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Drawn into the art.

Space Syntax and visual analysis of the effect of the architecture of the MAXXI on the experience of movement and sight in Gio Ponti's exhibition "Loving Architecture".

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1. Introduction

In 1997 when Frank Gehry designed the Guggenheim Museum of Bilbao, the characteristic architecture, which emerged on the industrial ruins of the abandoned bay of Bilbao, initiated what in urban planning is referred to as the Bilbao effect. The city started to attract more visitors to the museum and the whole bay of Bilbao got revitalized by its presence. In addition, visitors and tourists seemed to be more attracted by the architecture of the museum rather than the art displayed in it. With titanium curves, changing colours according to the weather and the light conditions of the environment, the architecture seemed to be a masterpiece on its own emerging from the water (fig. 1.1). It was a spectacular museum architecture and a discussion started around whether the architecture was competing with the art. From that moment on every city wanted to have its own outstanding contemporary museum architecture. Mayors were opening calls and inviting all the most prominent architects to design or build extensions to their own museums. It was the museum boom that benefited both museums' institutions, increasing the number and variety of visitors, and the quality of the urban life around the area in which the museum was located. At the same time, it coincided also with a flourishing moment for architecture. Every major architect was defining a signature architectural language that became recognizable worldwide. Architects became *archistars*. As noticed by Andrew McClellan, museums became not only places where visitors wanted to see the art but also spaces where they could get the latest currents in architecture.¹ Thus, the doubt that the architecture of the museum was competing with the art was not utterly unfounded. Nevertheless, what this issue overlooks is that behind every museum space there is a specific idea of how art should be experienced. By looking through the history of museums, McClellan reveals how changes in the architecture of the museum corresponded to changes of ideals in the society or in museums as institutions.² For instance, associated with the idea of the museum as a white cube there is the idea of art that should be experienced in isolation and absolute contemplation. According to this

¹ McClellan, *The Art Museum from Boullée to Bilbao*, 53

² Ibid.

perspective, museum architecture should be as neutral as possible to serve its function of letting the art stand out. But as pointed out by McClellan, Etienne-Louis Boullée (1728-1799), who was a significant figure in defining what an architecture of a museum should be, inspired architects to go beyond the function looking for the character of a museum architecture.³ This, combined with the fact that there is a specific intention behind every museum, makes it harder for a museum architecture to be neutral.

The Guggenheim of Bilbao was not the first time a museum architecture seemed to be competing with the art due to its characteristic configuration. According to contemporary art historian Gabriella Belli there was another Guggenheim that previously challenged the display of art: the one in New York designed by Frank Lloyd Wright.⁴ The architectural element of the spiral acting as a centrifugal force, seems to invite visitors to keep moving along the ascending path, experiencing the artworks as a passer-by. With its inclined path, the *rotunda* (fig. 1.2) does not invite to see artworks frontally in isolation but in constant motion and all together.⁵ This disorienting effect is what Belli recognizes as a tendency towards a certain autonomy of the architecture of the museum from the artworks.⁶ A far more interesting concept for trying to solve the confusion about a possible competition between art and museum architecture. Belli also remarks that the shift in museum architecture happened with this autonomy of the Guggenheim which was necessary to respond to the needs of a new mass society.⁷ Museums began to perform new functions serving the new purposes of being also event spaces, hosting shows that “needed to contain the complexity of new languages of visual art and media”, that led to different requirements for designing museum spaces.⁸ Paired up with the autonomy of museum architecture, this draws the attention towards the power of a museum architecture to create a space that affects the experience of art. Moreover, the autonomy of the Guggenheim *rotunda* encourages to go beyond aesthetical considerations and focus on movement and sight as it is induced by the architecture and that interacts in the way art is displayed and experience.

³ McClellan, *The Art Museum form Boullée to Bilbao*, 59

⁴ Belli, “The Contemporary Museum: of architecture and meaning”, 151

⁵ Ibid.

⁶ Ibid.

⁷ Ibid.

⁸ Ibid, 154.

Artworks are experienced in space through movement and sight, and these are defined by the architecture of the museum. Thus, rather than a competition between art and museum architecture, there seems to be a certain autonomy of characters in defining the experience. The autonomy of museum architecture in defining the experience of space, the autonomy of exhibition design in defining the narrative of how artworks should be experienced, and the autonomy of the artworks in themselves. Museum architecture, artworks and exhibition designs are in fact constantly shaping each other's experience because they are three autonomies manipulating the space of the museum for the visitors and the objects on display. To create a more complete experience, this complex interaction of autonomies needs to be better understood. The discussion should then revolve around the character of each, and on how to define relationships that respond to each specific intent, not to which one should renounce to its character in favour of the other. In defining a space where artworks can be contemplated without any distractions the white cube also has a character. It suggests a specific way of experiencing art which is in isolation. A character needs to be investigated at the level of the experience to reveal how it interacts shaping it for the visitor. Thus, to understand the character of a museum architecture might be necessary to go beyond an analysis of its aesthetical properties and stylistic choices.

Precisely for the Guggenheim in New York, the Iranian architect Zaha Hadid (1950-2016) curated the Suprematism exhibition *The Great Utopia* (fig. 1.3), using the element of the spiral she was able to play with the architectural element as a creative impediment. Inspired by the Suprematism idea of floating, she suspended all the paintings with the results that artworks could have been seen all in one go and from different perspectives at once.⁹ As Belli recognizes, Zaha Hadid further developed Wright's concept of the *rotunda* but resolving all the ambiguities of the spiral ramp in an explosion of vision.¹⁰ This way of playing with the interference of the architecture of the museum is what makes any exhibition designed in that space unique according to Zaha Hadid.¹¹ The effect on the experience is specific to the alchemy that is created

⁹ Obrist, *Lives of the artists, lives of the architects*, 676

¹⁰ Belli, "The Contemporary Museum: of architecture and meaning", 157

¹¹ Obrist, *Lives of the artists, lives of the architects*, 687

between the characteristic architecture and the art. So much that the former director of the Guggenheim Thomas Krens started to propose exhibitions and installations made for the *rotunda* again in New York in the Guggenheim in Bilbao, proving the totally different effect they would have on the experience of both the artwork and the museum architecture.¹² Exhibition designs and museum architecture work together to define the visitors' experience of art. Since Zaha Hadid was able to read the character of Wright's *rotunda* and had direct experience in curating an exhibition in relation to that, when the moment came for her to design a museum architecture, she transported this experience. For the MAXXI she created a very characteristic architecture. The MAXXI is special in the way that it is meant to display not only contemporary art but also exhibitions about architects and architecture. With this respect, Gio Ponti's exhibition, that was hosted from November 2019 until September 2020, offered an opportunity to research this interaction between museum architecture and exhibition design in defining the experience with a focus on how they shape visitors' movement and sight. This leads to the following research question: *what is the effect of the MAXXI architecture and the design of the exhibition of Gio Ponti: Loving architecture on the experience of movement and sight in the museum space?*

The project for the MAXXI, a new museum for contemporary art and architecture in the hearth of the city of Rome, won the competition in 1999 and it took almost ten years to be completed. Thus, the design of the museum is dated back to an early stage of the architect's career when she was still developing her repertoire. The resemblance with the Landscape Formation One building in Weil am Rhein in Germany is not mainly aesthetical, because of the use of the characteristic sinuous line, but rather processual. The building (fig. 1.4) seems to emerge and then dissolve again into the surroundings as a concrete landscape formation, not to emulate the natural environment but to present itself as a possible other landscape configuration which is the result of the information previously collected from the site and parametrically generated. Throughout all her career the architect developed a computational script-based process to build up a repertoire for her projects.¹³ A computational process where she embedded information and constraints regarding the environment, structure, and building occupation to

¹² Obrist, *Lives of the artists, lives of the architects*, 687

¹³ Ibid., 690

create an asset of design-generative capacity that enhanced her understanding of the designs' rule-based mechanism.¹⁴ By gathering information for every project and adding it to the repertoire the capacity of the repertoire kept expanding so that the MAXXI in Rome (fig. 1.5) comes from the same repertoire of the Landscape Formation One in Weil am Rhein. More than a personal architectural signature, the similarity among the projects lies in the parametric approach. According to Patrick Schumacher of Zaha Hadid Architects,

“parametricist compositions are like enhanced natural systems, they are highly integrated, and they cannot be easily decomposed into independent systems (...) the elegance of the space comes out of solving the problem, of ordering, structuring, and making legible the new level of complexity.”¹⁵

In this way the complexity increased due to the different urban setting and the museum function, the MAXXI is another possible situated landscape configuration parametrically generated from the surroundings. After the MAXXI, other museums designed by Zaha Hadid Architects followed the same repertoire. Amongst others, the Guggenheim museum in Taichung (fig. 1.6) which extends similarly in many directions, and the Loi & Richard Rosenthal Centre for Contemporary Art in Cincinnati (fig. 1.7) with different staircases interlocking in an endless variety of spaces.¹⁶ Looking at this repertoire of museums designed by the architect, what is interesting is that they all are more event spaces rather than ideal spaces.¹⁷ Based on movement and variety they all share the continuous line with curvatures and trajectories pulling in many directions creating a richness of space and experience in that space.¹⁸ The concept of space that results from this parametric operation is in fact a multitude of fields of spaces. An enclosed space that seems to act almost as a square. Squares in cities are, in fact, event spaces because at their junction many directions might be taken, creating in this way the possibility of multiple movements and explorations of that space. Thus, an event space is a space rich of possibilities.

¹⁴ Schumacher, “Design as second nature” retrieved from website:

<https://www.patrikschumacher.com/Texts/Design%20as%20Second%20Nature.html> (13/06/2021)

¹⁵ Ibid.

¹⁶ Obrist, *Lives of the artists, lives of the architects*, 663-664

¹⁷ Ibid., 662

¹⁸ Ibid.

With this respect the architectural intervention of Zaha Hadid in the MAXXI seems to be almost a contemporary take on Bernini's Roman Baroque, where the urban landscape with plastic facades, squares, and fountains, was all ordered to stage urban life. In the case of the MAXXI the stage is offered by the architecture of the museum to curatorial intent. In Zaha Hadid's opinion, the assumption behind an architectural design to be as free as possible from any interference, to the extent of even eliminating the context around the museum with a few windows rigorously shut, is that the neutrality of museum architecture assures the utmost freedom to any possible curatorial intent and design.¹⁹ But it should be considered that an excessive neutrality might also hinder any free curatorial act on the white cube configuration. In the MAXXI it is exactly the interference of the architectural configuration which creates possibilities of using the space in many possible ways. The architect intent was, in fact, to serve the peculiarities of each exhibition design, not by excluding the architectural intervention but by predominately including and suggesting specific and multiple ways of attuning to it.²⁰ At a first glance, the heart of the discussion seems to be whether the character of a museum architecture should interfere or not with the display and the art. The fear is that if the architecture of a museum shows too much character, it will end up capturing all the attention, distracting the visitor from the art and putting itself in competition with the art displayed. From this perspective, the white cube could be seen almost as an act of rebellion to a certain excessive characterization of museum architecture that might steal the scene from the art. But is the spectacular architecture of the MAXXI stealing the scene to the art? It seems it creates a characteristic stage for it instead.

The architecture of the MAXXI seems to be like Zaha Hadid's manifesto on how art should be presented, and museums designed as stages for contemporary art and exhibition design, "the idea of absolute space shifts to the idea of different adjacencies and porosity where you can see multiple things at one".²¹ In the MAXXI "space and temporality are reworked to address the polyvalent density of the 21st century".²² A characteristic which makes the museum particularly interesting to investigate the effect of museum architecture on the experience of art and

¹⁹ Obrist, *Lives of the artists, lives of the architects*, 663-682

²⁰ Ibid.

²¹ Ibid., 685

²² El Croquis, 180

exhibition design. This architectural design intent seems to oppose to the idea of a museum architecture that wants to compete with the art displayed or keep the two experiences as autonomous or separated. Since the MAXXI does not renounce to have a character and clearly states the intention to interfere in the way art should be displayed and experienced, it is an interesting case study to prove this. But it needs to be examined if this is also true from the point of view of the visitor's experience.

While it is difficult to define the subjective experience of a visitor, Space Syntax allows to read objectively an architectural configuration defining the visitor experience in terms of movement and sight. Therefore, to investigate the effect of the spatial configuration of the MAXXI on the experience of the exhibition of *Gio Ponti Loving Architecture* I use a combination of Space Syntax methods with visual analysis. Specifically, I analyse the accessibility of Gallery 5, where the exhibition was hosted, with respect to the entire configuration of the museum space. This is accompanied by a visual analysis of the path conducting to the Gallery 5 from the hall. Then movement is analysed from the access to the path on the third floor, which hosts only the gallery, and inside the gallery with and without the exhibition settings. This comparison shows the interaction of the architectural configuration and exhibition design in defining the experience of movement and sight from a visitors' perspective. Sight is analysed for Gallery 5 only, again making a comparison between the empty space of the gallery and the setting, paring it up with a visual analysis of the exhibition through photographs and notes that I took during my visit.

The methodology will be elaborated upon in the next chapter. There I will introduce the concepts behind Space Syntax, and the methods I will use to apply this methodology to the MAXXI. A few Space Syntax applications in museum studies that are relevant to the aim of my research will be presented. Combining Space Syntax methods with a visual analysis of the exhibition of *Gio Ponti Loving Architecture*, I design my methodology. In the third chapter I introduce the case study of the MAXXI elaborating on Hadid's intentions of creating a specific character for the museum to exhibit art. The analysis of the experience will be divided into two parts: movement and sight. I will explore the potential of visitors' movement and fields of view with and without the exhibition settings. In the conclusion I discuss the limitations of the methodology and I give suggestions for further research at the light of the findings.

2. Methodology and Method

Going beyond any aesthetic consideration about architectural choices or style, a method that can be used to analyse the spatial configuration of the MAXXI from the perspective of the experience is Space Syntax²³. Space Syntax is a theory and method developed by Bill Hillier (1937-2019) at the UCL School of architecture in the last decades of the sixties. Initially meant to analyse complex spatial configurations such as cities, it has been applied to many different fields from archaeology to social media design. In museum studies Hillier himself used it to analyse the Tate Britain. Showing the power of the museum to shape movement and social experience, it became the standard to research spatial layouts of galleries and museums.²⁴ Kali Tzortzi also used it to analyse exhibition design such as the one of Sainsbury Wing and Castelvechio showing how the display of the objects articulate the museum space turning the visitors' experience into a spatial event.²⁵ To understand how the architecture of the MAXXI interacts with the exhibition of *Gio Ponti Loving Architecture* in defining the experience of movement and sight for the visitor, a combination of methods will be used in the case study analysis. These methods will be accompanied by a visual analysis of the path conducing to the gallery space and the exhibition space itself. Before going into further details about these methods it is necessary to introduce a few key concepts that clarify the perspective from which space is analysed by Space Syntax. First an understanding of what space is, and then the one of architectural configuration. These are the concepts behind the name of this methodology: the concept of *space* and *syntax*.

2.1 The concepts of Space and Syntax

The architectural configuration of a building can be read from the perspective of the elements that define the space, such as walls, partitions, or any other physical obstruction; or from the perspective of the void created by the way these elements are configured. In Space Syntax *space* is seen and analysed from the perspective of the latter. Specifically, its focus is on making evident the relationship between the voids as they are defined by the spatial configuration. As affirmed

²³ Ostwald & Dawes, *The mathematics of the modernist Villa: architectural analysis using Space Syntax and isovists*, 5

²⁴ Ibid, 297

²⁵ Tzortzi, "Building an exhibition layout: Sainsbury Wing compared with Castelvechio", 129

by Hillier, “in a configuration the way certain elements stay together is more important than the elements themselves”, that is, it is the void created by the architecture and the way these voids are connected that is the object of Space Syntax analysis.²⁶ In a museum space the voids are the galleries. The spatial connection between the galleries is influencing the way visitors will access and perceive these areas, also shaping the way they will give meaning to a display. How galleries are connected to each other is more important than the design of these spaces because it is there that the visitors’ experience is defined. To understand how space works it is important to transcend aesthetical considerations about the architecture. Ultimately, it is how the gallery spaces are organized in a configuration that define how the visitor will be able to move and what they will be able to see, no matter if the shape is a white cube or a sinuous architecture as the one of the MAXXI. This perspective on spatial architectural analysis seems to be more appropriate to define how the MAXXI museum works at the level of the experience.

By delimiting and relating spaces the elements of architecture create a certain order, and this order is what lies behind the second concept, the concept of *syntax*. As in a language words are combined into sentences, in an architectural configuration spaces are ordered into a certain *syntax* of space. By analysing the space from the voids created by the architectural configuration, Hillier recognized a mechanism that was ordering and governing these voids, and that was strongly related to patterns of people movement in that space.²⁷ For this reason, he proposed a general *syntax of space* based on a language pertaining to shapes which borrows both from natural and mathematical language, while keeping at the same time the autonomy from both.²⁸ The relationships between the voids in a spatial configuration can be described in a natural language and measured in a mathematical one. This combination makes Space Syntax methodology both qualitative and quantitative. The approach is thus *syntactic*. From mathematical language it takes the ability to create as many syntaxes of space as possible, without having to attribute necessarily a semantic meaning to them. From natural language it takes that the meaning is only the abstract structure of the pattern and does not represent

²⁶ Hillier, “The hidden geometry of deformed grids: or, why space syntax works, when it looks as though it shouldn’t”, 170

²⁷ Hillier, “The reasoning art: or, the need for an analytical theory of architecture”, 1-5

²⁸ Ibid.

anything else.²⁹ This does not mean that the architectural configuration does not have a meaning, but that this symbolic representation is considered secondary in Space Syntax analysis.³⁰ The *syntax* created by the spatial configuration is more important than the symbolic meaning of an architecture because it underlines the importance of the relationship between spaces in a configuration rather than the elements of architecture in themselves. Beyond the symbolic meaning of the MAXXI museum to understand the effect on the experience is the spatial configuration and its void that needs to be analysed.

2.2 A network representation of space

As cities are an aggregation of buildings held together by voids such as streets, squares, and other open spaces in between the blocks, in an urban settlement it might be more immediate to see how these voids can be related to a network structure. In a similar fashion also the rooms of a building, such as the gallery spaces of a museum, can be abstracted in a network structure. The way one gallery is accessible from the hall or from another gallery is defined by the order that is given to the spatial configuration. This order is the *syntax of space*. Space Syntax methods are used to reveal this order by representing space as a network. Since the characteristics of a network are the relationships between the nodes, gallery spaces can be represented as nodes, and the relationship between them as edges of a network structure. This network representation of space enables the analysis of how the spatial configuration of the MAXXI works, connecting and defining a certain way of moving through the spaces, and seeing them. To analyse syntactically the gallery spaces of the MAXXI it is important to consider the whole architectural configuration. Hillier defines a configuration as “at least, the relation between two spaces taking into account a third, and, at most, as the relations among spaces in a complex taking into account all other spaces in the complex”, establishing hierarchies within them.³¹ Justified, convex and axial maps are all network representations of space with nodes and edges: in justified and convex maps, the nodes are the convex spaces and the edges the relationships between them; in axial

²⁹ Hillier, “Space Syntax”, 140-150

³⁰ Ibid.

³¹ Hillier, “Ideas are in things: an application of the space syntax method to discovering house genotypes, 363-364

maps the nodes are the paths and the edges the connection between them.³² In both axial and convex maps visual properties are generalized and abstracted.³³ The justified map is a method to analyse the spatial hierarchy of a structure, convex and axial maps are methods to analyse the permeability of a configuration and the axial map is a method to analyse the intelligibility of a space.³⁴ All together they can reveal the hidden structure of the relationship between the spaces ordered by the architectural configuration of the MAXXI. For all three it will be explained what they are and what their purpose is for this research.

2.2.1 Justified map

Taking a museum building configuration such as type A (Fig.2.1) all five galleries are directly accessible from the hall. While in building configuration type B (Fig. 2.2), since there is no direct access to gallery 2 and 4 from the hall, to reach gallery 2 and 4 the visitor must pass through gallery 1 and gallery 3. In Space Syntax this is expressed by saying that gallery spaces 2 and 4 are two steps away from the root space, which in this case is the hall. Using graph theory, it is possible to represent these relationships between the gallery spaces in a justified graph. Depending on the space from which access to all other spaces is analysed, the graph can be justified according to this space that is then called 'root space'. This is possible because the graph is a network of nodes and edges that does not have orientation or dimensionality and can be rearranged in different ways with the only condition that the connections are kept between nodes.³⁵ This network representation of space is the result of a process of abstraction that converts the architectural plan into a map of elements (nodes) and connections (edges) between them. A justified graph can help understand how Gallery 5 is connected to the hall for instance, and a simple analysis of its properties can allow a qualitative description of the museum in terms of *shallow* and *integrated* or *deep* and *segregated* gallery spaces. Thus, it tells how accessible galleries are in the museum.

³² Ostwald & Dawes, *The mathematics of the modernist Villa: architectural analysis using Space Syntax and isovists*, 28

³³ Ibid.

³⁴ Ibid, 24.

³⁵ Ibid, 29

2.2.2 Convex map

Justified graphs can also be derived from a convex map, which is another way of representing the space as a network that allows the exploration of the relationships between the gallery spaces with respect to the entire configuration. This type of network representation converts the architectural plan into the fewest number of visually coherent spaces and connections between them.³⁶ Ostwald defines a convex space as “a space where the entire perimeter of its shape is visible from any point within”.³⁷ While the justified map makes apparent the hierarchy of spaces with respect to a root space, the convex map is used to read the overall connectivity of the museum space with respect to all spaces bringing forward the permeability of the spaces. In this research it will be used to analyse the accessibility of Gallery 5 from the hall and the overall connectivity of the museum space.

2.2.3 Axial map

The axial map is also a network representation of space made up of the fewest number of straight lines that cover all spaces. It is a map of optimal system of movement in a space.³⁸ Each straight line, called ‘axial line’ in the map, is also a line of sight because it represents a space that can be visually overlooked and physically accessed by a person moving in that space. Thus, it is a map of paths visitors would most likely walk based on the intelligibility and permeability of space. Therefore, axial lines in an axial map represent the potential of movement in that space as it is defined by the architectural configuration. Axial maps will be used to get insights into potential visitor movement inside Gallery 5, including the path conducting there from the third floor, and will be compared with and without the exhibition settings of *Gio Ponti Loving Architecture*.

2.2.4 Visibility Graph Analysis (VGA)

A visual graph analysis (VGA) is the result of several iterations of development for a method that measures the field of view from a specific position in space. The VGA combines the fields of view

³⁶ Ostwald & Dawes, *The mathematics of the modernist Villa: architectural analysis using Space Syntax and isovists*, 28

³⁷ Ibid.

³⁸ Ibid.

from a whole room and creates a holistic map of spatial-visual properties of the entire environment.³⁹ This map is constructed of a series of polygons on a two-dimensional plane that represent the fields of view of a visitor from a specific point. These polygons are called isovists, and are the basic way of analysing visual properties of a spatial configuration, which were first used by Michael Benedikt who used them to demonstrate that in the same environment different spatial experiences are possible.⁴⁰ Exhibition design creates another environment in the existing one of the galleries, taking one or more ways of ordering things in space from the architectural configuration. This implies that multiple possibilities are inscribed in that space. The different routes that visitors can take in a gallery space can be represented by isovist fields. VGA abstracts the gallery space into a set of connected isovists to analyse the intervisibility of all the gallery spaces.⁴¹ In this research it will be used to analyse the impact of exhibition design on the visual experience of Gallery 5, by comparing the intervisibility of the two spaces with and without the exhibition settings. With respect to the previous Space Syntax methods, this method is closer to a description of space from the point of view of the visitor, whereas the other are more related in general to the spatial configuration.⁴²

2.3 Space Syntax applications in museum studies

In museum studies, Kali Tzortzi related the analysis of the spatial configuration of museums respectively to museum intent and visitors' patterns of movements, showing the different ways in which visitors respond to the given configuration.⁴³ Tzortzi relates museum intent to museum architecture as it is inscribed in the void of the spatial configuration and not in what might seem apparent by aesthetical considerations regarding the architecture of the building. In particular, she explored the relationship between visitors' movement and museum intent as it is expressed in four contemporary museum architectures. In the case of the Pompidou, for instance, the analysis of the spatial configuration from this perspective revealed a rather hierarchical structure

³⁹ Ostwald & Dawes, *The mathematics of the modernist Villa: architectural analysis using Space Syntax and isovists*, 47

⁴⁰ Ibid.

⁴¹ Ibid, 49.

⁴² Ibid, 46.

⁴³ Tzortzi, "Movement in museums intent versus experience", 327

with respect to the intent of the museum to create a more democratic space for contemporary art. The architecture of the museums needed, in fact, to facilitate the display and presentation of a complex new variety of visual art and media languages. In the case of the Tate Modern instead, which is organized around a central space granting direct access to all the galleries, it was expected to be a more controlled space. With respect to visitors' movements the analysis revealed that there is more choice for visitors to shortcut the sequence, even though the exploration of the gallery inhibits taking different routes.⁴⁴ At the light of these insights, Tzortzi concludes that museum intent might not always be reflected in the void of the spatial configuration, as it was meant to be in the case of the Pompidou. If it is instead successfully reflected in the architectural configuration, as in the case of the Tate Modern, visitors' movements are sometimes in accordance and other times in discordance with it because visitors tend to take different and unexpected routes.⁴⁵ In a more recent analysis Tzortzi explored the role of spatial layouts in sensory environments created through digital media in museums.⁴⁶ These environments create visitors' experiences that involve all the senses in a way that works sometimes independently from museum's main narrative, or it overlaps enhancing the itinerary as it is suggested by the architectural configuration. As a result, she concludes that the spatial configuration plays a role in defining patterns of visitors' movement, but this is a variable role in the case of the presence of sensory environments. Acknowledging that the spatial configuration of a museum plays a role in defining visitors' experience, also MacDonald explored movement in relation to different exhibition styles and different visitors' meaning-making processes.⁴⁷ The exhibition setting challenges the visitors' creation of personal meaning. Visitors can create different visiting maps in relation to the given structure of the spatial configuration because the experience of visiting a museum space is subjective.

⁴⁴ Tzortzi, "Movement in museums intent versus experience", 327

⁴⁵ Ibid.

⁴⁶ Tzortzi, "Rethinking museum space", 31

⁴⁷ MacDonald, "Interconnecting: museum visiting and exhibition design", 151

2.4 A combination of methods

In Space Syntax after undertaking the analysis of the spatial configuration using the software UCL Depthmap, results are usually compared with ethnographic observations of visitors' behaviour and movements in that space. Often combined with interviews to better understand users' perceptions and experience of that space. That is because the subjective experience is taken as the ultimate test for any correspondences between the structure of the spatial configuration and the way the subject structures the experience of that space through movement. The nature of Space Syntax is not to directly describe visitors' experience, but to analyse the intermediate language between the experience and the architectural configuration. Its level of abstraction is above the subjective experience of the visitors. As such it needs to be accompanied by a direct observation of actual patterns of visitors' movement to give meaning to the results obtained by the analysis. Since I was not able to confront the analysis with a direct observation of visitors' patterns of movement, the analysis is limited to the architectural configuration and the exhibition design. This can still be insightful as it describes how the relationship between the two defines visitors' experience.

The MAXXI was designed by Zaha Hadid with a certain way of exhibiting art in mind, which suits the investigation of the relationship between museum architecture and exhibition design in defining visitors' experience. Thus, to introduce the case study analysis Hadid's intentions will be analysed to understand how the museum architecture was meant to create a certain experience of art and architecture. Then the analysis focuses on the museum space itself using Space Syntax methods of convex map analysis for the accessibility, axial map for movement and visual graph analysis for sight. A classical visual analysis is then accompanied to these methods to analyse the path conducing to the exhibition gallery and the exhibition design itself. The first convex map analysis is run for the entire museum. The accessibility of the gallery is going to be analysed through a reading of the connectivity of Gallery 5, where the exhibition of *Gio Ponti Loving Architecture* was hosted, with respect to the entire spatial museum configuration. Whereas the other two Space Syntax methods are going to be used to analyse more in detail the experience of movement and sight directly inside Gallery 5. Specifically, movement is going to be analysed through an axial map and sight with a visibility graph analysis. The aim of the analysis is to

understand the influence architecture has on visitors' experience of the exhibition space. Since the intervention of exhibition design alters this experience by adding new architectural elements, such as walls and other architectural elements, a comparison between the axial map and the visual graph analysis is made in Gallery 5 with and without the exhibition setting. Through this comparison how the design of the exhibition interacts with the experience of movement and sight, given by the museum architecture, is explored. In addition, a classic visual analysis of the design of the exhibition space is performed using photographs and notes taken during a visit to the exhibition of *Gio Ponti Loving Architecture*. The visual analysis has been added for two main reasons. The first reason is that the Space Syntax methods used are two-dimensional, thus they do not consider what happens in the third dimension where the experience takes place. The second reason is that in visiting the exhibition I realized that it seemed to start already from the hall. Large signs with Gio Ponti's exhibition prints were suspended from the ceiling in between the intricate path conducting to the gallery space. At each floor quotes by Gio Ponti (1891-1979) and designs of the architect's original patterns were attached on the walls at different heights, scattering in a way parts of the exhibition throughout the whole path. An effect that could not be overlooked in wanting to analyse how the museum space invited to access the gallery space were the exhibition was hosted. To understand how the MAXXI invites to access Gallery 5 it was important to consider this certain invitation to the exhibition space.

3. Case Study Analysis

3.1 The MAXXI by Zaha Hadid

As Zaha Hadid affirmed, in her proposal for the MAXXI museum, any architectural intervention should be inspired by a critical relationship with contemporary social and aesthetical categories.⁴⁸ Behind Zaha Hadid's architecture there is a long-term fascination the architect had with Russian Avant-garde and Malevich's Suprematism.⁴⁹ The idea of elevating the form from the two dimensions of the paper to the third and fourth dimension of space and time of an architecture experience, comes from Kazimir Malevich (1879-1935) who declared: "I have transformed myself in the zero form", a zero form that can be read as horizontal or vertical at the same time.⁵⁰ A zero form that can be turned into space. Looking at the sketches for the plan of Zaha Hadid's MAXXI (fig. 3.1) they might as well just be read as bidimensional paintings. As compositions of lines and colours the architect elevated from the two dimensions of the paper to the third dimension of space. Norman Foster called this the ambiguity of Suprematism, a characteristic of Malevich's painting, that Zaha Hadid exploited in her approach to architectural composition.⁵¹ It is within this perspective that the continuous line of the walls of the museum takes many different trajectories in plane and section. The architecture of the MAXXI can be read as an intricate composition of lines that take and lose tridimensionality in space creating a very characteristic space for the art. From the architectural plans (fig. 3.2) the space seems to be configured as continuous, however it is not certain if this is also experienced by the visitor this way. And how this might affect the experience of the art displayed in it. An understanding of how the visitor might experience the museum space can give insight into the interaction between this space and the exhibition design. The classical composition of the walls where artworks can be displayed is, in fact, challenged in this sinuous line system. In the intention of the architect this was meant to offer "a new freedom in the curatorial palette", that is many possible ways of ordering artworks in space.⁵² To serve exhibition design and the display of the museum

⁴⁸ Zaha Hadid, *Zaha Hadid: 1996-2001*, 180

⁴⁹ Obrist, *Lives of the artists, lives of the architects*, 661,670

⁵⁰ Ibid., 672

⁵¹ Ibid., 675

⁵² Zaha Hadid, *Zaha Hadid: 1996-2001*, 181

collections, walls appear and disappear as if they were bi-dimensional lines, sinuously taking mass vertically, now from the ceiling now from the floor

“by constantly changing dimensions and geometry, they adapt themselves to whatever curatorial role is needed. By setting within the gallery spaces a series of potential partitions that hang from the ceiling ribs, a versatile exhibition system is created”

and offered to the designers of exhibitions.⁵³ The paths conducing to the gallery spaces depart from each other or intricate like in the hall (fig. 3.3). Visually, the hall, has been associated to Piranesi’s Carceri (fig. 3.4).⁵⁴ There the intricate passages were the stage of the oppression of a prison system, here they intricate to enable the ‘staging’ of the 21st century art and architecture. In Zaha Hadid’s intention the museum architecture is meant to be a stage to different curatorial intents:

“it is not only a question of how you exhibit art but also about [how] through complexity curators can interpret different leads and connections created by the architecture”

suggesting that this complexity is doing more than just serving the art.⁵⁵ The stage of museum architecture is offered to experimentation. The curator is invited to superimpose the exhibition design intervention to the experience of the museum architecture. Solid wall, projection screens, windows to the city “the exhibition wall is the primary space making device” for the curator to play with.⁵⁶ This is possible because it has a clear character. Presenting itself as a “versatile engine for the staging of exhibition effects”, where art can be experienced organically as part of the landscape created by the architecture.⁵⁷ In this way the museum already offers a certain experience of space. To analyse how an exhibition relates to it, first the character of this stage needs to be understood. The aim of the MAXXI museum spatial configuration is to ‘maximize’ exhibition design possibilities.⁵⁸ How are these used in the exhibition of *Gio Ponti Loving Architecture*? Embedded in this stage for the art there is the possibility to cluster and compact

⁵³ Zaha Hadid, *Zaha Hadid: 1996-2001*, 181

⁵⁴ By who, Gabriella Belli and others?

⁵⁵ Obrist, *Lives of the artists, lives of the architects*, 663

⁵⁶ Zaha Hadid, *Zaha Hadid: 1996-2001*, 181

⁵⁷ Ibid.

⁵⁸ Ibid., 180

displays in a way that recalls Suprematism. Suprematism would have ordered artworks in space in a way that would resonate more with the display of a *Wunderkammer*, where every inch of the walls would have been covered, being the display a synthesis of all the wonders of the world to be experienced. With the possibility of suspending artworks from the ceiling, laying them on the floor or floating, or simply placing them everywhere on the continuous wall system created by the spatial configuration, the architecture of the MAXXI seems to embody the Suprematism idea of experiencing art as part of a landscape, potentially evoking an experience of wonder. The architecture offers a stage where artworks can be experienced as part of a field of possibilities or a Cosmo.⁵⁹ A Cosmo which might draw the visitor into the wondrous experience of contemporary art and architecture. Is this intention also made clear to exhibition design in order for it to relate with it? With this respect the strong character of the stage that the MAXXI architecture offers might help to reveal the spatial relationships of the three autonomies of museum architecture, art, and exhibition design. There is a certain autonomy of the 'stage' offered by the museum architecture that influences the way visitors might experience exhibition narratives. As for the case of Wright's Guggenheim *rotunda*, Zaha Hadid was able to read and relate with in designing the Suprematism exhibition, because she understood the character of Wright's architectural intervention. It was probably this direct experience that made ideas clear for the architect on how to create a space for contemporary art and architecture. Without knowing beforehand, in designing the Suprematism exhibition for the Guggenheim, the architect followed Wright's suggestions to display paintings suspending them from the ceiling. As Zaha Hadid explains to Hans Ulrich Obrist, only on a later stage, she found out Wright had made provisional drawings on how to possibly display paintings not necessarily attached to the walls but in the middle of the *rotunda*.⁶⁰ This curatorial experience of relating with the strong character of Wright's architecture might have inspired Zaha Hadid in the moment she was the architect, designing a space for art and other curators to design exhibitions. Then, the question becomes whether and how the curators of *Gio Ponti Loving architecture* exhibition related to the character and suggestions of Zaha Hadid's museum architecture, and how this interfered in the visitors'

⁵⁹ Obrist, *Lives of the artists, lives of the architects*, 682

⁶⁰ Ibid., 676

experience of the exhibition. Space Syntax can help us understand the latter, through an analysis of how visitors are enabled to move through space and what they are able to see. The first question needs instead to be investigated with a classical visual analysis.

3.2 The experience of movement

Movement is analysed first as accessibility to the gallery space with respect to the entire museum through a convex map analysis. Then inside the gallery space, as potential of visitors' movement or lines of sight, through an axial map analysis. The way exhibition design interacts with the gallery space creating a combined effect to the experience of movement is analysed making a comparison between the gallery space through an axial map analysis with and without the exhibition settings. The visual analysis will be added for the path conducing to Gallery 5 and the exhibition of *Gio Ponti Loving Architecture* using Moser's questions regarding as guidelines.

An analysis of the accessibility of the entire architectural configuration is given by abstracting the plan into a convex map. The results are interpreted qualitatively. First a justified graph of the entire plan of the museum is produced manually per each floor (fig. 3.5). Then a convex and a step depth map are produced through UCL Depthmap software. The process of abstraction turns the gallery spaces into nodes and the connections between them into edges. In this sense a justified graph is also a network revealing the invisible structure of the configuration. Each gallery space is defined as a convex space and connections are made whenever it is possible from one convex space to directly access another. In the graph, the convex spaces correspond to the nodes and the connections between them to the edges. The convex map shows the fewest number of visually coherent gallery spaces and connections between them. This method shows the configurational relationship between the gallery spaces as it is defined by the possibility to pass between them. In the convex map analysis with the software the hall is treated as convex space. This has been done to enable the connection between the floors since not all the gallery spaces are directly accessible from one another, but almost all are from the hall. The hall is in fact the central connecting core. Gallery 5, which is the object of the detailed analysis is directly accessible from the hall by following the path along all the three floors without having to go through other gallery spaces in between to reach it and by a direct stairwell with an elevator. In the convex map

(fig. 3.6) it is possible to read the connectivity value for each gallery space. This is a measure that takes into consideration the whole configuration of the museum space, and it shows how the galleries are integrated or segregated with respect to the entire museum space. The gallery spaces that are coloured in blue in the map are the most segregated, the red ones are the most integrated, and the shades of green in between are relating to these two opposite poles. From the map Gallery 5, with respect to the entire configuration, is segregated. Meaning that if a visitor would position himself in a random area of the museum the gallery would be a deep space to reach. And this is also the case for the *Sala Carlo Scarpa* on the second floor, and the *Archive Wall* and the *Video Gallery* on the ground floor. The only integrated space, which is red in the map, is the hall and this is evident since it is the functional connecting core to all the gallery spaces.

Knowing that Gallery 5 is directly connected from the hall, a Step Depth analysis is also run using the hall as a root space to show the hierarchy of the gallery spaces with respect to the hall as a root space. The Step Depth map (fig. 3.7) shows per gallery space how directly they are connected to one another from the root location, also defined as step 0. All the gallery spaces that are directly accessible from the hall are one step away, and in the map, they are coloured in green to not confused them with the colours used for the convex map. From the ground floor to the third, the *Archive Wall*, the *Video Gallery*, Gallery 2, *Sala Carlo Scarpa*, and Gallery 5 are all directly accessible from the hall even though the visitors would have to walk the path between the floors. Since the graph is an abstraction, it does not consider this experiential feature but only the direct connection between adjacent spaces. This is the reason why the hall space had been selected as a root space, as it enabled to read the connectivity of the gallery spaces from that point, imaging a visitor entering the museum. Gallery 3 and Gallery 4 on the first floor are instead two steps away and the only gallery space that is three steps away is the *Sala Claudia Gian Ferrari* only accessible by reaching first either Gallery 3 or Gallery 4. The graph schematizes graphically this situation and it just another way of representing it. All the gallery spaces that are one step away lie on the first line on top of the root space which is the Hall. Gallery 2 lies on a second line on top of Gallery 3 and Gallery 4, and finally *Sala Claudia Gian Ferrari* is only accessible from Gallery 2, thus laying on the third and last row. The higher they lie on the graph the higher is their deepness or segregation in the spatial configuration with respect to the selected root space.

An axial map is generated for the entire third floor to also include the lines of potential movement (or sight) from the path. Again, the colours here represent the degree of integration and segregation. Red lines correspond to paths that would be most likely passed and blue ones less. The yellows and green are in between. Confronting the two maps, the first without (fig. 3.8) and the second with the exhibition settings (fig. 3.9), it becomes evident how the addition of the panels in the middle of the gallery redistributes movement potential in the gallery space. In particular, the red lines are in the latter on the opposite towards the big window. Axial lines represent idealized paths through space, thus, the axial map by reducing the plan to the fewest number of straight lines that surveil all spaces it is a representation of the movement potential in that environment.⁶¹

Moser explains how “the visitor experience starts with the architecture, its location, style and message about what will be the content of the museum”, in the case of the MAXXI the content is contemporary art and architecture.⁶² The first impression of the MAXXI architecture is that of entering an adventure into contemporary art and architecture. This is due to the spectacular architecture but also to the fact that ceilings, walls, floors, and windows are taking many directions also vertically in the third dimension. With this respect the architecture of the museum relates to the exhibition of *Gio Ponti Loving Architecture* giving from the very beginning a feeling of contemporaneity of Gio Ponti’s *oeuvre*, even though he is an architect of the 20th century. The narrative of the exhibition starts from the hall where a big banner reproducing the exhibition poster is suspended in between the intricate path (fig. 3.10). These are not artworks or installations but the way they are displayed recalls Zaha Hadid’s intentions of suspending artefacts from the ceiling and sends a clear message: *Gio Ponti Loving Architecture* exhibition is the key exhibition in the museum space. Moreover, along the path conducting to the gallery, quotes from Gio Ponti are printed at different height. Almost preparing the visitor, with their statements, to what must come in the actual exhibition space. The exhibition is, in fact, a major retrospective which shows the versatility and originality of Gio Ponti’s thinking and innovative

⁶¹ Ostwals & Daws, *The Mathematics of the Modernist Villa: architectural analysis using Space Syntax and Isovists*, 22

⁶² Moser, “The devil is in the detail: museum displays and the creation of knowledge”, 24

ideas, the visitor can get acquainted to already by walking the path conducting there. Again, the message is clear: Gio Ponti is still contemporary.

Even though it resulted segregated from the overall configuration analysis, Gallery 5 where the exhibition is hosted is the only one on the third floor. This gives it a certain importance, singling it out from the rest but at the same time making the experience more intimate.⁶³ The size of the gallery is not very big, but it is mostly free and open. Offering itself as a wide space in which being able to articulate the exhibition settings with a certain freedom as reflected by the axial map. Furthermore, it is not longitudinal as all the other gallery spaces. Thus, in a way *Gallery 5* is unique with the iconic window facing the city, that characterises also the façade of the museum from the outside (fig. 3.11). The floor along the path conducting to the entrance of the gallery presents ascendant inclination as if the visitor is reaching the peak of a mountain (fig. 3.12). Also, the path suggests turns and this is reflected in the axial map with lines of sight.

Inside the exhibition is divided in ten sections: *towards the exact house; living nature; classicisms; architecture of the surface; architecture as crystal; light facades; appearance of skyscrapers; the spectacle of cities; contemporary gazes*. Interesting to notice the word choices 'the spectacle', 'contemporary gazes', showing Gio Ponti's contemporaneity which aligns with the iconic and spectacular image of the museum. The exhibition uses the iconic message of the museum architecture to enhance its own message regarding Gio Ponti's architecture.⁶⁴ Objects are lined up on the walls, suggesting the visitor to pass by. But it is mostly text and pictures while maquettes are on tables in the middle of the space. This suggests a freedom of movement that is reflected in the almost equalitarian distribution of yellow and green lines in the middle of the gallery in the axial map (fig. 3.9). Entering on the right, the panels, that chronologically recap Gio Ponti's process, are slightly inclined offering a read of years passing by with selected milestones (fig. 3.13). In the middle the display is distributed less systematically inviting visitors to walk around the tables with maquettes that indeed need to be seen at 360 degrees (fig. 3.14). Overall, visitors are encouraged to move through the exhibition following the walls chronologically and randomly the thematic stands in the middle (fig. 3.15). This gives the freedom to focus and

⁶³ Moser, "The devil is in the detail: museum displays and the creation of knowledge", 24

⁶⁴ Ibid.

contemplate the maquettes individually at the corners and all together inside where they are grouped per section and definition, encouraging them to take a more active role in interpreting the display.⁶⁵ The arrangement of display suggests routes of movements that invite to experience the display in space. In accordance with the axial map results, visitors seem to be able to traverse the entire space focusing freely on the multiple displays. But the area that is mostly traversed is the one in front of the window. There is another ascending path inside the gallery, and it conduces right in front of the window facing the cityscape. This effect of the spatial configuration of the museum gallery is exploited by the design of the exhibition with the placement of one of the most important projects of Gio Ponti: the Pirelli tower in Milan. A maquette of it is displayed right in that area and it is considered a synthesis of Gio Ponti's experimentation with light façades (fig. 3.16). Thus, the ascension of the path might suggest the experience of reaching the apex of a process. Moreover, the view of the light from the inside maquette relates to the urban façades visible from the window.

In conclusion, the effect of the museum space on the experience of movement along the path and inside the gallery is used by the design of the exhibition to reinforce the exhibition narrative. Along the path, also the suggestions to place objects and artworks as part of the landscape and in a non-traditional and linear way on the walls, is also used to introduce and give relevance to the exhibition from the entrance to the museum space. In a way the displays might therefore be experienced as part of a Cosmo, the Gio Ponti's Cosmo which is aligned to the iconic image of the museum architecture being an innovative and explorative space to exhibit contemporary art and architecture. Entering the museum, the visitors might feel immediately they are in a contemporary environment where they will not see artworks in a traditional way. At the same time, the museum architecture experience is maximized by the way artefacts are displayed in the exhibition of Gio Ponti Loving Architecture. The two autonomies working together.

⁶⁵ Moser, "The devil is in the detail: museum displays and the creation of knowledge", 29

3.3 The experience of sight

To explore this interaction also from the experience of sight, a visibility graph analysis is run on the gallery space with the software UCL Depthmap. Two visibility graphs are produced, one with and another without the addition of the design of the exhibition. The results are then compared. The aim is to understand how the museum architecture influences the experience of seeing the exhibition space. The analysis is run from the direct access to the gallery space. Since the path was filled with Gio Ponti's quotes on the wall with big signs hanging from the ceiling even from the hall, it suggested that the exhibition was not just starting at the entrance of Gallery 5 but there was an invitation to visit the exhibition space from the entrance to the museum, thus this analysis is also combined with a visual analysis of the path. This is a choice that has been made by the curators as an invitation to the exhibition space. The overall connectivity of the gallery spaces has been analysed also for the entire museum at each floor, allowing the justified graph and convex space analysis to answer the question how the MAXXI architecture invites to move through the gallery space to reach the exhibition of Gio Ponti. Now we are going to look with the same mixed method at the visibility.

To run the analysis exclusively for the space of the gallery, the entrance has been closed in the design of the plan and a grid has been superimposed to the plan. The inter-visibility per each centre of the squares of the grid has been calculated with the software. The visibility graph of Gallery 5 without the exhibition setting (fig. 3.17) shows all the range of colours that go from blue, through green and yellow, to red and that correspond respectively to a low number of locations visible (blue) to many locations visible from each point of the map (red). A qualitative interpretation of the visibility graph indicates that being red most of the Gallery 5 area offers visibility to many locations whereas behind the stairwell and at the entrance of the right corner, the points in these areas offer the lowest number of locations visible. This means that visual information is partially hidden from the visitor if he would stand in one of the points of these two blue areas. An object or an artwork located in these two areas will not be immediately visible from the entrance, thus it can be perceived as a surprise, as it happens for the exhibition of Gio Ponti where there is a small home setting recreated (fig. 3.18).

In the visibility graph analysis, the connectivity is the number of visible connections per location in the gallery space.⁶⁶ Another simple measure that can be extracted is *step depth*. By considering any change in direction a step, this measure represents the number of steps a visitor would have to take to get from a selected point in the map to any other location in the gallery space.⁶⁷ With the entrance being the selected location, corresponding to step 0, in the step depth map (fig. 3.19) shows that the green area in front of the entrance is the only one directly visible therefore at one step away from the entrance. That is, for a visitor to get to this area only one change in direction would be needed. The yellow area is instead two steps away, thus requiring two changes of direction from the entrance. Finally, the red area behind the stairwell is three steps away. The connectivity value per each point of the grid in the map is calculated by the software and indicates how many steps are in between the entrance to any other location in Gallery 5, or in other words it represents the step depth per each location in the map from the entrance.⁶⁸ The step 0 location is arbitrary and from that the step depth of all the other locations in the graph is calculated. To exemplify that, another step depth map is produced for Gallery 5 (fig. 3.20) showing a different graph where the step 0 point is located from behind the stairwell, that is from the area that was most segregated being blue in the visibility graph (fig. 3.17). In this case the graph shows that the two areas, on the left and right, of what was before the red area three steps away from the entrance, are now one step away from the selected starting point. Even if the colour is the same in the graph, there is one step in between them because there is a change of direction both towards the right and left of the step 0 location. The yellow area is two steps away and the entrance is now three steps away. Besides showing how visibility conditions are different from each point of the space defined by the architecture, the graph shows in detail how different the invitation is to see and move through the gallery space for the visitor entering the exhibition and the visitor reaching a turning point in that space that was before segregated. The visibility graph measures the step depth of all locations in the map. Thus, the visibility graph (fig.3.17) displays the default measure of integration of every location in the gallery space,

⁶⁶ Ostwals & Daws, *The Mathematics of the Modernist Villa: architectural analysis using Space Syntax and Isovists*, 41

⁶⁷ Ibid.

⁶⁸ Ibid.

enabling in this way the comparison between locations in terms of visibility.⁶⁹ The integration measure tells us in fact how deep each location is to all others. Again, the red areas are the most integrated or shallow locations in the plan. This means that the visitor would not need to turn often to get from a specific location to any other in the gallery space. The blue areas are instead the less integrated or deep locations in the plan, which means that the visitor would have to turn quite often to get from there to any other location in the gallery space.

This analysis can help us understand how the space is configured to be experienced visually through movement in space. The curator of an exhibition intervenes in the space of the gallery to create a design that acts upon or complement this experience given by the architecture of the museum. Therefore, the visibility graph helps us to understand how exhibition design used visually segregated or integrated areas by adding new architectural elements and placing objects or artworks in that space. According to the order of magnitude of the architectural elements used to design an exhibition, the visibility graph of the gallery space will be altered. A stand or a panel almost as high as the ceiling in the middle of the gallery space, for instance, will generate different segregation or integration of areas.

To analyse the effect of the museum architecture on the experience of seeing the exhibition of Gio Ponti, the analysis needs to be run again but this time with the addition of the element of design created for the exhibition (Fig.3.21). Not all the elements are considered. Furniture, tables, and panels on the wall are excluded from the plan since they do not alter substantially the visibility of a visitor. Their impact might be on movement, in the case of the table for instance, but because of its height it cannot be considered preventing visibility to other locations in the graph. Therefore, the only architectural elements that have been added are the stands that due to their dimensions (in height and length) create an additional space in the gallery. This visibility graph looks quite different from the previous one. The curatorial intervention changed the integrated areas in red on the graph as well as the segregated areas in blue. The big area that before was all red is now reduced to a band that extends to the right corner of the gallery space from the entrance. Thus, the operation of adding the stands keeps

⁶⁹ Ibid.

only this area more connected. It is from here that the visitor can receive more visual information about the exhibition space and thus the gallery space. Conversely, the area that was all red before is now ranging from green to yellow, and blue because of the addition of the architectural elements of the exhibition design. It is worth to notice that the light blue areas, thus more segregated, are now behind the stands. This does not mean that the stands, in obstructing the visibility, are necessarily bad but that their placement creates a different visual experience of the gallery space.

According to Moser, the way exhibition design creates meaning for the visitor to be experienced is by ordering things and elements in space.⁷⁰ How much the visitor can see determines the intelligibility of the gallery space, and influences decision-making on which direction to take. This order is the result of a strategy that creates a certain narrative. The intentional way in which objects are presented defines a certain culture of seeing.⁷¹ What is the culture of seeing of the exhibition of Gio Ponti? The elements of architecture that exhibition design adds to the experience of a gallery space are listed by Moser: architecture, location, setting; space; colour, light; subjects, message, text; layout; display types; exhibition style.⁷² These elements create an environment in which visitors can get an understanding of art.⁷³ As the impact of the museum architecture is looked at, the impact of these elements of design that constitute an exhibition design intervention also need to be studied. They are not just props but devices that work together influencing the experience of visitors and their understanding of the exhibition content.⁷⁴ These elements cannot be analysed with Space Syntax, because as Moser says they aim at creating meaning.⁷⁵ Yet they work together with the spatial configuration to create an environment in which visitors can get an understanding of art.⁷⁶ To analyse them we need to look at them visually.

⁷⁰ Moser, "The devil is in the detail: Museum displays and the creation of knowledge", 1

⁷¹ Ibid.

⁷² Moser, "The devil is in the detail: Museum displays and the creation of knowledge", 24

⁷³ Ibid.

⁷⁴ Ibid.

⁷⁵ Ibid., 5

⁷⁶ Ibid., 23

The exhibition is a retrospective that is tapping into Gio Ponti Archives and is highly diversified in display types. A constellation of models, photographs, books, magazines, and objects synthesise the architect polyhydic career. From everyday objects to spatial configuration for modern homes the message of this collection is already clear: Gio Ponti is still contemporary. The path conducting to the exhibition reflects this. The space is part of the way displays are experienced.⁷⁷ And space is not simply the physical elements, such as walls on which things are displayed, but the void created by the spatial configuration that guides visitors' movement and sight within that space. Displays are created in existing spaces with a character, and with their own character they might enhance or override this guidance. According to Moser the space influences the choice of materials and the way things are displayed.⁷⁸ The exhibition design by adding the panels that compartmentalise the open space, added a feeling of mystery. Before, without the exhibition settings, everything was visible immediately, as confirmed by the visual graph analysis, with the ascending path that would have conducted directly from the entrance to the big window showing and singling out the beauty of the city outside. Now, with the exhibition settings, this effect is used to make the visitor reach, in collaboration with the architecture effect of surprise, Gio Ponti's Living Room reconstruction on top of the Pirelli skyscraper (fig. 3.22). This gives answers to Moser's question: how is the museum architecture used to reinforce or complement aspects of the display and its message? The character of the museum architecture is in fact used by the display to reinforce and enhance a certain message that the curator wanted the visitor to experience about Gio Ponti's architecture. In Gallery 5 there is a slope in the red area of the visibility graph map with the exhibition design setting (fig. 3.21). The slope conduces to the window without the exhibition settings, with the exhibition to the Appearance of skyscraper section (fig. 2.23) which is key in the exhibition. The architecture draws the visitor directly into it.

A mysterious entrance escamotage is used. Entering only a sign that depicts the Gio Ponti exhibition print is visible (fig. 3.24), and it recalls the one that was in the hall (fig. 3.10), suggesting that the visitors arrived where he was enticed to. The visitor needs to make a turn to have almost

⁷⁷ Ibid, 24

⁷⁸ Ibid.

full visual of what the exhibition is, enhancing the element of surprise given by the architecture. The collection is grouped. Visitors can see briefly the entire exhibition setting but the parts behind the panels and the stairwell are going to be a surprise since they require to walk and make a turn to see them. This is confirmed by visual graph analysis. Design, colour, and light are according to Moser features that constitute the interior design of a museum space can also influence the mood as much as the architecture because they create the atmosphere.⁷⁹ The MAXXI is quite minimalist in material and texture. The concrete has been worked on to be extremely smooth but still it has the original grey colour. Only the path is black, and furniture and pavement white. From the point of view of interior design, it is a quite naked space that treats the materials as finitudes but leaving the feeling of being just structure. In the MAXXI it is all about the experience of space and art and architecture. In Gallery 5 there is no display furniture integrated. The space is naked. The possibility to connect furniture and hang artworks is embedded in the structure. In this way the colours of the panels stand out and give clarity of the division of the sections. Each section has a certain colour. Ceilings and floors are naked but with a character like the *rotunda* consisting in the slope and the structural bones in the ceiling. No decoration or style of the exhibition design only pastel colours. The visual analysis looks at decoration, style, colours, design, furniture, all the elements that are left out from space syntax analysis. Therefore, it should always be complementary, at least while it is not able to include them in space syntax analysis. But even if it is included, they also talk to deeper levels of the visitor's experience of space, the level of feelings and emotions. Colours affect visitors' emotional responses. The naked backdrop of the museum enhances the colours chosen for the exhibition. It helps the interpretation. In the gallery there is light from the ceiling and natural light from the big window. The exhibition design added a diversified system of lightening to make the gallery more luminous also because there was also text to be read alongside the artefacts (fig. 3.25). Additionally, the window with natural light, being without a screen, can also affect moods according to changes in weather conditions. Light acts subliminally creating atmosphere and ambience but also as clarifier defining objects as key, spotlight on maquettes, then there is the light that recreates the whole atmosphere of an interior as for the reconstruction of Gio Ponti's living room (fig. 3.18).

⁷⁹ Ibid., 25

The gallery and display are lit with artificial and natural light that affects how objects appeared. Objects are grouped or singled out through lighting suggesting a certain way to interpret them.

Concluding, the exhibition design of Gio Ponti Loving architecture exploited the way Zaha Hadid meant to exhibit art in the paths and hallways. Also, this intervention seemed to be able to compensate the fact that Gallery 5 is segregated in the overall connectivity analysis, even though it is directly accessible from the hall as exemplified by the justified graph. The design of the exhibition did not exploit the suggestions given by the architecture to hang artefact from the ceiling but acted upon the space of the gallery, redefining movement and sight according to a more classical intent. From the analysis of movement, it is possible to recognize how the intervention, by articulating the space much more, increased the potential of movement, giving at the same time a more constraint direction: first the visitor enters, and must go to the right to follow the narrative, from there everything is still visible, but the visitor will lose information about what is going on in the space right after he leaves the read area in the visibility graph (fig. 3.21). From that moment on he is invited to follow the path and turn quite often to get the visual information that is available in the different areas created by the exhibition design. This is not necessarily a bad choice since it increases the feeling of mystery. Especially this mystery is exploited following the suggestion given by the architecture in the placement of a reconstruction of a Gio Ponti living room area behind the stairwell, an area that before the exhibition intervention was the only one deep and segregated. Since the rest of the visual information in the gallery space was available to the eye of the visitor all at once, reaching that area, whatever would have been placed there would have exploited the element of surprise given by its segregation. Also, the placement of the Gio Ponti reconstructed living area exploits the fact that in front, there is the big window inclined facing the city. Giving in this way also the feeling that Gio Ponti's living room is at the top of a high building as an interior imagined in one of his skyscrapers.

4. Conclusion and Discussion

While the research was successful in answering the research question there were some limitations in doing so which are listed below.

Gallery 5 is directly accessible from the hall, but the analysis of the overall connectivity of the museum space showed that the gallery is segregated. This might be misleading. Even though with respect to the overall configuration Gallery 5 is segregated a direct access to it has been granted by an elevator on the ground floor and by another direct access from the path from in the hall. Moreover, the exhibition design acted upon this situation announcing and presenting the exhibition already in the hall, and with signs and quotes on the walls of the path that led to the gallery. A clear invitation to reach the exhibition space directly, even though walking the path visitors might be attracted to visit other galleries since they must pass the first and second floor to get to Gallery 5. This is something that can be considered only with a visual analysis confirm the need to combine this type of analysis with Space Syntax methods. Another case of segregation that has been overruled by the design of the exhibition design is inside the gallery space. In the comparison between the two visual graph analysis with and without the exhibition design, the most visually segregated area behind the stairwell has been used to locate a reconstruction of a Gio Ponti Living Room design. This choice seemed to have exploited the mystery of less visual information available to the visitor entering the gallery space, therefore evoking a sense of surprise when making the turn while walking around the space of the Gallery. But this observation might benefit of a direct observation of visitors' behaviours and reactions or with a questionnaire to be handed in to visitors to test this assumption.

With respect to the interaction between museum architecture and exhibition design, the curators of the exhibition Gio Ponti Loving Architecture played with the bearing of the architecture but in a classical way. The arrangement is structured chronologically on the walls and thematically inside the gallery space. The first creating a linear narrative through the space and as such not exploiting Zaha Hadid's suggestions of displaying artefact as part of the whole architectural landscape has it has been done on the path to get to the exhibition space. The second intervenes in the void of the gallery creating a different of moving in it but not acting on

ceiling and inclined walls. Even though artefacts are placed at different heights on the panels the suprematism suggestion is not fully explored. The analysis is affected by this, which would have been quite different had a curator made different choices. The effect is of two kinds, in one way it is reinforcing the statement that architecture and exhibition design are both redefining the space for one another, but in the other way it could have made this part of the analysis pertaining to different curators' interpretation of the museum space. Further research could consist in analysing different exhibitions taking place in the same gallery space and read how curators can create different experiences of moving and seeing the same space.

With respect to the analysis of the experience of sight and movement, the fact that the promotion of the exhibition started from the hall, with signs suspended from the ceiling and quotes on the walls along the path at each floor, is not demonstrable with only quantitative analysis, therefore the visual analysis proved to be a good combination of methods together with Space Syntax ones in analysing museums. The design of the exhibition does not follow the potential given by the architecture of the MAXXI of having artworks suspended from the ceiling inside the gallery space. But it takes advantage of the stairwell to create the surprise effect of the Gio Ponti living room reconstruction, and it is used in the hall and along the path as an invitation to visitors to reach Gallery 5. This somehow overrides the information regarding the accessibility of the gallery space offered by the convex map analysis, and it was not possible to find out solely through the analysis with the software. Therefore, it found its completion with the visual analysis. However, for further research it would be interesting to also include observation of patterns of visitors' movement, for example with ethnographic observations of visitors' behaviours, to analyse the effects of this on visitors' decision making. With this respect, another aspect to be considered is that the convex map reveals integrated and segregated areas of the whole spatial configuration. Meaning that, if a gallery is well integrated by the architectural configuration there are less chances that a visitor would miss visiting it, clarifying in this way the accessibility of the exhibition space. On the contrary, if a gallery space is segregated there are higher chances that visitors will not visit the gallery unless this was highly promoted elsewhere, or a particular artwork or exhibition, already known to the visitor, is in that space. Thus, it is important to also

acknowledge that the placement of elements of an exhibition in other museum areas outside the gallery in which the exhibition is hosted may override this segregation.

The comparison between the two conditions of Gallery 5 with and without the exhibition design settings demonstrates how exhibition design acts upon overriding or enhancing what the architecture is suggesting to the experience of seeing through space. This was in the intentions of the architect Zaha Hadid who equipped the architecture of the museum with various ways of displaying art in a suprematism fashion. This specific way of seeing was offered to the curators to play with in shaping the desired experience of visitors seeing the exhibition space. With this respect in the analysis of the exhibition Gio Ponti Loving Architecture the tables in between the stands were not considered because they were an addition of the exhibition design that indeed might have affected movement but not sight. Since there is an order of magnitude from an architectural element to be considered an obstacle both to movement and sight and thus to be included in the analysis. Partition walls can always be considered to analyse the effect exhibition design might have on the experience of movement in that space as it has been defined by the architecture. But further research might also include furniture at least for the analysis of movement. With this respect also contemporary artworks that take space both in elevation and the of a gallery space such as the one of Anish Kapoor in Gallery 2 (fig. 4.1), for example, or the one of Giuseppe Penone on the second floor (fig. 4.2), might be included. An analysis of how these artworks affect the experience of the gallery spaces might show the interaction between the way museum architecture defines a certain experience of space and how an artwork taking this space might change the experience of movement and sight in that space. This relates back to the discourse about the three autonomies of museum architecture, exhibition design, and art in creating space as it has been explained in the introduction with the example of the Guggenheim *rotunda*. The autonomy of the *rotunda* induces a certain way of experiencing artworks as passer-by. Artists and curators are challenged by the strong character of this museum architecture which defines a specific way of experiencing art. By reproposing certain installations, such as the one of Dan Flavin made for the Guggenheim in New York inside another Guggenheim the one of Bilbao, Thomas Krens, showed how the experience of the space of the museum can be affected by the placement of artworks of a certain scale and magnitude. This proves how

inseparable is the experience of an artwork, in terms of movement and sight, from the one of the architecture of a museum. Thus, we can say that also certain contemporary artworks possess a certain autonomy because of their almost architectural presence as much as the placement of artworks hanging on the ceiling influencing differently the experience of a museum space. Further research could consider artworks that take space in museum architecture and analyse how they change the experience of space according to their dimensions and height. For example, the Anish Kapoor artwork on gallery 2 it is an installation that has an order of physical presence in the space of the gallery that can be considered changing the way the space is experience from the point of view of movement and sight. While the artwork of Giuseppe Penone, on the second floor, presenting an element that stands in the middle of the gallery space but that does not elevate in the third dimension, might affect i the experience of movement but not of sight in that space. The compared analysis of both these artworks would indeed benefit also of the three-dimensional approach. A third example could be offered by the artwork of Maurizio Mochetti in the hall (fig. 4.3). This artwork might not be even analysed well in the third dimension, because its materiality is not 'architectural' enough to be considered a presence in the analysis that might affect the experience of movement and sight in the hall. But a visual analysis might instead reveal that the colour and the extended direction of the tubes suggest indeed a directionality that might influence movement and sight in the hall as much as the stands promoting the Gio Ponti exhibition did for the visual analysis of this research.

In conclusion, what is the effect of the MAXXI museum architecture on the experience of the exhibition "Gio Ponti Loving architecture"? The effect is combined, and it is the result of movement and sight induced by the architecture of the museum which interacts with the one created by exhibition design. There is no competition between the architecture of a museum and the artefact displayed because they both have a certain autonomy in defining the experience of space. How well one relates or interfere with the other is a matter that might be mediated by exhibition deign but sometimes even by the artist as well. When Thomas Krens moved the installations made for the Rotunda to another Guggenheim, he showed the impact of this inextricable relationship between the art and the space surrounding it. They cannot be experienced separately even though they both have a certain autonomy in defining the space:

the artwork by being located with a certain order of magnitude inside a space; the architecture and exhibition design properly defining the space to be experience.

A museum architecture might draw into the art in many ways. Zaha Hadid did it through conceiving a museum architecture that would offer a high degree of flexibility to exhibition design, remarking at the same time a specific character the one of suprematism. With this respect even the white cube can draw into the art but in the art of contemplation of isolated pieces. Curators or artists who create exhibitions or artworks specifically for a certain museum space might benefit of such combined analysis that enabled the reading of what is the MAXXI museum architecture suggesting in terms of visual and moving experience to visitors. Further research can enable more informed decisions to act accordingly, enhancing the effect of the museum architecture on the experience, or on the contrary even overriding the intent of the museum architecture on how art should be experience in that space. For this it is important to understand how the invisible structure of a museum space works to act upon it and draw the visitors experience into the art according to each specific curatorial or artistic intent.

Illustrations

Chapter 1: Introduction



Fig. 1.1 Guggenheim Bilbao by Frank Gehry (source: <https://www.guggenheim-bilbao.eus/en/the-building>, retrieved 13/06/2021)



Fig. 1.2 Guggenheim New York by Frank Lloyd Wright, interior, *rotunda* (<https://www.guggenheim.org/press-release/guggenheim-schedule-of-exhibitions-through-2021>, retrieved 13/06/2021)

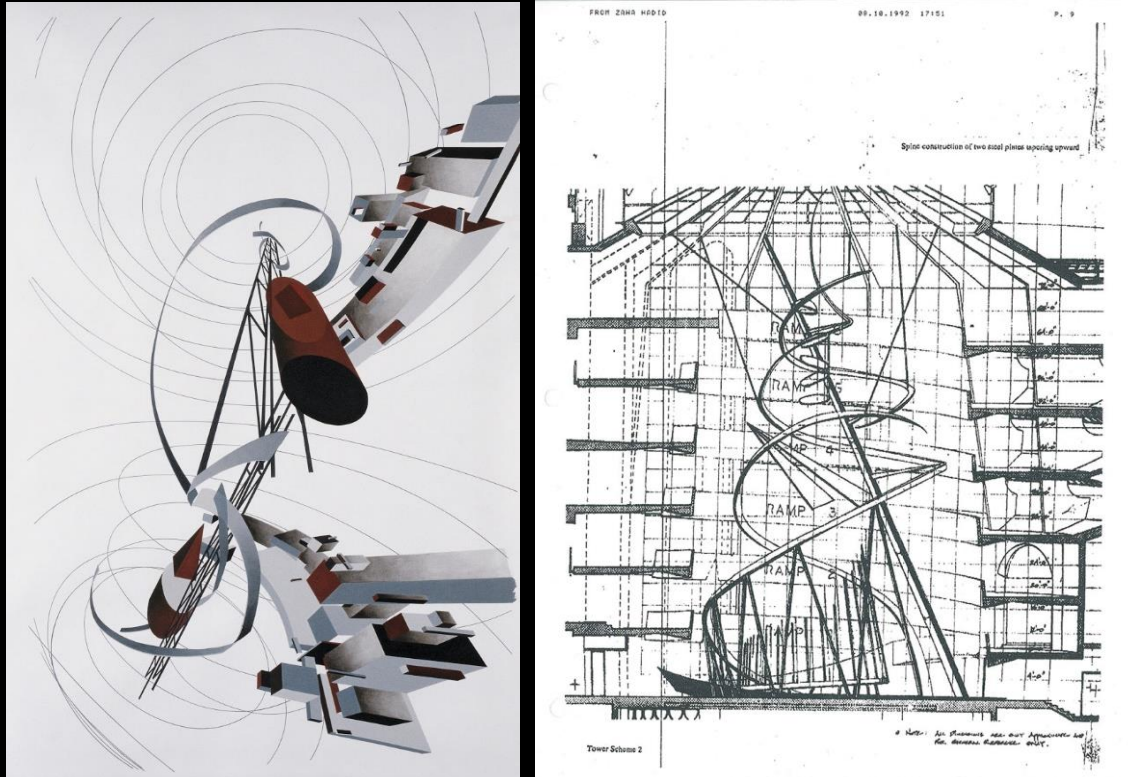


Fig. 1.3 (a, b), Sketch and technical drawing for The Great Utopia exhibition for the Guggenheim New York by Zaha Hadid (source: artsandculture.google.com, retrieved 13/06/2021)

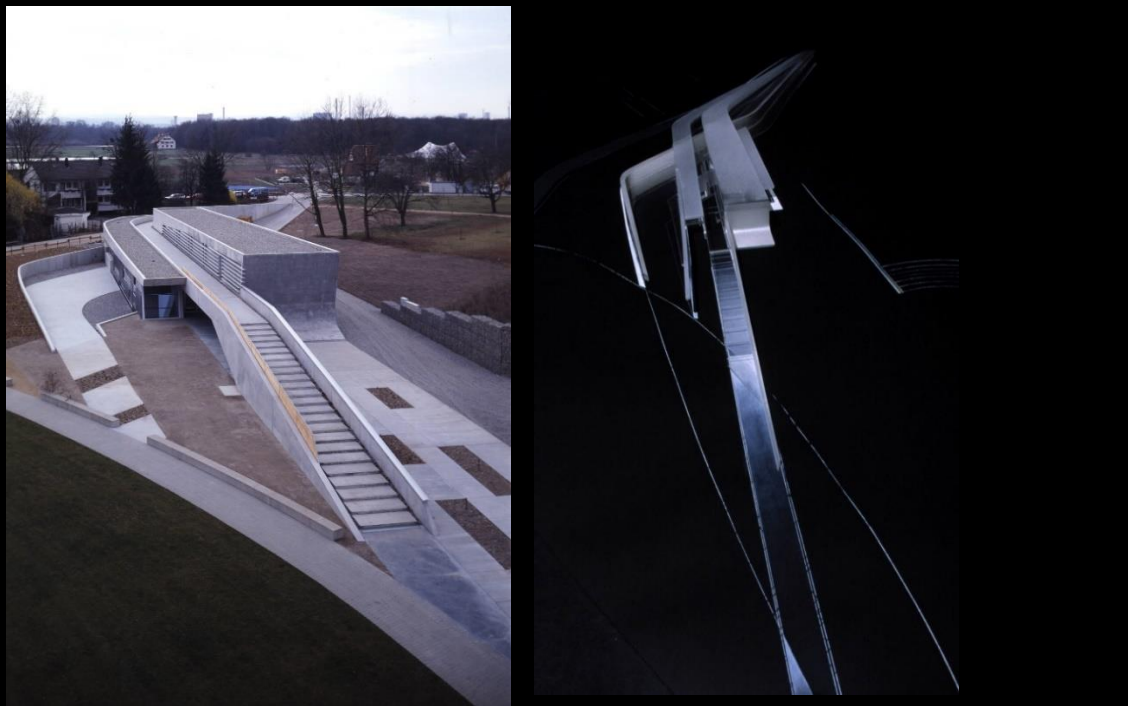


Fig. 1.4 (a, b, c) Landscape Formation One (source: Zaha Hadid Architects, <https://www.zaha-hadid.com/architecture/landesgardenschau-landscape-formation-one/>, retrieved 13/06/2021)



Fig. 1.5 Zaha Hadid Architects, the MAXXI museum in Rome (source: Zaha Hadid Architects, <https://www.zaha-hadid.com/architecture/maxxi/>, retrieved 13/06/2021)

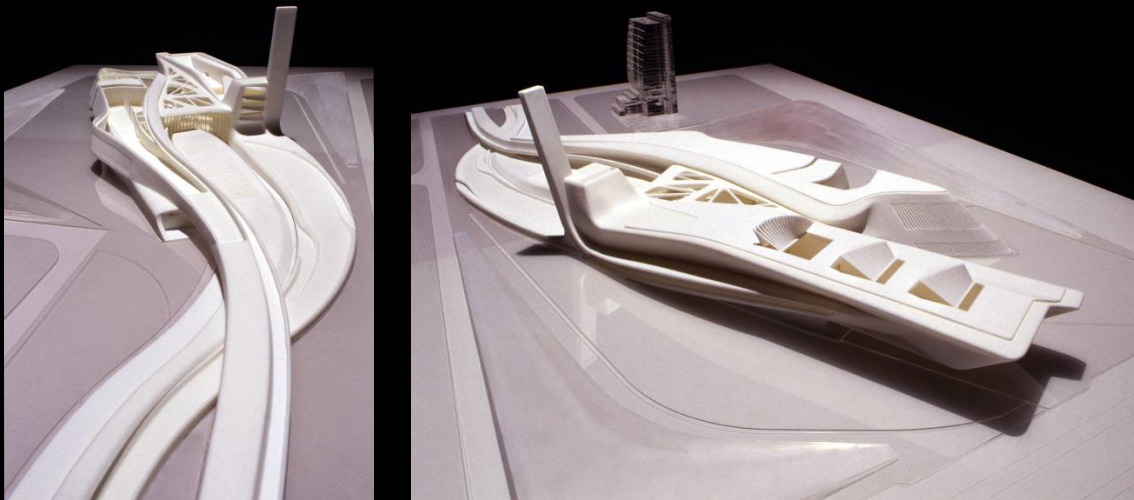


Fig. 1.6 (a, b) Guggenheim Museum in Taichung (source: Zaha Hadid Architects, <https://www.zaha-hadid.com/architecture/guggenheim-museum/>, retrieved 13/06/2021)

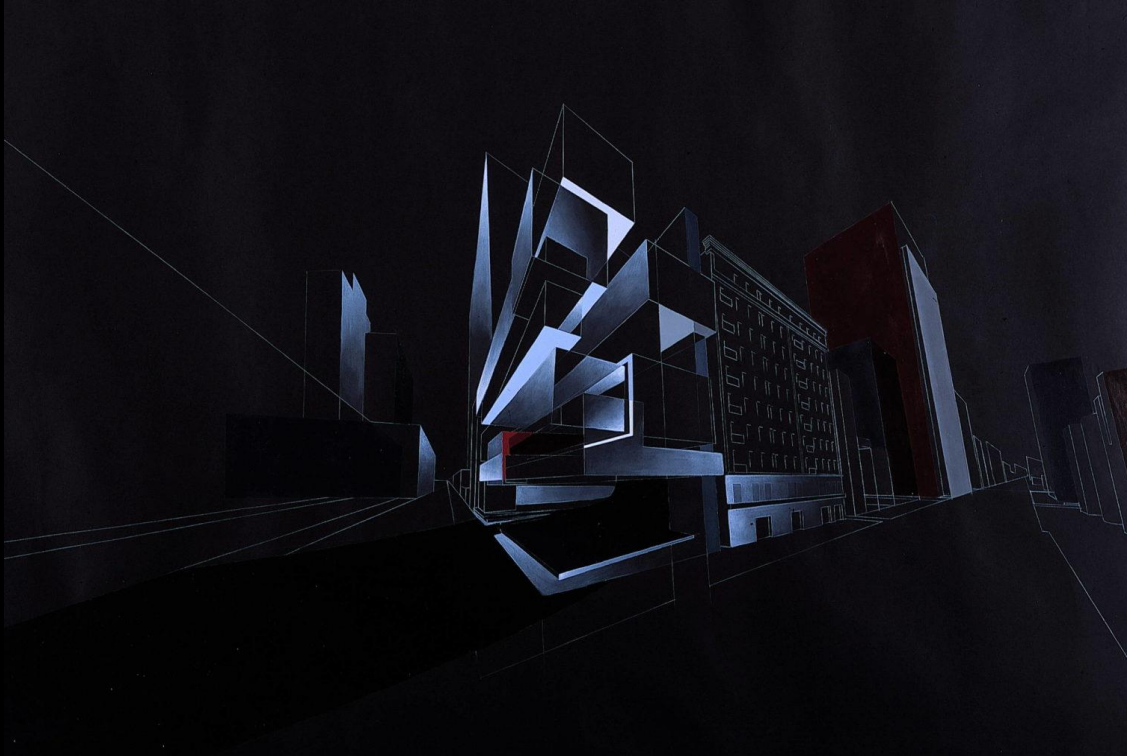


Fig. 1.7 Lois and Richard Rosenthal Center for Contemporary Art in Cincinnati (source: Zaha Hadid Architects, <https://www.zaha-hadid.com/architecture/lois-richard-rosenthal-center-for-contemporary-art/>, retrieved 13/06/2021)

Chapter 2: Method and Methodology

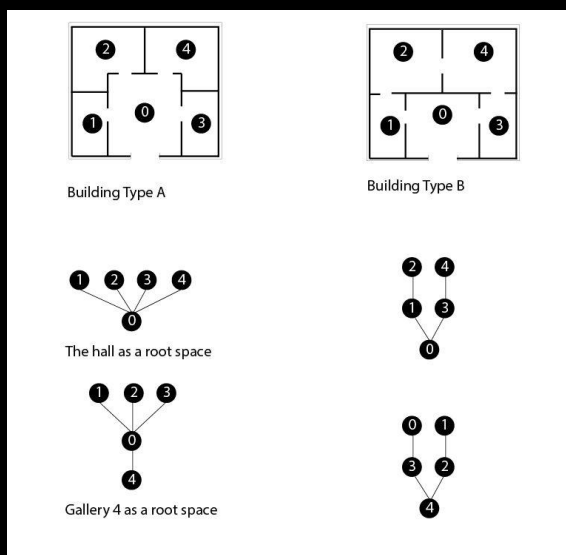


Fig. 2.1 Justified graphs. Building type A graph is more shallow thus more integrated whereas building type B graph is more deep thus more segregated.

Chapter 3: Analysis

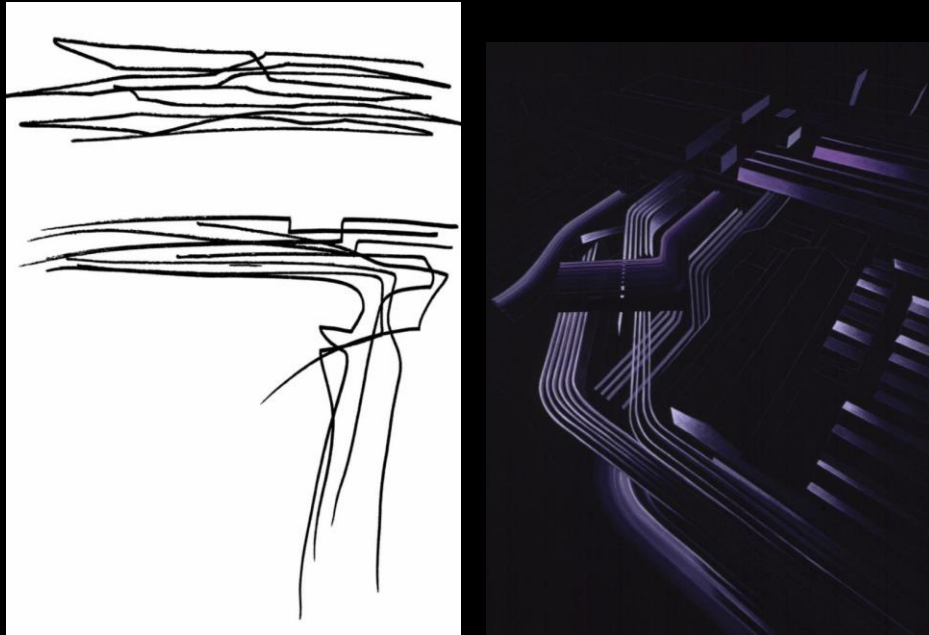


Fig. 3.1 Zaha Hadid Architects, sketches for the design of the MAXXI museum in Rome (source: Zaha Hadid Architects: <https://www.zaha-hadid.com/architecture/maxxi/>, retrived 13/06/2021)

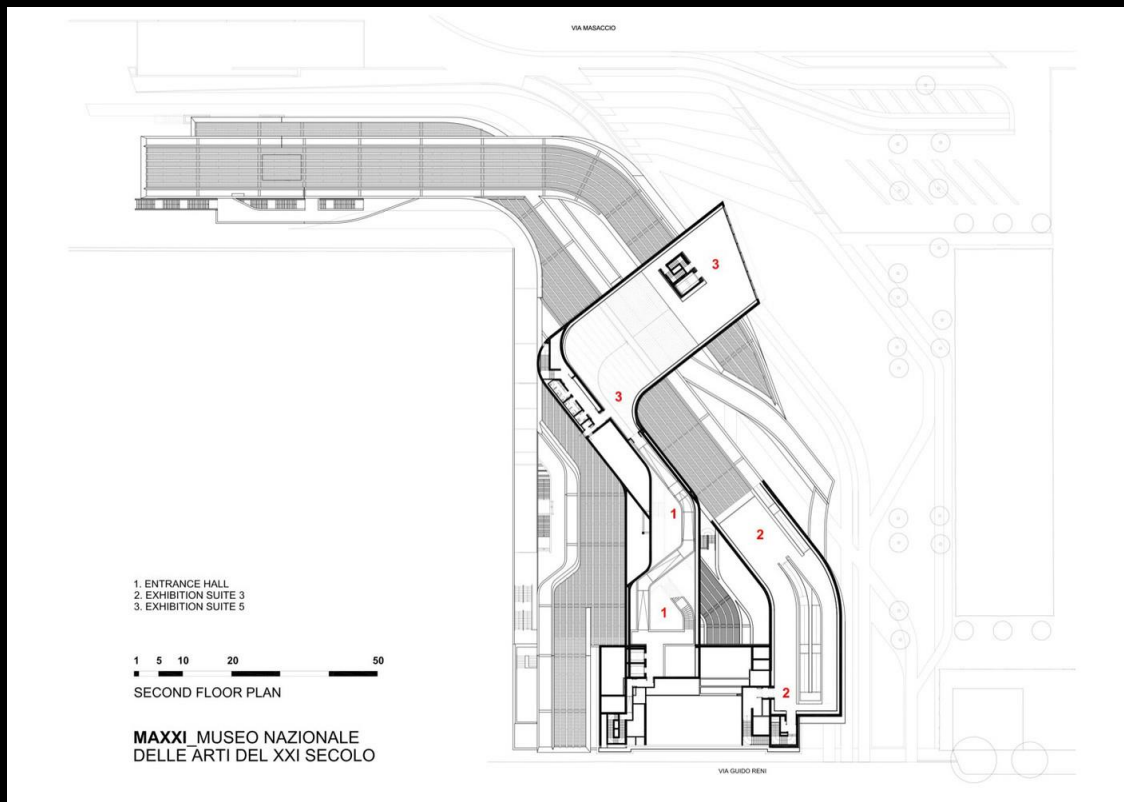


Fig. 3.2 Zaha Hadid Architects, Museum blueprints (source: <https://www.archdaily.com/43822/maxxi-museum-zaha-hadid-architects>, retrived 13/06/2021)

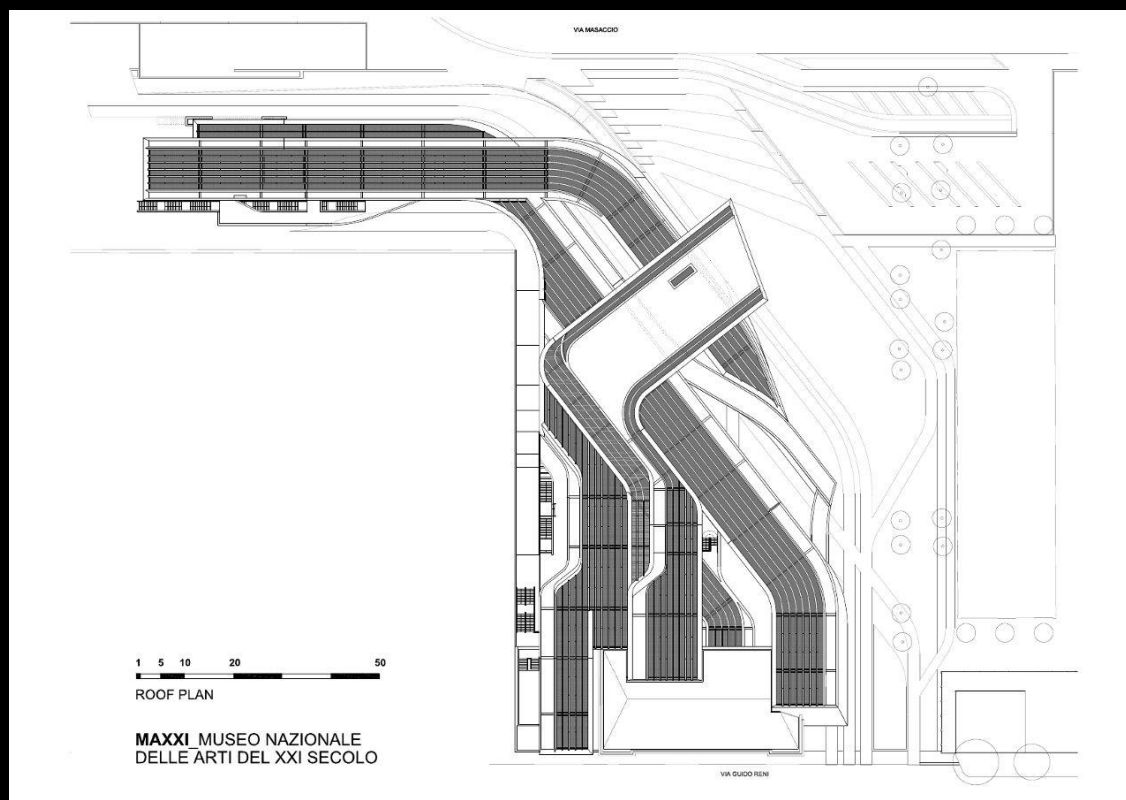
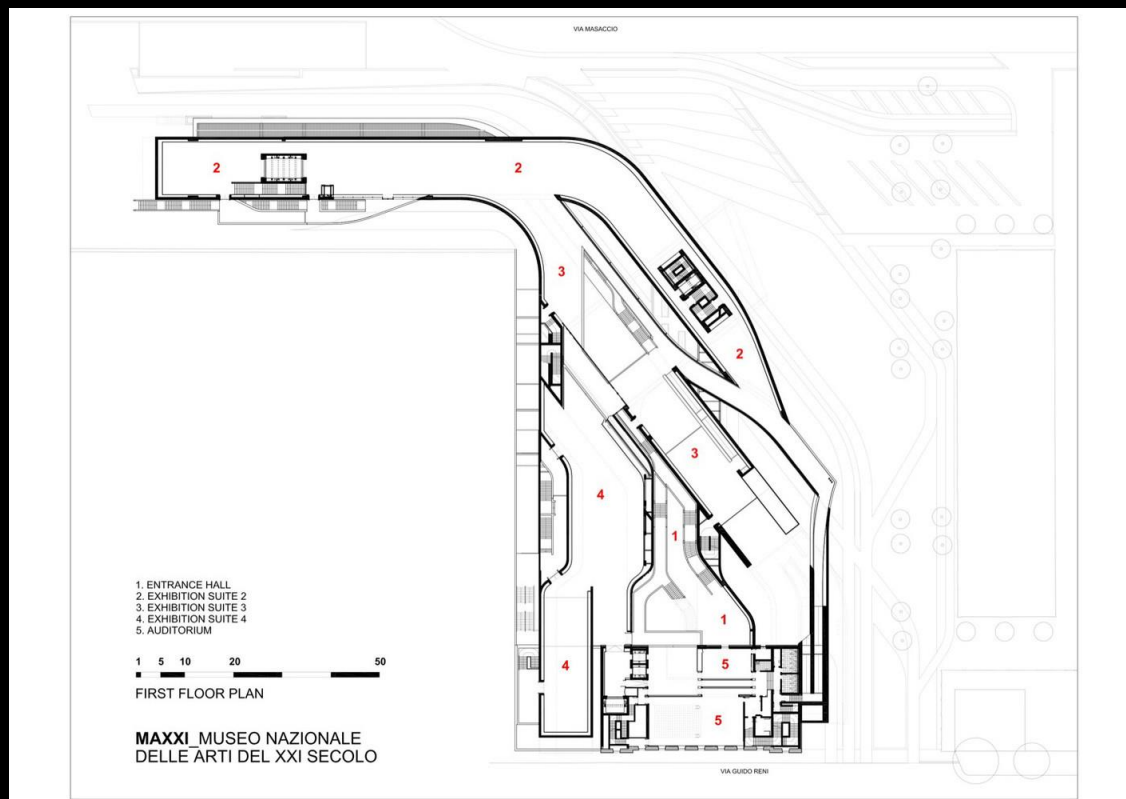




Fig. 3.3 MAXXI interior hall (source: zaha-hadid.com, <https://www.zaha-hadid.com/architecture/maxxi/>, retrieved 13/06/2021)



Fig. 3.4 Giovanni Battista Piranesi, The Drawbridge, plate 7 from *Carceri d'Invenzione*, (source: <https://artgallery.yale.edu/collections/objects/178055>, retrived 13/06/2021)

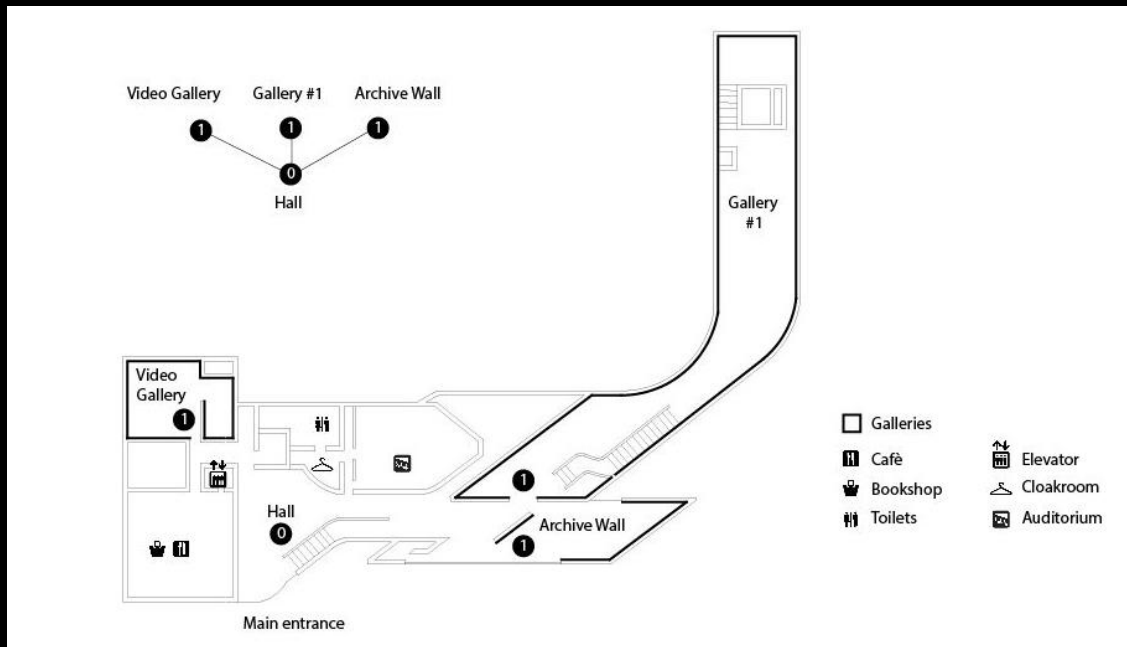


Fig. 3.5.1 Justified graph MAXXI ground floor. Architectural plan of the museum reproduced and pruned from museum blueprints to be used for the analysis.

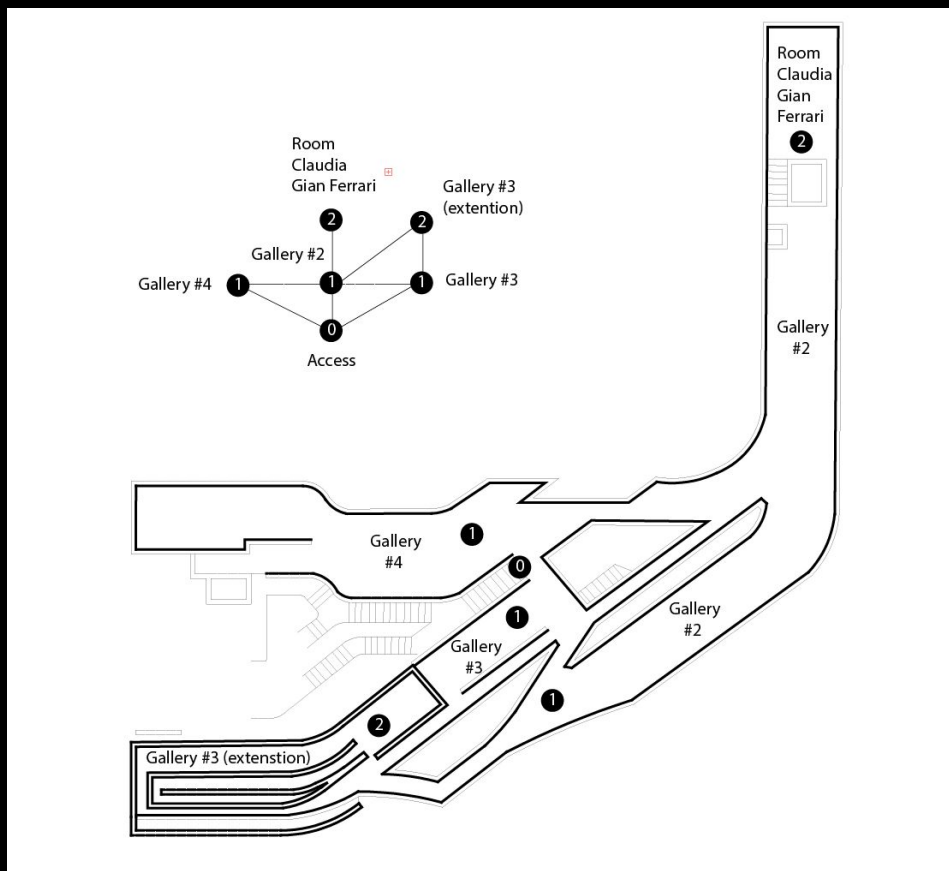


Fig. 3.5.2 Justified graph MAXXI first floor.

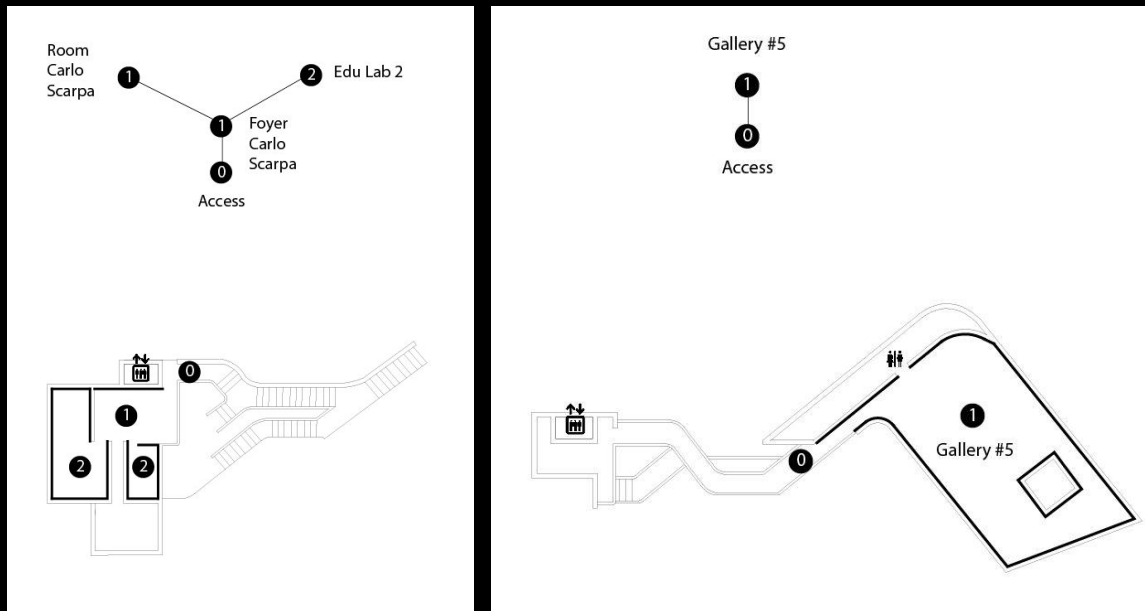


Fig. 3.5.3 Justified graph MAXXI second and third floor.

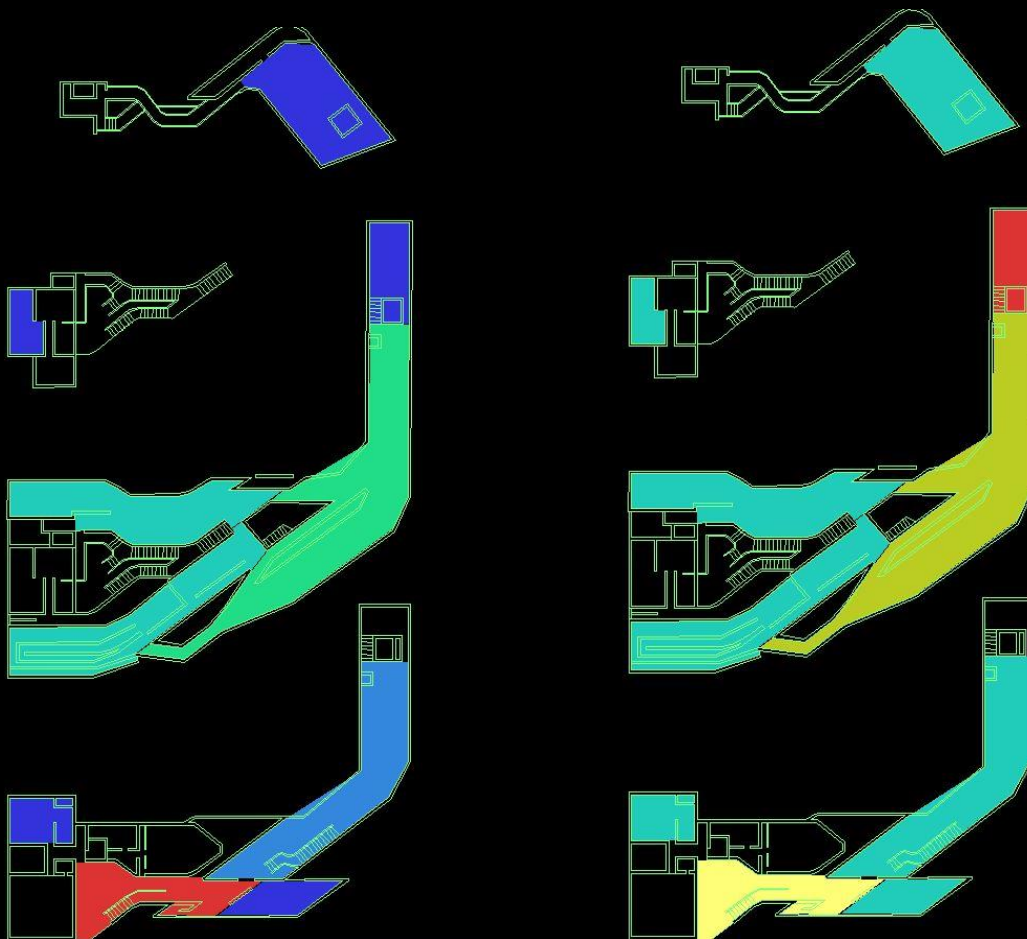


Fig. 3.6 and 3.7 Convex map (on the left) and Step Depth map with the hall as a root space (on the right). The maps have been produced using UCL Depthmap. a

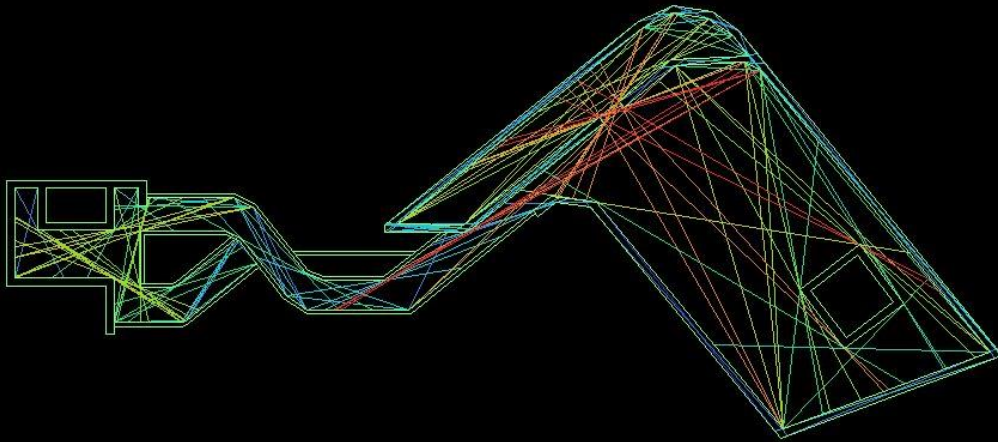


Fig. 3.8 Axial map of the the third floor of the MAXXI hosting only Gallery 5. The axial map has been produced using UCL Depthmap.

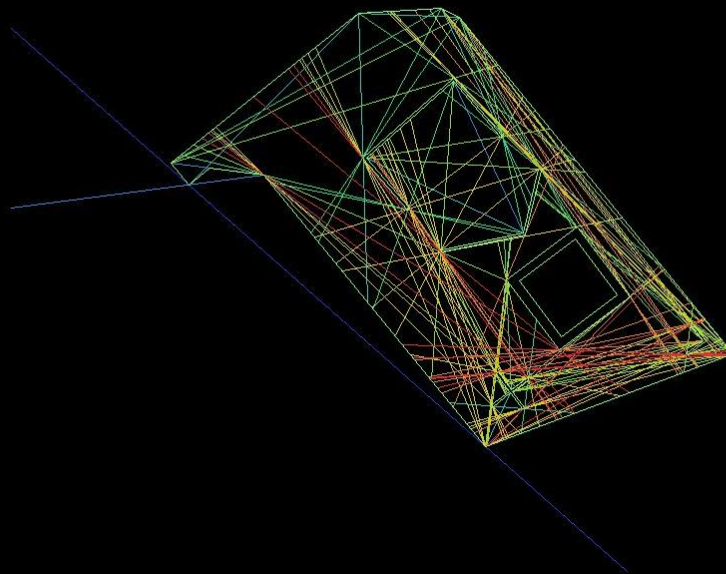


Fig. 3.9 Axial map of Gallery 5 with exhibition design. The Axial map has been produced using UCL Depthmap.



Fig. 3.10 Path from the hall (on the left) and from the third floor (on the right). Pictures have been taken during a visit to the museum in August 2020.

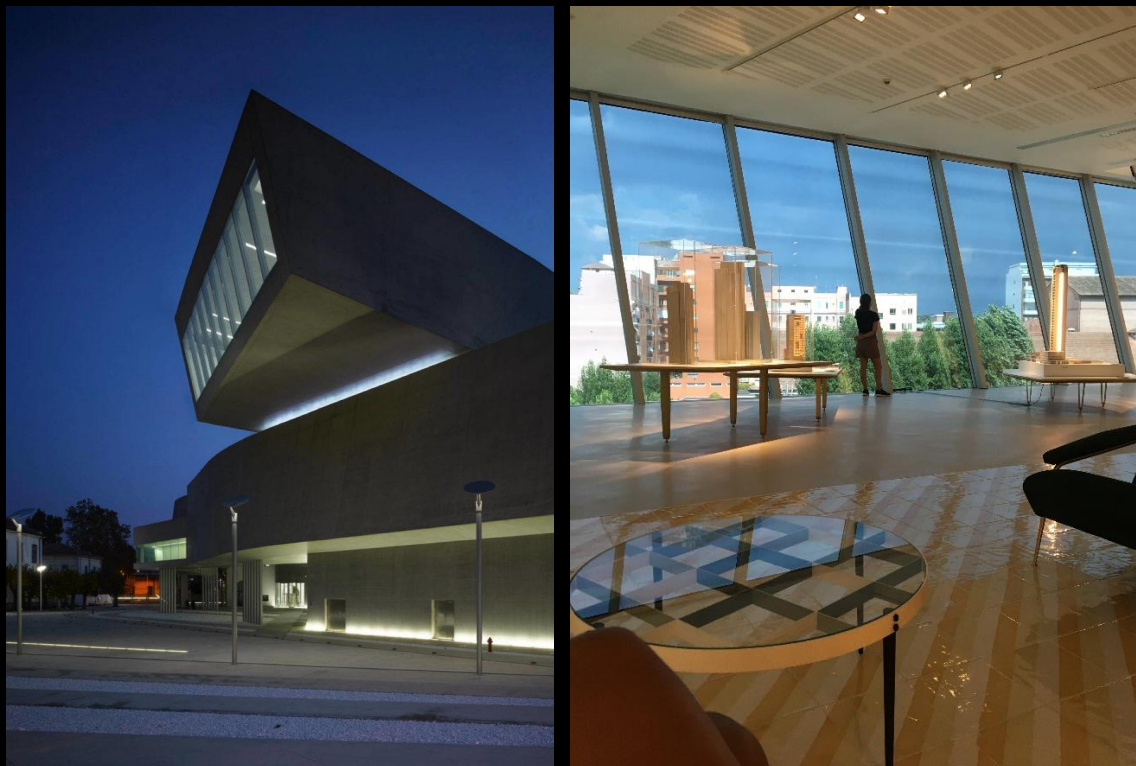


Fig. 3.11 Gallery 5 window from the outside (on the left) and from the inside (on the right). Pictures have been taken during a visit to the museum in August 2020

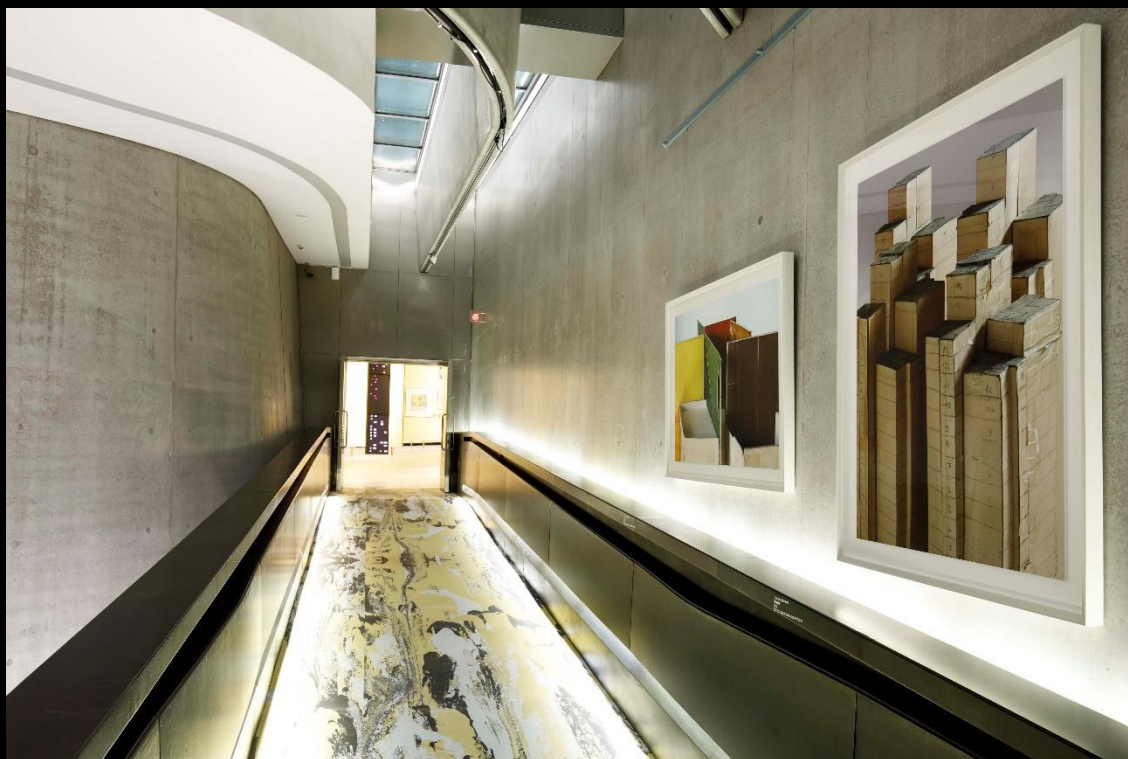


Fig. 3.12 Path conducting to Gallery 5 on the third floor. (source: <https://www.maxxi.art/en/events/gio-ponti-amare-l-architettura/>, retrieved 13/06/2021)



Fig. 3.13 Entrance to the exhibition of Gio Ponti. Pictures have been taken during a visit to the museum in August 2020.



Fig. 3.14 Living nature section of the Gio Ponti Loving Architecture exhibition at the MAXXI (source: <https://www.maxxi.art/en/events/gio-ponti-amare-l-architettura/>, retrieved 13/06/2021)

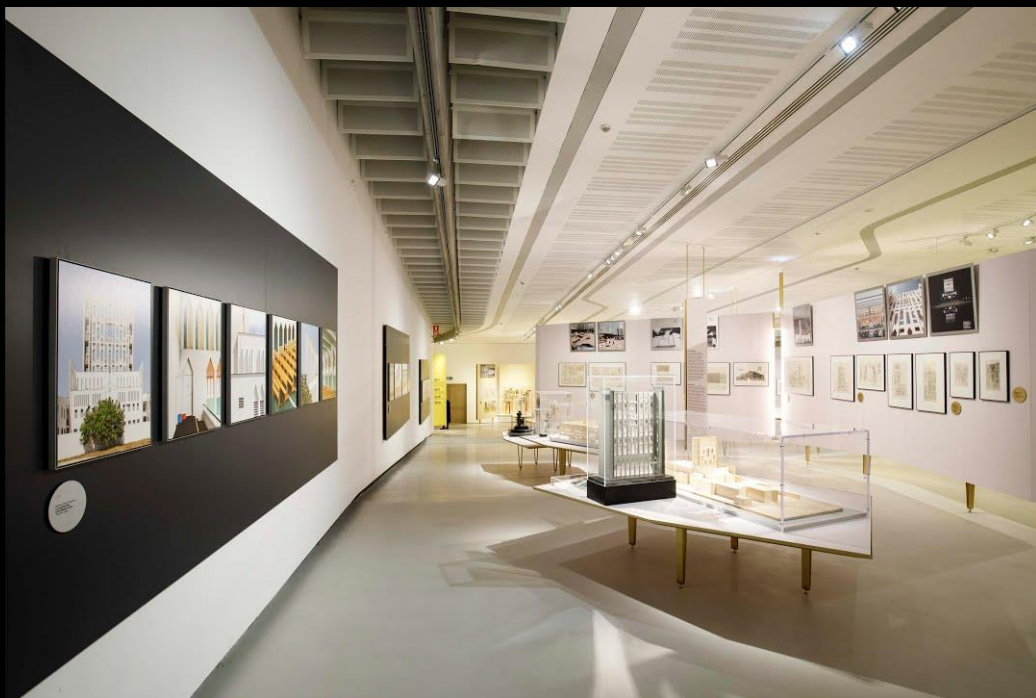


Fig. 3.15 Contemporary gazes section of the exhibition Gio Ponti Loving Architecture (source: <https://www.maxxi.art/en/events/gio-ponti-amare-l-architettura/>, retrived 13/06/2021)



Fig. 3.16 Maquette of Gio Ponti's Pirelli Tower in Milan (source: <https://www.maxxi.art/en/events/gio-ponti-amare-l-architettura/>, retrieved 13/06/2021)

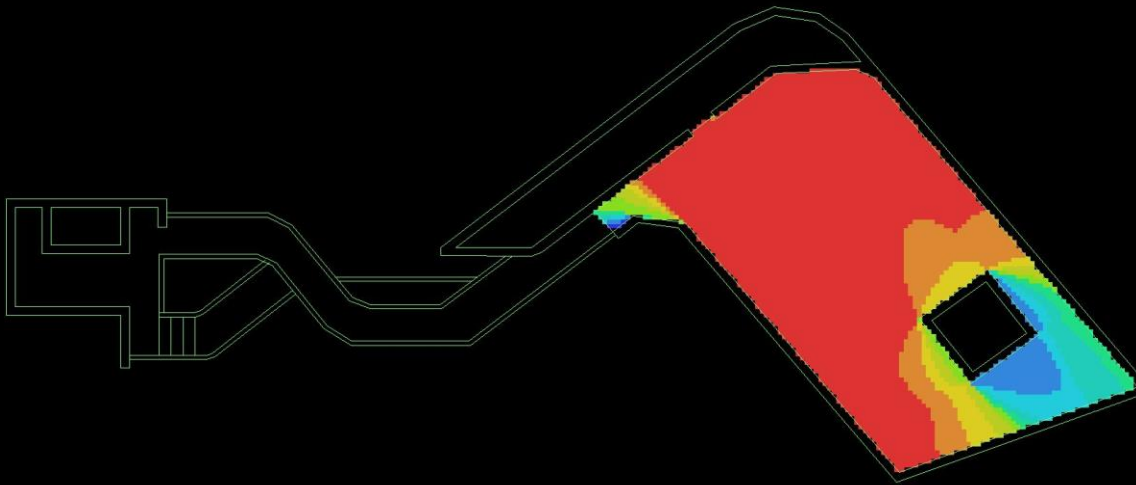


Fig. 3.17 Visibility Graph of Gallery 5 without the exhibition design. The Visibility Graph has been produced using UCL Depthmap.



Fig. 3.18. Gio Ponti home setting recreated behind the stairwell in Gallery 5 facing the window. (source: <https://www.maxxi.art/en/events/gio-ponti-amare-l-architettura/>, retrieved 13/06/2021)

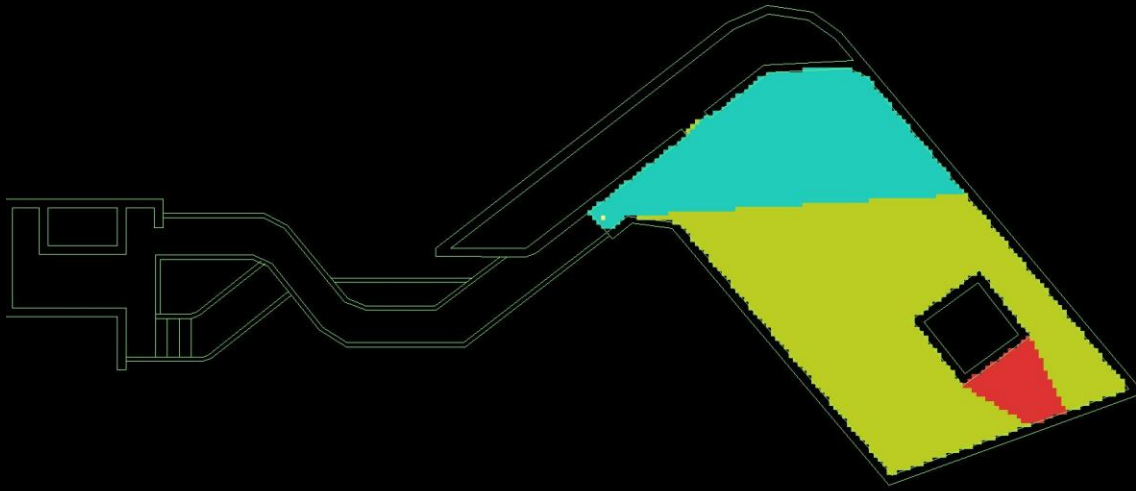


Fig. 3.19 Step Depth map from the entrance of Gallery 5 without the exhibition design. The Step Depth map has been produced using UCL Depthmap.

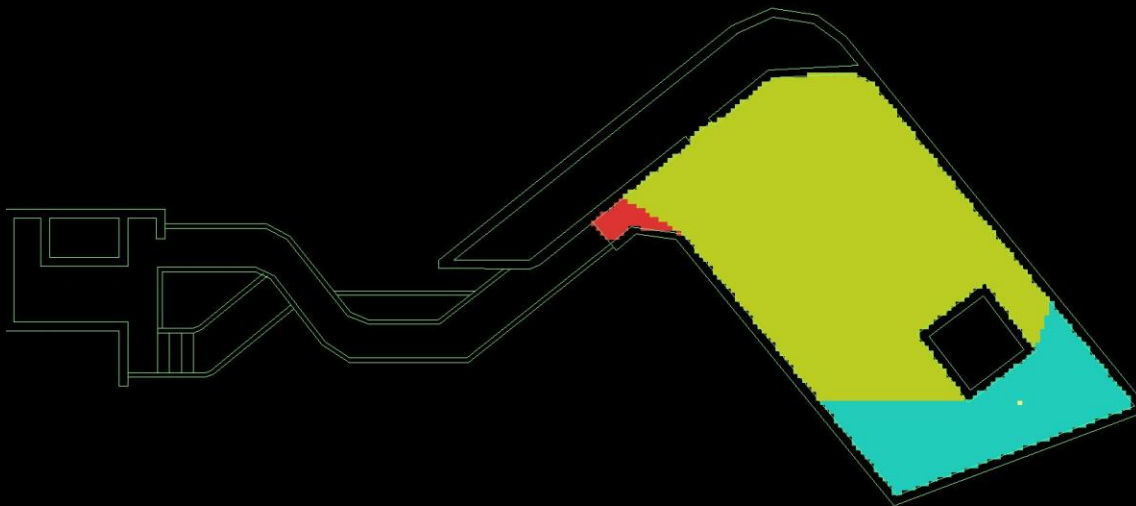


Fig. 3.20 Step Depth map from the window of Gallery 5 without the exhibition design. The Step Depth map has been produced using UCL Depthmap.

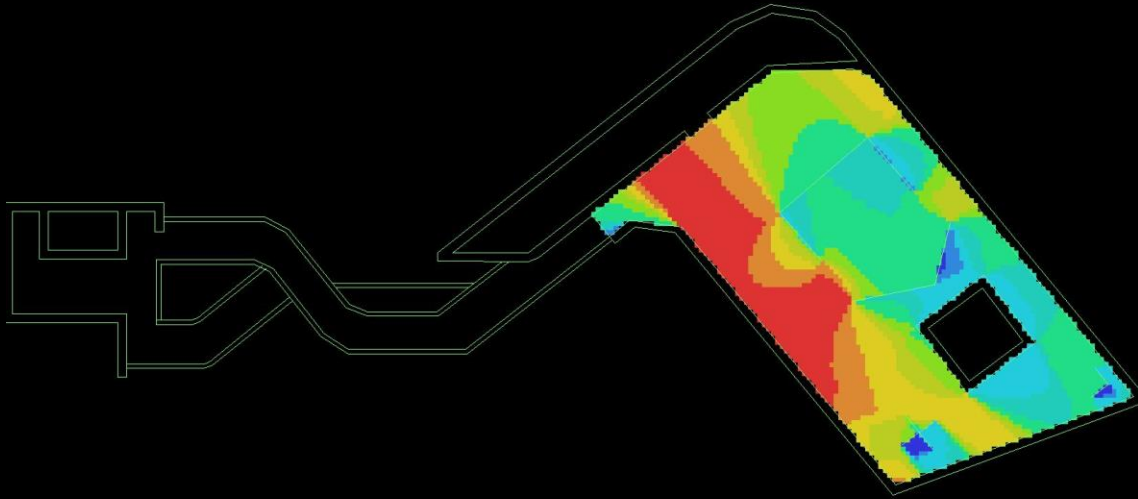


Fig. 3.21 Visibility graph of Gallery 5 with exhibition design architectural elements for the Gio Ponti Loving architecture exhibition. The visibility graph has been produced using UCL Depthmap.



Fig. 3.22 Contemporary gazes section of the exhibition Gio Ponti Loving Architecture (source: <https://www.maxxi.art/en/events/gio-ponti-amare-l-architettura/>, retrived 13/06/2021)



Fig. 3.23 Appearance of skyscraper section of the Gio Ponti Loving Architecture exhibition at the MAXXI (source: <https://www.maxxi.art/en/events/gio-ponti-amare-l-architettura/>, retrived 13/06/2021)

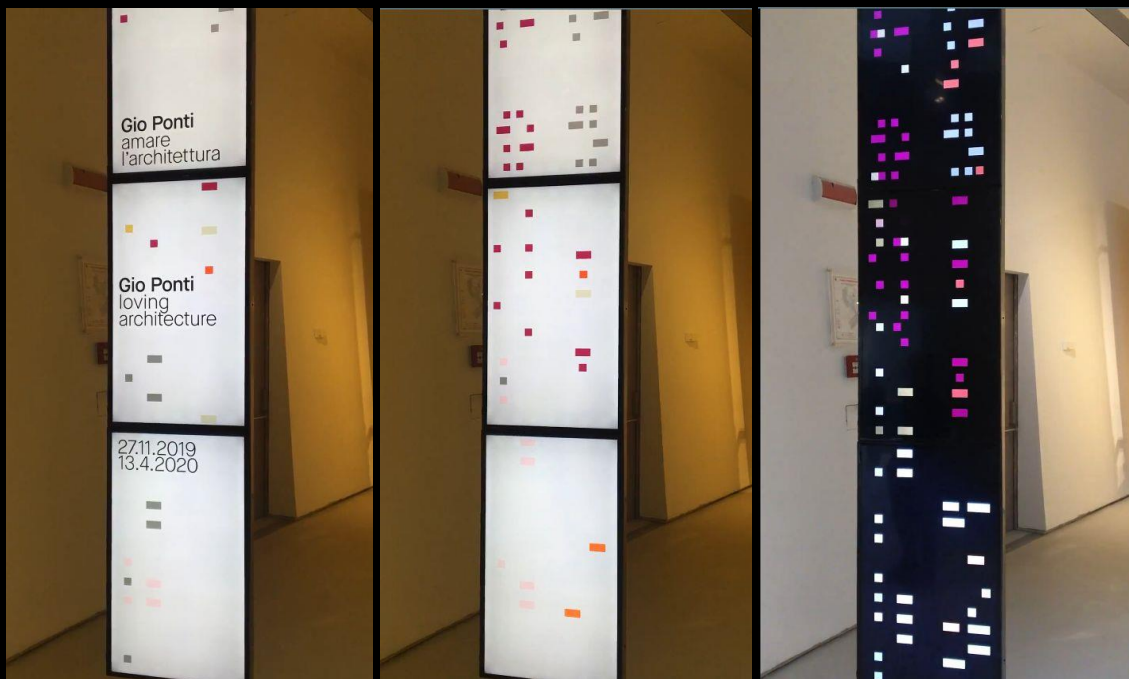


Fig. 3.24 Sign of exhibition Gio Ponti Loving Architecture at the entrance of Gallery 5. Pictures have been taken during a visit to the museum in August 2020.



Fig. 3.25 The spectacle of cities section of the Gio Ponti Loving Architecture exhibition at the MAXXI (source: <https://www.maxxi.art/en/events/gio-ponti-amare-l-architettura/>, retrived 13/06/2021)

Chapter 4: Conclusion and Discussion

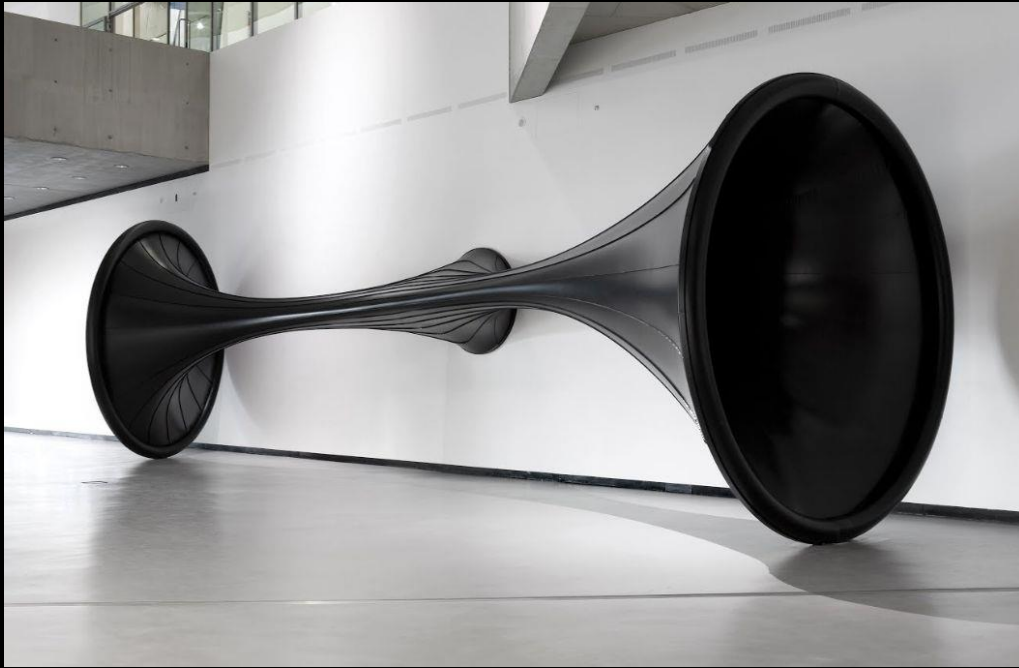


Fig. 4.1 Anish Kapoor, *Widow*, 2004, MAXXI Rome, permanent collection (source: <https://artsandculture.google.com/asset/widow-anish-kapoor/1AEDLkyRzcRRPg>, retrieved 13/06/2021)



Fig. 4.2 Giuseppe Penone, *Sculture di linfa*, 2007 MAXXI Rome, permanent collection (source: <https://artsandculture.google.com/asset/sculture-di-linfa-giuseppe-penone/JgEUbmQbWgKqow>, retrieved 13/06/2021)



Fig. 4.3 Maurizio Mochetti, Linee rette di luce nell'iperspazio curvilineo (Lines in curvilinear hyperspace), 2010
MAXXI Rome, Foyer (source: <https://artsandculture.google.com/asset/linee-rette-di-luce-nell-iperspazio-curvilineo-mochetti-maurizio/7AHM13bA39IMdw?hl=it>, retrived 13/06/2021)

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