypal architectural act, it is also possible to read it as one of his abstract compositions[18] of darks and lights, figures and grounds, orbiting about the rustic bench, as the only identifiable – because of the sitting and the logs – locale in the composition – and hence 'architecture'. Like the freestanding window and table in the garden room, it is a small model of the house.

A diagram captioned 'The plan is located' explains the purpose of the garden 'windows' (*Une Petite Maison*, p. 9). In this image a sketch of the lake/mountain horizon is counter-posed to a site plan to demonstrate the views that marry the project to its site via openings or breaks in its boundary wall. In addition to the view from the main window already discussed, it shows that two views the lake and the passage/threshold between house and garden) and a shaded stair (that stages descent to the *cave* and ascent to the roof). And of course at another level it also seeks to *locate* the dwelling (house/garden) within the ultimate enclosure of the landscape.

The light of La Petite Maison

What Le Corbusier does choose to say about light more overtly in *Une Petite Maison* is interesting. As ever, the idea that the sun is a source of orientation is given particular prominence. In a Corbusian world the sun is always out, a building typically an orchestration of one (or several) routes from darker enclosed space to a distant sun-filled view. This project is no exception, representing as it does perhaps the most compressed example of such thinking. The house is understood as an unfolding of routes from darkness to light: the *cave* to the roof, the entrance hall to the living space, the front gate to the lakeside terrace.[19] When justifying his approach from a more technical standpoint, the text also focuses on the building's solar response, as when Le Corbusier demonstrates his awareness of the impact of solar geometry on the house's view across the lake:

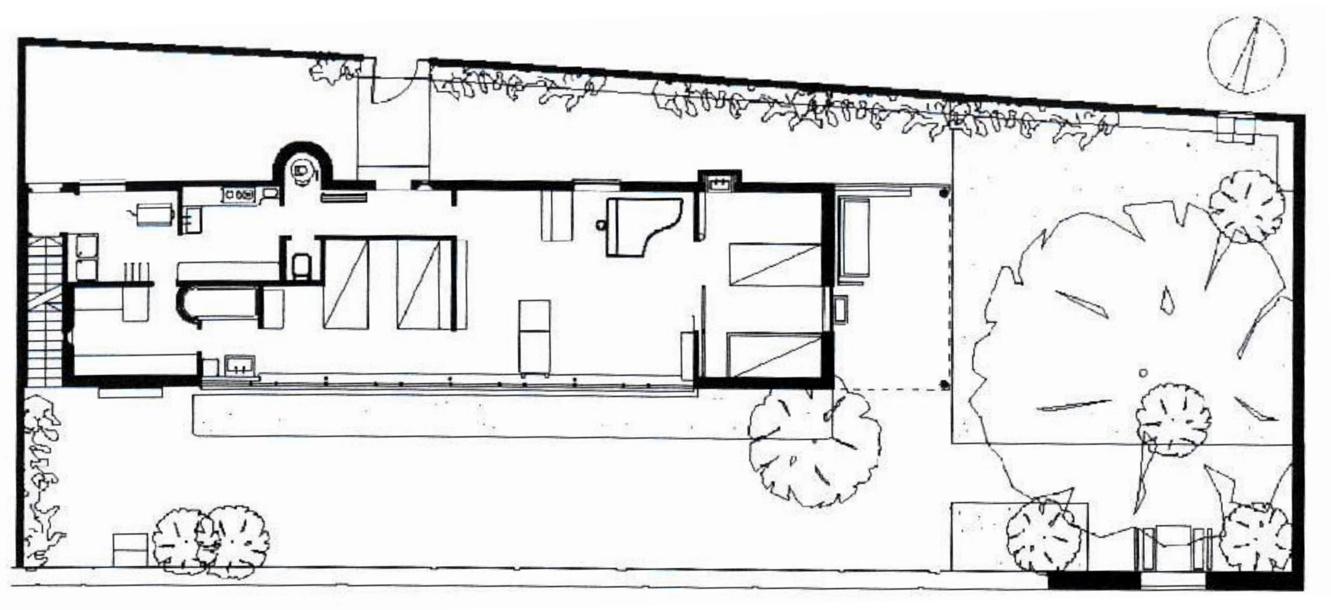
> Glare? The sun is in front from east to west, only reaching (even now) the zenith at the summer solstice. Its angle of incidence means it will never affect the little house. It reaches (and dazzles) the inhabitants of the hillsides, those at heights of fifty to one hundred metres.[20]

This solar emphasis is further strengthened by the famous diagram which introduces the project. Entitled 'A circuit', this sketch-plan presents the building as a dwelling within a walled enclosure, over which the sun arrives from the south, in a powerful statement of the parallel significance (and potential reciprocity) of the daily passage of the sun around the building and the routes which give rhythm to its daily life (*Une Petite Maison*, p. 6).

As a light-filled, light-weight building dominated by the luminosity of its main space, the house is typical of Le Corbusier's early work. This is because its plan's layering of space is keyed to light and orchestrated through colour. In this case the plan is divided by its zigzagging spine into two differently oriented territories placed back to back. To the south are sunny spaces lit by the *fenêtre en longueur*: the bathroom, the bedroom and the living space. To the north a series of more heavily partitioned (and thus less transparent) windows give steadier light to the laundry room, the kitchen and the entrance hall. (Here roof-lights also provide top-light, and some sunlight in spring and summer, above the laundry sink and an internal WC.) As is also typical of this period, the use of a Purist colour palette intensifies the way in which the free-flowing space of the *plan libre* is ordered and differentiated through light. The darkest areas for example are the more enclosed spaces to the east and west ends of the building. Given deep blue walls and small apertures (a use of dramatic chiaroscuro), their intense shadow frames the long, much calmer, lighter and light-filled space behind the main window (predominantly white, with areas of mid-tone turquoise or peach, and a brighter accent of burnt umber). In contrast whiteness, shallowness and a location beside this window make the bathroom the lightest area of all, while next to it, the peach-coloured inner walls of the main bedroom locate the 'warmest' space at the centre of the dwelling. The end result is that on walking through the *partie de réception* between the guest bedroom and the closet, the house is encountered as a rhythmic sequence of alternating lighter and darker spaces.[21]

As a project on a lakeside site, the house illustrates how a major theme in Le Corbusier's thinking, the poetics of water and light, is expressed in his early work. Here water is not the opposite of light (as he suggested in *Le Poème de l'Angle Droit*), but its ponderous equivalent in material terms. If one takes a section through the site east-west through the garden door looking south, it is evident that the two windows command the proposition. As the windows are openings in their walls, so is the house in its site, and so is the lake in its landscape. It is possible that this explains why the bath is given such prominence in the scheme, uniquely in his architecture. It and the boiler (both warm water) have the only curved walls, and the brightly lit bath is the lake.[22] Both windows are depicted with archaic water jugs sitting on their ledges. Similarly, as the forms of the house sit on the land, so do the objects on tables (like the sailing boats on the lake). Moreover, the project's early attunement to the primitive[23] includes the roof, where the glass is set in the grass like little ponds (Le Corbusier would do this again on the terrace of Poissy). The character of the site as an abstract landscape is most evident, however, in the little image entitled 'la petite villa ...' in the description of the project in the *Oeuvre Complète* (vol. 1, p. 75 [Fig. 1.9]). The way the trees, hills and the wall to the lake weave through the white architecture, and the way this image is paired with 'le jardin' below – the most obviously painterly rendering of dwelling (and a view redrawn by Le Corbusier at the end of *Une Petite Maison*) – all suggest that one is meant to think in terms of a *concetto* where the use of architectural 'windows' intimates a direct involvement with 'nature'. The way 'le jardin' is established by its two columns (and note the curtains) points to a conception of dwelling in this in-between condition where metaphors are allowed to flourish.

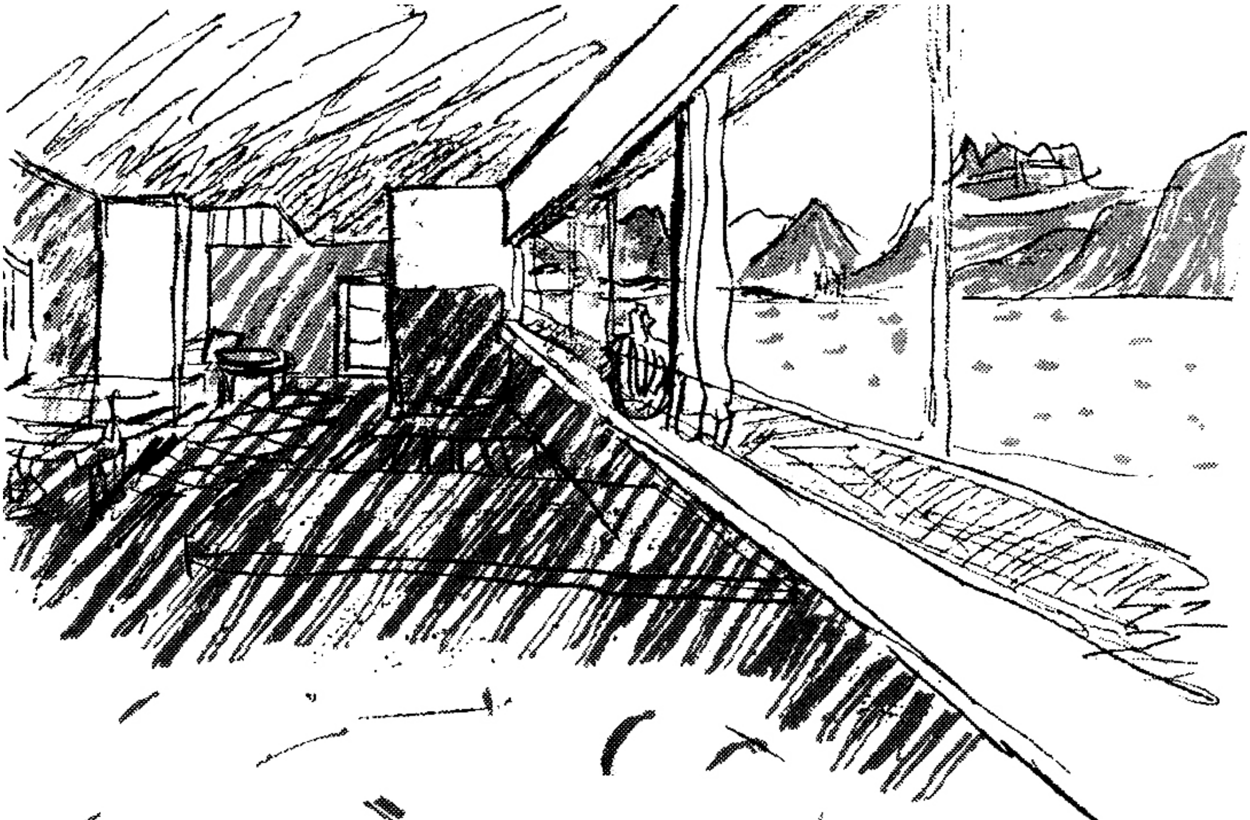
Une Petite Maison begins with a diagram of the region of Lake Léman, a written evocation of the landscape of ancient terraced vineyards which surround the lake, and an introduction to the building's clients, Le Corbusier's father, a nature lover, and his mother, a musician (*Une Petite Maison*, pp. 4–5). It ends with a series of drawings of the completed project (*Une Petite Maison*, pp. 63–77). Six of these drawings, dated 1945, are views drawn on site that 'confirm the architectural facts implied in this simple enterprise of 1923'. They are all drawings of the project in sunlight. The last, from 1951, is a portrait of his mother in front of the building and the view it commands across the lake (Fig. 1.11). This final drawing, a reworking of the book's introductory diagram, 'The site was discovered', is captioned, 'At ninety one years, Marie Charlotte Amélie Jeanneret-Perret reigns over the sun, the moon, the mountains, the lake, and the hearth, surrounded by the affectionate admiration of her children'. The message Le Corbusier is conveying via this careful structuring of his narrative is that the house is both another set of walls layered into the site, and a *domus*, the physical manifestation of a family's way of life centred on the hearth and enclosed by the landscape. What he emphasizes in the process is the response to the daily rhythms of the light that makes this possible.



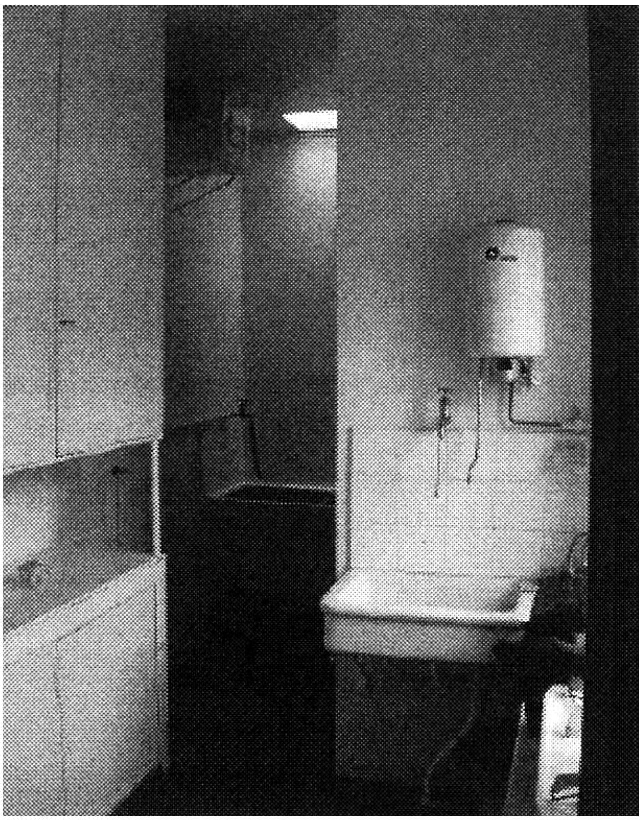
1.1 Site plan of La Petite Maison after drawings by Le Corbusier.

1.2 The soft light in the main living room of La Petite Maison.

1.3 View of Lake Léman from the main window of La Petite Maison.

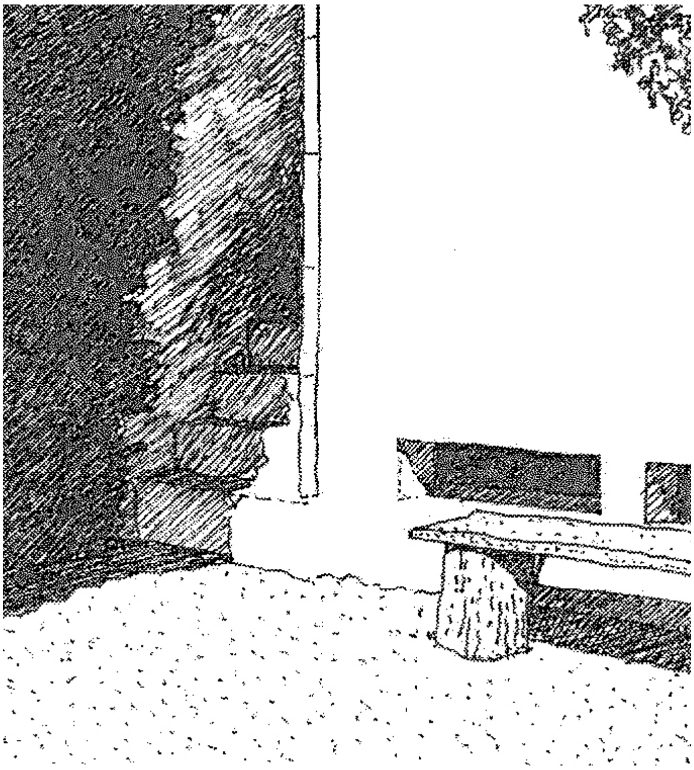


1.4 Le Corbusier's sketch of the view down the living room towards the garden from pp. 72 – 73 of Une Petite Maison.

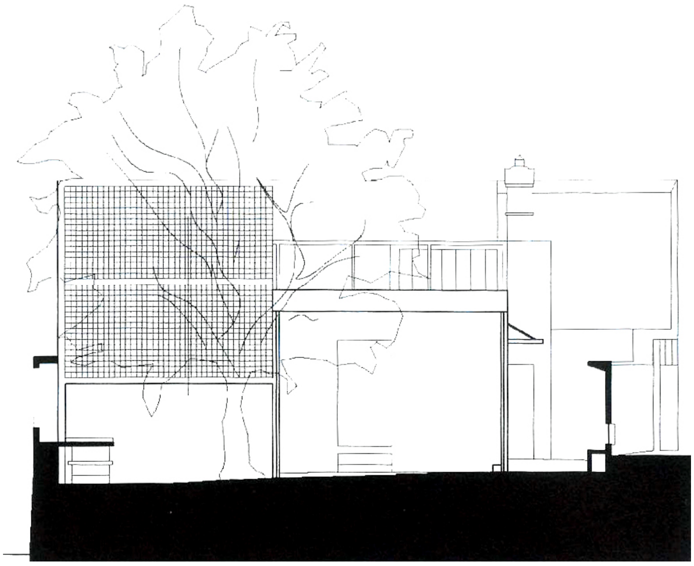


1.5 Roof-light over the laundry room visible from main entrance room.

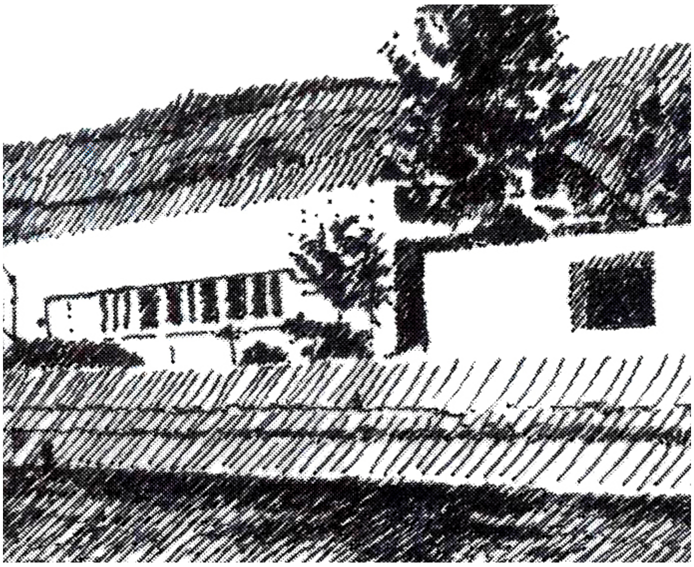
1.6 Light from clerestory lantern window in the guest room.

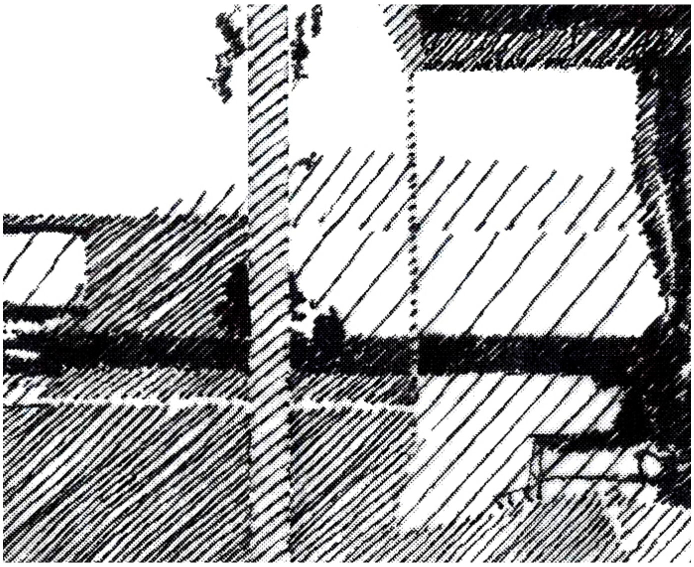


1.7 Sketch of Une Petite Maison.



1.8 Section through the garden room of La Petite Maison, by Le Corbusier.





Sketches of the photographs entitled “la petite villa” and “le jardin” in Le

Corbusier's presentation in the first volume of his Oeuvre Complète.

GLASS ARCHITECTURE
Paul Scheerbart, 1914

Section from book GLASS! LOVE!! PERPETUAL MOTION!!! A PAUL SCHEERBART READER.
Burgin, Christine. Christine Burgin/ The University of Chicago Press, 2014

The close friendship and similar thinking on glass and modernity between Bruno Taut and Paul Scheerbart resulted in two prominent works on glass: Tauts celebrated Glashaus at the 1914 Werkbund exhibition at Cologne, dedicated to Scheerbart, and Scheebart's Glasarchitektur (Glass Architecture), written in 1914 as an architectural manifesto calling for a new glass architecture, dedicated to Taut, this text is inserted below.

1
Environment and its influence on the development of culture

We live for the most part in closed rooms. These form the environment from which our culture grows. Our culture is to a certain extent the product of our architecture. If we want our culture to rise to a higher level, we are obliged, for better or for worse, to change our architecture. And this only becomes possible if we take away the closed character from the rooms in which we live. We can only do that by introducing glass architecture, which lets in the light of the sun, the moon, and the stars, nor merely through a few windows, but through every possible wall, which will be made entirely of glass – of coloured glass. The new environment, which we thus create, must bring us a new culture.

2
The veranda

Obviously the first thing to tackle is something quickly done. To start with, therefore, the veranda can be transformed. It is easy to enlarge it, and to surround it on three sides with double glass walls. Both these walls will be ornamentally coloured and, with the light between them, the effect of the veranda in the evening, inside and out, will be most impressive. If a view of the garden is to be provided, this can be achieved by using transparent window-panes. But is it better not to fit window-type panes. Ventilators are better for admitting air.

In a modest way, it is thus comparatively easy for any villa-owner to create 'glass architecture'. The first step is very simple and convenient.

3
The Botanical Gardens at Dahlem

We already have glass architecture in botanical gardens. The Botanical Gardens at Dahlem near Berlin show that very imposing glass palaces have been erected. But – colour is missing. In the evening sunlight, however, the Palm House and the Cold House look so magnificent that one has a good idea of what could be achieved if colour were exploited. The Palm House is particularly interesting: outside, the seemingly unsupported iron* construction; inside, the framework of the wood glazing bars, so that no rust-water accumulates and the iron can be repainted again and again. Wood, because of its impermanence, is not an impressive material. The worst thing, though, is that the glass walls are single and not double; in consequence, the expenditure on winter heating is simply enormous. In one of its guidebooks, the management recounts with unjustified pride that in winter, in a single day with a temperature at 8 am of -10 degrees centigrade, a load of 300 centners† of best Silesian coal is consumed. That, it will be conceded, is rather excessive and not a fit source of pride. Heating expenses of this sort should have been countered with double glass walls.

* Throughout the translation of *Glasarchitektur* the German word *Eisen* is given as "iron."

† About 15 tons [Ed.]

4
Double glass walls, light, heating and cooling

As air is one of the worst conductors of heat, the double glass wall is an essential condition for all glass architecture. The walls can be a metre apart – or have an even greater space between. The light between these walls shines outward and inward, and both the outer and the inner walls may be ornamentally coloured. If, in so doing, too much light is absorbed by the colour, the external wall may be left entirely clear; it is then advisable simply to provide the light between the walls with a coloured glass shade, so that the wall light in the evening does not dazzle on the outside.

To place heating and incandescent elements between the walls is in most cases not to be recommended, since by this means too much warmth or cold is lost to the outer atmosphere. Heating and cooling elements, however, can be suspended like lamps in the interior, where all hanging lights are to some extent superfluous, since light is distributed by the walls.

In the first instance it is clearly advisable to build glass houses only in the temperate zones, and not in the equilatorial and polar regions as well; in the warmer climates one could not do without a white reinforced concrete roof, but in temperate zones, this need does not arise. To provide floor heating and cover, electrically-heated carpets are recommended.

5
The iron skeleton and the reinforced concrete skeleton

An iron skeleton is of course indispensable for glass architecture. This will inevitably stimulate an extraordinary upsurge in heavy industry. How to protect iron from rust has not yet been solved in a satisfactory manner. There are many methods of counteracting rust, but so far we do not know which is the best. The simple protective coating, long in vogue, leaves much to be desired aesthetically. The glass architect must surely think of something better to offer. But we can confidently leave this to future developments.

If we are ready to allow larger dimensions to the structural frame, for not every particle of the glass house has to be of glass, a reinforced concrete skeleton is well worth thinking about, for it has proved itself so admirably as a building material, that nothing more need be said about its merits here. Reinforced concrete can also be handled artistically – either with colour or to aesthetic effect with designs cut with the chisel.

6
The inner framework of glass surfaces

The iron or reinforced concrete skeleton virtually frames the glass, but the glazed surfaces must have another smaller inner frame. For this purpose in the Botanical Gardens, as already mentioned, impermanent wood was used. Instead of wood a durable material must now be found. Iron is certainly more lasting, but has to be protected against rust, which can be done by nickelling or coating it with paint. The latter, as has been said before, is aesthetically displeasing and has to be renewed often. Perhaps reinforced concrete is an ideal building material here, as it does not take up so much surface.

Various other new building materials might be considered, but these have not yet been sufficiently tested for them to be thought of as entirely credible materials suitable for framing glazed surfaces. It is the technical man's problem, and he will surely find the right answer. In any case, only very strong and rust-free materials are potentially appropriate; wood is not durable and in iron constructions should only be used as a last resort. Wood is no longer used in bridges either; they are built entirely of iron and reinforced concrete. Similarly, glass architecture is half-iron architecture. Heavy industry has consequently won a completely new market, which is bound to raise the consumption of iron tenfold.

7
The avoidance of wood in furniture and interior decoration

Inside the glass house, too, wood is to be avoided; it is no longer appropriate. Cupboards, tables and chairs must be made of glass if the whole environment is to convey a sense of unity. This will naturally be a grievous blow to the wood industry. Nickel-steel would, of course, have to be decorated with enamel and niello, so that the furniture may create a striking aesthetic effect – like extremely fine wood-carving and wooden cabinets inlaid with other woods. Wood is to be avoided, because of its impermanence, but the use of iron in iron-glass construction lies along the natural line of development.

8
The furniture in the middle of the room

It will surely appear self-evident that the furniture in the glass house may not be placed against the precious, ornamentally-coloured glass walls. Pictures on the walls are, of course, totally impossible. Given the highest intentions, this revolution in the environment is inevitable. Glass architecture will have a tough fight on its hands, but force of habit must be overcome. Ideas derived from our grandparents must no longer be the deciding influence in the new environment. Everything new has to wage an arduous campaign against entrenched tradition. It cannot be otherwise, if the new is to prevail.

9
The larger veranda and its independence of the main building

Whoever has provided his veranda with colour-ornamented glass on three sides will soon want to have more glass architecture. One thing leads to another, and to stop the process is unthinkable. So the veranda continues to grow; in the end it emancipates itself from the main building, and may become the main building itself. To promote this evolution of the veranda will be the chief task of every glass architect.

10
Garden houses and pavilions

The ancient Arabs lived far more in their gardens than in their castles. For this reason garden houses and kiosks were very quickly developed by them. Unluckily, since perishable wood was their constant choice of building material, nothing remains of this Arabian garden architecture.

The task of the modern architect, therefore, is to use only the best iron and reinforced concrete materials for garden houses and pavilions, and to encourage double colour-ornamented glass walls everywhere in the garden. In introducing glass architecture, it is best to begin with the garden; every owner of a large garden will want to have a glass garden house.

11
Stone flags and majolica on garden paths

In their gardens, the Arabs had patterned floors of stone and majolica; they thus transferred their taste for carpets to their gardens. The Dutch have copied this from the Arabs.

Modern glass architects will be well advised to pave their garden paths with stone and majolica tiles, for in this way the splendour of the glass palaces will be worthily framed.

12
Magnesite and the perfect floor covering for the house

We can now hardly avoid considering many new building materials, but only by way of suggestion. Jointless magnesite floors have much to recommend them; but whether they are equally suited to the house, with its colourful glass walls, is not so easily decided. In any case, many other materials obviously come into the picture as the perfect floor covering – even stone 'parquet', consisting of stones arranged like mosaic. But magnesite should be very durable, and therefore good. Inside the house one will have to be sparing with colour for the floor, in order to achieve a contrasting effect with the walls.

13
The functional style

The reader might gain the impression that glass architecture is rather cold, but in warm weather, coolness is not unpleasant. Anyhow, let me make it clear that colours in glass can produce a most glowing effect, shedding perhaps a new warmth. What has been said up to now takes on a somewhat warmer atmosphere. I should like to resist most vehemently the undecorated 'functional style',* for it is inartistic. It has often been adopted before in other contexts, and this is happening once again.

For a transition period, the functional style seems to me acceptable; at all events it has done away with imitations of older styles, which are simply products of brick architecture and wooden furniture. Ornamentation in the glass house will evolve entirely of its own accord – the oriental decoration, the carpets and the majolica will be so transformed that in glass architecture we shall never, I trust, have to speak of copying. At least, let's hope so!

14
The cladding of building materials and its justification

A housefront faced with perishable plaster is clearly reprehensible, and a single coat of paint, which is not weather-proof, is obviously not permissible. Architects have therefore declared any cladding unjustifiable and display the brick front completely naked. A ghastly sight! Brick is only effective if it has weathered and has the character of a ruin – when it looks like a ruin. The ancient Egyptians faced their brick pyramids with smooth granite slabs. These have not been destroyed but stolen. If the latter occurs, preservation is naturally out of the question. A cladding of an inferior material is, in my opinion, fully justified.

Since, nowadays, there are very many buildings which cannot be replaced in a day by glass structures, we may reasonably give some thought to durable facing materials for factories, harbour installations, etc. Enamelled panels of iron and majolica are particularly suitable. Old walls, brick 'fences', stables, and so on, can be clad in this way.

Houses, too, can be given a passable veneer with roof-gardens, if large numbers of glass pavilions are erected in them.

15
The finishing and plastic treatment of reinforced concrete

Reinforced concrete is a building material which is very strong and weather-resistant. It has been rightly acclaimed by architects as the ideal material. A pity that it is not transparent: only glass is.

But reinforced concrete is unsightly if left in its natural state. A smooth finish to reinforced concrete, which is perfectly feasible, is therefore much to be recommended; the finish should also be able to take weather-proof colour. In addition, reinforced concrete should be provided with plastic decoration; it is as easy to work with the chisel as granite.

Granite is not exactly easy to work, but it can be done.

16
Enamel and niello applied to metal panels on reinforced concrete

If thin metal panels can be pressed into the surface of reinforced concrete during casting, these can be given an enamel coating – possibly one of transparent cloisonné enamel.* Small surfaces can also be hollowed out and filled with niello,† although lacquered niello is only suitable for interiors. Externally, metal niello would be very effective, but only precious metals should be used; the patina of bronze would also be suitable. Glass mosaic, too, is an obvious possibility.

17
Glass fibres in applied art

It has been forgotten by many that glass can be developed as fibres which can be spun. The story goes back more than forty years, perhaps further. I am not sure. These glass fibres may lead to a whole new industry in applied art; divan covers, chair arms, etc., can be made of them.

18
The beauty of the Earth, when glass architecture is everywhere

The face of the earth would be much altered if brick architecture were ousted everywhere by glass architecture. It would be as if the earth were adorned with sparkling jewels and enamels. Such glory is unimaginable. All over the world it would be as splendid as in the gardens of the Arabian Nights. We should then have a paradise on earth, and no need to watch in longing expectation for the paradise in heaven.

19
Gothic cathedrals and castles

Glass architecture is unthinkable without Gothic. In the days when Gothic cathedrals and castles were rising, an architecture of glass was also tried. It was not completely realised, because iron, the indispensable material, was not yet available, and this alone enables the totally glass room to be constructed. In Gothic times, glass was entirely unknown in most private houses. Today it is a principal factor in the architecture of every house. But it still lacks colour. Colour, however, will come.

20
Ancient Greece without glass, the East with ampullæ and majolica tiles

In ancient Greece glass was almost unknown. But before the Hellenic civilisation there were already many colourful glass ampullae and lustrous majolica tiles in the countries bordering the Euphrates and Tigris, a thousand years before Christ. The Near East is thus the so-called cradle of glass culture.

21
Glass, enamel, majolica and porcelain

All building materials which are durable and obtainable in weather-resistant colours, have the right to be used. Brittle brick and inflammable wood have no such right; a brick building is also easy to shatter by explosives, which endanger the whole building equally. This is not the case in a glass-iron building; only partial destruction can be induced by explosives in the latter.

Wherever the use of glass is impossible, enamel, majolica and porcelain can be employed, which at least can display durable colour, even if they are not translucent like glass.

22
The effects of Tiffany

The famous American Tiffany, who introduced the 'Tiffany glass', has by this means greatly stimulated the glass industry; he put coloured clouds into glass. With these clouds the most marvelous effects are feasible – and the walls acquire an entirely new charm, which admittedly puts the decorations into the background, but in particular situations is quite practicable.

23
The avoidance of the quicksilver effects of mirrors

If the dangers of Tiffany effects may not be wholly ignored – they are only dangerous, after all, in inartistic hands – one should only allow the quicksilver effects of mirrors a utilitarian existence in the dressing-room. In the other rooms of the house mirror-effects, which continue to reflect their surroundings again and again in a different light, disturb the general architectural impression, for they do not last. When kaleidoscopic effects are wanted, they are perfectly justified. Otherwise it is best to do without the quicksilver-mirror; for it is dangerous – like poison.

24
The avoidance of figure-representation in architecture

While architecture is spatial art, figure-representation is not spatial art and has no place in architecture. The animal and human body is made for movement. Architecture is not made for movement, and is concerned with formal composition and ornament. Only the plant and mineral kingdoms should be exploited – better still the whole repertoire of free invention – one should not think of the animal and human body as a design element. The fact that the ancient Egyptians did so is no reason at all for doing so today; we no longer associate our gods with the bodies of animals and humans.

25
The landscape architect and the tree and plant world in the Rococo period

The Rococo period treated trees and plants as if they were mouldable clay; to create perspective effects trees were shaped like walls and yew hedges clipped into geometrical figures. At the same time, the architect ruled the garden, which he should do today. But such laborious treatment of plant and tree material does not pay – because of the changing seasons and transitory results.

More glass walls in the garden would give it quite a different aspect, linking the garden to the architecture of the house, if the latter is glass architecture. It is scarcely imaginable what wonderful effects could be achieved in this way. An occasional mirror-wall close to pools is worth considering. But not too many.

26
The door

In our technical age developments occur rapidly; we often forget this. There is no reason to think that they will suddenly slow down. Fifty years ago there was not a single town in Germany with main water and drainage. Fifty years later one cannot imagine a home without a vacuum cleaner. And there will be many other things which now strike us as utopian, although those which are now feasible, like glass architecture, should never be so described.

The door in the glass house, for example, will be unlike those most commonly found today in brick houses. Self-closing doors are commonplace nowadays, but self-opening doors will be equally common soon. The outside doors do not need to open by themselves, but if the inside ones are self-opening, it is like a friendly gesture by the householder, although he does not have to make any movement with his hands. The mechanism is actuated by treading quite lightly on a sensitive plate. It already exists in Berlin pubs, and has been fully worked out and patented. The idea can be extended; rotating crystal elements – or flashing lights – can be set in motion in doors; a friendlier greeting than that of a liveried supercilious servant.

The doors can be made of transparent glass with crystal effects, and of ornamentally coloured glasses. To every room, then, its own particular entrance. This should create a more festive atmosphere. The outside doors can also be of glass.

Cities in their present form are not yet fifty years old. They can vanish as quickly as they came. Even the permanent way of the steam railway is not immortal.

27
The chair

The most complicated item in the whole of applied art is the chair. The steel chair seems to be an aesthetic impossibility, yet steel can be made so splendid with enamel and niello that it need not fear comparison with the finest Venetian carving. The prices of enamel and niello chairs are far from being higher than carved wood chairs, for which 400–500 marks are willingly paid. Enamel work is so cheap that enamelled chairs can be produced very well for 100 marks apiece.

Of course, an industry which turns out identical chairs by the score will have to be disregarded. But one can reasonably expect that an industry which wants to satisfy artistic requirements will stop the indiscriminate production of identical objects.

The industry of the future will also turn eagerly to glass fibres. For only fire-resistant materials will be used – both for divans and for flooring, where glass fibres will prove the most important material.

28
Metal in art and applied art

It seems to me that habit lies like a heavy lead weight upon art and applied art. Because in grandfather's time most furniture and artifacts were made of wood, they must continue to be made of wood. But this should not be so. Glass architecture is also a compelling influence on applied art and art in general. We shall therefore be obliged to give preference in all fields to metal. The æstheticians will naturally try to counteract this, and the threatened timber industry will mobilise them.

There will be a lot of talk about the valuable associative ideas inherent in wood. I believe, however, that all the associative ideas inherent in wood can be transmitted to metal – by developing the artistic potentialities of metal – as I have already indicated many times. Metal is supposed to be cold, whereas wood is supposed to be warm. These are notions born of habit: we found glazed tiles cold before the existence of the tiled stove. Majolica only became warm to us because of this association. The same thing may occur with metal.

29
Hollow glass elements in every possible colour and form as a wall material (the so-called 'glass-brick')

So-called glass bricks make a wall material which may well become an interesting speciality of glass architecture. Large industrial undertakings have been formed already which could have a big future. Everything fire-proof and transparent is aesthetically justifiable as a wall material. Glass bricks should make many iron skeletons superfluous.

30
Aschinger's buildings in Berlin, 1893

If ideas are to be productive, they must really be 'in the air' – in very many heads at the same time – even if in a distorted form. This became clear to me in 1893 or a little later. Franz Evers was editing the theosophist journal Sphinx, and in consequence was overwhelmed with theosophist, spiritualist and other such literature; in this wilderness there was a lot to make one laugh. One gentleman, whose name escapes me, asserted that glass was the source of all salvation; that one must always have a glass crystal near one on the writing-table, and sleep in a room of mirrors, etc., etc. It all sounded crazy. But Aschinger's beer halls, with their frightful mirrors, seemed to me an echo of that theosophist publication about mirrored bedrooms. At any rate some telepathic influence was at work.

I am convinced that every constructive idea will appear in many heads at the same time and quite irrationally; one should therefore not speak carelessly about the seemingly confused and crazy; it generally contains the germ of reason.

In the East the madman is left at liberty and honoured as a prophet. But that is by the way.

31
Glass mosaic and reinforced concrete

It must be emphasized that reinforced concrete with a glass mosaic skin is probably the most durable building material which we have so far discovered. People are always so afraid that glass may be shattered by some malicious hand. Now, cases of windows being broken by stones thrown from the street are probably infrequent nowadays; stones are far more often thrown at a man's head than at a window-pane. But I have never heard of stones being thrown at glass mosaic.

During the last century, when telegraph wires were introduced, it was thought that they should all be laid underground for fear of the rude populace. Today nobody thinks of destroying the overhead wires.

Therefore there is no need to fear that glass houses would be destroyed by stones flung by the lower orders.

But that, too, is by the way.

32
Heating and cooling appliances in special columns, vases, suspended elements, etc.

Although the electric light commands the room from between the double walls, this is not the place for the heating and cooling because, as already stated, half the warmth and cold air is uselessly dissipated.

For this reason the heating can be installed in columns, vases and suspended elements, and their outer shells can be designed, like the oriental ampulla, as delightful decoration.

33
Lighting between the double walls (which does not exclude suspended fittings in the room)

I have so often said that the double walls are there, not merely to maintain the temperature of the room, but to accommodate the lighting elements. I must ask to be forgiven for repetition but I want to stress and underline it.

With this type of lighting the whole glass house becomes a big lantern which, on peaceful summer and winter nights, shines like fire-flies and glow-worms. One could easily become poetic. But lighting can also be installed inside the room. This interior lighting also illuminates the walls – if not so strongly as the light between the double walls.

34
The vacuum-cleaner – in the park, too – also as an insect-exterminator

In the near future the vacuum-cleaner will seem as important as main water, and it will be used in parks, for the inlaid paths must be kept free of 'dust'. The vacuum-cleaner will naturally be needed as an insect-exterminator. It is absolutely horrifying that today it is still not used for this purpose. That the vacuum-cleaner has already been employed for getting rid of street dust, I take to be a known fact.

35
Ventilators, which are ousting the customary windows

It will seem very natural that ventilators should have a principal part to play in a glass house, and will supplant everything window-like. When I am in my glass room, I shall hear and see nothing of the outside world. If I long for the sky, the clouds, woods and meadows, I can go out or repair to an extra-veranda with transparent glass panes.

36
Light columns and light towers

Hitherto, columns have served only as supports. Iron construction needs fewer supports than masonry; most of them are superfluous in the glass house. In order to make the columns in larger glass buildings lighter, they can be equipped with light elements behind a completely glass surround, so that the light columns do not give the impression of supporting, and the entire architectural effect seems much more free – as if everything were self-supporting; glass architecture will acquire an almost floating quality with these light columns.

Towns and other places should always be distinguished by towers. Every effort must naturally be made to lend enchantment to towers by night. Under the rule of glass architecture, therefore, all towers must become towers of light.

37
Direction-finding for aeronautics

Aeronautics will undoubtedly be determined to conquer the night. All towers must therefore become towers of light. And – to simplify navigation – every light tower will be built differently, emit a different light, and be fitted with glass elements of widely differing form. Uniformity in light towers is consequently out of the question. The signaling impulse can be so simple, and the tower itself must be so different from any other, that the aeronaut will immediately be informed where he is.

38
Ukley mother-of-pearl on the concrete wall

Naturally, transparent walls are not possible everywhere, in particular because the householder may not always want to sit or lie down between transparent walls. For such rooms, however, wallpapers and wall-fabrics are to be avoided because of fire risks, and wood-panelling is no longer appropriate – it is as impermanent as paper and fabrics, encourages woodworm and is potentially inflammable.

Another wall cladding material must now be found. Reinforced concrete is not easy to handle artistically; it is as hard as granite, and enamel and niello are not all that cheap, anyway. Imitation pearls are coated with Ukley mother-of-pearl. This coating is perhaps to be recommended for walls as well. It could easily be embellished with semi-precious stones and glass brilliants.

But it is quite possible that a mother-of-pearl coat, applied to an uneven surface, could do the job alone. Whether this artificial mother-of-pearl retains its colour when daylight is kept away from it would have to be tested.

Dome-like undulating bulges may be very effective if they occur regularly and symmetrically.

39
Wired glass

For the walls, a good glass material is still, of course, the most worthwhile. After glass mosaic, however, the most durable glass material is the fairly familiar wired glass, which is particularly suitable for the external wall. Nowadays, wired glass can be handled in such a way that the wire mesh is scarcely visible. In the external wall the mesh does not matter because to an outside viewer it is practically invisible.

40
The vertical in architecture, and how to overcome it

The brick architecture of the past often overcame the problem of the vertical by domes, but to escape from the vertical in walls seemed impossible. In glass architecture it is quite different. The large Palm House in the Botanical Gardens in Berlin no longer has vertical walls; the upward curve begins at a height of three metres.

41
The developments made possible by iron construction

Iron construction permits walls of any desired form. Vertical walls are no longer inevitable. The developments made possible by iron construction are thus quite unlimited. One can shift the overhead dome effects to the sides, so that, sitting at a table, one has only has to glance up sideways to appreciate them. Curved surfaces are also effective for the lower parts of walls – it is specially easy to get results in smaller rooms which are even less tied to verticals. The importance of the ground-plan in architecture will be reduced by such means; the building's silhouette will now be more significant than it used to be.

42
Movable partitions in the home and the park

The Japanese constantly changes his living space by dividing it into smaller areas by partition-screens. Different silk materials are laid over these screens from time to time, so that the smaller 'room' can have a frequently varying appearance. The same can be done in the living-rooms of glass houses by mobile and sliding glass partitions.

If one introduces movable glass walls, which of course do not have to be vertical, into a park, one can create wonderful perspectives, and a very delicate architecture of higher wall-screens could give the park a new architectural significance. This novelty would be perpetually flexible.

43
Overcoming the danger of fire

After what has been said, it is probably obvious that glass architecture makes fire-protection superfluous. By avoiding all inflammable materials fire insurance can be abolished. But the exclusion of fire risks should always be borne in mind in architecture; in the applied arts and interior decoration, only materials which do not burn should be permitted.

44
Vanquishing vermin

That in a glass house, if properly built, vermin must be unknown, needs no further comment.

45
Floodlights in the park, on towers and house-roofs

As coloured glass greatly softens the strength of light, we have far too little electric light at the present time. But we should have a thousand times as much, if, wherever there is running water, we installed turbines, as is feasible. Given adequate light, we can have far more floodlights than before, and night can become day. The night, indeed, can be more glorious than the day, quite independently of the splendour of the starlit sky, which when it is clouded, is invisible to us anyway.

Even the private citizen will have his 'park' flood-lit, and there will be flood-lights on all roof constructions and roof-gardens. And a tower without flood-lights will then be entirely unfamiliar and look unnatural. Aeronauts will show their indignation at unlit towers.

46
Getting rid of the usual illumination effects

Glass architecture will be scornfully called 'illuminations architecture' by its opponents, who naturally should not be ignored. This contempt is unjustifiable, for nobody will want to illuminate a glass house the way a brick house is lit up today; when it is lighted inside the glass house is in itself an illumination element. When there are many such elements, the effect cannot be so harsh as the primitive elements of present-day illumination. By manipulating mobile reflectors, the floodlights can project a thousand beams of every conceivable colour into the sky. Mirrors (used with discretion) and floodlights together will oust the usual illumination. The new illumination will be essentially for airship travel, to guide the aeronaut.

47
The end of the window; the loggia and the balcony

With the introduction of electricity for cooling and heating, the chimney must unquestionably be abolished. People claim that such an introduction would be expensive, but forget that the tempo of technical development is continually quickening. Admittedly, this happens in the workshop and the expert's room; where talking a lot about oneself is frowned upon. But the enthusiasm is no less.

When glass architecture comes in, there will not be much more talk of windows either; the word 'window' will disappear from the dictionaries. Whoever wants to look at nature can go on to his balcony or into his loggia, which of course can be arranged for enjoying nature as before. But then it will not be spoilt by hideous brick houses.

These are visions of the future, which we must none the less keep in mind, if the new age is ever to come about.

48
Stone mosaic as paving

Up to now, we have not adequately discussed how to pave the surface underfoot. Stone flags are recommended for all paths and paved areas in gardens, but inside the house only magnesite has been mentioned for floors, in rooms of secondary importance. For better rooms, stone mosaic alone is advisable. Of course, the colours of the floor must be made to match the glass walls or to contrast with them. Perhaps a fibre-glass carpet would also be practicable. But inflammable materials must be rejected, and carpets of materials not fire-proofed, even if this is difficult.

49
Models for glass architecture

The most important objective would be for a number of models of glass architecture to be exhibited. Let us hope this happens at the 1914 Werkbund Exhibition in Cologne, for which Bruno Taut has built a glass house, in which the entire glass industry is to be represented. It does not seem right to me to produce models of glass architecture of pasteboard and selenite, but brass and glass models would not be cheap. A new model-building industry ought to be created to make models only for glass architecture, including church buildings, from good materials. Perhaps it would be advisable to use a different imitation glass for larger models. About twenty years ago there was a substance called Tektorium – it was transparent, coloured, leather-like material on wire netting. For model purposes it would be admirable, but for buildings it would not be durable enough, although it could always be mended.

50
Mountain illumination

So much sounds fantastic, which actually is not fantastic at all. If one suggests applying mountain illumination to the Himalayas, this is just a ridiculous fantasy outside the realms of practical discussion. Illuminating the mountains near the Lake of Lugano is quite another thing. There are so many hotels there which would like to be part of the scenery, that they would be well disposed to glass architecture, if the proposition were not beyond their means. Their means are not inconsiderable, and the illuminations of the mountains by illuminating the hotels, if these were built of glass, can no longer be described as fantastic. The rack-railway, which ascends the Rigi, could also be illuminated very easily and effectively by flood-lights.

When aeronautics have conquered the dark, the whole of Switzerland will have her mountains colourfully lit up at night by glass architecture.

We constantly forget how many things have changed in the last century. In the 1830s the aged Goethe did not see the coming of the railways. Less than a hundred years have passed since then, and the whole earth is encompassed by steel rails. Mountain illumination, which today still seems a fantasy to many, can develop just as quickly.

51
Park illumination

But park illumination will develop sooner than mountain illumination. If only we have more electric light, much will evolve of its own accord. Above all, we should consider towers of various forms in the parks for guiding airships (as already discussed).

A glass tower should not only be equipped with flood-lights; many of the glass surfaces could be made to move and so bring about kaleidoscopic effects. Here also the possibilities are boundless.

52
Ghostly illumination

When we speak of light, we are generally thinking of the glaring light of gas and electricity. In the past fifty years light has progressed quite surprisingly. It is all happening so quickly that one can hardly keep up. But if we had light in greater quantity (and this is perfectly feasible by using more turbines and dynamos), it would not have to be harsh in its effect and could be softened by colour. It can be so reduced by colour that it looks ghostly, which to many people would perhaps seem sympathetic.

53
The solid wall as background for sculpture

Where one either cannot or will not remove a solid non-transparent wall, it may perhaps be suitable as background for plastic art. This need not be statuary. Ornamental work stands out very effectively against a wall, and plant motifs are also simple to apply. But painting should not be used. In any case, it detracts from the architectural unity of a building.

54
Cars, motor boats and coloured glass

Now let us transfer glass architecture to the world of movement – to cars and motor boats. In this way the landscape will become quite different; it has already been permanently transformed by the steam train – so transformed that for decades people could not grow used to the change. The coloured automobile, with its glossy glazed surfaces, and the glass motor boat, however, will alter the landscape so pleasantly that mankind, let us hope, should adjust itself to the change more quickly.

55
The steam and electric railway lit up in colour

When glass architecture has once successfully captured the car and the motor boat, there will naturally be no course open to the other vehicles, especially those which scorch along rails, except to accommodate themselves to it. We shall then enjoy a wonderful impression, if we see an express illuminated in colour speeding by day or by night through the countryside. The railway, greeted so sourly by sensitive natures to start with, will in the end reach a level of artistic charm beyond our present powers of description.

56
Nature in another light

After the introduction of glass architecture, the whole of nature in all cultural regions will appear to us in quite a different light. The wealth of coloured glass is bound to give nature another hue, as if a new light were shed over the entire natural world. There will be no need to look at nature through a coloured piece of glass. With all this coloured glass everywhere in buildings, and in speeding cars and air- and water-craft, so much new light will undoubtedly emanate from the glass colours that we may well be able to claim that nature appears in another light.

57
Reinforced concrete in water

Reinforced concrete, as is well known, has proved itself in water; it is practically indestructible. It is therefore suitable for a new Venice, which must have foundations that are non-transparent, stable, rust-free and indestructible. Upon this sound base the most colourful glass architecture can rise and be reflected in the water. A new Venice in this style will eclipse the old one. Water, because of its intrinsic capacity to reflect, belongs to glass architecture; the two are almost inseparable, so that in future water will be introduced wherever there is none at the moment. If, after the example of the old Venice, a 'colony' were to be laid out with canal-streets, the traditional Venice façade-architecture would have to be renounced from the outset; it does not agree with glass buildings which, when they are to be several storeys high, have in any case to be built in pyramid shape with terraces; otherwise too few of the glass walls come in contact with the daylight.

Should the individual sites be very close to one another, care must be taken over suitable boundaries. These can be walls of reinforced concrete, perhaps sheltering a covered way, open on one side. But they could be made in plenty of other ways.

Anyone can develop the theme further, even a non-architect.

58
Floating architecture

If reinforced concrete, as has often been asserted in many quarters – even by the State Material-testing Commission* – cannot be attacked by water, then it is capable of carrying the largest building, like a ship. We can talk in all seriousness of floating architecture. For this, of course, everything which was said in the previous chapter holds good. The buildings can obviously be juxtaposed or moved apart in ever changing patterns, so that every floating town could look different each day. The floating town could swim around in regions of large lakes – perhaps in the sea too. It sounds most fantastic and utopian, but it is far from being so, if reinforced concrete, shaped to the form of an indestructible vessel, carries the architecture. Indestructible boats have already been built out of reinforced concrete in German New Guinea. We must learn to accept that new building materials, when they really are of unrivalled strength and free from rust, can guide the architecture of the whole world into new paths. Reinforced concrete is one such material.

59
River and lake shipping in coloured lighting

As soon as there is floating glass architecture, ships – both great and small – will be fitted out in glass. The rivers, lakes and seas will then become very gay. It does not take much perspicacity to predict this development in lake and river shipping, once a floating building is erected and is imitated.

60
Aircraft with coloured lights

It is generally known that the aeronauts would like to take over the night. That they have not so far done so is easily explained; on the earth the night is not yet light enough. But when, thanks to glass architecture, it has become light down below, it will also be light up in the air; the aircraft will be equipped to project coloured lights, which will also form the vocabulary of a signal-language, understood everywhere by the light-projecting stations of the earth-towers and giving a practical value to the colour display both above and below. Here the elements of progress fit smoothly together and are slowly but steadily completely transforming life on the surface of the earth. The changes brought about by the steam train have not been so significant and far-reaching as those which glass and iron construction is bound to produce. The crucial factor in this is undoubtably reinforced concrete.

61
Reinforced concrete and the architecture of fences

Reinforced concrete can be a few centimeters thick, and is very convenient to use for fences. If it is treated artistically, with enamel and glass mosaic or embellished with niello ornamentation, areas with such concrete boundary fences can easily be converted into places of recreation.

In the architecture of fences reinforced concrete has a great part to play.

62
Terraces

In higher glass buildings, where there are several storeys, the terrace-form is beyond question a necessity, for otherwise the glazed surfaces do not touch the sunlit air but can only fulfil their purpose at night and not by day. These terrace-form storeys will naturally oust the tedious façade-architecture of brick houses.

63
View-points

One imagines the view-points, from which nowadays we can survey a town or landscape. These view-points will show us quite different pictures, when glass architecture has become general and all vehicles (even the flying ones) reveal the full possibilities of coloured glass. One must simply try to make such view-points clear to visualise. It is not easy, but the imagination soon adapts itself in the end to giving more than isolated details.

64
Glass in factory buildings

To have a comprehensive picture of the glass architecture world, it is essential also to think of factory buildings in glass. There will be no question of immediately destroying brick structures everywhere, but at first the brick will be faced with glass materials and glazes – and glass garden pavilions will be put on the roofs, etc.

65
Market halls entirely of glass and iron

It is well known that market halls are already being built entirely of glass and iron. Missing only are the double walls and ornamental colour. It is not fanciful, however, to assume that both these will come soon. A total architecture of glass and iron cannot be far off.

66
Churches and temples

In Europe the larger church buildings are very well planned and executed as a result of the unnatural concentration of people in larger towns. Whether it will be possible in this field to impose a purely glass and iron architecture in individual cases by rejecting brick, I do not know. But I do know well that the greater cheapness of glass and iron building must help towards success; we shall only have this greater cheapness when a larger number of firms are in competition – and for that we must wait. The free churches of America may well be the first to build glass temples, thus making a good step forward for glass architecture in the religious sphere.

It ought to be stressed here that the whole of glass architecture stems from the Gothic cathedrals. Without them it would be unthinkable; the Gothic cathedral is the prelude.

67
Club and sports buildings

Club and sports buildings are today being erected in large numbers. As these are almost always the concern of well-to-do societies, glass architects would do well to pay closer attention to them; the advantages of glass architecture for rooms mainly used for social occasions are obvious.

68
Militarism and brick architecture

So often only the obnoxious side of militarism is alluded to; but there is also a good one. It consists in the fact that, with the significant advent of the 'dirigible' aerial torpedo, it inevitably draws attention to the dangers of brick architecture; if a brick church tower is struck low down by a torpedo, it will in every case collapse, kill many people and reduce an entire group of buildings to rubble.

If, therefore, militarism evolves logically, it is bound to bring our brick culture into disrepute; this is its good side, and one constantly emphasized, especially by those tired of living as 'brick-dwellers'. A glass tower, when it is supported by more than four metal piers, will not be destroyed by an aerial torpedo; a few iron members will be bent, and a number of glass panels will have holes or cracks, but such damage is simple to repair.

69
Parliament buildings

What has just been said about glass towers applies also to parliament buildings built entirely of steel and glass. In wartime these, too, are much more resistant to damage than the old parliament building of brick faced with sandstone. To many this claim will seem very paradoxical, but it is quite logical. Dynamite can only damage a glass house partially; in relation to the whole it is fairly harmless. It needs a hailstorm of dynamite bombs to destroy a larger building made of glass and iron.

70
Restaurants, cafés, hotels and sanatoria

It seem to me to beyond question that restaurants, cafes and hotels will be the first to show an interest in glass architecture, in order to attract a larger public, who always have plenty to spend on anything new. Sanatoria also will want glass buildings; the influence of splendid glass architecture on the nerves is indisputable.

71
Transportable buildings

Transportable glass buildings can be produced as well. They are particularly suitable for exhibition purposes. Transportable buildings of this type are not easy to make.

But one must not forget that, in a new movement, the most difficult step is often the first.

72
The future inventor, and the materials which could compete with glass

To earn a lot of money by inventions is not exactly easy. All the same, as I am bound to concede at once, the number of inventors grows daily; while many inventors lose all their goods and chattels and achieve nothing, the others are not deterred. Despite everything, however, the amply provided inventor is, in the long run, a very rare exception. Failure has its humorous side, and, so long as this is so, things are not so bad. But that is by the way. Nevertheless, it cannot be doubted that inventors – for their number, as we have said, is constantly growing – could or should have a great future.

73
The timelessness of ornamental glass and glass mosaic

Meanwhile, since we do not yet have the better, we must put up with the good, and this good is glass and ornamental glass mounted in lead, glass mosaic, and enamel. These glorious materials have not been outmoded by time; they have survived hundreds and thousands of years. It is regrettable that they have not been protected from infamous hands, but tough granite, which was used to face Egyptian pyramids, has fared no better, and has also been stolen.

But this is no place for lamentations; our hope is that glass architecture will also improve mankind in ethical respects. It seems to me that this is a principal merit of lustrous, colourful, mystical and noble glass walls. This quality appears to me not just an illusion, but something very real; the man who sees the splendours of glass every day cannot have ignoble hands.

74
Exhibition buildings in America and Europe

In the past twenty years we in Europe have frequently heard fabulous tales of American glass buildings. In part, these have certainly been only the idle fancies of reporters, but there may well be a grain of truth in them. Tiffany plays a great part in America, and the Americans are very well disposed to glass things. It would be very interesting to know what is planned in glass for the World Exhibition of 1915 in San Francisco.

In my opinion the exhibition buildings in America must differ considerably from those in Europe. The American bridge constructions at Niagara Falls are at all events so magnificent that an exhibition hall, if it is built of iron and glass, should also reveal impressive dimensions. Whether it will be double-walled with coloured decoration, we do not yet know.

America is also the chief country for impressive giant buildings; the Pan-American Railroad, which is intended to protect the North and South against military attacks from East and West, is at present probably the greatest engineering work on earth.

A hope lies here that America might also tackle the greatest architectural work on earth. May it be composed of iron with glass of every colour.

Europe is too conservative and slow.

75
Experimental site for glass architecture

Glass-painters never fix the glass pieces with lead, without first testing the effect experimentally. This is done with all new designs. The full effect cannot be appreciated in the imagination. For the same reason, experiment is also essential for glass buildings. We need an experimental site for the purpose. It would be advisable for such a site to be provided by private enterprise rather than by the state. The latter brings in its official architects, who unhappily are rarely artists and are incapable of becoming so overnight.

76
A permanent exhibition of glass architecture

A glass architecture exhibition would have to be linked to the experimental site, and it would have to be permanent. Glass architecture can only be effectively promoted if every new idea can be exhibited at the same time, and all those interested can constantly order or buy on the spot whatever is best or newest.

77
The crystal room illuminated by translucent floors

At the exhibition, particular attention would have to be given to the lighting tests. We do not yet know, for example, what the effect would be of a room lit by translucent floors. One could discuss lights for ever, but things like flooring, and many other ideas, would have to be tested. In my view a Glass Building Association would have to make capital available for the site and exhibition. If the interest were general, the association would soon be formed.

78
Metal filigree with enamel inlay hung in front of crude reinforced concrete

Many experiments could be imagined; the choice is almost unlimited. Particular thought must be given to overcoming the crudeness of reinforced concrete: filigree ornament with enamel inlay is perhaps worth considering. It would look like a piece of jewelry, on a large scale. Much of glass architecture concerns the jeweler, and jewels should be transposed from necks and arms on to walls. For the time being, ladies are not going to allow this because they are afraid of losing their share of adornment. It is one of the most unpleasant things about many new movements, that the first thing everybody asks is: can it be harmful to me? The old fear of competition is in all things a far from pleasant phenomenon, even in art. The oil-colour manufacturers are undoubtedly opponents of glass-painting, because they cannot make anything out of it.

79
The aeronaut's house with airship models on the roof

Let's turn to something pleasanter! In my opinion, air-navigation will be eager to build an aeronaut's house in the restaurant garden of the exhibition, with airship models projecting little mobile lights fixed to the domed roof. This would be a variant of the *Seeschifferhaus* at Bremen. To immortalise aircraft models in this way would be of great interest to the aeronautical profession, and would lie very close to its heart.

80
Soft lighting

It must be repeated that efforts should not be directed towards achieving greater brightness in lighting, for we have got that already. We should think all the time of the softening of light in choosing colours.

81
Twilight effects

Incidentally, we should consider introducing light behind coloured glass panels into a few corners, even in bright sunshine. It produces wonderful twilight effects during the dusk and dawn hours. A great many lighting experiments will, of course, be necessary.

82
Lighthouses and shipping

When new lighthouses have to be built, the glass architect must see to it that in the immediate future glass architecture is adopted on a large scale. Since lighthouses generally stand on high eminences, it is undoubtedly cheaper than designs in brick, where the frightful labour of lifting such material to the site disqualifies them. Building will unquestionably be cheaper with the simple equipment needed for carrying up metal and glass. This must be repeatedly emphasized.

83
Airports as glass palaces

For the building of airports, also, glass-iron construction has much to recommend it; airports must be visible and identifiable from far off and this is best achieved by coloured ornamental glass. This will reach its full effect at night, when the entire building is crowned by a diadem of projected lights, delighting not only the aeronauts, but also people who have no airship at their bidding.

84
Light nights, when glass architecture comes

It seems easy to say that something is indescribable, but of those light nights which glass architecture must bring us, there is nothing else left for us to say except that they are truly indescribable. One thinks of the lights shining from all the glass towers and in every aircraft, and one thinks of these lights in all their many colours. One thinks of the railway trains all gaily lighted, and one adds the factories in which at night, too, the light shines through coloured panes. Then one thinks of the great palaces and cathedrals of glass and the villas of glass, and of the town-like structures, on solid land and in the water – often in movement – and of ever more water in ever different colours. On Venus and Mars they will stare in wonder and no longer recognize the surface of the earth.

Perhaps men will live more by night than by day. Astronomers will erect their observatories in quiet mountain ravines and on peaks, because the huge sea of coloured light may disturb the study of the heavens.

This is not a modern concept – the great Gothic master-builders thought of it first. We must not forget that.

85
The brilliant (diamond) effect in architecture

Brilliants are treasured on the hands and neck, but in architecture the diamond effect is by no means prized. I suggest that this only happens because the brilliant is too small and architecture is too big. Large glass brilliants, however, can be produced of pumpkin size, without becoming too expensive. Will architecture despise the brilliant effect, when glass can be seen everywhere in large quantities? That seems to me unlikely. It is no argument against coloured glass that primitive people and small children are enraptured by it.

86
Three-dimensional and two-dimensional ornament in architecture

In the Albambra, we mostly find three-dimensional ornament, but of perishable plaster-work. Glass architecture can also use such ornament, but of imperishable glass materials. The most delicate blown decoration is made of glass, even of frosted and filigree glass. This kind of plastic art for the ornamental glass wall should admittedly only be considered for formal rooms; there it is entirely feasible and not merely a figment of the imagination. Venice is no longer the pinnacle of glass culture, although it has contributed much that often obliges one to return to it later. I do not recommend copies, but it certainly seems to me that the splendours of Venetian glass, as reflected in particular by the palaces of Isola Bella, are valuable sources of inspiration. One often forgets that present-day Italy, without glass, really has very little attraction.

87
The transformation of fireworks

When there is more glass everywhere, fireworks will be transformed; thousands of reflection effects will be possible. But this chapter must wait until pyrotechnics have been further developed.

88
Colour-lit pools, fountains and waterfalls

This chapter shall be left to the landscape architects. They will tackle the job with great enthusiasm and be determined to offer more than the rococo period offered us.

89
The discovery of the brick bacillus

Brick decays. Hence fungus. The discovery of the brick bacillus is no great discovery, but now the doctor also has a major interest in finally ousting the cult of brick.

In the cellars of brick houses the air is always full of brick bacilli; glass architecture needs no cellars beneath it.

90
The nervous effect of very bright light unsoftened by colour

We have to thank very bright lights, in part, for the nervous ailments of our time. Light softened by colour calms the nerves. In many sanatoria it is recommended by nerve doctors as beneficial.

91
Railway stations and glass architecture

For station premises, which have to be screened at least partially against wind and rain, glass architecture is so appropriate that nothing further needs to be said about it.

92
Uniform street lamps and their elimination

If we must mention something detestable, this is, in my view, those street lamps which in every town look so alike that one cannot help wondering how mankind can be capable of such monotonous repetition. Happily, this repetition can be quickly eliminated by combinations of coloured glass hanging-lamps, which are adaptable to a vast number of forms. This elimination will of course come very soon.

93
Present-day travel

Today people travel from nervous habit: they want to have something different and although they know that all hotels and towns, mountain villages and health resorts have a dreadful sameness, they travel there just the same. They travel, knowing well that they will find nothing better wherever they go.

94
Future travel

In the future, people will travel in order to look at new glass architecture, which will differ widely in various parts of the world.

To travel for the sake of glass architecture has at all events a meaning; one may surely expect new glass effects in other places. One may also assume that nine-tenths of the daily press will report only on new glass effects. The daily press wants novelty – so it will not be unfriendly to glass.

95
The Doppler and the Zeeman effects

It has often been said that glass is not a ‘precious’ commodity.

In contrast to this, remember Frauenhofer’s lines of the glass spectrum. In addition, Christian Doppler discovered that light, when it approaches or recedes, breaks up Frauenhofer’s lines into infra-red and ultra-violet. By using photography it has been possible to measure this, and from these measurements we know precisely whether stars of weak luminosity are approaching us or receding, and at what speed. Without glass the Doppler effect would not be discernable; I should think that this speaks volumes for the importance of glass.

The Zeeman effect occurs through the action of a magnetic field and a flame; the spectrum then shows Frauenhofer's lines suddenly triplicated. From the 'triplets' one can determine the existence of magnetic fields, which are detectable in sun-storms and explain the constitution of sun-spots. I believe that the Zeeman effect also speaks volumes for the importance of glass.

Thus one can no longer be permitted to describe glass as of little value; whoever does that has no right to be considered an educated person.

96
Which spheres of interest are fostered or endangered by glass architecture

The livelihood of masons and carpenters – from what has been said above – is clearly threatened; also that of the whole timber industry, joiners, turners, etc. But the process will not be so rapid that it will be impossible to assimilate those affected into other trades; they will have plenty of time to transfer to the metal and glass industries. Very many new skills are required, and nothing stands in the way of change.

Admittedly, many locksmiths say that a mason could never become a locksmith; the locksmith only says this because he fears competition.

But the spheres which will inevitably be stimulated by glass architecture are principally heavy industry, the chemical dye industry and the glass industry.

97
Heavy industry

The introduction of iron into house-building will, beyond question, bring so many new orders to heavy industry that it could continue to exist even if all cannon-making were stopped. Accordingly, heavy industry would be well advised not to take the ideas discussed in this book too lightly; they will bring it great pecuniary advantages. In any case, heavy industry should note that there will be many new potential clients because of glass architecture.

98
The chemical dye industry

The same thing applies to the colour industry. Glass architecture will consume vast quantities of colour.

99
The glass industry

It is undeniable that the glass industry has the lion's share in glass architecture. The present scale of the industry, however, is inadequate for the greater demand; it must expand in proportion. The financial success which will result from this is quite incalculable.

100
The influence of coloured glass on the plant world

Glass architecture will also exercise an influence on botanical gardens; entirely colourless, plain glass will be gradually abandoned. Coloured glass will only be used externally, where it does not absorb too much light. The plants will then be exposed experimentally to coloured light, and the experts may well have some surprises. The experiments should not be carried out in haste.

101
Art in bridge building

There have been times when the engineer has had the upper hand over the architect; not unnaturally, for the engineer was more needed.

Today the engineer no longer wants to stuff all the fees into his pocket; he gladly allows half to the architect. This will soon be apparent in bridge building, where there are high artistic ambitions. One could wish that these related to glass architecture.

102
The transformation of the Earth's surface

So many ideas constantly sound to us like a fairy-tale, when they are not really fantastic or utopian at all. Eighty years ago, the steam railway came, and undeniably transformed the face of the earth. From what has been said so far the earth's surface will once again be transformed, this time by glass architecture. If it comes, a metamorphosis will occur, but other factors must naturally be taken into consideration, which cannot be discussed here.

The present brick 'culture' of the city, which we all deplore, is due to the railway. Glass architecture will only come if the city as we know it goes. It is completely clear to all those who care about the future of our civilization that this dissolution must take place. To labour the point is useless.

We all know what is meant by colour; it forms only a small part of the spectrum. But we want to have that part. Infra-red and ultra-violet are not perceptible to our eyes – but ultra-violet is perceptible to the sensory organs of ants. If we cannot at the moment accept that our sensory organs will develop appropriately overnight, we are justified in accepting that we should first reach for what is within our grasp – i.e., that part of the spectrum which we are able to take in with our own eyes – in fact, the miracles of colour, which we are in a position to appreciate ourselves. In this, only glass architecture, which will inevitably transform our whole lives and the environment in which we live, is going to help us. So we must hope that glass architecture will indeed transform the face of our world.

103
The transformation of the official architect

When the private client wants to build, he looks for the best architect. When the state wants to build, government architects are at its disposal – not the best architects, who are generally freelancers. This is a deplorable situation, and it is the state that one chiefly deplores. These official architects, who are always hamstrung by the bureaucracy (hence their inhibitions and conservatism), must once again become free; otherwise they will hinder future architectural progress. One sees from the buildings produced by official architects that they are scared of colour; scared of ridicule. This remarkable colour-shyness stems from old Peter Cornelius who would have nothing to do with colour.

In the botanical gardens at Dahlem there is as yet no orchid house. This is bound to be a glass palace. Its construction must be already assigned to government architects. I am curious to see the result. Heating by (ceramic) stoves has been proposed, for they are supposed to be better-suited to orchids than central heating; I do not know whether the construction of the stoves is being entrusted to a government master-potter.

104
The psychological effects of the glass architectural environment

The peculiar influence of coloured glass light was already known to the priests of ancient Babylon and Syria; they were the first to exploit the coloured glass hanging lamp in the temples, and the coloured glass ampulla was later introduced into churches throughout Byzantium and in Europe. From these were developed the stained glass windows of the Gothic period; it is not to be wondered at that these make an especially festive impression, but such an impression from coloured glass is inevitably inherent in glass architecture; its effect on the human psyche can accordingly only be good, for it corresponds to that created by the windows of the Gothic cathedrals and Byzantium glass ampullæ. Glass architecture makes homes into cathedrals, with the same effects.

105
A composed and settled nation, when glass architecture comes

When home life has reached the stage where even the wildest fancies appear to be realized, the longing for something different ceases; people will travel only to learn about a particular type of glass art and possibly to bring it home – to be able to reproduce it in a similar design.

Perhaps somewhere one may discover the art of making glass fibres like brocade, so that the fibres, viewed from different angles, will show different colour effects. Perhaps somewhere they can make a lace-like fabric from glass fibres and fix it to a darker glass wall of one colour; an intimate effect might result, and this would make for a homey appearance, which one would leave reluctantly; a curtain effect would be created. Perhaps then one would only travel to find out about new glass crafts; much that was new might emerge from old designs. But the entirely new is also to be expected from the great inventors of our own and future times.

106
More coloured light!

We must not strive to increase the intensity of light – today it is already too strong and no longer endurable. But a gentler light is worth striving for. Not more light! – 'more coloured light!' must be the watchword.

107
The main entrance

In my opinion, the entrance to a great palace should always be an open hall of many glass walls, gathered together one upon another like the petals of an exquisite flower. The best architects should devote themselves particularly to entrance-hall construction, and then invite the interior designers to surpass the complicated architectonic effects. This should create a splendid challenge; and it would simply be necessary for the client to bear the cost and not come to the end of his financial resources too quickly.

108
The monumental

The pyramids are monumental. Cologne cathedral, too, is monumental – the Eiffel tower is also often so described nowadays, but the idea of what is monumental will be changed by glass architecture. Glass towers will be built deep in the sea, creating a special kind of luxury architecture, cool and very peaceful. Many people might think of giant windmills, with sails over a hundred metres long; but town hall and powder-magazine towers might not be suitable for windmill purposes; brick architecture would not stand up to a severe storm.

109
Streets and highways as light-column avenues

The verges of streets and highways will no longer be planted with trees, which are not high enough for the purpose, but columns of light, provided with festoons of lights and shedding constantly changing coloured light, would be highly appropriate for verges.

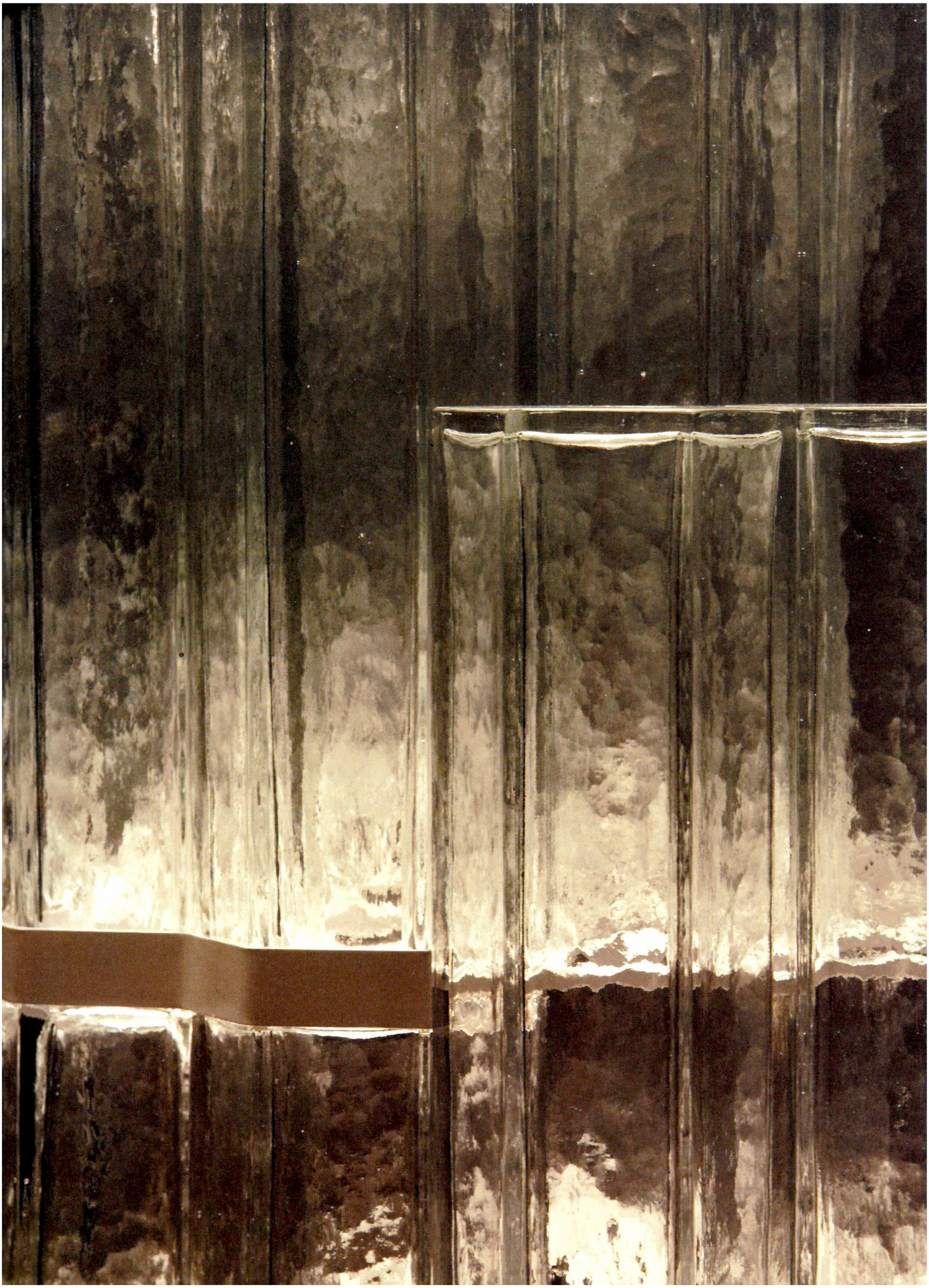
110
Chemistry and technics in the twentieth century

We are not at the end of a cultural period – but at the beginning. We still have extraordinary marvels to expect from technics and chemisty, which should not be forgotten. This ought to give us constant encouragement. Unsplinterable glass should be mentioned here, in which a celluloid sheet is placed between two sheets of glass and joins them together.

111
Glass culture

After all the above, we can indeed speak of a glass culture. The new glass environment will completely transform mankind, and it remains only to wish that the new glass culture will not find too many opponents. It is to be hoped, in fact, that glass culture will have ever fewer opponents; to cling to the old is in many matters a good thing; in this way at any rate the old is preserved. We, too, want to cling to the old – the pyramids of ancient Egypt should most certainly not be abolished.

But we also want to strive after the new, with all the resources at our disposal; more power to them!



PRIVACY AND PUBLICITY MODERN ARCHITECTURE AS MASS MEDIA
Beatriz Colomina
Mit Press, 1996

Short excerpt. Interior

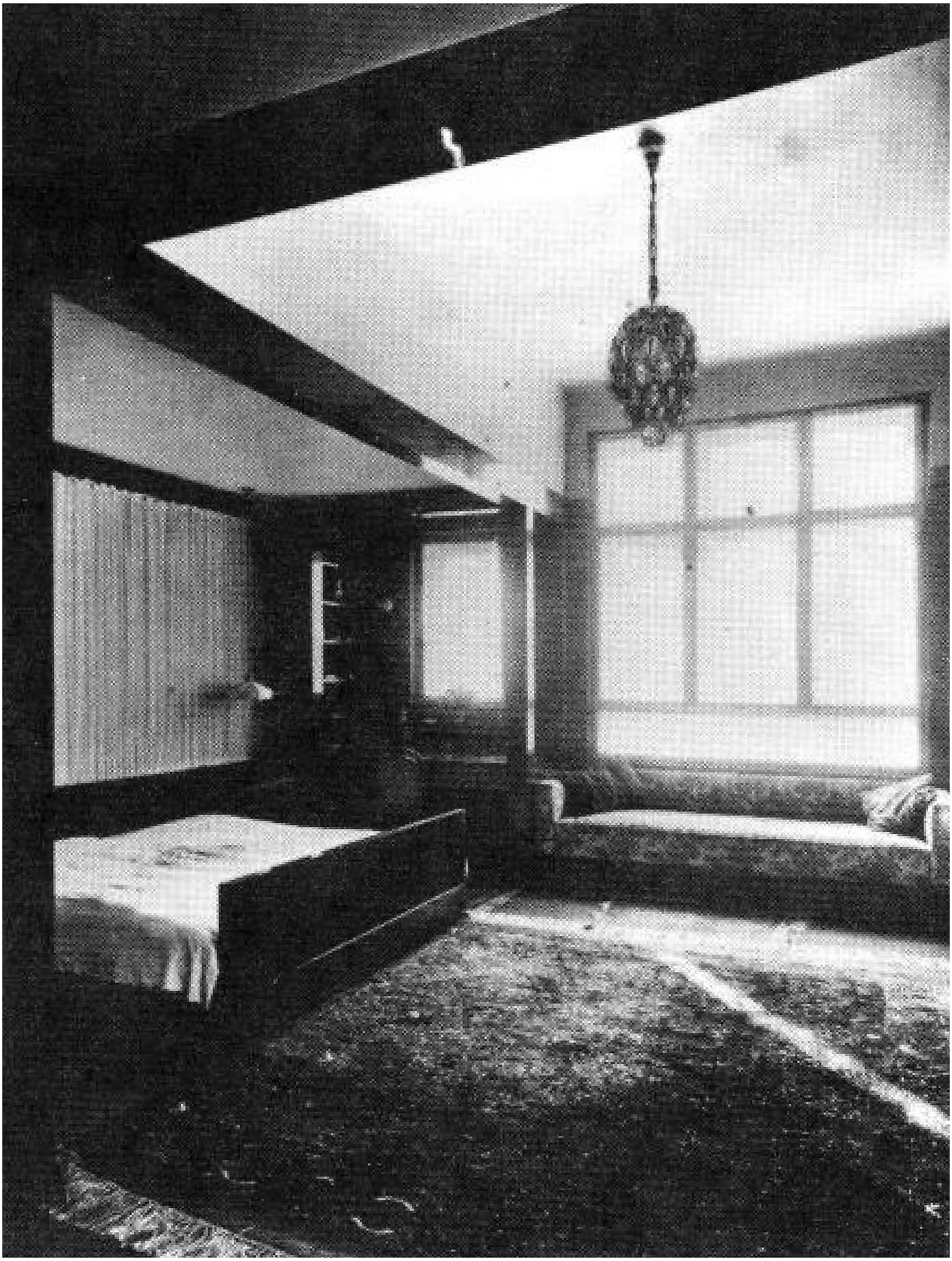
In this short excerpt, Colomina focuses on the work of Adolf Loos. She details his speculation on the use of windows primarily to let light in and "not to let the gaze pass through". Further noted in his interior layouts; how the user of the space is mostly guided away from the window through precise furniture placement. Raising questions on how glass placement can be used to define light in space as well as direct movement within space.

"To live is to leave traces," writes Walter Benjamin, discussing the birth of the interior. "In the interior these are emphasized. An abundance of covers and protectors, liners and cases is devised, on which the traces of objects of everyday use are imprinted. The traces of the occupant also leave their impression on the interior. The detective story that follows these traces comes into being. . . . The criminals of the first detective novels are neither gentlemen nor apaches, but private members of the bourgeoisie."[1]

There is an interior in the detective novel. But can there be a detective story of the interior itself, of the hidden mechanisms by which space is constructed as interior? Which may be to say, a detective story of detection itself, of the controlling look, the look of control, the controlled look. But where would the traces of the look be imprinted? What do we have to go on? What clues?

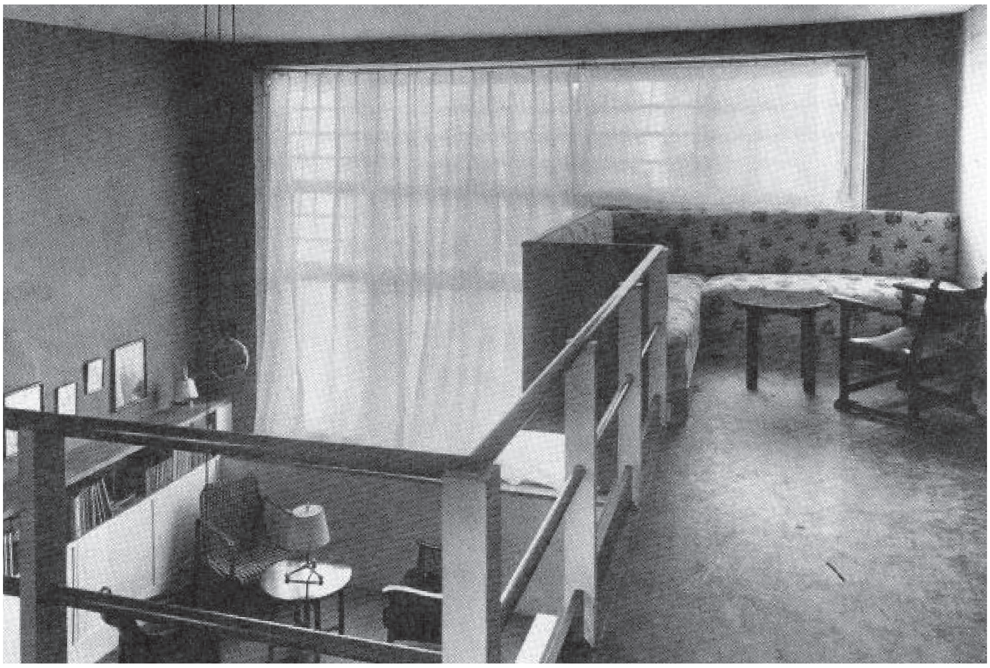
There is an unknown passage of a well-known book, Le Corbusier's *Urbanisme* (1925), that reads: "Loos told me one day: 'A cultivated man does not look out of the window; his window is a ground glass; it is there only to let the light in, not to let the gaze pass through.'"[2] It points to a conspicuous yet conspicuously ignored feature of Loos's houses: not only are the windows either opaque or covered with sheer curtains, but the organization of the spaces and the disposition of the built-in furniture (the *immeuble*) seem to hinder access to them. A sofa is often placed at the foot of a window so as to position the occupants with their back to it, facing the room, as in the bedroom of the Hans Brummel apartment (Pilsen, 1929). This even happens with the windows that look into other interior spaces—as in the sitting area of the ladies' lounge of the Müller house (Prague, 1930). Or, more dramatically, in the houses for the Vienna Werkbundsiedlung (Vienna, 1930–1932), a late project where Loos has finally brought himself to make a thoroughly modern, double-height window; not only is this opening still veiled with a curtain, but a couch in the sitting nook of the upper-level gallery places the occupants with their back to the window, hovering dangerously over the space. (Symptomatically, and we must return to this point, when the sitting nook in an identical house is used as a man's study, the seat faces the window.) Moreover, upon entering a Loos interior one's body is continually turned around to face the space one has just moved through, rather than the upcoming space or the space outside. With each turn, each return look, the body is arrested. Looking at the photographs, it is easy to imagine oneself in these precise, static positions, usually indicated by the unoccupied furniture. The photographs suggest that it is intended that these spaces be comprehended by occupation, by using this furniture, by "entering" the photograph, by inhabiting it.[3]

In the Moller house (Vienna, 1928) there is a raised sitting area off the living room with a sofa set against the window. Although one cannot see out the window, its presence is strongly felt. The bookshelves surround-



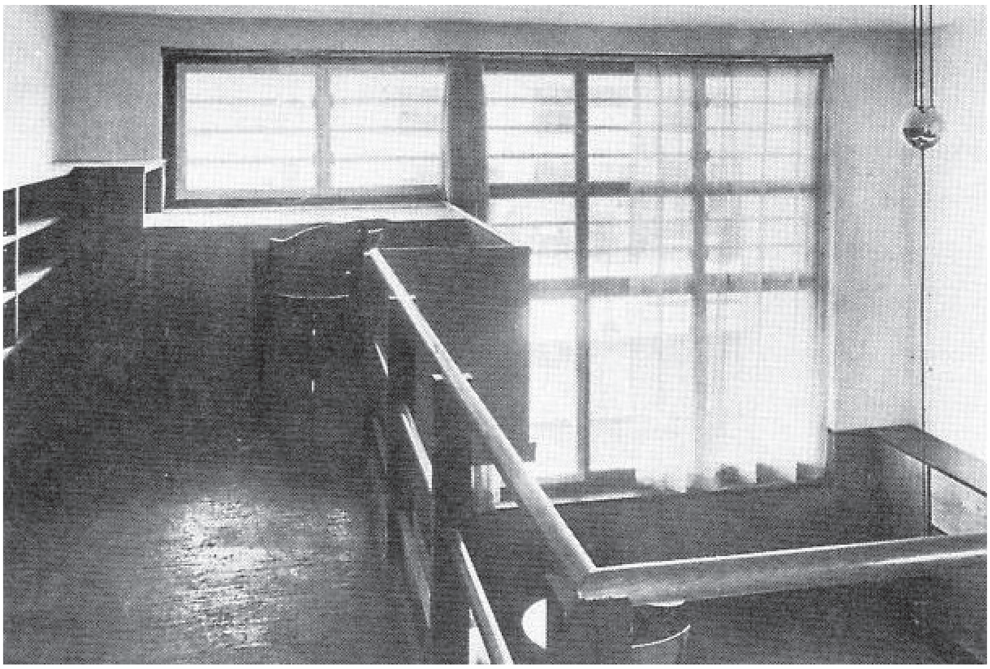
Adolf Loos, FLAT FOR HANS BRUMMEL, Pilsen, 1929

Bedroom with a sofa set against the window.



Adolf Loos, HOUSE FOR THE VIENNA WERKBUNDSIEDLUNG, Vienna, 1930 – 1932

Living room on two levels suspended in space.



HOUSE FOR THE VIENNA WERKBUNDSIEDLUNG

Corner Study in the gallery, photo 1932

ing the sofa and the light coming from behind it suggest a comfortable nook for reading. But comfort in this space is more than just sensual, for there is also a psychological dimension. A sense of security is produced by the position of the couch, the placement of its occupants against the light. Anyone who, ascending the stairs from the entrance (itself a rather dark passage), enters the living room, would take a few moments to recognize a person sitting on the couch. Conversely, any intrusion would soon be detected by a person occupying this area, just as an actor entering the stage is immediately seen by a spectator in a theater box.

Loos refers to this idea in noting that "the smallness of a theater box would be unbearable if one could not look out into the large space beyond."[4] While Kulka, and later Münz, read this comment in terms of the economy of space provided by the *Raumplan*, they overlook its psychological dimension. For Loos, the theater box exists at the intersection between claustrophobia and agoraphobia.[5] This spatial-psychological device could also be read in terms of power, regimes of control inside the house. The raised sitting area of the Moller house provides the occupant with a vantage point overlooking the interior. Comfort in this space is related to both intimacy and control.

This area is the most intimate of the sequence of living spaces, yet, paradoxically, rather than being at the heart of the house, it is placed at the periphery, pushing a volume out of the street facade, just above the front entrance. Moreover, it corresponds with the largest window on this elevation (almost a horizontal window). The occupant of this space can both detect anyone crossing-trespassing the threshold of the house (while screened by the curtain) and monitor any movement in the interior (while "screened" by the backlighting).

In this space, the window is only a source of light, not a frame for a view. The eye is turned toward the interior. The only exterior view that
The split between sight and the other physical senses that is found in Loos interiors is explicit in his definition of architecture. In "The Principle of Cladding," Loos's most Semperian text, he writes: "The artist, the architect, first senses the *effect* that he intends to realize and [then] sees the rooms he wants to create in his mind's eye. He senses the effect that he wishes to exert upon the *spectator* . . . homeyness if a residence."[22] For Loos, the interior is pre-Oedipal space, space before the analytical distancing that language entails, space as we feel it, as clothing; that is, as clothing before the existence of readymade clothes, when one had first to choose the fabric (and this act required, or I seem to remember as much, a distinct gesture of looking away from the cloth while feeling its texture, as if the sight of it would be an obstacle to the sensation).

GLASS IN MODERN ARCHITECTURE OF THE BAUHAUS PERIOD, 1968

Arthur Korn

First published in 1926

This introduction text by Korn describes the 20th-century shift towards glass architecture, alongside supporting images of projects that help illustrate the range of glass applications developed during this time period.

To this edition

When this book was written about forty years ago outstanding buildings like the Barcelona Pavilion (1929) by Mies Van der Rohe or the Boot's Factory, Nottingham (1932) by Sir Owen Williams did not yet exist. Yet it contained the best buildings in glass by Mies, e.g., the competition Friedrichstrasse, Berlin (1922), a mushroom construction planned in free-shaped curves and a dreamlike exhibition of coloured plate-glass rooms for an annexe to the Weissenhof-siedlung in Stuttgart (1927).

Since then, glass buildings have appeared all over the world, particularly in the U.S.A. and England. The Vickers Tower, Castrol House and New Zealand House in London to mention just a few together with the United Nations Building, the Seagram and Lever Buildings in New York have changed the character of the existing Towns.

The use of glass has become a mass-phenomenon most significant in the design of shops and in the 'prestige' vestibules to the new office blocks producing what Lissitzky would have called 'Infinite Space'. 'The continuity of space is thus established in a singular way in contrast to all other materials'.

The three-dimensional effect which was established some forty years ago as a new and outstanding feature of glass has become more conscious to-day and it is to be expected that further developments towards the potential qualities of this material may discover new possibilities in the near future.

To the first edition

Glass is an extraordinary material. It gave us the beauty of mediaeval stained glass windows. Tightly held between supporting piers they opened a door to allow a glimpse of paradise in luminous colours from the shadow of the grave.

Nothing has been lost from the richness of those earlier creations, but glass has now been associated with other materials to meet new functions. A new glass age has begun, which is equal in beauty to the old one of Gothic windows.

Up to the present time glass has been a secondary building material, which remained subservient in spite of all its intrinsic ornamental strength, in spite of its crucial position in the interplay of structural forces, in spite of its underlining contrast with the masonry of the walls. The contribution of the present age is that it is now possible to have an independent wall of glass, a skin of glass around a building; no longer a solid wall with windows. Even though the window might be the dominant part—this window is the wall itself, or in other words, this wall is itself the window. And with this we have come to a turning point. It is something quite new compared to the achievements through the centuries . . . it is the disappearance of the outside wall—the wall, which for thousands of years had to be made of solid materials, such as stone or timber or clay products. But in the situation now, the outside wall is no longer the first impression one gets of a building. It is the interior, the spaces in depth and the structural frame which delineates them, that one begins to notice through the glass wall. This wall is barely visible, and can only be seen when there are reflected lights, distortions or mirror effects.

Thus the peculiar characteristic of glass as compared to all materials hitherto in use becomes apparent: glass is noticeable yet not quite visible. It is the great membrane, full of mystery, delicate yet tough. It can enclose and open up spaces in more than one direction. Its peculiar advantage is in the diversity of the impression it creates. Only in recent years has it been realised that this material opens quite a new range of possibilities to the architect. A few examples may illustrate what I mean. If we take, for example, the Bauhaus in Dessau by Walter Gropius, or the buildings by Mies van der Rohe, or the design for the Kopp & Joseph shop by Arthur Korn, we notice quite different aims behind the use of glass.

1) In the office block by Mies van der Rohe (p.12) and the workshop at Dessau (p. 17) the visible depth behind the thin skin of glass is the exciting factor.

2) In the curved office block by Mies van der Rohe (p. 10), the strength of the outer skin with its reflections and mirror effects, as well as the curvature of the smooth glass surface as such, is predominant.

3) With the Kopp & Joseph shop by Arthur Korn, apart from the spatial articulation, the strong colour effects behind an invisible screen are specially emphasised. Here the glass skin is no longer of any visual importance but purely a medium to form a barrier against the weather etc.

When looking at these various possiblities we realise that new rules are at work here, different from those of the past. Glass has an extraordinary quality which enables it to render an outside wall practically non-existent, when one compares such a wall to those made of other materials—stone, wood, metal or marble—all of which form solid barriers.

Obviously, the opening up and perforation of a wall has been an aim and a problem for a considerable time and in some instances solutions were found which even made the interior of a building visible from without, but never before did man succeed in enclosing and dividing up space by a single membrane. It is this membrane which really encloses a building, but only with certain qualities of a solid wall, such as defence against temperature variation and noise, as well as the provision of safety. This is not a purely imaginary wall as it is in the case of the regular rhythm of columns around a classical temple.

It is evident that a material of such qualities requires the building itself to be remodelled, conceived in a revolutionary way. The building by Mies van der Rohe, a structure of unusual and perfect clarity, is based on new and different rules for the use of glass. There is evidence of a new structural concept where all load-bearing elements are kept within the core of the building, leaving the outside wall free to be nothing but a wrapping to enclose and to allow light to penetrate. This function is just the peculiar characteristic of glass, which in this formula shows itself to be at the same time a medium for the penetration of light and a skin for a building, reflecting the sparkling of its own lights and heightening the effect through the occasional glimpses of the load-bearing supports in its interior.

Even if the intensity of colour effects of the new neon lights compete with the strength of those of the old Gothic windows, they are both two-dimensional coloured surfaces only. The new characteristic of glass is evident only when it opens up views deep into the inside of the building, thus exploiting its peculiar property through its position. It is only here that it can show in all its purity the strength of this sophisticated, yet in a way simple, characteristic. Compared with this special and individual property, all other effects of glass—colourful, brilliant and stimulating—are of secondary importance.

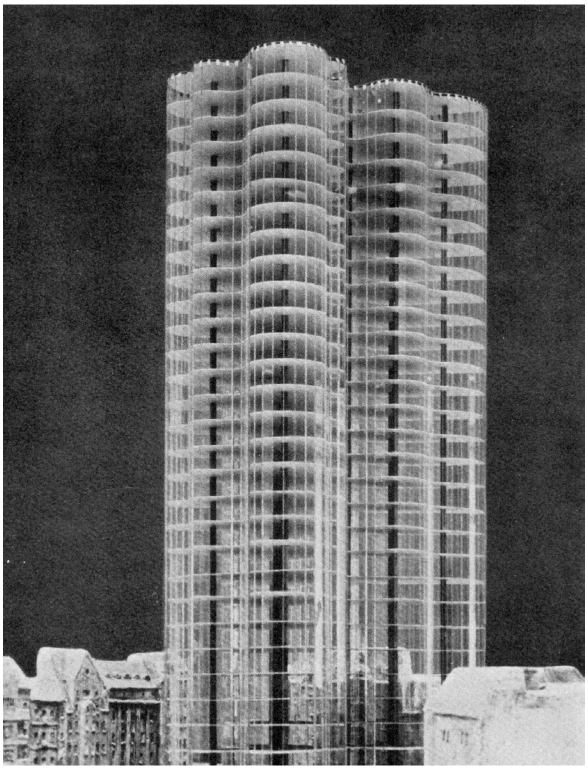
The disappearance of the outside wall of a building has its counterpart in a similar process inside. Partitions dissolve into glass walls. This can be observed in various examples, as for instance in the girls' hostel in Prague by Tyll (p. 50) where one passes glass partition after glass partition and meets the same fullness of light inside as in the street outside. Where solutions like this are also coupled to a process of eliminating as many solid walls as possible in the core of a building, delicate structures emerge such as the house for the co-operative by Le Corbusier (p. 19) or the sanatorium at Hilversum by Duiker (p. 55).

The qualities of the architectural concept which have proved both new and lasting have also been evident in the approach to the designing of shops. Here again the tendency to utilise the two-storey skin effect for visual penetration into depth offered possibilities other than the flatness of former shop windows.

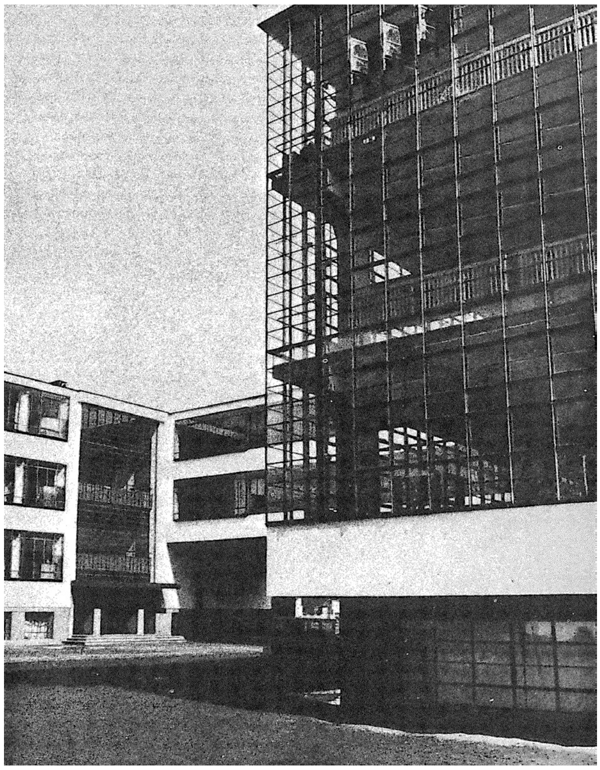
Novel developments followed in the area of large-scale advertisements and hoardings in the townscape. Today, it is possible to show these to similar advantage by daylight and during the night with the aid of glass bricks and large sections of sheet glass which can be covered by signs and lettering up to fifty feet high. These large glass surfaces can glow with a diffuse light by night as in the staircase tower in Magdeburg by Carl Krayl (p. 46), where the large signs hardly impede the penetration of daylight. With the help of these large glass surfaces it is now possible to have much greater freedom for advertising designs which hitherto had to be hemmed in between the spandrel panels below window cills.

The window as the structural element of the large glass surface had to be redesigned from basic principles. This was done not only because of the general tendency to reconsider and redesign each of the few basic elements of the modern building, but also because the window is the most exposed element in an outside wall, and furthermore, because a window has to be moveable with a frame as thin as possible. This is the reason why quite a number of new window constructions appeared on the market—both casement and sliding windows. One of these new constructions is shown in the example by a Swiss architect (Artaria & Schmidt p. 69). With the advance of glass as a building material its use for other purposes also increased. Apart from its extensive use for light fittings, it is being used for the sake of its intrinsic beauty, its hygenic, hard and protective surface in conjunction with furniture of various kinds. The glass table by Marcel Breuer (p. 120) is a good example in this connection. But glass is also used for the manufacture of cooking utensils in the form of fire-proof dishes and other glassware, including intensely refined test tubes and complicated laboratory glass vessels, and these show the wide scope of its use and its form. It is just in these admirable shapes and forms that we see how much we can still expect if one day men are to succeed in extending these creations into the realm and dimension of large buildings with suspended pipes in spirals and glass tubes to take staircases and escalators.

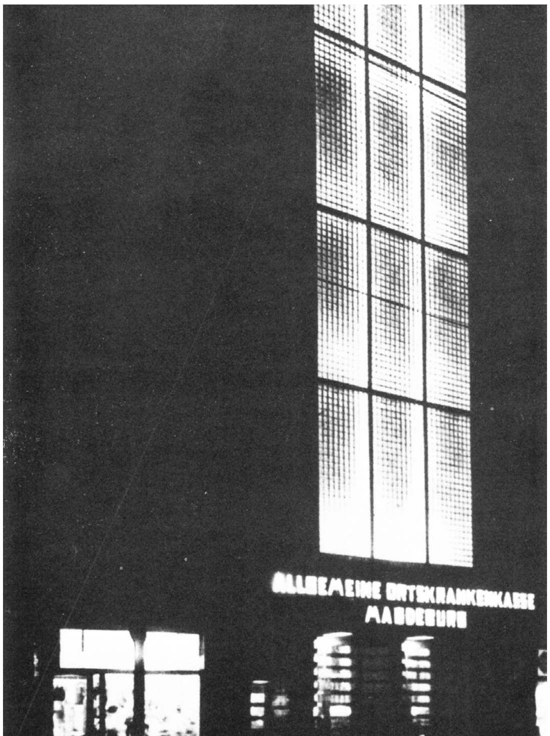
The object of writing this book was to point to new opportunities which are still dormant in glass. The technical details of how these may be put into practice can be left to the experts to put into words.



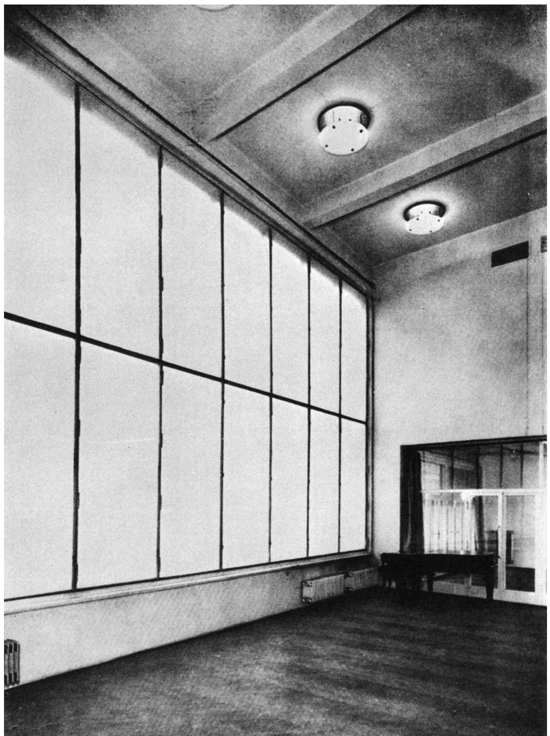
Page 10: Mies van der Rohe, project: A Glass Skyscaper, Model



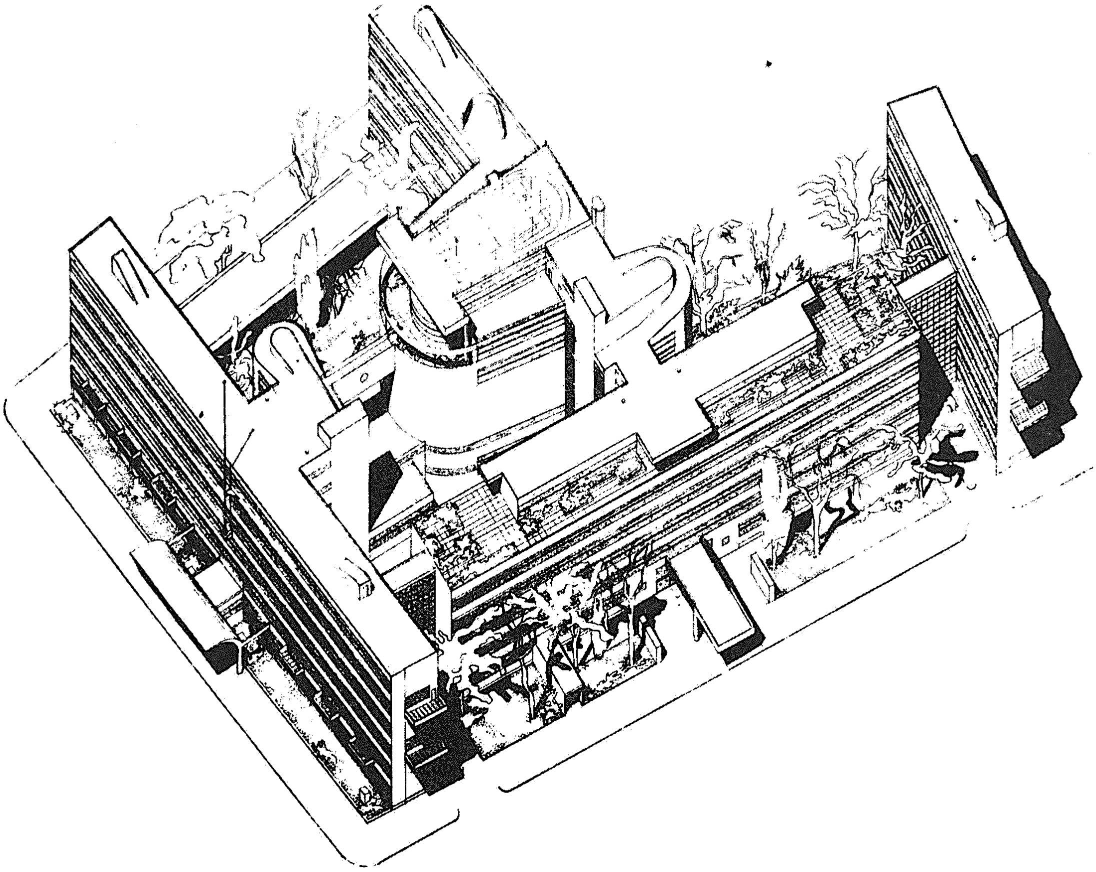
Page 17: Walter Gropius, Bauhaus, Dessau, Workshop Wing

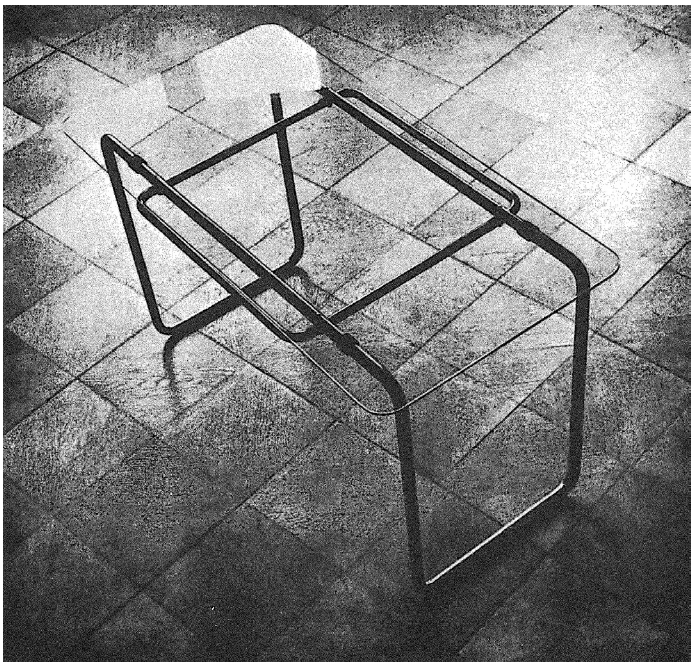


Page 46: Carl Krayl. Local Health Insurance Building, Magdeburg

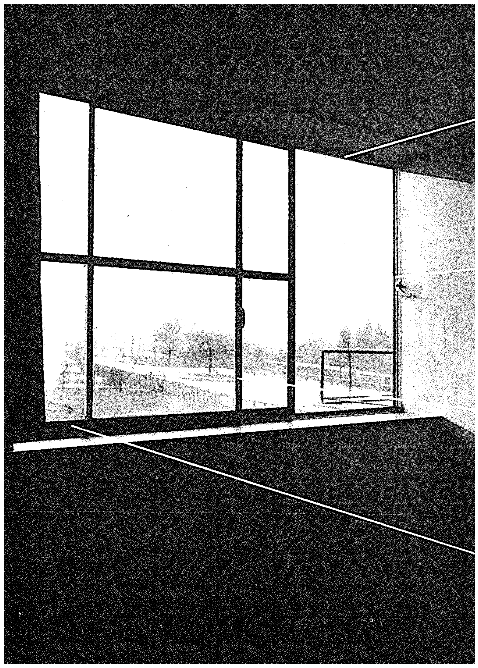


Page 50: Oldrich Tyll, Girls' Hostel, Prague. View of the large window.

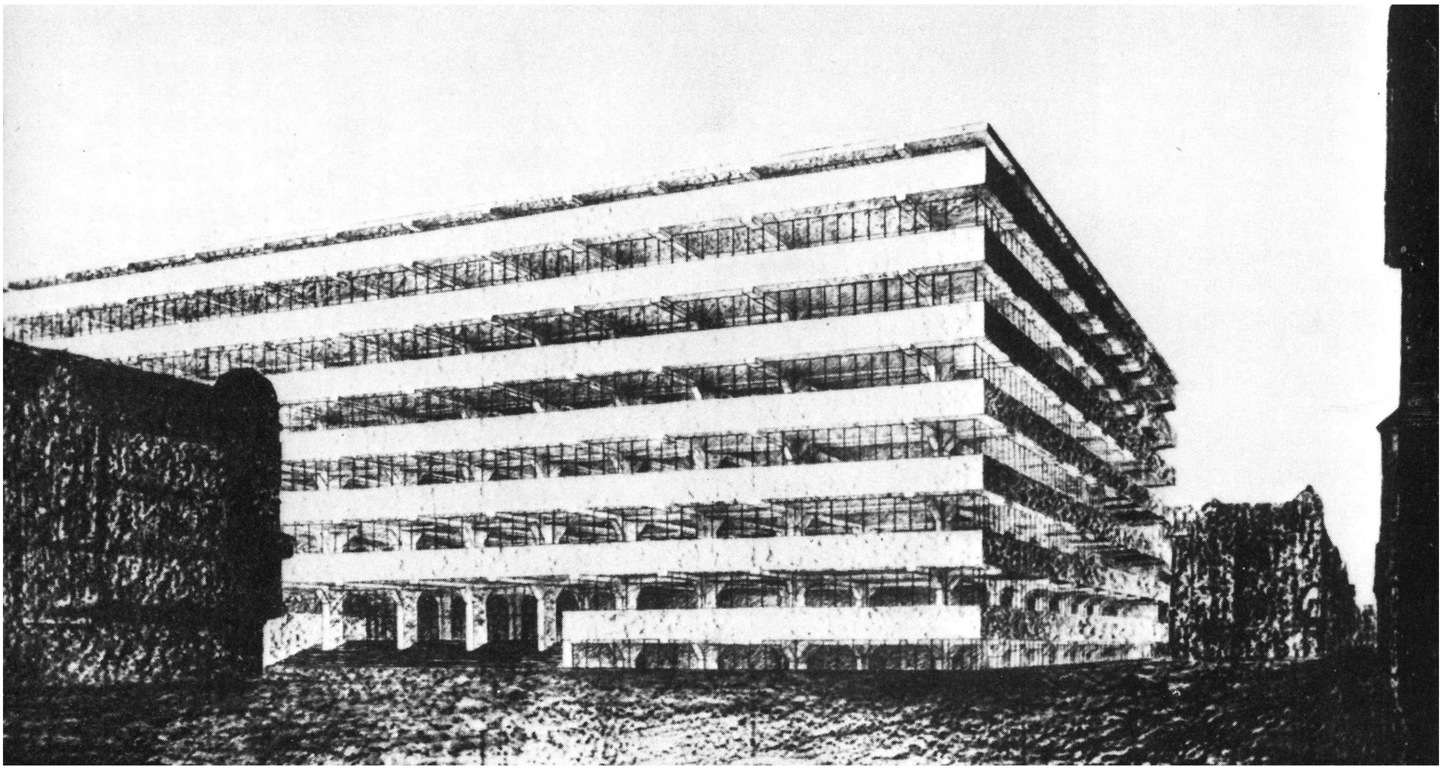


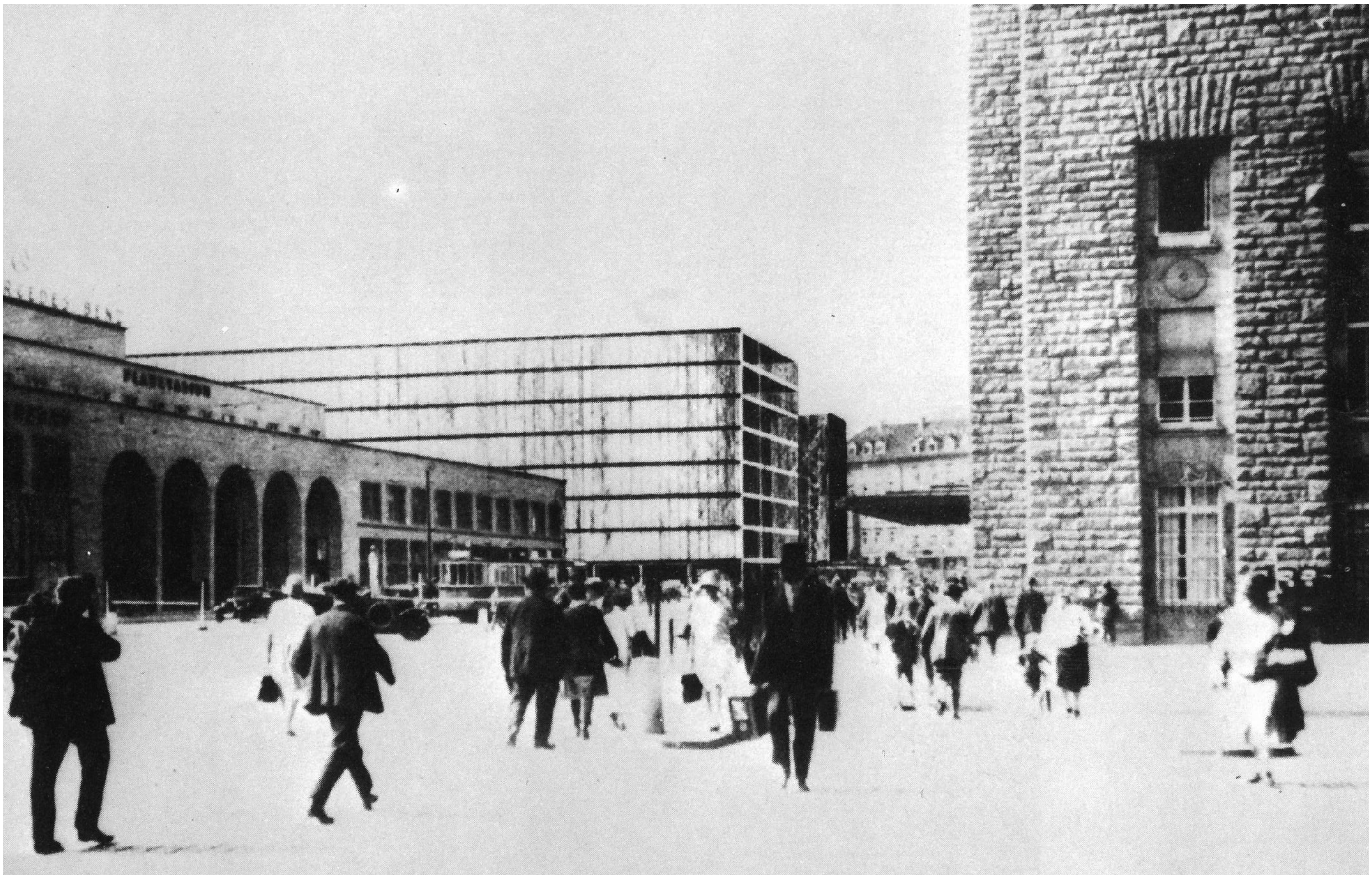


Page 120: Marcel Breuer, Steel and Glass Table.

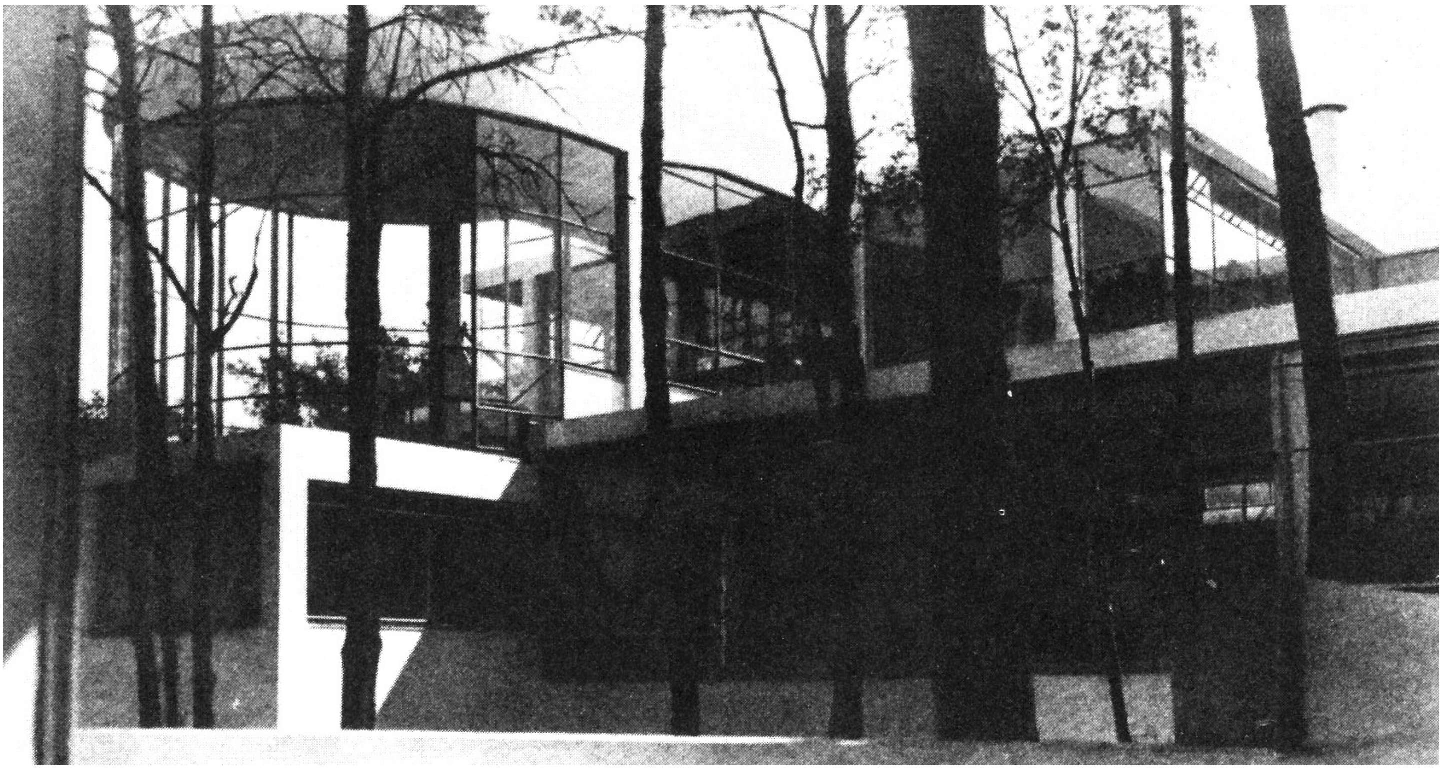


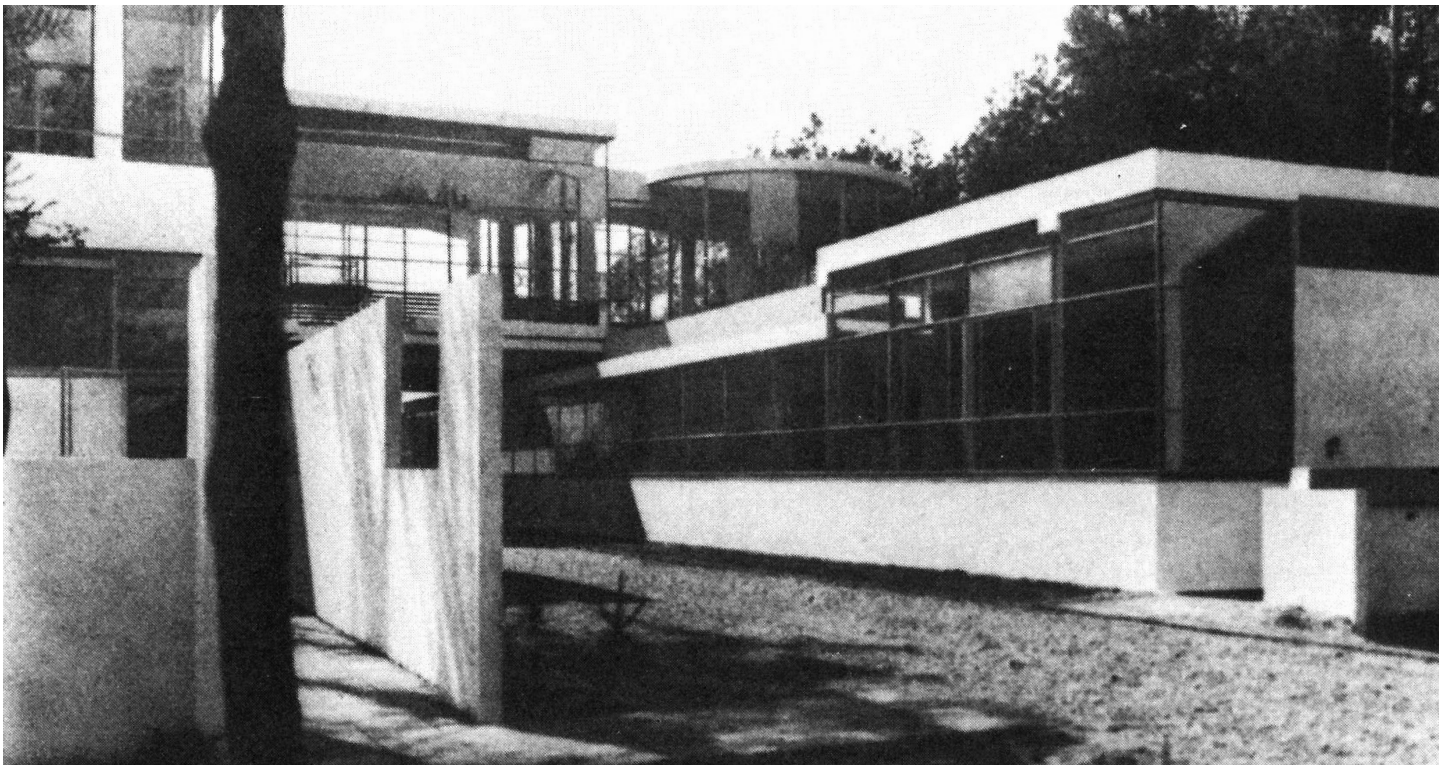
Page 69: Steel sash-window. Prototype by Artaria and Schmidt, Architects, Basel.





Page 12: Mies van der Rohe, Office Block



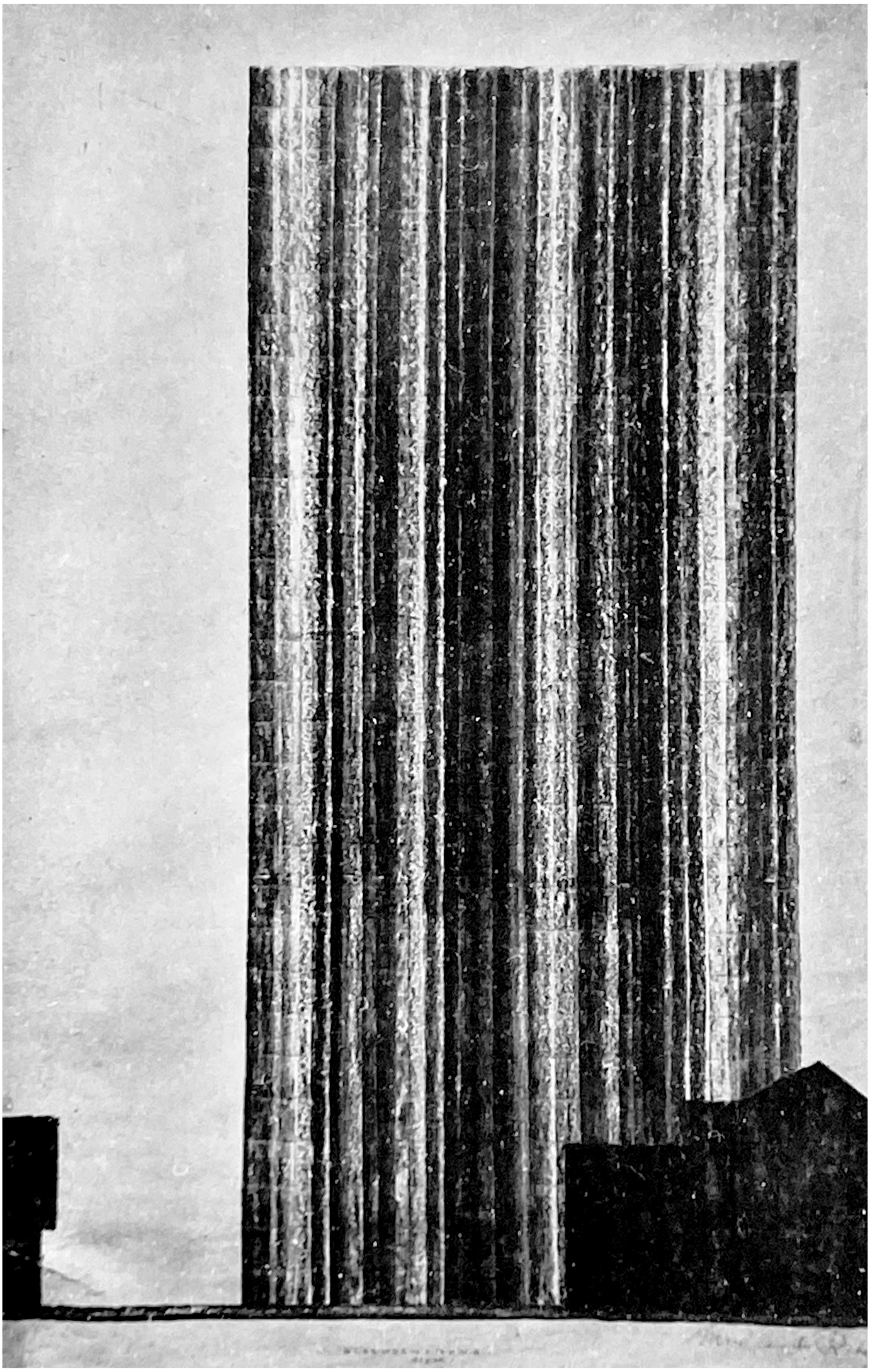


Page 55: J. Duiker. Zonnestraal Sanatorium, Hilversum, 1928

Mies Van Der Rohe Johnson, Philip.
THE MUSEUM OF MODERN ART, 1947

Excerpt. 1922: Two Glass Skyscrapers

In this short excerpt, Rohe outlines the nature of skyscrapers in architecture. The text briefly lists their structural qualities and presence on a city, writing that "the use of glass imposes new solutions". Rohe then details the decisions taken for his Friedrichstrasse skyscraper project in Berlin, and notes the results of his experiments carried out using real glass models.



1922: TWO GLASS SKYSCRAPERS

Illustrations, pages 23-29; text, page 21.

Skyscrapers reveal their bold structural pattern during construction. Only then does the gigantic steel web seem impressive. When the outer walls are put in place, the structural system which is the basis of all artistic design, is hidden by a chaos of meaningless and trivial forms. When finished, these buildings are impressive only because of their size; yet they could surely be more than mere examples of our technical ability. Instead of trying to solve the new problems with old forms, we should develop the new forms from the very nature of the new problems.

We can see the new structural principles most clearly when we use glass in place of the outer walls, which is feasible today since in a skeleton building these outer walls do not actually carry weight. The use of glass imposes new solutions.

In my project for a skyscraper at the Friedrichstrasse Station in Berlin [page 24] I used a prismatic form which seemed to me to fit best the triangular site of the building. I placed the glass walls at slight angles to each other to avoid the monotony of over-large glass surfaces.

I discovered by working with actual glass models that the important thing is the play of reflections and not the effect of light and shadow as in ordinary buildings.

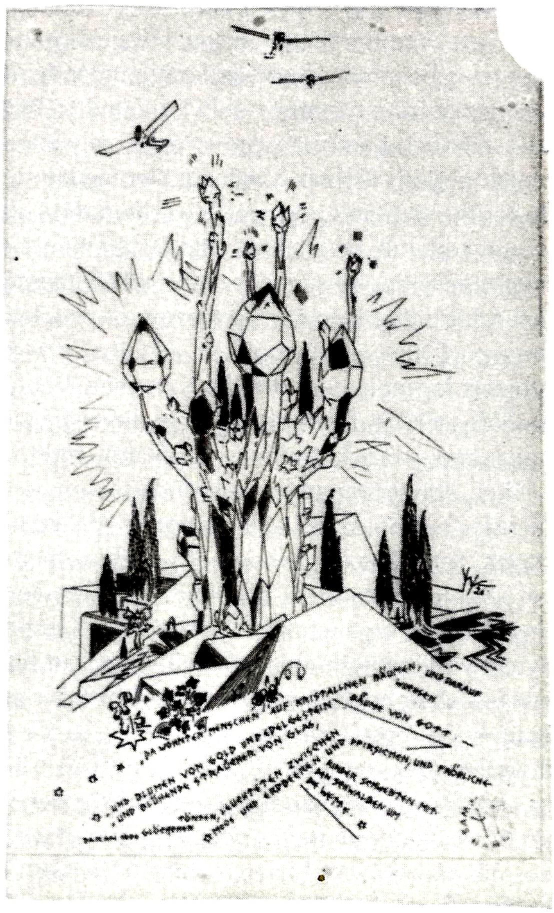
The results of these experiments can be seen in the second scheme published here [page 28]. At first glance the curved outline of the plan seems arbitrary. These curves, however, were determined by three factors: sufficient illumination of the interior, the massing of the building viewed from the street, and lastly the play of reflections. I proved in the glass model that calculations of light and shadow do not help in designing an all-glass building.

The only fixed points of the plan are the stair and elevator shafts. All the other elements of the plan fit the needs of the building and are designed to be carried out in glass.

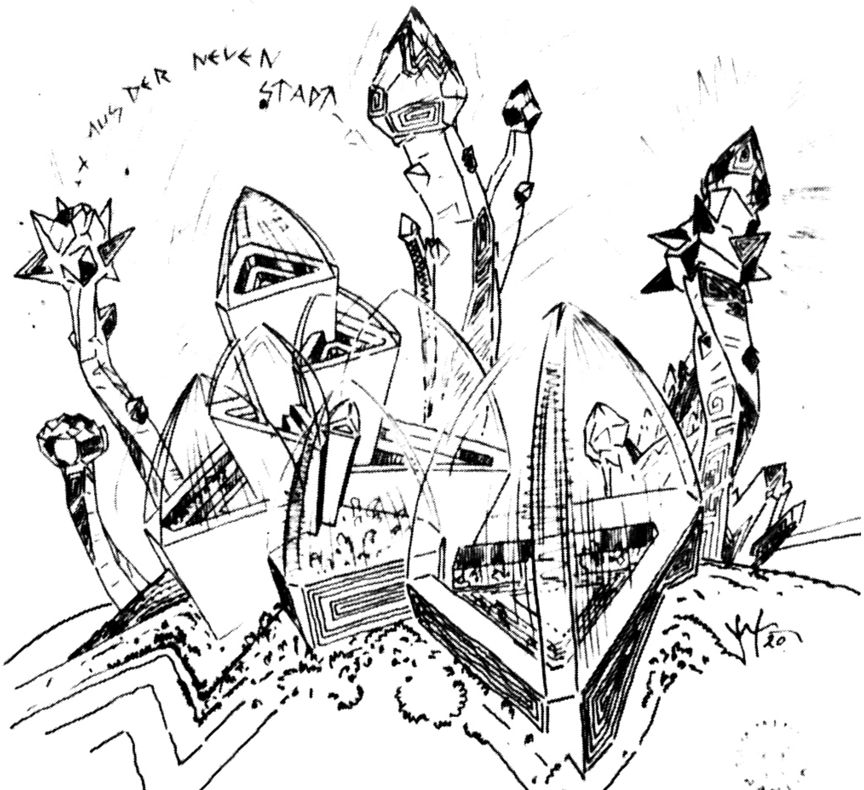
From *Frühlicht*, (bibl. 1)

THE CRYSTAL CHAIN LETTERS: ARCHITECTURAL FANTASIES BY BRUNO TAUT AND HIS CIRCLE
Iain Boyd Whyte, Bruno Taut
MIT Press, 1985

This letter describes a futuristic film scenario of building a glass house by the sea, written by Wenzel Hablik, taken from Die Glaserne Kette (The Crystal Chain Letters); a corporate manifesto in the form of letters and sketches created by a group of Berlin-based artists and architects with Glass as its central interest, initiated by Bruno Taut (pseudonym Glas), the correspondence ran from 1919 – 20.



Wenzel Hablik (W.H.), 1920. Hablik Collection, Itzehoe



Wenzel Hablik (W.H.), VILLAS: FROM THE NEW CITY, 1920

Hablik Collection, Itzehoe

Through the breakers a ship is seen landing, cutting deeply into the sand of the beach as if digging itself in. Men leave it, carrying seven-pointed metal stars which are distributed to fixed points, laid down on the sand, and linked to a central control by electric cables. Thin tubes connected to electric pumps in the ship are lead to the individual stars (these could possibly be dropped by one or even seven airplanes). The pumps in the ship supply special dissolving and bonding fluids, which seep into the sand around the stars. A small airplane circles above the building site sending signals. From the ship's hull rises a glittering mast, showering sparks, and at the same time cascades of sparks speak from the stars in the sand. Craters of flowing fire develop around each star (the biggest around the largest star, the smallest around the smallest). Radio signals from the circling airplane of the engineer. An airship-workshop approaches and hovers a certain distance away. Hollow spheres are lowered into the molten, heaving craters in which the stars revolve, and attach themselves to the metal tubes. Immediately the glowing mass begins to take shape. Large bubbles rise up, iridescentin all the colors of the rainbow and as round as domes, are absorbed by one another to form even larger bubbles (like soap bubbles). Signals: Once again some spheres are lowered from the airship and remain stuck to the bubbles. Pipes blow streams of sand at them. Valves open up, and the bubbles stretch and stretch, forming themselves into perculier forms. Solidification. The process continues at craters 2, 3, and so on through the transference of gas from the airship. Magnificent structures are already appearing, giant iridescent glass domes drawn out into spikes and points – globes and tongues, spheres and flowery tubes – glittering and shining – showering out sparks. The interior of the crater s hardens, attached to a molten foundation, and room after room rises up from the center. The great airship moves away – seven airplanes leave it and circle around the site. Workers disembark from the ship and the details are completed. Some of the domes leave their foundations, rise up, and are then remoulded and reattached again. Finally, a look into the interior of a globe-shaped dome. Glass furniture and so on. A similar procedure would be shown for building underwater (in the sea, in lakes).

Airship greetings from your W.H.

THE BUILDING OF A GLASS HOUSE BESIDE THE SEA (a film scenario). W.H., 1920

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Gian Luigi Calderone, CASA VENINI, Video, 56 mins

Gian Luigi Calderone, PAOLO VENINI, L'UOMO DI NOTTE, Video, 74 mins

Gian Luigi Calderone, GIACOMO CAPPELLIN, M.V.M. e CIACOLE, Video, 60 mins

Gian Luigi Calderone, NAPOLEONE MARTINUZZI, MIO COMANDANTE, Video, 60 mins

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