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Disturbance of transparency in the architecture of contemporary glass façades. Part 1

Introduction

Architecture communicates with the viewer through the façade. Façades, apart from their function of the cover and illumination, are the hallmark of the building – they communicate its meaning and prestige. However, the complexity of the relationship between the different architectural "forms" and the "messages" makes contemporary architecture not easy to understand or value. Already 150 years ago, Gottfried Semper claimed that buildings "should be cloaked by a façade" [1], just like the gentleman is dressed in a frock. Some 50 years later, the modernists postulated "honesty" in design, which resulted in radical formal operations involving the removal of all classical ornamentation. The widespread introduction of skeletal structural systems allowed for the use of the then-revolutionary glass curtain walls, which were completely independent of the building's supporting structure. Smooth glass panes representing the "new architecture", apart from illuminating the interiors of buildings, also created mirror reflections. This is because the use of glass makes it transparent in certain lighting conditions, while – with the different balance of internal and external illumination – the glass surface becomes the mirror. Therefore the first phase of the formal development of the so-called "glass architecture" was focused on studying the basic laws of optics. In his garden, Mies van der Rohe […] *photographed a model of the famous glass skyscraper to assess the optical effects that influenced the appearance of the building* [2, p. 82]. This basic optical effect of transforming the transparent into the mirrored surface (with the increasing use of reflective coatings) has become the source of many critical opinions concerning entirely glazed buildings. Those critical opinions are also currently formulated by renowned authors, critics, and publicists. L. Alter, a journalist for the influential TreeHugger portal, writes that […] *all-glass buildings are an aesthetic, as well as a thermal crime* [3]. In some buildings transparent façades have turned into a large-scale version of the one-way-mirror, in others, the reflective coating makes the façade disappear and thus the façade becomes a trap for people and animals.

The division of the building into "the structure" and "the envelope", was originally motivated by strictly engineering reasons. Over time this division also gained an important narrative function. In historical epochs, the façade – apart from its load-bearing and covering functions – played an important role in communicating the meaning, the prestige of the client, and even the purpose of the building. However, especially in the era of "international style" the spread of identical-looking glass curtain walls caused this important narrative function of the façade to be significantly reduced, and in some cases, it ceased to be performed at all. As a counteraction, new buildings began to emerge for which the façade is much more than just a simple physical climate barrier between the internal and external environment. This new façade gained an additional meaning: informational, communicative, and also political [4]. In a sense, it returned to its historical roots when the façade informed about the status of the building and the client.

Modern glass façades – and especially the latest frameless systems – are characterized by high transparency (*nota bene* it is even possible to buy panes without a greenish tint, caused by the content of iron ions in the glass mass – the product called *clear glass*). The most recent glass surface modification makes the application of coatings on glass cheap, easy, and available on a large scale. Many of the coating technologies are created to meet the growing

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environmental requirements, i.e., to protect buildings from overheating or to reduce the escape of heat. These important technologies are developing dynamically, but remain outside the scope of interest of the author of the presented paper.

However, the designers of "transparent" architecture do not always push the glass/façade to be more and more transparent. Recent trends may be found, in which – along with significant formal transformations – the pane of glass is losing its basic optical feature of light transmission. In those façades, the transparency is deliberately disturbed, and glass is no longer chosen solely because of its basic function of light transmission, but also because of its other optical properties. E. Diller and R. Scofidio emphasize this very aptly, writing that: […] *glass is now understood as a surface to look at, not only through. Transparent glass is no longer invisible, rather, it is a display surface* [5, p. 355]. The clients and building users […] *also show a particular interest in surface design, in tactile properties, colour and texture* [6, p. 7], at least as much as in the real needs of users.

State of the art

The issues of the disturbance of transparency have been the subject of many publications and scientific articles. Due to the limited space, it is worth mentioning those which – in the author's opinion – are the most important for the subject of this article. In 1995, after the exhibition organized in the MoMA in New York entitled "Light Construction", the exhibition catalogue was published, followed by a joint publication including papers of the authors that studied the issues of transparency in architecture [7]. In 2004, in the series Detail Praxis, a book entitled *Translucent Materials* was published, which covers the subject of light-diffusing materials and perforated metals [6]. It is mainly a technical review including the presentation of details important for the development of design practice. This study was published in a popular, widely-readable series and – according to the author – has significantly increased the use of translucent materials in architecture. The book titled *In Detail: Japan – Architects, Constructions, Ambiance* [8] gives a special insight into the use of translucent glass and other translucent materials in Japan. Not only details are shown in the book but also comments on trends in architectural transparency, especially in the chapter titled "Toyo Ito, Blurring Architecture". E. Blau's books and papers are particularly important for the development of the theoretical foundation and make a significant critical contribution to the issue, with an essay titled *Tensions in Transparency…* written in 2008 [9] which particularly stands out. An important summary of the issue is included in the book titled *Translucent Building Skins: Material Innovations in Modern and Contemporary Architecture* from the year 2012 [10] written by S. Murray. In 7 chapters the author presents case-studies in which various light-transmitting materials are used: diffusing, ornamental, perforated. The narration focuses more on the reasons for their use than on visual effects. This is – so far – the most comprehensive monograph on the issues of the use of translucent glass/façades in architecture.

Many books and papers were also written in the Polish language. The general issue of the transparency of glass façade was presented by W. Celadyn in his book entitled *Przegrody przeszklone w architekturze energooszczędnej* [Glazed envelopes in energy-efficient architecture] [11]. In chapter no. 7.3 titled "Glass vs. Aesthetics and Perception of Buildings" the author addresses the optical aspects of perception of glass envelopes and forms the basis of nomenclature in the Polish language. This book constitutes a local reference for all subsequent scientific publications on the issue. Celadyn's book has become a direct inspiration for the presented research undertaken by the author. In 2012, a book entitled *Szkło we współczesnej architekturze. Monografia* [Glass in Modern Architecture. Monograph] [12] was published by E. Wala in which the author in the chapter titled "Transparency, Semi-transparency, Translucency" discusses the issues of the glass envelopes that diffuse or interfere with the light transmission in various ways. The issues of translucent glass in architecture are also addressed by M. Zielonko-Jung [13] and J. Marchwiński [14].

The novelty of the presented approach

According to the author's knowledge, issues of the disturbance of transparency presented in this article have not been addressed in this way yet. In the previous references, typological distinctions were made, but this was done either according to the type of material (glass, lux, plastic, perforated metal) – see F. Kaltenbach [6], or according to the function of the element in the building – see Murray [10]. The typology presented here is based on the visual effects – regardless of the material type that is used. The visual effect is defined as a characteristic configuration of the images received by the observer, created as a result of the interaction of the light-transmitting pane and the light itself [15]. Additionally, due to the different degrees of intensity of visual effects, a relational matrix was created to systematize the case-studies, allowing to organize them according to two criteria (features): haze intensity (simply speaking the degree of light scattering) and intensity of the pattern which is applied to the glazing. In this method, the position of the case-study in the presented matrix is determined in a "fuzzy" way [16], according to the degree of the optical phenomena (haze and pattern) marked on the *X* and *Y*-axis. Therefore, it is possible to determine the hazing intensity in the range between zero (clear) and 100% (fully scattered), and pattern intensity between zero (clear) and 100% (opaque).

Aim and the scope of the paper

The article aims to systematize the issues of the disturbance of transparency in contemporary architecture and to present the typology of light-transmitting façades in which this optical phenomenon takes place. The author distinguishes the two most distinctive sub-trends of the main trend and illustrates them with case studies of light-trans-

mitting façades. All presented case studies are assigned to the sub-trends based on the characteristic features of façades, which allows for the trend's model definition (see chapter titled "Matrix approach" in the second part of the paper). The author also uses the matrix approach to systematize case studies (for a detailed description see the paragraph above).

Method

The research methods adopted in the presented paper are typical for architectural research conducted ex-post on the built environment, the aim of which is to broaden the knowledge about architecture [17]. The author started research with the desk study (scientific publications and internet portals). Then a database containing case-studies was created. Next, GPS location data of all case-studies were collected. This stage was followed by the field research and study trips to photograph, measure, and record the case studies included in the paper. As emphasized by J. Sławińska and B. Widera it is important to establish the knowledge about architecture not only based on the literature and references but also "on *in situ* visits and research" [18]. The analytical part of the presented paper is based on the photographic material that was collected by the author. This way of gathering/acquiring the research data has advantages and disadvantages. The disadvantage is a limited territorial range resulting from physical possibilities of relocation and budgetary limits. The advantage is the experience that results from the personal, direct contact of the researcher with the analysed case-study [15].

The author used the research method of logical argumentation [17], analysed the collected case-studies of façades, distinguished the characteristic features of the trends, and then undertook the effort to describe them briefly in a model. The inductive method reasoning was used – experiences and observations were synthesized to come up with a general truth – in which detailed analysis of individual case studies resulted in the process of the trends classification and the establishment of their models [17]. The collected photographic data were subjected to comparative analysis, on the basis of which the author drew the conclusions and created a simplified typology proposed in chapter titled "Simplified typology". The research method adopted consisted of the following techniques: desk study (literature review and internet portals) case study trips, field study, documentation using the photographic equipment. The individual stages of the research procedure are shown in the diagram – see Figure 1.

Definition of the trend and criteria

The article aims to classify and characterize trends in contemporary architecture to the extent specified above by the author. Based on the analysis of the available references on the subject it has been assumed that […] *the trend in architecture is a group/collection of buildings, while its model is a set of characteristic features of the trend* [19, p. 55]. Case-studies with similar characteristics have been grouped, and their distinctive features are used to define the trend model in the chapter titled "Matrix approach" in the second part of the paper.

In the comparative analysis carried out below the basic criteria were: (i) degree of the distortion of an image that is visible for the observer after the light is transmitted through the façade; (ii) the density of the pattern visible on the pane of glass. Research techniques previously developed by the author were used to carry out the analysis of the digitally recorded image of the façade and specification of the regions that have been blurred or/and blocked [15]. Based on this, it was possible to estimate the type of translucent or patterned material, its optical parameters, and the case-study location in the proposed relational matrix.

Case-study selection principle

While working on the database, the author observed many trends in contemporary architectural transparency and determined their change in time and space; some of them were described in other publications by the author [20], [21]. For the presentation in this paper, only those case-studies were selected that manifested the formal features of the disturbance of transparency in the most expressive way. Those case-studies became later the basis

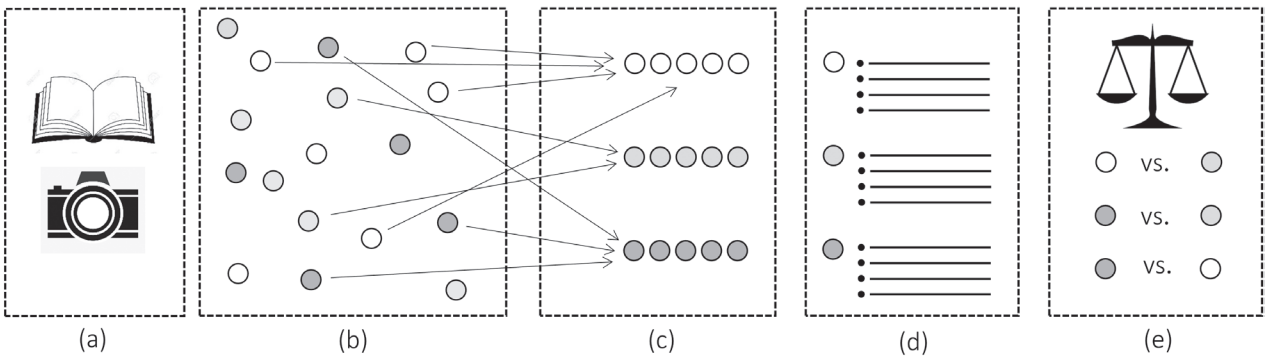

Fig. 1. The diagram of research techniques used: a) desk study, field research; b) building data collection; c) formulation of trend models; d) description of distinctive features; e) comparative analysis (elaborated by M. Brzezicki)

Il. 1. Schemat pokazujący wykorzystane techniki badawcze: a) badania literaturowe, wizje lokalne; b) zbieranie danych o budynkach; c) formułowanie modeli nurtów; d) opis cech wyróżniających; e) analiza porównawcza (oprac. M. Brzezicki)

for the description of the trend's model. As a consequence, the paper includes case-studies that are widely known (e.g., Kuursaal in San Sebastian) but also little-known ones, that are significant for the research (e.g., Hopital Mermoz in Lyon). The paper includes case-studies build not later than 25 years ago, in which the transparency of the façade was deliberately modified as a formal procedure used by the architect/designer. Featured case-studies are located in Europe, the USA, and Japan and present a possible large spectrum of techniques used in transparency disturbance. The presented case studies were selected from 382 case studies, that were visited within the research project titled "New trends in the architecture of transparent façades – formal experiments, technological innovations" in the years 2015–2018, funded by National Science Center, Poland.

Definitions

To clarify the terms used in the article, it is necessary to briefly characterize the issues at the interface of architecture and optics. A standard pane of glass is described in the paper by the term "transparent" and should be understood as a flat pane that allows the light to pass through without any distortion, meaning that it is possible to observe the objects located on the other side of the pane without any blur. In optics, this type of optical device is described as an "optical flat". The "flatness" of its geometry is essential here, as this type of device allows a parallel passage of the rays of light, without any concentration or dispersion (it does not act as a lens).

The term "translucent" has been used to describe panes that scatter the rays of light. The term originates from the Latin words "trans" and "lucere", meaning "through" and "light". Scattering is the phenomenon of the interaction of light with matter, that results in the random change of the direction of the ray of light. In the case of translucent panes, an observer can see the blurred contours of the source of light and all objects located behind the pane. In material science, two parameters of light scattering are measured: narrow- and wide-angle scattering. Wide-angle scattering [15] is called *haze.* Haze determines the number/percentage of rays of light that have deviated by more than 2.5° from the original direction. In contrast, the parameter called *clarity* determines the number/percentage of the rays that have deviated by less than 2.5° in a process called narrow-angle scattering. Due to the scale of optical phenomena observed in the presented case-studies linguistic simplifications are used. The terms: translucent, milky, foggy, misty are used in the text interchangeably.

In optics, translucent light scattering materials allow light to penetrate but prevent the formation of sharp images (in focus) [15]. Thus, translucent pane works like a screen – when backlit, it reveals its light-permeable/ornamental structure, when it is illuminated […] *its opacity increases as the space behind the glass grows darker* [22, p. 151]. As the result, the pane seems indifferent from a solid wall. The use of such translucent glazing makes the interior of the building either invisible or visible depending on lighting conditions, e.g., with strong direct sunlight.

Ornamental panes (called also *obscure glass*, *figured glass*) from an optical perspective act as an assembly of adjacent optical elements: flats, prisms, concave or convex lenses that form the surface of the pane. The surface of the ornamental glass can be compared to the rippled water surface, which is "not flat, but smooth" [15]. In the typology proposed by the author ornamental panes are an intermediate phase between smooth transparent panes and translucent panes. The reason for this is because on a building scale ornamental panes with a very fine pattern are perceived by observers as translucent – individual small compound lenses are beyond the perception of an observer.

In the paper, the author also refers to panes decorated with various types of patterns. It should be understood as such optical systems, where transparent areas are adjacent to areas that are not transparent because they have been covered with various prints that do not let light through at all or do it only partially.

In the paper, two terms are used: "façade" and "envelope", which need to be explained. By the "façade" the author understands a climate barrier separating two environments internal and external (e.g. glass curtain wall). The term "envelope" is also used in the paper in the meaning of "shell, casing, and cover", usually meaning an additional, external layer, mounted outside the actual façade, frequently as an optical device to achieve additional visual effects.

Disturbance of transparency

Transparency as an optical property of material has been questioned in architecture many times. As early as in the 1950s in order to limit the overheating of extensively glazed office buildings glass coated with metal oxides was used. This type of glass is often called reflective. Reflective panes were also used in the famous works of modernist architecture and in high-tech (e.g., Willis-Faber office building, arch. N. Foster, 1978). Thus, from an optical perspective, reflective glass was considered as a tool of quantitative modification – part of the incoming daylight was reflected, part transmitted, but – in general – the direction of the penetrating ray of light did not change. Disturbance of optical transparency – if visible at all – usually resulted from assembly errors or from imperfections of the material itself (defects of products or used material, e.g., glass mass). Since the 1990s, however, a new trend has been developing in which optical transparency is deliberately questioned by architects using new types of glass. Those new types of glass change the direction of the penetrating ray of light by refraction in a different scale (on macro or micro level). In contrary to quantitative modification, this new trend could be distinguished as a qualitative modification – the amount of light transmitted does not change fundamentally, but its quality changes – it is scattered or refracted in different directions when penetrating through a translucent or ornamental pane.

The new trend in contemporary architecture is associated with a deliberate departure from the most desirable feature of glass, i.e. optical transparency – transmission of both light and image. It seems that it stems from a departure from pure modernist ideals, when a transparent façade

allowed not only for illumination the interior, but also allowed users to "be seen" and "become visible" [23, p. 36]. The use of coatings that interfere with light is strongly connected with a significant transformation taking place in the dialectic of the building, with the transformation of the modernist *curtain wall* – a mullion and transom skeletal system filled with transparent glass – into *an envelope*, more metaphorical membrane. This new *envelope* allows for the perception of the distorted image of the building by the observers located outside and the distorted image of the surrounding environment by those located inside. While the façade – in the sense of the modernist curtain wall – is something very literal and specific but nevertheless closely related to the building, the new envelope gains its independence. In the literal, technical sense, as an element forming an additional layer of façade, in formal sense, as an element introducing additional quality into the façade space.

As early as in 1966, R. Venturi observed the division of the building into the *volume* and *facade/envelope* [24]. In 2011 in the text titled *Building Envelope as Surface* S. Lee and S. Holzheu write: […] *here the medium is the actual, physical and material presence of the façades themselves, while the content consists of visual effects, messages, signs and other elements that are superficial to the façades* [25, p. 125]. From their perspective – in the Venturian view – the façade is […] *a communicative device that is expected to signify, symbolize and convey certain narratives, messages and information* [25, p. 125]. After the book *Complexity and Contradiction* was published, the trend of the envelope independence went even further than Venturi himself had expected. However, gradual erosion of transparency has been observed in architecture progressing only after 1989, from the time the R. Koolhaas proposal of the French National Library was revealed – see Figure 2 [26]. In the proposed design one cuboidal block made of translucent glass enveloped small functional elements that were contained inside. Only a few oval-shaped, clear openings allowed for illumination and an unobstructed view into and out of the interior; the remaining envelope served more as a "cover than a fenestration" [15]. This specific relation of "closeness and inaccessibility" was noted by French philosopher J. Starobinsky as early as 1961 [27] and in 1995 T. Riley described a very similar mechanism of […] *shifting the objects meaning from its form* [meaning the spatial form – M.B. note] *to its surface* [7, p. 29], thus strengthening the role of the façade itself, regardless of the volume to which it was attached. H. Muschamp concludes well: *building skin is used not to reveal but to veil* [28, p. 1].

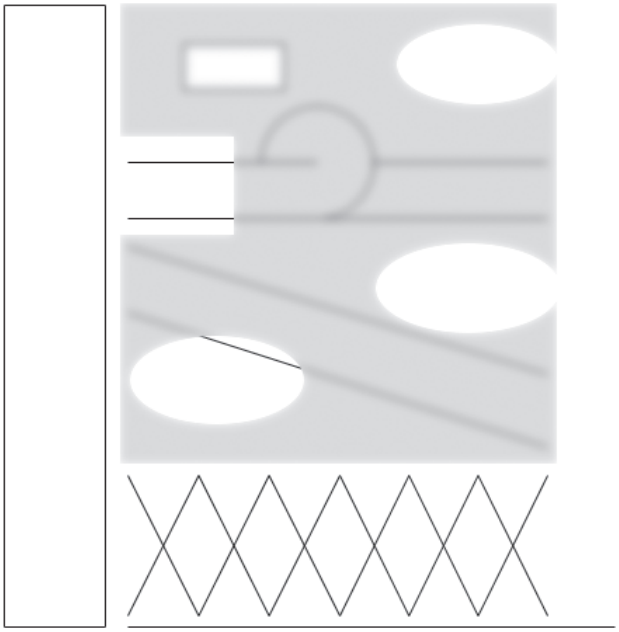

Fig. 2. OMA's competition proposal
for the French National Library (1989)
(drawing M. Brzezicki based on R. Koolhaas' own sketch; source: [26])

Il. 2. Koncepcja konkursowa pracowni OMA's
na projekt Francuskiej Biblioteki Narodowej (1989)
(rys. M. Brzezicki na podstawie szkicu R. Koolhaasa; źródło: [26])

Simplified typology

The disturbance of transparency can be manifested in many different ways. It can take place within the space of the façade when the transparent pane is replaced by a translucent pane and the light penetrating through the façade is scattered to a degree that depends on the optical parameters of the pane (e.g., the *shoji effect* – a matte screen made of rice paper mounted in bamboo frames which is present in the Japanese building tradition). The disturbance of transparency can also occur at the level of the envelope, an additional element applied or laid over the actual façade. This additional envelope usually has optical parameters other than transparent pane. It is therefore possible that the transparent façade is covered with a translucent envelope. However, the disturbance of the transparency may also result from the fact that the path of the ray of light becomes so complicated – and there are so many obstacles on this path – that guessing what is hidden on the other side of the pane is almost impossible. This phenomenon occurs when the pane is covered with a dense ornament, which entangles the observer's gaze in its complexity, not allowing for deeper penetration. This "voile" can also take the physical form of a screen or a blind, which is located in front of or behind the actual pane. In this case, the "voile" effect might not be permanent – the blinds can be retracted, the cover can be removed. More and more often it happens automatically, without human intervention, e.g., in the so-called adaptive façades [29].

The optical phenomena taking place in the translucent façades have already been described. The author of the article proposes his original simplified typology, according to which – depending on what optical phenomena occur in the façade or the envelope – the disturbance of transparency can be classified as homo- and heterogeneous disturbance:

Homogenous disturbance

The first group is homogeneous disturbance in which the whole surface of the pane is the source of the same optical distortion. A good example of this phenomenon is

a light-scattering pane that makes objects located behind optically blurred. Homogeneous distortion usually occurs when translucent, etched, or sandblasted glass (or acrylic) panes are used. The mechanism of the optical phenomenon is simple and well known: one ray of light falling on the surface of a pane is "scattered" into many randomly oriented rays. This change of the ray's direction results from the microstructure of the pane's surface. Similar optical effects can be achieved with materials that scatter light not only on the surface (as in the case of etched glass), but in its entire mass of the material like in the milk glass, polycarbonate, or even solid stone (e.g., alabaster).

Detailed optical experiments prove that there is a significant difference: light is more evenly scattered in the mass of the material (mass-scattering) vs. when the scattering process takes place only on the surface (surface-scattering). Figure 3 shows the difference. In the case of the surface scattering the central group of scattered rays is visibly stronger and the contours of objects on the other side of the pane are visible. What is more, the closer they are to the surface of the pane, the more recognizable the outline will be. In contrast, the scattering in the mass of the material results in an image devoid of contours of objects that are located on the other side of the pane and the pane itself radiates/illuminates an even brightness. What may seem an insignificant difference at first glance, has significant consequences for the perception of the entire building. Etched panes can transmit the colour, while in the case of mass-scattering this transmission is either equal to zero or is strongly limited. Surface-scattering allows for the better integration of the object with the environment as the blurred boundary of the building body "melts" with the colour "taken" from the surrounding.

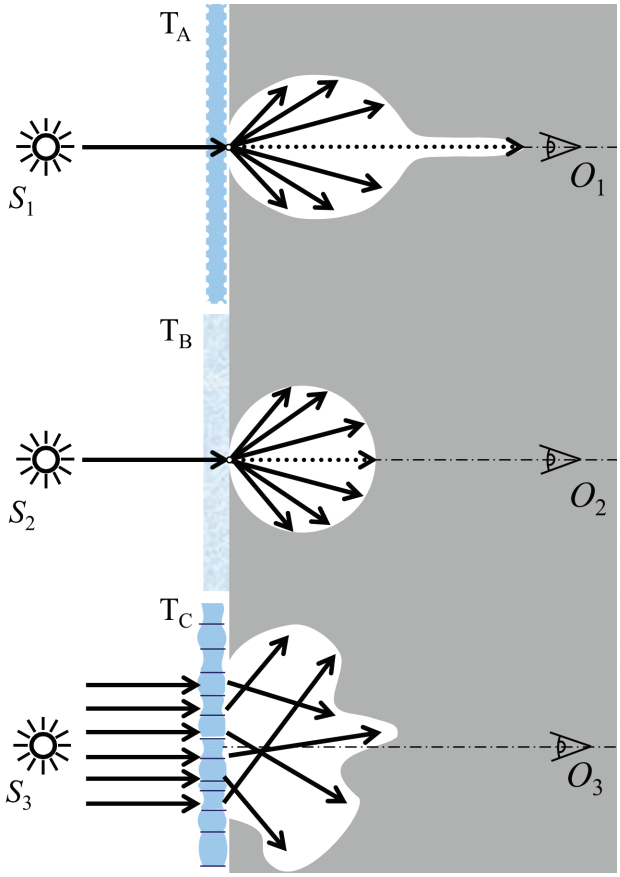

Fig. 3. Diagrams showing three main types of light scattering: scattering on the surface of the material (T_A), scattering in the mass of the material (T_B), and refraction when passing through complex lenses, e.g. an ornamental pane (T_C), which, due to the scale of the pattern, is perceived as passing through a translucent sheet of glass. The light sources S_1, S_2 and S_3 are identical (elaborated by M. Brzezicki)

Il. 3. Schematy przedstawiające trzy główne rodzaje rozpraszania światła: rozpraszanie na powierzchni materiału (T_A), rozpraszanie w masie materiału (T_B) oraz załamanie przy przejściu przez złożone soczewki, np. szybę ornamentową (T_C), która ze względu na skalę wzoru odbierana jest jako przejście przez przeświecalną taflę. Źródła światła S_1, S_2 i S_3 są identyczne (oprac. M. Brzezicki)

Glass pane optically composed of smaller or larger groups of convex and concave lenses constitutes the so-called compound lens. From the optical perspective, this type of pane does not scatter the light at all, only the direction of the ray of light is changed by refraction. Light transmission is less homogeneous and the specific pattern is superimposed on the image visible through the pane, which reflects the arrangement of smaller convex and concave lenses in the pane. The influence of such a pane on the visible image depends on the size of lenses vs. the size of the building and the building-observer distance. In large-size glass elements, optical refraction will visibly distort the image of the building behind the glazing and this distortion will be visible to the observer. On the contrary, ornamental glass the surface of which consists of many small lenses will produce similar optical results as an evenly light-scattering pane. Although the optical mechanism is different, typologically, compound lenses (ornamental glass) can be classified as belonging to the homogenous disturbance group.

Heterogeneous disturbance

The second group is a heterogeneous disturbance in which some areas of the pane change the path of the ray of light, while others do not. This type of disturbance is therefore not uniformly distributed over the whole surface of the pane but is present only in selected regions. It is usually observed in the case of screen-printed panes with the pattern or when selective acid etching is applied to the regions of the pane. A heterogeneous disturbance is very sensitive on the scale in the sense that the scale of the pattern determines the final optical effect visible to the observer. The distance from which the building is observed is decisive. Small patterns (e.g., small dots, squares, dashes) that are too small to be recognized by the observer from a distance are perceived as a homogeneous disturbance, while large, easily recognizable patterns are perceived literally – as patterns. The large, easily distinguishable ornament on transparent glass usually entangles an observer's eye with its complexity, not allowing for deeper penetration. In this way, the pattern – print of frit – gains independence, becomes more important than the light-transmitting surface on which it is placed. These

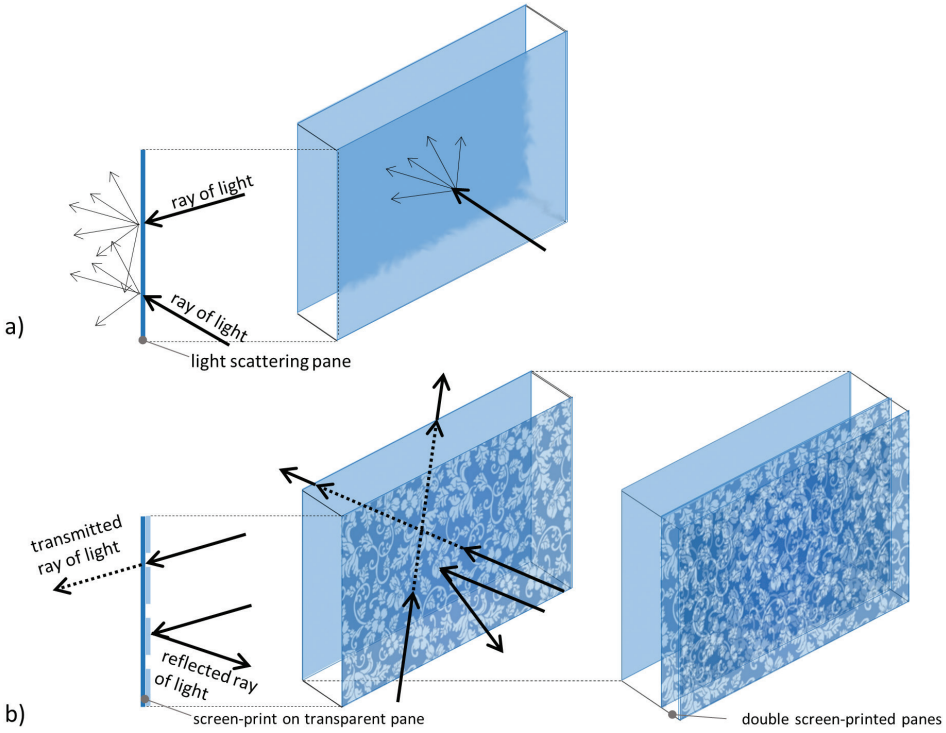

Fig. 4. A diagram illustrating optical phenomena in sub-trends defined by simplified typology: a) homogenous disturbance; b) heterogeneous disturbance (elaborated by M. Brzezicki)

Il. 4. Schemat ilustrujący zjawiska optyczne występujące w pod-nurtach: a) zniekształcenie jednorodne; b) zniekształcenie niejednorodne (oprac. M. Brzezicki)

patterns are often applied to an additional envelope laid over the proper glass façade of the building. In optical terms, they resemble classic decorative jacquard curtains and behave similarly. Observed from the outside, they form a barrier, viewed from the inside, usually with the pattern backlit, allow for a limited view of what is happening outside like a one-way mirror.

Summary of part 1

An envelope "rich in ornamentation" and a "tempting veil" are two different design strategies in the disturbance of transparency, leading to different visual phenomena. The first part of the paper addresses the issues of methodology, definitions and proposed the simplified typology of light-disturbing envelopes in contemporary architecture. Matrix approach, case studies and the characteristics of sub-trends based on conducted analyses are presented by the author in the next part of the presented paper in the next issue of an journal. The following part will also include the discussion and conclusions.

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Various elements of simplified typology have already appeared in the author's previous publications [20], [21], [30] but were not described in such detail. The case studies shown there have not been systematized in the form of a matrix system before.

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Abstract

Disturbance of transparency in the architecture of contemporary glass façades. Part 1

Over the last two decades, new trends have emerged in the design of translucent façades. Those trends result from the dynamic technological progress and achievements in material engineering. The trends that are associated with the use of envelopes that interfere with the transmission of light through the façade are particularly interesting. This is strongly related to the significant transformation that took place in the dialectic of the building, the transformation of the "façade" into an "envelope". The paper presents the author's original distinction between the two most characteristic main sub-trends, distinguished based on optical phenomena occurring within the façade. The proposed division includes two main groups of disturbances: homogenous and heterogeneous. The former is present where panes of glass are used to disperse/diffuse light evenly, while the latter in façades with strong – usually printed – ornamentation. The article systematizes the issues of transparency disturbance in contemporary architecture and presents the typology of light-transmitting façades, in which this phenomenon takes place. The author also presents a matrix of relations that systematizes the presented case studies. Only this type of matrix makes it possible to illustrate an issue in which more than one variable is present. An assignment of the case studies to the trends and the determination of trend models are also included in the paper. The first part of the paper presents the introduction, methodology and simplified typology, the second one presents case studies, discussion and conclusions.

Key words: transparency, theory of architecture, façade glazing, printing on glass, coatings on glass

Streszczenie

Zakłócenie przezroczystości w architekturze współczesnych szklanych fasad. Część 1

W ciągu ostatnich dwóch dekad pojawiły się nowe nurty w projektowaniu przezroczystych fasad. Są one wynikiem dynamicznego postępu technologicznego i osiągnięć w dziedzinie materiałoznawstwa. Szczególnie manifestują się te nurty, które związane są z zastosowaniem powłok zakłócających przenikanie światła przez fasadę. Wiąże się to silnie z istotną przemianą, która dokonuje się w dialektyce budynku, z przemianą fasady (ang. façade) w obudowę/powłokę (ang. envelope). W artykule przedstawiono dokonane przez autora rozróżnienie zjawisk optycznych, które zachodzą w obrębie fasady. Proponowany podział obejmuje dwie główne grupy: jednorodne i niejednorodne zniekształcenia przezroczystości. Te pierwsze występują tam, gdzie zastosowano tafle równomiernie rozpraszające światło, te drugie natomiast w fasadach o silnej – zazwyczaj nadrukowanej – ornamentacji. Artykuł systematyzuje zagadnienia zniekształcenia przezroczystości w architekturze współczesnej i przedstawia typologię tych fasad przepuszczających światło, w których występuje to zjawisko. W artykule przedstawiono też macierz relacyjną, która systematyzuje opisywane studia przypadków. Jedynie ten typ macierzy pozwala na pokazanie zagadnienia, w którym obecna jest więcej niż jedna zmienna. W tekście dokonano również przypisania studiów przypadków do nurtów, a także charakterystyki samych nurtów – stworzenia ich modeli. Pierwsza część tekstu zawiera wstęp, opis metodologii oraz uproszczoną typologię, a w drugiej znajdą się studia przypadków, dyskusja oraz wnioski.

Słowa kluczowe: przezroczystość, teoria architektury, szklana fasada, nadruk na szkle, powłoki na szkle