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Transparency in Architecture and its Mutual Effects Between Built and Natural Environment

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Abstract: **This paper is concerned with studying the concept of transparency in architecture, which is not only limited to the physical aspect related to the penetration of natural light through transparent surfaces into the building, but is linked to the psychological and spiritual aspects of the building's occupants through the virtual removal of barriers between them and the natural environment.by studying a variety of iconic buildings which Representing a group of different architectural schools till reaching the contemporary architecture, the paper deals with how the concept of transparency has been developed in conjunction with the development of the construction industry over the ages, so that transparency has become an essential part of the architectural design philosophy.**

Keywords**: Transparency, Built Environment, natural Environment**

1. INTRODUCTION

Since ancient ages, people have been interested in the connection between inside and outside the building. in the architecture of caves, it was initially purely functional, whether through making an entry and exit opening. Also, in terms of functionality, window openings were made to provide ventilation and lighting from the natural environment to the built environment.

In the middle ages, especially in Christian religious architecture, which characterized by its bright, shimmering colors, and also in Islamic architecture, which was characterized by simplicity and diversity in the works of stained glass with plaster or wood and wooden mashrabiyas with various colors of glass.

With the era of the industrial revolution, the building industry developed significantly, and the building structure became metal and then concrete rather than stone blocks, which gave a clear flexibility to increase the connection between inside and outside the building by increasing the surfaces of the glass openings, especially with the production of glass panels with large areas compared to before.

In this paper, the concept of transparency in architecture will be addressed through various ages, leading to the invention of transparent aluminum which provide a new architectural language that will have an important impact on futuristic architecture.

2. RESEARCH GOALS

- Reviewing the concept of transparency and its importance in architecture.
- Running comparative philosophical study to review the different effects of transparency in buildings.

3. METHODOLOGY

Through an inductive study, the research deals with the development of the concept of transparency in architecture through different ages and the impact of new materials on the rooting of this concept since the industrial revolution until the invention of transparent aluminum.

4.TRANSPARENCY IN ARCHITECTURE

The concept of transparency in architecture emerged as one the design concepts in the 20th century. It is a human, spiritual and social concept and constantly evolving with the development of construction industry techniques. This concept is not limited to the link between the built environment and the natural environment through glass surfaces, but goes beyond that to create a state of integration between the outside and inside of the building, and completely denies Le Corbusier's concept at his early beginning "the house is a machine to live in". that glass buildings create relationships between the occupants of the building and the outside world, and modify their visions and habits.

In 1863, the Russian writer "Nikolai Chernyshevsky" was inspired by the idea of glass construction in his novel "What is to be done?", in which the protagonist dreams of a glass palace that will be his home in the future, embodying an ideal vision of a society open to the public, in which the separation barriers between the powerful and the common people collapse.[8]

In 1914, German poet and writer Paul Scheerbart praised glass for its ability to transform the built environment and elevate culture through its openness and color. For him, the enclosing Quality of conventional brick buildings imposed a separation between a person and society, resulting in isolation and darkness. He envisioned a new architectural world, in which light filled spaces reconnected society, and boundaries between indoors and outdoors dissolved. [6]

Le Corbusier designed Maison Dom-Ino, a ground-breaking modular building, between 1914 and 1915. He installed reinforced concrete slabs and columns in place of the thick load-bearing walls. Large glass facades and an open floor plan with few thin features provided the internal areas with wholesome natural sunshine and desirable architectural transparency, blurring the lines between inside and outside.

After more than a century contemporary architecture continues to using glass as a walls and facades. A new, prismatic landscape would replace the dreary, masonry cityscapes of old Europe, this crystalline world relied on the liberation of the facade from its opaque, load bearing function.

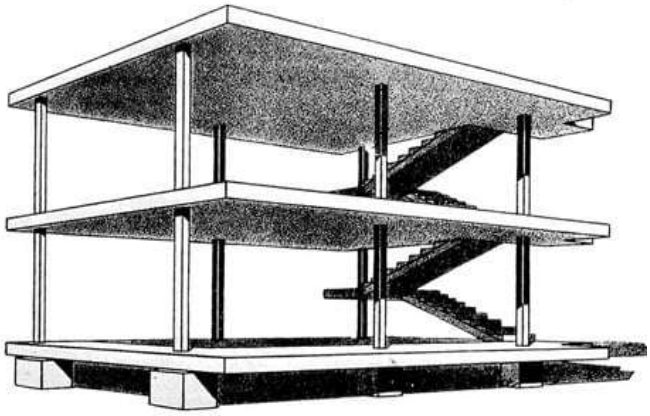

Figure 1. Maison Dom-Ino.
source: (https://www.dezeen.com)

Figure 2. Glass House, New Canaan, USA,
source: (https://www.archdaily.com)

So he described a two-part system in which iron framework is shaped to support the glass, Together, iron and glass could release buildings from an oppressive past and activate a new, free form environment and society.[3], the idea of the "glass house" expressing the ideas of transparency and openness was not limited to the European school alone, but extended to the trends of American modern architecture, through the engineer "Philip Johnson" (1906 - 2005), who built himself a glass house in sprawling site in1949 that has become a cultural center today.

In terms of intellectual development, the important discoveries from the Renaissance to the present day, represented by liberation, democracy, and the emphasis on human ability to achieve great achievements had an important impact on the development of the concept of transparency, also the art schools specially the cubist movement had a significant impact in defining the principles of transparency, as it was concerned with the characteristics of space and its relationship to the natural environment.

The transmission of light through transparent materials plays an important role in defining the features of the architectural space, both external and internal in architecture, and redrawn the boundaries of the architectural space functionally and aesthetically, it gives the designer new possibilities in terms of controlling the determinants of the relationship between the multiple functions in the architectural component without the need to build solid and covering barriers, and thus offering an horizontal extension, visual and social communication toward the natural environment, with providing the required privacy and protection from various weather factors.

Transparency has become increasingly associated with ideological values and has been used in government buildings because it evokes an idealistic openness that transcends the material world and embraces symbolism. [14]

The concept of transparency is considered a rebellion against the box buildings that are isolated from the outside world and depend on some narrow openings for the entry of light and air.

The first credit for rooting this concept is due to the invention of glass, which achieved the difficult equation by linking the outside and inside of the building while achieving the necessary protection and privacy at the same time.

In the Netherlands, the government set up a camp to accept refugees who fled during World War II in 1939, and only the house of the security chief remains of this camp.

Instead of demolishing the house and erasing the history of the camp, the Dutch government decided to make it a memorial center and designed a glass box to encase the entire building. As a great solution to preserve this historical site and the building has become like a piece of precious jewelry. [20]

Figure 3. Glass House, New Canaan, USA,
source: (https://www.archdaily.com)

A. The Importance of Transparency in Architecture

The importance of transparency is not limited to providing natural lighting inside the building despite its importance, but it achieves a set of positive points related to the building and its occupants as well as the people outside the building, figure (4) shows the importance of transparency at the level of the building, occupants, and passersby outside.

B. How to Achieve The Concept of Transparency

Transparency directly depends on the nature of the architectural design either in terms of the shape of the plan or the form and also the various vertical and horizontal elements which connecting the built and natural environment, This is clearly evident in Frank Lloyd Wright's philosophy of achieving the connection between inside and outside through the open floor plan via the external envelope. the curtain walls is the best elements through which this relationship can be achieved with the necessary protection inside the spaces.

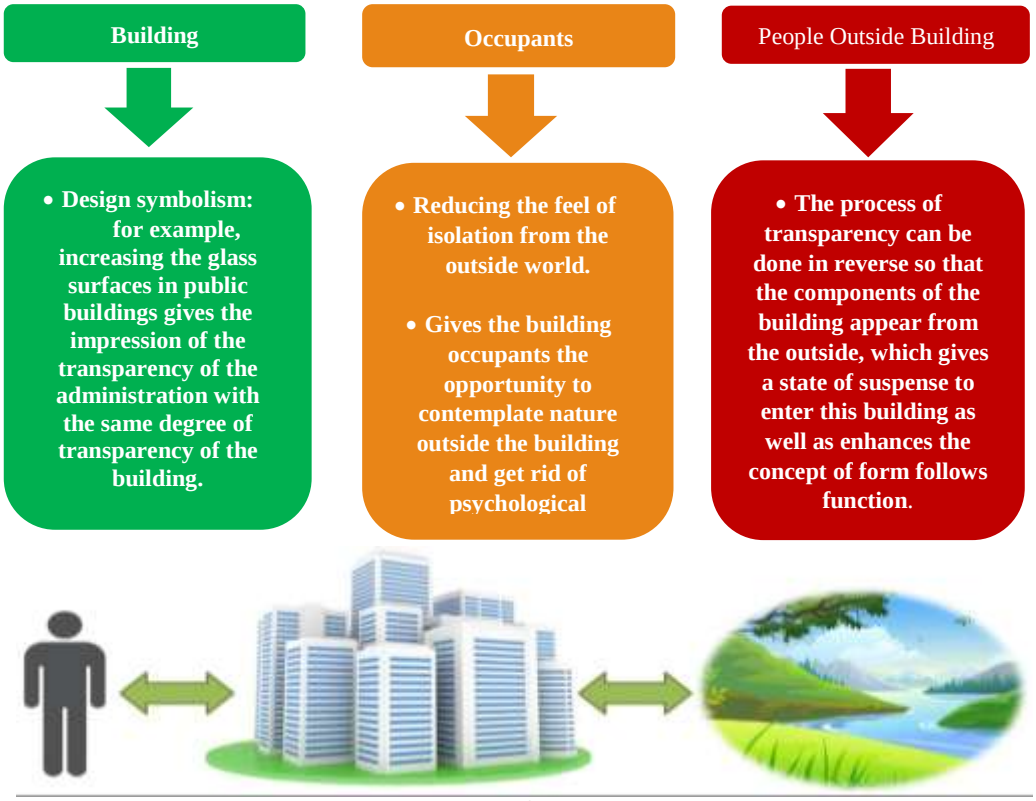

Figure 4. The Importance Of Transparency, By Author

Figure 5. Transparent Building Envelope
Source: (http://www.rexiindustries.com)

So, the concept of transparency is achieved through the following architectural solutions:

- Horizontal Relationship

Connecting the building horizontally to the natural environment through the design so the relationship between built and natural environment doesn't not only depend on the transparency of the outer building envelope, but it aims to make the building an integral part of the natural environment (Figure 6).

- Vertical Relationship

Connecting the building vertically to the natural environment /represented by the sky through open or covered courts. The atrium spaces are one of the best elements to achieve vertical transparency (Figure 7).

Figure 6. horizontal transparency
Source: (http://www.rexiindustries.com)

Figure 7. Vertical Transparency
Source: (https://www.viator.com/)

- Horizontal & Vertical Relationship

The form of the building directly influences its horizontal and vertical connections to the external environment and to the sky. The pyramid and spherical shapes are the best for

providing complete transparency to the building. The Louvre glass pyramid is one of the best examples of this (Figure 8).

Figure 8. Vertical & Horizontaltransparency
Source: (http:// https://www.flickr.com)

5. TRANSPARENCY DEVELOPMENT STEPS

The concept of transparency in architecture passed through several stages, according to the development that occurred in a number of diverse aspects, including what is human and economic, as well as the innovation of new materials, in parallel with the development in architecture design philosophies over the various ages.

- *Step (1): The Later Middle Ages, (Structure Transparency)*

Transparency at that stage was represented by the movement of the structural elements outside the building, while the vertical circulations elements remained inside. One architectural style predominated in Europe during the later middle Ages: the Gothic Style. For hundreds of years, it was favored especially in the strongholds of Western Gothic architecture is known for its numerous distinguishing characteristics, including its pointed arches, stained glass windows, massive, soaring towers, naves and flying buttresses.[18] (Figure 9).

Figure 9. Cathedral in Prague Castle.,1344
Source: (https://www.archdaily.com/)

- *Step (2): The Industrial Revolution, (Glass Transparency)*

One of the first man-made materials to have been utilized continuously since its creation is glass. Although the exact time span of glass history is uncertain, the earliest date of discovery is 7000 B.C., during the Neolithic era. Prior to 3000 B.C., it was initially employed in Egypt for decorative purposes, mostly as colorful glaze on stone, pottery, and beads. However, it appears that Romans were the ones who first used it in windows. A significant advancement in lead glass technology during the seventeenth century allowed for the production of enormous glazing for windows, "a technology that brought glass into the history of architecture." In 1800, as interest in greenhouses and conservatories increased, glass use in architecture became a popular building material. Large, well-lit spaces could be designed in new building types like exhibition halls, train stations, and other public structures. Glass was seen as a luxury commodity up until 1851; however, when glass became more widely available during the industrial revolution, this perception progressively faded. The possibility of vast glass expanses led to improvements in metal framing technology as iron and steel. Since then, glass has become an essential component of contemporary architecture elements. With the advent of new concepts during the industrial revolution and the growth of the construction industry, where big glass surfaces were utilized in addition to the transformation of building structures into cast iron, the idea of transparency evolved magnificently. With his inventive design of the Crystal Palace Building in 1851, English engineer "Joseph Paxton" is regarded as the first person to produce a design that expresses transparency directly.[1] (Figure 10).

Figure 10. The crystal palace 1851,
Source: (https://www.archdaily.com/)

- *Step (3): The Age of Modern Architecture*

The concept of form follows function (Lewis Sullivan) is one of the most important foundations of modern architecture, it is as a virtual transparency of the shape of the building, so it resulted a simplified buildings forms, and then turned into the concept of a less is more (Ludwig Mies van der Rohe).The idea of translucent, all-glass structures captured the imagination of modern architects more and more.

In all of his designs، Frank Lloyd Wright used transparency to create movement, his organic style works was defined as "a modest, dwelling place that has no feeling at all for the magnificent save as the house spreads itself in the flat parallel to the ground, a partner to the horizon, adoring the ground with the new sense of space, light, and freedom. [3]

in his iconic project, Edgar kaufmann house (falling water villa) in Pennsylvania, wright took the concept of transparency to an unprecedented stage, where the house was built amidst a forest of high trees crossed by a steep gondola, forming a waterfall amidst the huge rocks. by this building, he connected the horizontal lines of concrete with the vertical lines of the walls, glass openings, and tree trunks in the forest.

In his latest project, the Guggenheim Museum, the exterior was a white compact cylinder coiled towards the sky, and the interior was a huge atrium 28 meters high, all the way to a wide glass dome. Along the sides of this lobby there is a winding ramp six stories up to over 400 meters, allowing one floor to merge with the other and allowing the visitor to enjoy the artwork displayed along the walls as he soars up into the sky. (Figures 11 and 12)

Figure 11. Edgar kaufmann house 1937,
Source: (https://www.archdaily.com/)

Figure 12. Solomon R. Guggenheim Museum 1959,
Source: (https://www.architecturaldigest.com/)

Mies van der rohe imagined and created models of possible 20 and 30 storey skyscrapers coated entirely in glass in 1922, which resemble buildings currently being built today, mies developed a new architectural language known as "skin and bone architecture" that could be utilized to symbolize the emerging technological era. Chicago architects were erecting America's first high-rise glazed buildings at the time. Technology did not allow for the building of multi-story glass facades like those on Bunshaft's Lever House and Seagram Building until the middle of the 20th century.[7] (Figure 13).

Figure 13. Seagram Building, 1958
Source: (https://www.archdaily.com)

- *Step (4): The Age of Late Modernism*

I. Brutalism Architecture

The concept of transparency has evolved by Brutalism Architecture in an expressive way through honesty and clarity in the use of materials with a concentration on textures and construction, As a Honest Architecture, brutalism was directly concerned with the appearance of the building as it is without changing the texture or color of the finishing materials. Consequently, the transparency of the building has become represented in honestly expressing its external appearance and structural structure without changing or embellishing. (Figure 14)

Figure 14. The Geisel Library, California, 1970
Source: (https://bluprint.onemega.com/brutalism)

In the Habitat apartment building, the spaces between the building blocks became transparent and parts of the sky could be seen through those distances. This unique design was able to use architectural form in an atypical manner, creating irregular spaces that led to the sky being seen through those spaces. This building has achieved amazing transparency by connecting the areas outside the building to the sky through the building itself (Figure 15).

II. Hitech architecture

Center George Pompidou was an architectural innovation when it was built in 1977, with colored pipes, a jumble of steel, and an escalator in a Perspex tube. Despite being likened to an oil refinery, it became the city's most popular tourist destination. The elements of horizontal and vertical movement

and electro mechanic suppliers became outside the building, which is mean that what's inside became outside as a great new step in symbolic transparency (Figure 16).

Figure 15. Habitat apartment building, montreal, Canada,1967
Source: (https://bluprint.onemega.com/brutalism)

Figure 16. Center George Pompidou, 1977
Source: (https://www.centrepompidou.fr/en/)

- *Step (5): Transparency in Contemporary Architecture*

I. Norddeutsche landesbank building:

One of the important advancement steps in transparency whether at the level of transparency of walls or form, designed by Gunter Behnisch and his son Stefan, the design shifted toward "de constructivism" due to the building's informal, clashing parts and lack of conventional geometries or axes of reference. Modern glazed walls are made of angular volumes and discontinuous shapes (Figure 17).

II. Mediatheque Sendai

The true meaning of transparency is clearly embodied in mediatheque building in Sendai japan, since it's in front of a large grove, building extensive views towards the rescues as well as the use of trees in the design of the structure. It is above all a space where the flow of light and frankly between the different levels of the building. The main idea of the building is based on the metaphor of Aquarium, its transparency and hence the similarity of the pillar with algae by an open and fluid space.

Figure 17. Norddeutsche landesbank hannover, Germany, 2000
Source: (https://architectuul.com)

The outer envelope is a transparent membrane that allows fluid communication with the interior's visual exterior, so the boundary between the two seems to be fading. The building's structural system is made up with two of the three basic elements for the design of the building, the floor are sheets of metal, and pipes, which are columns in the form of tubes combined. [22] (Figure 18).

Figure 18. ediatheque building, Senda, japan, 2001
Source: (https://www.architectmagazine.com/)

- TRANSPARENCY AND DEMOCRACY

In 1995, the English engineer Norman Foster created a glass dome design for the German parliament building (the Reichstag) after the declaration of German unity in 1991 to

express the approach of the new federal state, and it became a landmark of the city of Berlin, suggesting transparency and democracy. The transparency of the dome also plays an important symbolic role in linking the general public on the roof with parliamentarians inside the hall. Inside the dome there is a glass cone that transmits sunlight during the day into the hall and at night it transmits the lights of the hall outside.

The German parliament building was built in 1884, then the building was left since the Second World War without development or restoration until this dome was built. [19] (Figure 19).

Foster's glass work has been repeated for government buildings in Singapore, where the Supreme Court building, which took place between 2002 and 2005, was designed on an area of 72,000 square meters, with a mixture of marble and glass, in an expression of the integrity and transparency of the Singaporean judiciary (Figure 20).

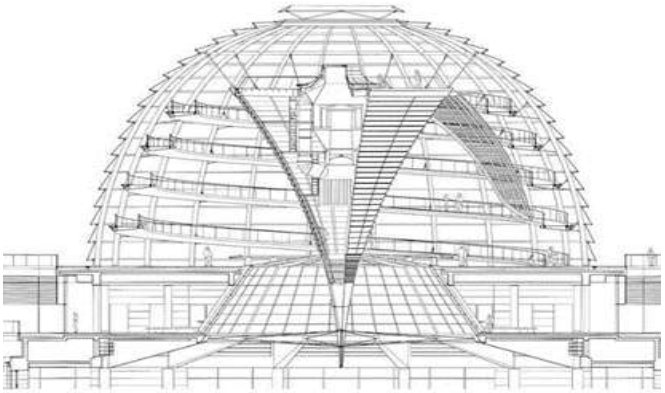

Figure 19. Reichstag transparent dome, 1991
Source: (https://www.berlin.de/)

Figure 20. Supreme Court building, Singapore, 2005
Source: (https://www.fosterandpartners.com/)

He also designed the Pyramid of Peace and Reconciliation in the Kazakh capital, "Astana," as a glass pyramid with a height of 62 meters and a base width of 3,444 square meters, to be a global center for interfaith dialogue, renounce violence, establish justice, and equality between human structures, and a symbol that accommodates different religions (Figure 21).

The process of transparency can be done in reverse so that the components of the building appear from the outside, which gives a state of suspense to enter this building as well as enhances the concept of form follows function.

Figure 21. The glass police stations, Georgia, 2006
Source: (https://www.fosterandpartners.com/)

Figure 22. The glass police stations, Georgia
Source:(https://georgiaabout.com/)

Otherwise the idea of using glass in government buildings as a tool to show transparency has spread from Germany to many countries, the most famous of which is the buildings of police stations made of glass in Georgia, which the government deliberately built in this style to emphasize transparency and honesty in the performance and dealings of the policeman, after the revolution in Georgia in 2003. [23]

Transparency is described as the quantity of light that passes through a substance in broad physical terms. It's also the ability to see through normally solid objects. In design, we sometimes presume that transparency allows us to experience many built and natural environments at the same time, resulting in diverse perceptions and feelings inside and outside the space.

Transparency through solid barriers, as permitting a fluid to flow through transparent medium.

Building outer envelope is a barrier that act as rigid filters which allow light and outdoor scenes to pass through or be seen through. This allows people inside building to see the natural environment around them and people outside to see inside. The concept of transparency is considered a rebellion against the box buildings that are isolated from the outside world and depend on some narrow openings for the entry of light and air.

The first credit for rooting this concept is due to the invention of glass, which achieved the difficult equation by linking the outside and inside of the building while achieving the necessary protection and privacy at the same time.

Figure (23) shows a comparative analysis study for selective examples of some buildings dealt with in this research paper with a comparison between them in terms of achieving the concept of transparency from several points, including what is humanitarian related to the occupants of the building and those others outside it, or functional related to the nature of the design, shape, services and type of the building.

6.CONCLUSIONS

i. Transparency is described as the quantity of light that passes through a substance in broad physical terms.
ii. The concept of transparency emerged as one of the design concepts in the 20th century
iii. Transparency linked to the psychological and spiritual aspects of the building's occupants.
iv. Transparency is not limited to the link between the built environment and the natural environment through glass surfaces, but goes beyond that to create a state of integration between the outside and inside of the building
v. Transparency can be achieved through a reciprocal relationship between the built environment and the natural environment, horizontally through the outer envelope of the building, or vertically through open and covered courts.
vi. Transparency has been developed in conjunction with the development of the construction industry over the ages.
vii. The transmission of light through transparent materials plays an important role in defining the features of the architectural space.
viii. Building outer envelope is a barrier that act as rigid filters which allow light and outdoor scenes to pass through or be seen through.
ix. Transparency has become increasingly associated with ideological values and has been used in government buildings.
x. Transparency is considered a rebellion against the box buildings that are isolated from the outside world
xi. Transparency directly depends on the nature of the architectural design either in terms of the shape of the plan or the form.
xii. Transparency achieves a set of positive points related to the building and its occupants as well as the people outside the building.
xiii. Transparency through solid barriers as permitting a fluid to flow through transparent medium.
xiv. Transparency in governmental buildings strengthens the principle of democracy.

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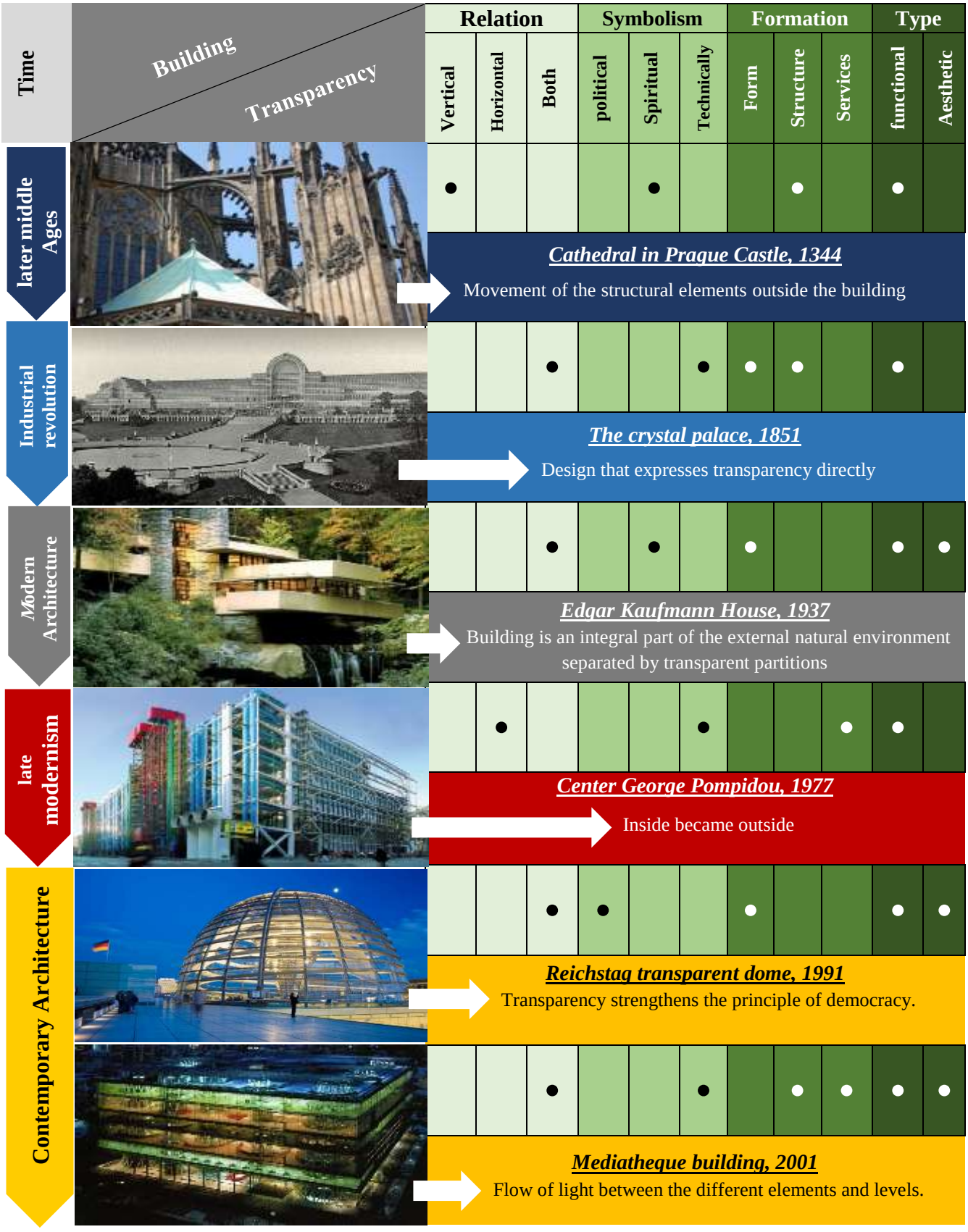

Figure 23. Comparative analysis study for selective examples, by author