Visual Interference in the Glass Facade

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Abstract. The paper analyses questions concerning the integration of architecture and art. The objective of this publication is to examine visual interferences that occur in architecture and to determine their effects on how the building is seen and on the architectural space. This phenomenon is an important artistic issue that opens the way for new compositional values in architecture. Visual interferences can occur when there are at least two layers of an image composed of repetitive elements, put in a certain order. Overlapping of graphical layers results in image concentration, and in this way compositions such as lines, circles and polygons are created, which are known as interference patterns. In art glass, it is possible to remove image layers from each other, thus obtaining an additional effect. This creates visually mobile surfaces, which react to movement of the observer. The present paper will analyse this phenomenon with the aim to determine what principles govern the occurrence of visual interferences as well as how they affect the building’s reception. The typology, classification and characteristics of each type of arrangements will be presented. An attempt will also be made to establish conditions for the design of interference arrangements, which may be used as guidelines by graphic artists and designers alike. The phenomenon will be examined based on buildings created over the past two decades. Examples will include works set both on the façade as well as in the interior of buildings. Due to the global nature of artistic phenomena, no restriction is given on the area where the examinations take place.

1. Introduction
Intentional use of visual interferences has been on the rise in art and architecture. Its popularity stems from the search for ever newer forms of expression with simultaneous return to minimalism and geometric layouts. The seeking of an increasingly more advanced and processed form of art is linked to the fascination with physics and maths. The objective of this publication is to examine visual interferences that occur in architecture and to determine their effects on how the building is seen and on the architectural space.

2. Interferences
The name interference occurrence refers to the physical wave occurrence between at least two layouts located within the area of their mutual influence. Wave sources may be punctual or linear, and have a range corresponding to visible light or sound frequencies. Where the waves overlap, intensification (Figure 1A) or reduction occurs (Figure 1B). In linear layouts, this depends on the location of waves relative to each other. In centric layouts, this process happens dynamically within a set area.
Figure 1. Interference occurring as a result of at least two waves overlapping: A – wave is strengthened; B – wave is being muted. Source: Author’s study based on illustrations [1]

3. Visual interferences
The occurrence of interference patterns is also known as Moiré pattern. The name, which means loose fabric, is French. The warp and weft arrangement creates visual effects that resemble stripes. Visual interferences are created as a result of two images affecting each other. As a prerequisite, the component images must have the right structure, and the right relation between them is necessary. A component image is composed of smaller repetitive elements put in a certain order. There must be a space between the elements. Interference occurs as a consequence of angular rotation of the image (Figure 2A, Figure 3A), or a change in the density of elements at least in one of the layers [2] (Figure 2B, Figure 3B), or a change in the shape of the layout of at least one layer (Figure 2C, Figure 3C). Where the images overlap, swellings occur, which are seen as dark linear [3] or geometric layouts. In centric arrangement, the interference phenomenon arises through: translocation, rotation and radial stretching [4].

Figure 2. An image composed of stripes – interference patterns resulting from: A – angular rotation; B – change in the density of one of the layers; C – change in the shape of one of the image layers. Source: Author’s study

Interference patterns are often an artefact from images created using various digital imaging techniques and computer graphics, for instance while scanning or colour printing a raster image. Interference is often undesirable, like in a raster image composed of spots and lines. This phenomenon may occur in transparent objects, when different colours are used. When two images overlap, a third colour occurs as a resultant of the two constituents (Figure 4).
Based on the arrangement shapes, the following forms can be distinguished: surface arrangements in an open composition; and forms created from a transformation of a geometric figure: circle, ellipsis, triangle, square or a polygon in a closed composition. The most natural figure is the circle. Around the punctual source, the waves radiate from the centre.

A different classification can be applied if one takes as the determining factor the shape of elements from which the image is composed. Raster arrangements are built of different types of fine spots of various shapes, such as a dot, square, or polygon. The other type is a linear element, which may take the shape of a straight or curved line with an irregular form.

An interesting use of interference is its application in art glass. In artistic printmaking, all component layers are on a single surface. In glass, each graphical layer can be located on a different sheet. Removing glass surfaces away from each other results in an additional effect. Images set apart create interference arrangements which change as the observer’s position relative to the structure changes (Figure 5).
Figure 5. Change of arrangements composed of two raster image layers. As the observer’s location changes, the arrangements and the properties of visual interferences change too. View from the inside, University Library, Cottbus: A - location of the viewer from afar; B - location of the viewer from a shorter distance. Photos: by the author

In art glass, visual interferences are used in structures in the form of installations fixed to the wall, both the walls inside the building as well as in facades, which are permanently linked to the building and visually constitute an integral part thereof.

4. Glass installations – glass images
As an example of experimenting with interference phenomena, one can look at this author’s installations created in recent years. In her works, the author experiments with various geometric motifs, including both monochromatic and polychromatic structures. The structures involve two glass planes in which graphical elements are put on two, three or four surfaces.

The presented series is a triptych¹ which contains several geometric shapes that maintain a relation through common surfaces. Within these spaces, interference occurs (Figure 6A), which activates these surfaces visually (Figure 6B). From afar, the arrangement of interference shapes changes depending on the viewing point. The installation is lit on edges, and works in both well-lit as well as dark interiors (Figure 7).

¹The author: Alina Budzyńska, Title: Interferences, Realization: 2016, Dimensions: 3 x 50 x 50 cm.
5. Glass installations – walls

One example of an installation in which visual interferences have been used is a glass-covered wall in a building occupied by a brokerage firm in London’s Baker Street. The object can be seen in the entrance hall, and it consists of the outer section, which presents the firm’s logo, and the inner section, which is a decorative item (Figure 8). Visually, the two components constitute a whole. The installation, set in a steel frame, consists of nine panels and fills the gap between the ceiling and the floor. There are several paint layers arranged as radiating stripes of opaque print (Figure 9 A). The layers of the image overlap each other, creating

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Figure 6. Part of the triptych (Alina Budzyńska, 2016): A - one of the works lit around the edges; B - an example layer with varying transparency levels; B - semi-transparent section; b) transparent section consisting of two layers: sandblasting and painting. Photos: by the author.

Figure 7. Author’s work, the glass installation made using two glass layers; image is placed on three glass surfaces, lit around the edges. Photo: by the author.

2The author of the picture: Alexander Beleschenko, Realization: 2011, Dimensions: 13,5 x 3 m [5]
a unique abstract composition. The background consists of two arrangements of fine designs with a raster-like structure (Figure 9B). The fact that the two print layers are removed from each other at a distance equalling the thickness of glass adds more space to the image. The coloured shapes remain in a compositional relation to each other. Interference phenomena can be observed between the arrangements of coloured stripes.

The large-scale glazing is used as a decorative feature. The sizeable hall, with its shape that is nearly a square, has been finished with light-coloured material on the floor and ceiling. The interior is dominated by geometric shapes. The graphical features on the glazing correspond to the modern style of the interior, and its white background connecting with light walls and floors. The ephemeral shapes, which include radiating fine stripes, add an extra dimension to the space, breaking the pattern of orthogonal divisions. The outer extension of the glazing intensifies the effect of the glass wall inside. The outer feature is a recognisable motif, and informs passers-by about the firm’s location.

**Figure 8.** The entrance hall with the view of the glazing, together with the outer section that is located on the street side, Baker Street, London (Alexander Beleschenko, 2011). Photo: Alexander Beleschenko

**Figure 9.** Detailed view of the glazing at the brokerage firm’s office, Baker Street, London: B - the composition of layered print; B - close-up showing the visible background pattern. Photos: Alexander Beleschenko.
6. Facades
The University Library\(^3\) in Cottbus is one of the primary examples of a fully glazed building which includes graphic interference. Graphic elements in this building have been placed on two glass layers and they cover the entire façade of the building\(^4\). Both layers, between which there is a gap of approximately 60 cm, are covered with a one-sided white raster print. Print layers overlap and, when viewed from afar, create a texture that resembles lettering (Figure 10 A). The image consists of overlapping alphabetical symbols originating from various language groups [7].

The linear arrangements in the image underline the building’s irregular shape; while the lettering is a unique graphical component that refers to the purpose of the building. As one moves closer to the building, the shape of the image begins to blur and look like a light veil around the building. From one metre, the print is seen as surfaces of a white raster that filter through each other (Figure 10 B). The perception of the print changes depending on the type, intensity and angle of light. When lit by strong sunlight, it becomes clear, contrasting with the darker elevation background against the backdrop of a blue sky. On cloudier days, the print’s contrast decreases, and the elevation becomes more transparent. At night, the image, which is lit from the inside, becomes nearly invisible, and can only just be distinguished from the dark construction elements of the second glazing layer and the horizontal strips of the ceilings. A white opaque print put on the outside creates a matting layer and reduces reflections on glass.

From the interior, the print is almost invisible. It looks like a white veil that disperses light and makes it difficult for sunrays to penetrate directly. The two layers of the print overlap, creating geometric visual interference (Figure 10 C). The interference shapes are best visible when lit from behind from the interior. The unlit part of the façade is seen from the inside as an area affected by the dark raster (Figure 10 D). And from the outside, the wall that the sun shines directly on is cut off from the sky by the white colour of the print.

\(^3\)Authors: Herzog & de Meuron Architects, Jürgen Johner, Florian Marti; Realization: 2004; graphic area: 1500 m\(^2\), screen printing [6].

\(^4\)size of glass panels: outer layer 98 x 100 cm, inner layer 148 x 272 cm.
Another well-known building with visual interferences in the façade is the Institute for Hospital Pharmaceuticals\(^5\) in Basel. The building’s façade is made up of a glass layer put a distance of 50 cm from the front of the actual wall. The glass layer is covered by an opaque layer of green screen print. The raster layer consists of spots placed at regular intervals in lines and rows. The glazing creates a semi-transparent partition that allows light to go in (Figure 11 A). The surface of the actual wall has been covered with white perforated metal sheet. Both layers – the print layer on the glass and the perforations overlap, leading to the occurrence of visual interferences. The fact that the glass is removed from the front of the external wall adds more space to the building. Interference phenomena occurring between the two layers change as the observer moves along, and the elevation begins to look lively, pulsating.

The green raster is a graphical feature that controls the transparency of the façade. As lighting varies during the course of the day, it affects how transparent the partition [8] is, and therefore how the entire building is perceived. With sunlight, the colour of the glazing becomes lighter. When light passes through the glass façade, it stops on the screen print layer and on the white perforated metal sheet layer. This exposes visual interferences occurring between the two layers (Figure 11 B). Shaded parts of the wall are dark green. In unlit sections of the building, interference is not easy to see. Instead, the image of the surroundings reflected in the façade is well exposed in these sections. Parts of the neighbourhood that are lit, such as building elevations and other bright structures, are visible particularly clearly. There is a very strong interaction especially with the green colour. The reflections of surrounding trees and bushes in the glass surface deepen the colour of the elevation.

\(^5\)Authors: Herzog & de Meuron Architects, Mathis Tinner; Realization: 1998; graphic area: 1545 m², screen printing [6].
Figure 11. Institute for Hospital Pharmaceuticals, Basel, Switzerland (Herzog & de Meuron, 1998): A - the section of the building on the street side; B - elevation structure and graphical features. Photo: Maarten Helle.

7. Results and discussions

Upon analysing the collected material, it was possible to distinguish several features that occurred in works in which interference patterns were used. Based on the provided examples, it was established as follows.

Interference patterns, used for instance in graphic arts, can be naturally transferred to the field of art that is art glass, where each image layer is put on a different glass surface. Spreading the image over at least two glass layers enables to create an image that changes as the observer moves along. Visual mobility is a value unknown in other methods of forming images, for instance, painting or artistic printmaking.

Smaller installations create decorative, visually mobile arrangements, which can be used in an interior as a component that either moves or is permanently connected with the building.

Interference patterns can be made using surfaces with varying degrees of transparency. On the outer layer, the image is placed on a glass plane; while the inner layer can be made up of another opaque material covered with graphical features, which simultaneously acts as the wall’s cladding.

An enamel layer is a unique decorative element, in which reception depends on the location relative to the façade plane and the distance from the front of the building. Graphical features can be seen properly from a few to over ten metres. The image of the raster and interferences can be seen from half a meter to less than ten metres, depending on the raster’s size.

Interference patterns constitute an additional element that integrates the building’s façade; graphical features composed of fine elements remove divisions in the glazing, and provide a partial cover for the structure enclosed in the space between the graphical layers.

Surfaces made of small, repetitive texture elements or a raster provide a unique aesthetic feature, both on the façade side as well as inside the building. Despite the use of opaque enamels, a glass façade creates a semi-transparent veil that makes it impossible to see through from either side. And the
layer also looks different when seen from one side or the other. From the lit side, the image is seen in colour; and from the other side, when backlit, opaque pixels provide a dark cover and the image is the negative of that seen from the outside.

The distance created between the images provides a buffer inside an architectural structure. In double glazing, it boosts the sunlight protection and affects the building’s thermal protection. Additionally, the building is protected against noise [9].

8. Conclusions
Visual interferences can be effectively used in the interior, as a decorative element, or in the outer partition, as part of façade’s integration strategy. The removing of the two graphical layers from each other results in the occurrence of a visually mobile layer, and creation of a buffer layer, which is used for the thermal and sunlight protection of the building. The double graphical layer becomes a unique decorative element, the reception of which depends on the location relative to the façade. Two independent images are created, and they filter through each other to produce a new single image. In the raster image, the screen print layers seen from the interior overlap, creating visual interferences. An advantage that this solution provides is sunlight protection as well as effective see-through protection. This provides control over the integration of the outer space with the building’s interior, and also more effective protection of the building against noise.

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