Significant Social Space:

Connecting Circulation in Atrium Design

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Significant Social Space:
Connecting circulation in atrium design

By

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Abstract

This thesis examines visual and physical connectivity in multi-level public atrium spaces in modern public buildings, and seeks out common factors and key design principles behind their design.

Enhanced physical and visual connectivity in multi-storey public buildings can contribute appreciably to the social significance of interior public spaces. At present, connectivity is typically assessed in the design stages of buildings using two-dimensional spatial analysis theories of syntax. This thesis investigates how three-dimensional spatial analysis tools can be applied to the assessment of connectivity during the design of multi-level public atrium spaces, to provide a more accurate reflection of connectivity under built conditions. The thesis focuses on atria in public buildings such as museums, investigates prominent features and factors in their design, examines three examples of atrium buildings as case studies, and asks the question: how can multi-level atrium spaces be analysed for connectivity?

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This work in this thesis has been part of my focus for a number of years, and I owe a debt of thanks to the many people who have assisted me, talked with me, and put up with my questions in that time.

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Mostly however, I have to thank my parents, Robin and Alan, for their willingness each year to allow me to turn their painting atelier into a writing studio, where I could selfishly sit and write through the summer. Many, many thanks.

Guy Marriage,
2012.

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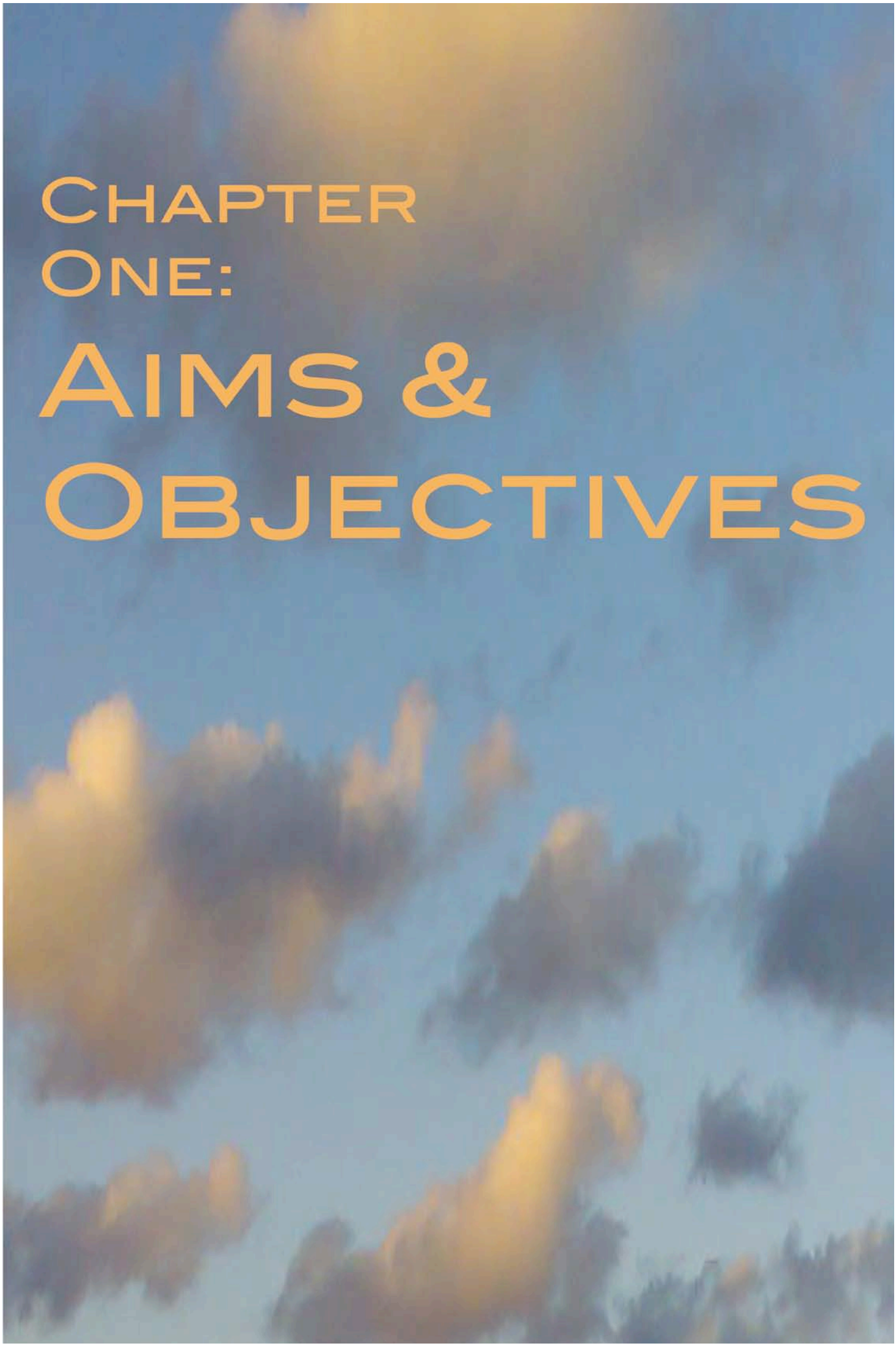

Chapter One: Aims & Objectives

Chapter 1 – Aims and Objectives

1.1 Introduction - Architecture and Space

Architecture is two-fold: the built fabric, and the space that the fabric encloses. While the visible and physical aspects of architecture, namely that which is built, can be described and understood relatively easily, it is more difficult to grasp and describe the implications of that which is felt and heard but unseen: the space enclosed. Bill Hillier notes that:

> Space is, however, a more inherently difficult topic than physical form, for two reasons. First, space is vacancy rather than thing, so even its bodily nature is not obvious, and cannot be taken for granted in the way that we think we can take objects for granted. [...] Second, related spaces, almost by definition, cannot be seen all at once, but require movement from one to another to experience the whole.[1]

Atrium Space

The research area of this thesis is on one type of enclosed space in buildings that requires movement to experience the whole: the public atrium. In particular, this research examines pedestrian circulation within the atria spaces enclosed in multi-level public buildings, and the physical and visual connections into and across these atrium spaces. The design and configuration of these connections within an atrium have a significant effect on the social relationships of the users within that space.

> A building then becomes socially significant over and above its bodily functions in two ways: first by elaborating spaces into workable patterns to generate and constrain some socially sanctioned - and therefore normative - pattern of encounter and avoidance, and second by elaborating physical forms and surfaces into patterns through which culturally or aesthetically sanctioned identities are expressed.[2]

Hillier's comments emphasise that the elaboration of space generates important social encounter patterns. A space that encourages encounters, by means of increasing spatial activity and greater circulatory flow, will grow in terms of social significance. As such, an atrium space that encourages this interaction will become a significant social space.

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[1] Hillier, *Space is the Machine*, 18.

[2] Hillier, *Space is the Machine*, 16. The phrase "socially significant" is used here in relation to buildings and space: and it has been seized on as an explanation of what this thesis seeks to find. As a result, it is from this phrase that I have taken the title of my thesis.

1.2 Thesis Problem: Atrium Design

This research project stems from an awareness that central atrium spaces can play an important role in modern public building design. Some atria are well designed and work well as places for human interaction, while other atria are less successful. This thesis investigates connectivity within atrium spaces, examining methods used for assessing connectivity within those spaces. While traditional 2-D tools may have worked reasonably well in low-rise buildings, high-rise buildings pose significantly different variables that often make 2-D tools inaccurate in assessing connectivity. This thesis proposes new means of assessment that implicate 3-D conditions.

There has been considerable work undertaken on the urban design of spaces, with early investigation by William Whyte[3] establishing principles of sunlight access, people looking at other people, street corners, width and amount of seating, the edges of spaces etc and overall: that people tend to sit where there are places to sit. More recently, architects such as Jan Gehl have been given prominence in the field of making 'good spaces'. However there are few such rules regarding what makes an atrium space 'good' or 'successful' or how they can be made to 'work' coherently. These attributes 'good' and 'successful' are subjective qualities, not objectively assessable. Whyte has some advice regarding the siting of Plazas. Regardless, an atrium is a different type of space than a 'place' with many different attributes.

Exactly why do some atrium spaces 'work' well, and others do not? Just as there are key guidelines for the design of buildings, there must also be important points to consider when designing their internal atrium spaces. The utilisation of atria spaces as places for circulation and socialisation is a key to that success.

Atria in public buildings

Since the late 1960s, multi-level atrium spaces have become a common, almost obligatory feature at the core of modern public buildings, especially in Europe and North America.[4] This focus on creating atria within public buildings is less pronounced in New Zealand than in larger foreign countries; primarily because there is a far smaller amount of public buildings which are constructed in New Zealand. Christchurch has a recently completed Art Gallery where the foyer features a small (two storey high) atrium space, side lit, as the prime architectural feature or expression of the new gallery. Dunedin's art gallery does not feature an atrium. In Auckland, there are two prime cultural buildings: the Auckland War Memorial Museum and the Auckland Art Gallery. The Auckland

[3] Whyte, *The Social Life of Small Urban Spaces.*
[4] In 1967, the Regency Hyatt Atlanta's new 'atrium' design started a renewed focus on atria as design features in hotels and other buildings.

Museum has recently infilled their former atrium, and the Art Gallery was still under reconstruction at time of writing. In Wellington, there is Te Papa, with a large atrium – or rather, several atria.

Exact reasons why there is an increasing use of atria have not been widely discussed within architectural circles, although many reasons could be advanced as to why this is so. Conservative thinking (such as that of quantity surveyors) of maximising architectural coverage of a site equates to a view of an atrium as 'wasting' space, yet the increased use of atria invites recognition that 'wasted' atrium space has other advantages. Is there recognition of the value of spatial excitement within daring architecture? Can a square metre rate be placed on the value of an atrium? Or is it more a means of allowing logical wayfinding for users? Is the enclosing of a large volume of air beneath a skylight acting as a social attractor, increasing value that way, or is it merely as a means of moving people to a higher floor for retail purposes?

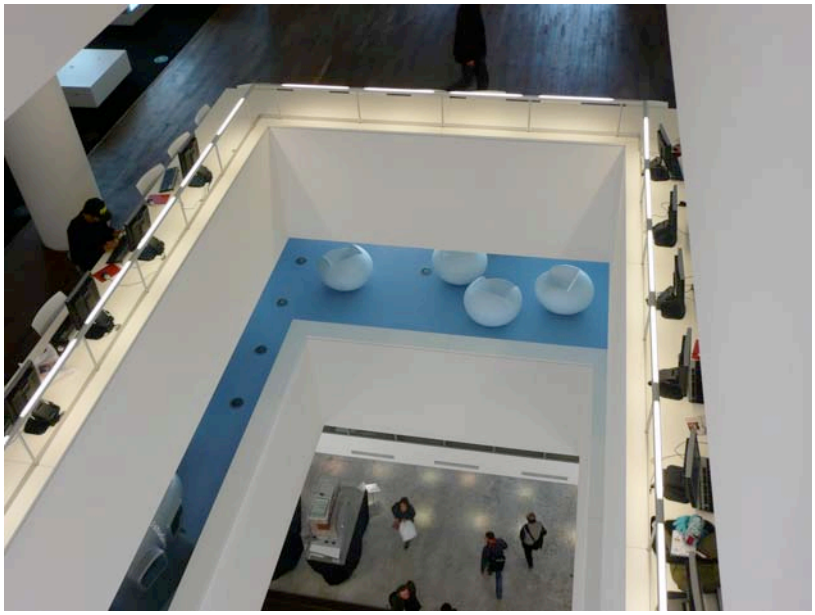

Figure 1.1 Amsterdam public library, View down through atrium, piercing through all six floors of the building. Although relatively small and thin, the atrium functions as a spatial orienting device, as well as enhancing sociality through the building. *Source: author.*

The answers are complex. While atrium space is 'unused' mostly, there is without doubt an increase in value to a building with an atrium space; while developers may typically want to obtain maximum floor area, the value per square meter of floor area increases with an atrium. While some buildings with atria are more successful than others (impacting rentable value), the means to assess the social impact of those atria has not been determined. There is a need **to accurately assess levels of connectivity in high-rise atrium buildings** during the design stages to ensure greater understanding of spatial forces. This thesis assesses current approaches, and proposes a better approach to this assessment.

Beyond design commentaries, the increasing use of atria has not been widely studied in recent architectural literature, outside of discussion such as safety-related fire egress issues.[5] The design of multi-level public atria has been little investigated as an architectural or spatial phenomenon. In particular, the use of atrium spaces as a design feature within New Zealand buildings is only rarely employed: it is not yet a common part of the New Zealand architectural heritage. New Zealand is a very young country by world standards and was the last major landmass on the planet to be settled by humankind.[6] Public architecture is at an early stage in comparison with other countries' years of experience, and our population is exceedingly small by comparison with most other countries. The financial basis for building large numbers of public buildings simply does not exist. It is no wonder therefore that New Zealand's public buildings are relatively small, comparitively simple, and are largely spatially unsophisticated. Guidance and understanding of what makes an atrium work may increase their adoption and ensure design success within New Zealand. Although in a country with a small population, Auckland city in particular is very fast growing, and will need to densify to avoid stagnation. More high-rise buildings are likely: more adroit manipulation of space in both the public and private realm will be required.

Connections within atria

Atrium spaces are primarily places for people: Katherine Shum argues that the atrium is a place for space.[7] This thesis has the underlying assumption that movement through the atrium is a key spatial design feature of the atrium, and positively affects understanding of the building when visible and physical connections are available at the atrium. Recent means of analysis back this up for buildings around the world, and this is discussed further in a later chapter.

Sophia Psarra notes that, regarding the atrium in New York's MoMA (Museum of Modern Art): "The visibility analysis of all floors shows that the atrium dominates the experience when moving extensively throughout the building."[8] This may seem obvious; however to date there has been little spacific analysis of the role of visual and physical connectivity associated with atrium design. This demands further analysis in order to aid designers' understanding of factors contributing to successful design.

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[5] Harrison, *Smoke Control in Atrium Buildings: A Study of the Thermal Spill Plume.*
[6] Western civilisation was also even later to arrive in New Zealand. Cities such as New York were established in 1624, Los Angeles was founded in 1781, and even a modern city like Vancouver was established in 1824. By comparison, New Zealand cities generally date only from around the signing of the Treaty of Waitangi in 1840.
[7] Shum, *The Atrium – a Place for Space*.
[8] Psarra, et al., *Tracing the Modern.*

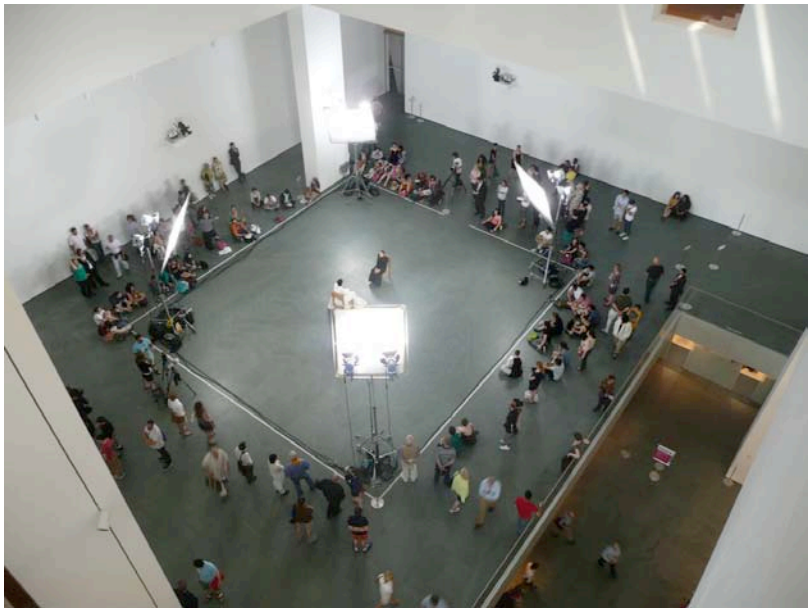

Figure 1.2 Metropolitan Museum of Art, New York. View down into main atrium space during performance: views are direct from one exhibition space to at least two others, and visual connections to other circulatory spaces also: views of the space are used to orientate and reconnect the viewer.
Source: author (2011).

The physical and visual connections made into and across the atrium are often a key part of building design. Atrium design is a means to enhance and the ability to control the flow of people into and through the building and therefore also the way that people use the building. This thesis seeks to examine these and other issues regarding atrium design, in particular it asks: what roles does visual and physical connectivity play in the use of multi-level, socially active atrium spaces in modern public buildings? These roles encompass:

- Means to enhance the way that people use the building
- Ability to control the flow of people
- How visual connectivity affects use of socially active spaces
- Increasing value by enhancing visual connections to other parts of the building
- Perceptions of the number of other customers
- Perceived levels of excitement and new experience
- Awareness of levels of lighting available
- Focus on opportunities to explore and to connect

1.3 Aims and Intent

A primary aim of this research project is a new application of contemporary technology to a contemporary problem in New Zealand. The complex, issue of floor area value within atria buildings needs to be carefully examined; the thesis argues that three dimensional (3-D) tools now available can better reflect vertical attributes as well as attributes involving 3-D perception. It compares three multi-level atria in order to ascertain factors used in the design and analysis of these spaces. It also compares analysis methods to ascertain how a 3-D space such as an atrium can be analysed. The reason this thesis is focused on the visual and physical (instead of also including the olfactory and aural) is that it tests 3-D digital analytical tools that are best interpreted in relation to physical and visual relationships and patterns.

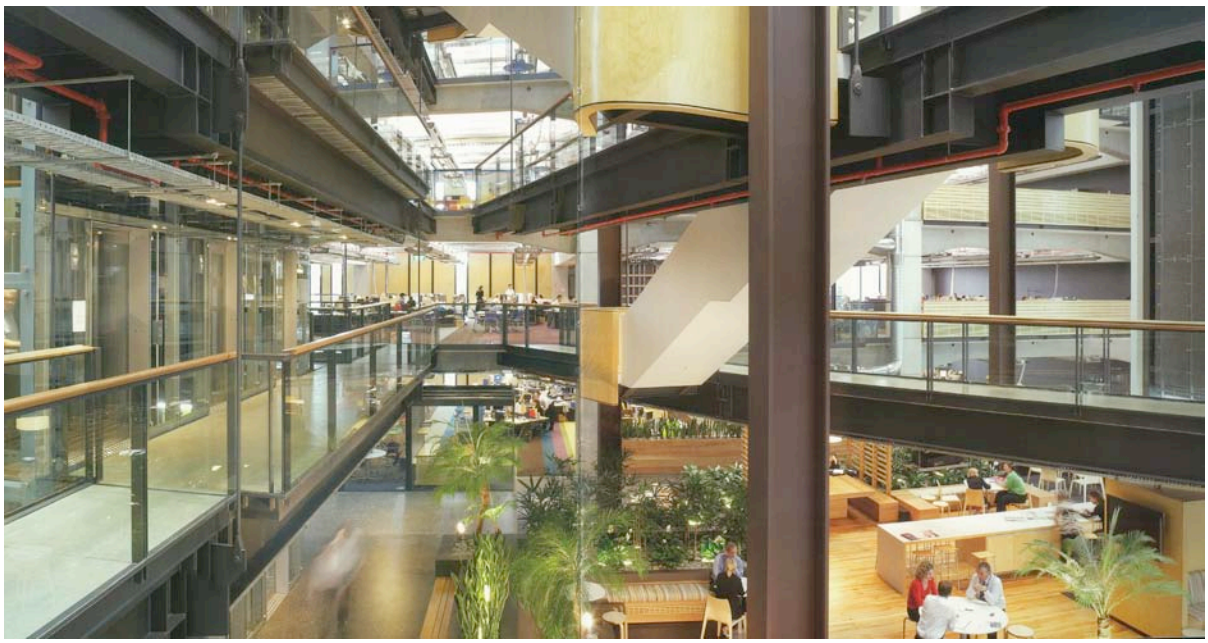

Figure 1.3 Sovereign House, Takapuna, 2009. View across office atrium in insurance building. Unfortunately this exciting atrium space belongs to a private insurance corporation and is unable to be accessed by the public. Therefore, this atrium is not examined as a case study as as it is not a public place.
Architects: BVN / Jasmax *Source: ASB / Sovereign*

Specifically, this thesis deals with connections within atrium voids and with the elements that go towards creating atria that form active spaces for people. It discusses principles concerning these atrium space design issues and ways for analysing their connections to other parts of the building. Hillier noted that:

> Spatial patterns in buildings also arise as elaborations on primitive logical emergents from the physical act of building. ...The origins of relational schemes of space lie somewhere between the ordering capacities of the mind and the spatial ordering inherent in the ways in which social relationships are

> realised in space. ...The passage from the simple space to a configuration of space is also the passage from the visible to the intelligible.[9]

Hillier's observation that movement from one space to another is a key means of experiencing space itself is a key part of the focus of this thesis – that connection and therefore circulation through space is a key ingredient of the successful functioning of the space itself. The connection can be purely visual – the ability to see from one point in space to another, making contact by eye: visual connectivity. The visual dimension is a key point to an understanding of spatial characteristics.

Physical connectivity, by comparison, refers to an actual walking route: a path enabling movement from one point to another. Physical connectivity is movement, and movement is key to the experiencing of space. There are other means of sensory connectivity as well, such as olfactory or aural connections, but in this research, connectivity is used primarily in the sense of the visual and physical connections that humans can establish across a space: seeing and moving. The intent of this thesis therefore, is to investigate physical and virtual connectivity within public atrium spaces in buildings, and to assess how these spaces can be analysed for connectivity.

1.4 Research Question

At present, spatial connectivity is typically assessed in the design stages of buildings using two-dimensional spatial analysis theories of syntax. The thesis seeks to analyse three-dimensional spatial theories within atrium spaces, by addressing the following research question: Can new three-dimensional spatial analysis tools be applied to the assessment of connectivity during the design of multi-level public atrium spaces, to provide a more accurate reflection of connectivity under built conditions? In summary therefore:

How can multi-level atrium spaces be analysed for connectivity?

The research looks in particular at the use of atrium spaces as venues for both visual and physical connectors between adjoining spaces. These connections permit atria to hold a special importance in building design. The thesis considers the internal spatial environment as perceived by the eye, and the connections within that spatial environment that can be followed on foot.

---

[9] Hillier, *Space is the Machine*, 18.

1.5 Objectives - Atria research

The key focus of the thesis is that atrium design needs to be understood as a relational and configurational consideration of physical space. It considers that the internal spatial organization around an atrium is central to the performance and good functioning of the building. The planning of the atrium relies upon careful setout of the circulation within and across the atrium, from one floor to another, and an awareness of the differences between physical and visual connections that can be made. In order to examine these physical and visual connections (their 'connectivity'), and to facilitate this investigation, a number of objectives have been set:

Objective 1 – Analyse atrium features generally and identify key attributes that contribute to enhanced social connectivity in atrium buildings

Objective 2 – Examine traditional 2-D spatial theory with regard to connectivity and sociability

Objective 3 – Establish 3-D digital analysis methods that can be applied to more accurately assess atria connectivity

Objective 4 – Test relevant 3-D digital spatial analysis methods not normally applied to atria connectivity, with regard to their ability to provide more accurate assessment of connectivity

1.6 Research Methodology

There has been much analysis of space undertaken in the 20th and early 21st Centuries, with a broad interpretation of the word 'space'. However, while different spatial theories have been put forward, no one particular spatial theory has proved predominant and different spatial theories continue to coexist concurrently. Little attention has been focused on the role of the atrium as a spatial element, and there does not appear to be a body of knowledge in evidence regarding atrium spatiality. Research into the field of study on physical connectivity within atrium spaces is therefore wide open to exploration, discussion and subsequent refinement.

The primary research method utilised in this study is a literary review of existing research methods on space. Live testing in atria and interviewing or tracking of users of atria has not been undertaken for this exercise, due in part to the selection of international examples of case studies. Research on this thesis has concentrated on

the examination of analysis methods within each of three separate Case Studies, following in the methods set out by Wang and Groat.[10]

This thesis research is focused toward the public atrium space, a building feature that can be viewed as being both inside and outside. The atrium can be thought of, and thereby analysed as either an indoor or an outdoor space. Investigation and analysis of interior space is often treated differently from the analysis of exterior space. These methods may not be just from the field of architecture or from that of interior architecture, but also the field of urban design as well: ie the physicality and materiality of the buildings that surround the space concerned. A building can be considered as a collection of rooms, arranged in a particular sequence. A city can be considered as a collection of buildings, arrayed in an expanse of indifferent space, or as a series of spaces divided and channeled into forms by extant buildings. An atrium falls curiously into both categories, and invites further exploration into this nature of the inbetween.

The research looks broadly at the nature of the atrium, and its functions and features. There are several key types of atria, discussed in chapter 2. This thesis examines three principle types of atria as case studies, in chapter 5. Different methods of spatial analysis are examined for relevance in the study of visual and physical connectivity within atria. Promising methods are utilised to examine three case studies of buildings with atria, and results are discussed with regard to their connectivity. Ultimately, this study can contribute towards understanding of economic viability of atrium spaces, although this is not an aspect covered in depth here.The key focus of the thesis is on issues of connectivity within multi-level atrium spaces, and how that helps contribute to the user's experience of the atrium space concerned.

[10] Wang and Groat, *Architectural Research Methods,* 346.

1.7 Thesis structure

Chapter One – Introduction to subject, and Research Outline

The discussion of the relationship between atria and circulation will be developed through the following structure (refer figure 1.4), where this first chapter introduces the subject and states the research aims.

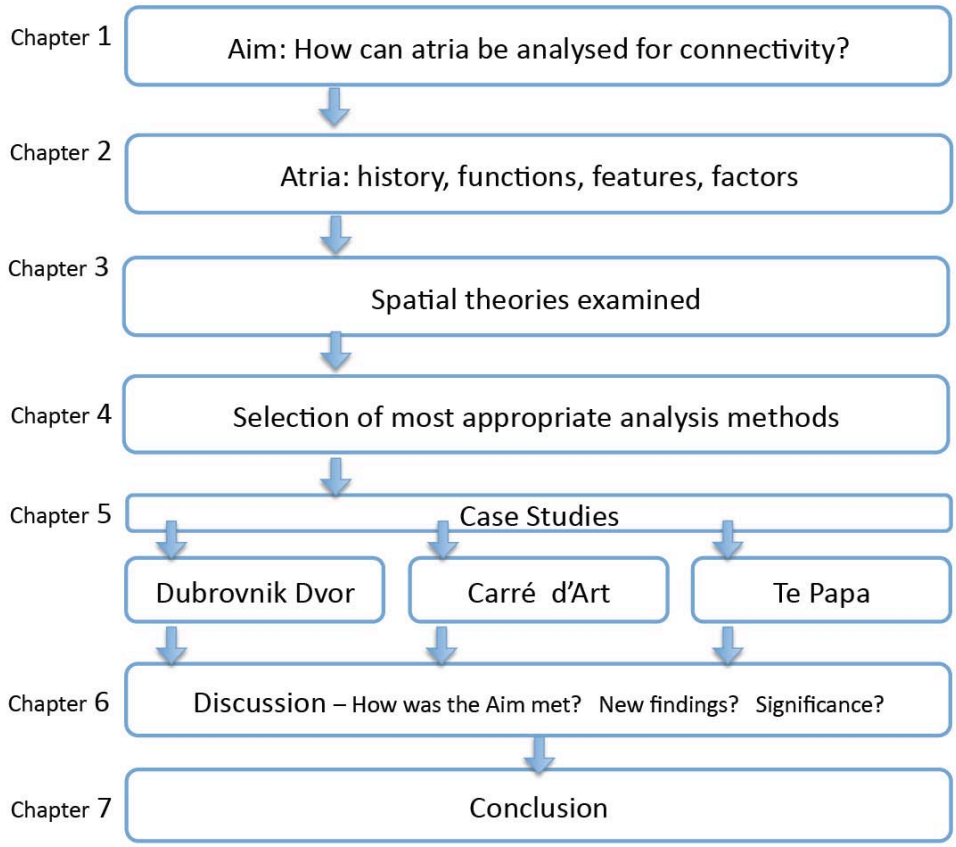

Figure 1.4 Thesis structure diagram. Each chapter will have a similar diagram at the start that covers the scope of research within that chapter.

Chapter Two - Atrium Features

This chapter starts by examining the history of the atrium, and its evolving role in architecture. Figure 1.4 shows that the key factor of chapter 2 is to examine the many varied aspects of atria that could play a part in evaluating their design and use. The chapter reviews the evolution of the atrium through history from a number of disparate sources, and how their different origins converge on a more common, modern building type – the public atrium building. It looks closely at features associated with atrium design and atrium factors: the means by which features are integrated, and maximised / minimised into the overall building design. It concludes by noting that connectivity, both visual and physical (ie pedestrian circulation), is an often overlooked element in atrium design, and proposes that this should actually be one of the key design principles of atrium design.

Chapter Three - Theories on Space

This chapter reviews relevant literature regarding space from a variety of disciplines, focusing on a search for connectivity. The chapter is structured chronologically around recent themes of architectural spatial theory, as well as discussion on recent emerging spatial theories. While confined mainly to studies of modern spatial theories it also examines literature relating directly to atria, and focuses attention onto methods of space syntax. The review concludes that there are many possible viewpoints on the subject of space, but no one spatial conception dominates current architectural literature. Specific theorists are selected on the basis of potential understanding of connectivity.

Chapter Four – Selected methods

In this chapter the research aim was to look at the space analysis tools available, and assess which tools would be the most appropriate to use in relation to identifying connectivity. Four key tools were selected. The growing field of space syntax emerges as the most appropriate to this study, and concentrates on isovist fields as the most likely to be a suitable method. Recent work on offshoots of syntactic analysis are discussed for relevance and future possible research directions. This chapter also incorporates attempts to recreate work pioneered by Luigi Moretti in the 1950s.

Chapter Five - Case Studies

Chapter Five examines three key atrium buildings which rely heavily on pedestrian circulation and connections. So that effects can also be observed by others, only public buildings were examined as case studies. No private office buildings were used. Case studies were chosen which relate to large scale atria in public buildings such as museums, galleries, and libraries. These case studies were identified from wide temporal and geographical spans to include a historical European example, a critically acclaimed contemporary European atrium, and a large-scale local example which includes large atria and many means of circulation. All examples have been subject to field visits so personal experience has significantly impacted upon my assessments of the atria operation and relative success. Figure 1.4 shows the chapter breakdown into case studies.

The first case study is that of an ancient courtyard fortress, palace and civic building now turned into a museum and performance venue: the Dubrovacki Dvor, or Rector's Palace in Dubrovnik, Croatia (architects Onofrio de la Cava, c1442, and Michelozzo di Bartolommeo, completed 1464). This atrium space was the initial source of enquiry into the whole subject, posing the initial research questions regarding what makes an atrium space so

good. The atrium space within this building is well-proportioned and feels engaging, welcoming, and encourages exploration. The case study will attempt to unravel what some of these reasons may be.

The second space examined is in a modern building: the Carré d'Art in Nimes (architects Foster and Partners, completed 1993).[11] This building has attracted critical acclaim due to its successful siting next to an ancient Roman temple, as well as for its light-filled interior atrium space with glazed central stairs. The Carré d'Art is a mediatheque: a public library, a video research environment, a venue for public information. Inside the building spatial complexity and connectivity achieve strong interaction between floors, as well as interaction between inside and outside. The Carré is an award-winning public atrium building, where the central space is well-resolved and effortlessly connects the many floors.[12]

The third and final case study is a New Zealand public building: a modern, public museum building that is, somehow, perhaps not as successful in its use of space in the atrium: Te Papa Tongarewa, the Museum of New Zealand (architects Jasmax, completed 1998). The building design has attracted varied responses, with its external appearance and its internal way-finding in particular subject to explicit negative criticism. The case study examination will examine connectivity within the atria of Te Papa to see if there are reasons of connectivity, or lack of, that may be .

These three case studies are analysed with the use of the four selected methods, including basic space syntax techniques. Recent computer modeling techniques for spatial analysis have not been utilised to any great extent: the search is for a broad basis direction for potential future research in this area.

Chapter Six – Discussion of Case Studies

In this chapter the findings of the case study analyses are evaluated, in relation to identifying how well connectivity was identified. The use of space syntax techniques is discussed, and possible further investigative avenues are laid out. While the space syntax analysis of these spaces in the case studies is at a basic level, it nonetheless brings out the obvious salient points regarding physical and visible connections in a space such as an atrium.

[11] Client: Ville de Nimes. Consultants: Ove Arup and Partners / OTH Mediterranee.
[12] Awards include Veronica Rudge Green Prize in Urban Design; 'Interiors' (USA) Award.

Chapter 7 – Conclusion

Lastly, Chapter Seven discusses the results and draws final conclusions. It makes a statement on the significance of the findings, and shows how both visual connectivity and physical connectivity may be analysed within multi-level atria.

Chapter Two: Atrium Factors

Chapter 2 - Atrium factors

2.1 Introduction

This chapter looks specifically at the architectural features common to atria and how spatial and social connectivity is engaged by atria. It relates specifically to Objective 1 of this research project: **analyse atrium features generally and identify key attributes that contribute to enhanced social connectivity in atrium buildings.** The chapter structure diagram, shown below in figure 2.1, shows the complexity and the limits of the analysis shown. As a means of focusing the thesis investigation, only atria within public buildings are examined. The diagram divides atria into three distinct areas: function, factors, and features.

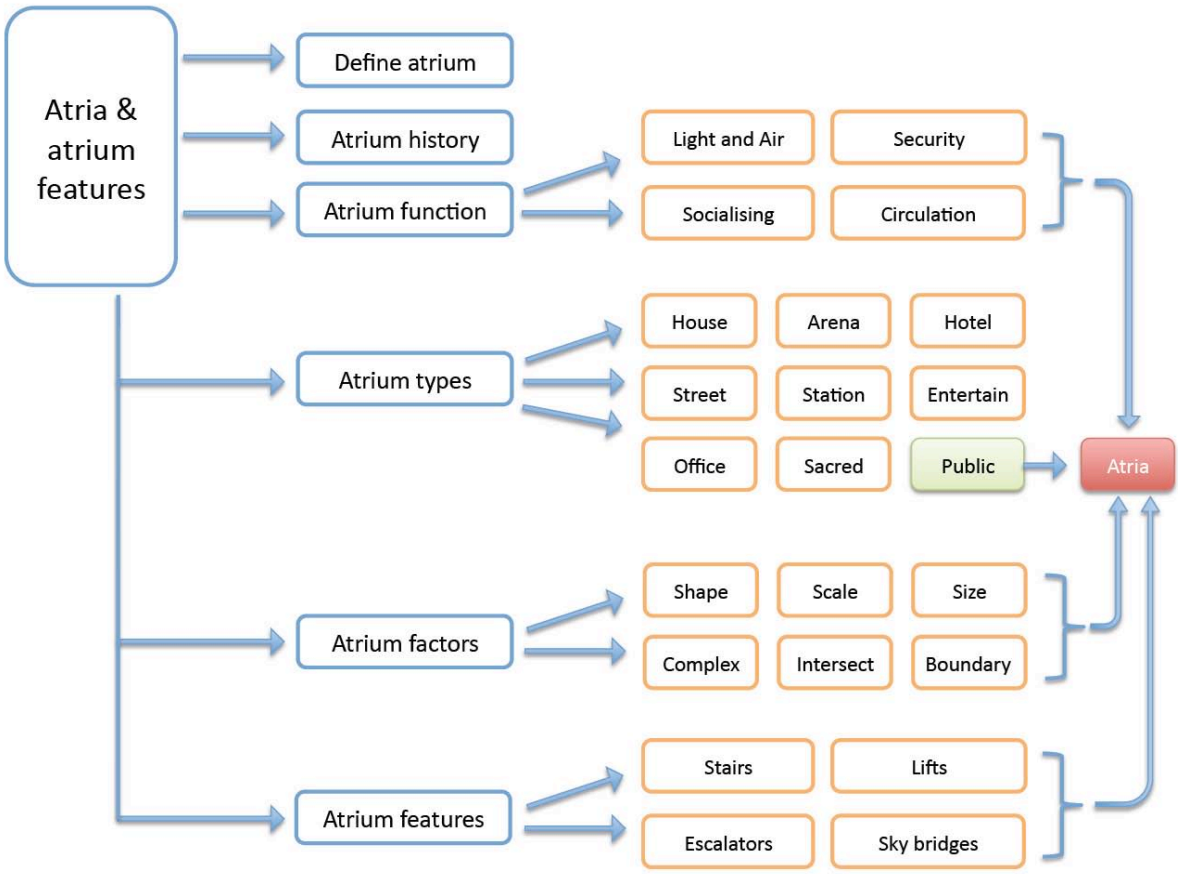

Figure 2.1 Chapter 2 structure diagram

In this chapter the aim is to briefly review the origin, history, and development of the atrium, and to examine traditional functions, types, factors, and features within the physical construction of an atrium. Atria have been selected as a key example of a special kind of space: one neither fully inside, nor fully outside, and one that has a special relationship with multi-story buildings in the way that other spaces do not. The relative visual prominence of the circulatory systems within an atrium will be examined. The research focuses on how the

different factors help facilitate the physical and visual connectivity within the atrium. This chapter does not attempt to undertake a complete history of the atrium, as works by Bednar, Saxon, and Shum have already covered that ground more than adequately.[1]

This chapter concentrates upon the intangible aspects of the atrium space, including the social aspects and the visual / physical connections through the space within the atrium. The research presents the case that an atrium is not just a space, but has influence on the configuration of the built space around it. In arguing that the atrium is a place for people to connect; meet, mix, and mingle, the design of the atrium in terms of its social aspects become crucially important. In particular, the ways that people physically connect into the space are examined for importance. While the overall aim of the thesis is to look for new and more reliable 3-D tools with which to examine atria spaces, this chapter incorporates a critical discussion of matters relevant to the research focus of social and spatial connectivity in architectural spaces. The first step is to examine the subject area: What are the general attributes that define an atrium? How does connectivity work within an atrium?

Figure 2.2 Atrium in ancient Roman-era residence, showing atrium in ceiling, letting smoke out / rainwater in (collected in pool / impluvium in floor). *Source: Luigi Bazzani, 'A Pompeian Interior, Pompei, Italy'. 1882. National Gallery of Art, Washington DC.* http://www.nga.gov/exhibitions/2008/pompeii/villa_houses.shtm

[1] Bednar, *The New Atrium*; Saxon, *Atrium Buildings – Development and Design*; Shum, *Atrium – a Place for Space.*

2.2 Atrium – Etymology

The names *atrium* (singular)[2] and *atria* (plural)[3] originate from the Roman names for the open courtyard at the centre of their residential housing. Predating modern glazing, this courtyard was always open to the sky. While the word itself is Latin, Shum notes that the basis was an Etruscan word relating to the darkened hole in the roof where smoke escapes from a central fire.[4]

The Shorter Oxford Dictionary offers two definitions for the word, quoted here in full:

> *Atrium* – noun (origin: Latin)
>
> 1. Architecture. A central court, originally that of a Roman house; a covered court or portico; (a building with) a large light well; a central hall or glassed in court on any building.
>
> 2. Anatomy & Zoology. Any of various chambers into which one or more passages open; spec (a) either of the two upper chambers of the heart into which the veins conduct blood (b) the tympanic chamber of the ear.[5]

The inclusion of the anatomical meaning of the word shows the importance of the spatial aspects of an atrium; it refers to a vital void within a solid, whether it is in a building (ref fig 2.2) or within the body (ref fig 2.3), as well as the crucial role of circulation that it performs. The word atrium refers not just to the physical walls of the building that surrounds the space, but also to the importance of the space itself: it is both inside and outside; both opening and enclosing. An atrium is an important place: a space for people flows, as well as for blood flows.[6] An atrium is often referred to as the heart of the building.[7]

---

[2] atrium "Also called *cavaedium*, the main or central room of an ancient Roman house, open to the sky at the center and usually having a pool for the collection of rain water." Online Etymology Dictionary, © 2010 Douglas Harper www.dictionary.reference.com

[3] While the plural of *atrium* in Latin is *atria*, in modern English language usage the term atriums has also become acceptable as a plural. For consistency however, I refer to the plural as atria.

[4] atrium - Word Origin & History 1570s, "from L., "central court or main room of an ancient Roman house," sometimes said (on authority of Varro, "De Lingua Latina") to be an Etruscan word, but perhaps from PIE *ater- "fire," on notion of "place where smoke from the hearth escapes" (through a hole in the roof). Meaning "skylit central court in a public building" first attested 1967." Online Etymology Dictionary, © 2010 Douglas Harper

[5] *Shorter Oxford Dictionary*, 6th edition.

[6] As well as a medical term for the large blood-pumping portion of the heart, a chamber also means a room (typically bedroom) - *chambre* in French, etc, originated from the Latin word *camera*, meaning room. The chamber can also be a large room in the English language, such as a debating chamber in the houses of Parliament, or where lawyers reside and practice in 'Chambers' in England, and (archaic usage) in New Zealand. Thus atrium can be taken to mean both room/void in both architecture and anatomy.

[7] This is argued by Shum, Bednar, and also by Portman, all of whom state that the atrium is the heart of the building.

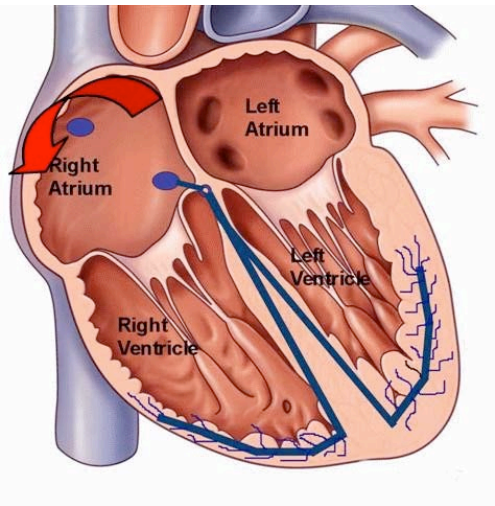

Figure 2.3 Heart diagram, depicting left and right atria, showing circulation path in atrium. The atrium is a space for collection of blood, while the ventricles are a space for expulsion.

Source: Washington Heart Rhythm Associates. www.washingtonhra.com/39.html

2.3 Courtyard history

The Courtyard house as an architectural form is an ancient and common feature in residential housing forms. Shum notes that the form of a courtyard house dates from many hundreds of centuries BC, in the form of Indo-Chinese dwellings with courtyards at their centre.[8] Vitruvius notes the use of courtyards as a regular part of the domestic architecture of the Romans.[9]

Traditionally in Roman courtyard houses, entry (by foot or by horse) occurred at ground floor level and with single floored dwellings circulation occurred naturally to the periphery of the courtyard. This pattern was repeated as the dwelling increased to a second and third floor. On multi-storey buildings a colonnaded peristyle would often surround the courtyard, often coinciding with stairs ascended into the upper floors. This has been seen in other cultures also, pre-dating Roman times.[10]

There has been clear and consistent use of the courtyard as an architectural device – as a mechanism for housing – right from early pre-Roman times, right up to and including modern times in many cultures. The primary exception has been the western suburban housing model, where it is exceptionally uncommon.

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[8] Shum, *The Atrium – a Place for Space*.

[9] Vitruvius, *Twelve Books on Architecture*. Vitruvius defines five different kind of atria dependant on their wall / column layout: Tuscan, Corinthian, Tetrastyle, Displuviate, and Testudinate.

[10] Multi-level court-yarded buildings have been found at Knossos in Crete, at what is known as the Royal Temple. Multi-storey building is likely to have been reserved only for those that could afford it: most residential buildings of ancient time were only single storey.

2.4 Courtyard function – centralised connection

Space is the building block of architecture: the raw substance of which we build our architecture around. An open space at the heart of a building, open to the sky, the courtyard atrium space is a primary form of spatial organization. The most basic logic for any courtyard is simple: to increase light and air to otherwise inaccessible central areas within a building, as well as enabling secure outdoor space within an external wall. The atrium courtyard accomplishes all these functions and also provides additional advantages.

Often used as garden space, especially in hot or windy climates, where the courtyard provides wind protection for planting within, in return the plants provide shading and cooling for the inhabitants of the courtyard. A courtyard atrium (ref fig 2.4), in these hot cultures, is literally an earthly paradise.[11]

The courtyard functioned primarily as a central light source: a safe and sheltered area where light and air floods into the interior, with visual connections out to the exterior. Rooms surround the courtyard and open onto it: the courtyard aids connectivity by forming a physical connection as the circulation zone.

Figure 2.4 Courtyard Garden, the Cloisters, New York, c1136. European gothic cloister from Bonnefont-en-Comminges, a Cistercian abbey, transported to America and re-erected in suburban museum setting. Location: Metropolitan Museum of Art Cloisters, Fort Tyron Park, New York. Circulation is here both important and strongly peripheral. *Source: author.*

[11] Paradise – from *pairidaeza* – an Assyrian term for paradise, meaning an enclosed space, ie an enclosed garden surrounded by a wall.

Figure 2.5 Secure courtyard space, Reichstag, Berlin, 1894. Light, air, security are evident in this government building. Circulation is highly limited. Sociability appears negligible. Vertical circulation and inter-floor physical connectivity is also at a minimum. *Source: author.*

Structurally, the perimeter to a courtyard dwelling was perforated with openings for windows and doors, often ringed with circulatory verandahs. Spatially, rooms open towards the central space of the atrium, and thus the central atria or courtyard functions as a welcoming zone for the occupants of the house - a highly social space. A central courtyard enables occupants of upper floors to securely look down into the courtyard, observe, focus and control people movements both in and out, as well as within the building (refer to fig 2.5 and fig 2.6 for examples). This has been a common feature throughout architectural history. Michael Jenner notes the importance of open courtyards in examples such as the George Inn in Southwark, London, as a "clearly related" design input to early Elizabethan theatre buildings such as the Globe. The galleries permitted and encouraged dramatic spectacles to be performed.[12]

In the Arab and Turkish tradition, where this building form has continued from ancient times until the modern era, courtyards existed in the *caravanserei*, where means of transport (traditionally camels or horses) were safely housed. This form of dwelling continues to this day to be used by merchants (ground floor commercial, upper floors residential) in some cultures. In the Middle East, Arabic as well as Berber variations of this building

[12] Jenner, *London Heritage,* 81.

model include the *madrasa*, or Islamic 'university,' where a central courtyard is open to the sky, and surrounded by a ring of building.[13]

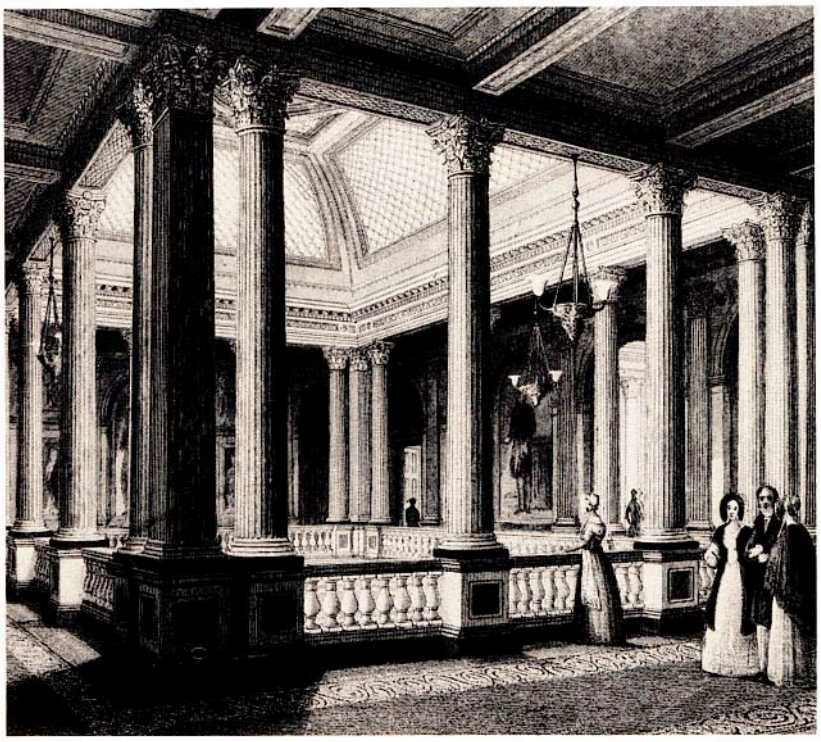

Figure 2.6 Glazed entry space, Reform Club, London, 1836. This glazed canopy is in the lobby above the main entry stairwell, affording daylight, security, circulation, and presumed high degree of sociability. Architect: Sir Charles Barry. *Source: Trustees of The British Library, c 1836.*

An atrium dwelling, no matter what culture, therefore broadly speaking consists of a ring of building surrounding a central space. As noted in 2.3 above, the form of the courtyard house has continued in many countries right up to the present day. However, in typical Western-style suburban residential accommodation, by contrast, the spatial form is completely inverted and comprises a dwelling surrounded by a (relatively) wasteful ring of suburban space. While courtyard housing models are still in use today in some hot climate countries, due to changing planning settlement patterns and western suburban building regulations, the use of courtyards and atria as individual domestic forms are rare today in western residential architecture.

In summary then, an atrium can not only provide sunlight to an interior, provide fresh ventilation air away from a boundary wall, and provide secure access to outdoor air while maintaining a secure perimeter; it can also provide a centralised place to meet, trade and socialize. Being a vertical cut through a building, it provides a

[13] In the case of the *madrasa*, the surrounding walls are typically not perforated with openings but instead are largely blank (perforated with surface decoration only), with perhaps only a single window: the building is effectively socially withdrawn from this

logical place to circulate vertically through a building. Importantly, this allows visual connections to be made across the space to other floors, and if coupled with vertical circulation, encourages physical connectivity throughout the building. These key design features are common considerations for any type of atrium space: big or small, old or modern.

As briefly indicated, courtyards and atria have continued to be a feature of many buildings in many cultures over the last two or three millennia. However, this thesis does not go deep into the history of the atrium (for more discussion on history of atria, refer to Bednar, Saxon, and Shum) and instead rejoins the timeline of atria design at the period of resurgent atrium usage in the modern era.

2.5 Modern use – The Atrium

The modern usage of the word atrium has shifted since the time of the Romans. It still continues to describe a space containing volumes of air and daylight from either above or at the side, but now incorporates a glazed roof or wall (refer figure 4.6). The atrium has evolved from a courtyard, becoming an internal rather than external space. However, the design principles of a modern glazed atrium are consistent with the courtyard houses of antiquity: light, air, security, structure, socializing, and circulation: a hub for connectivity.

During the middle of last century, the use of the term 'atrium' had become uncommon when used to describe a courtyard space – as an ancient Latin term, it was perhaps as unlikely to be used as the terms *caldarium, frigidarium, apodyterion* or *vomitorium*. The modern use of this phrase dates precisely from the 1967 adoption of the word 'Atrium' as a marketing term when referring to the massive new glazed spaces being incorporated into the Hyatt Hotel chain, by the architect John Portman.[14] Hyatt (and their chief architect John Portman) used the word Atrium to describe the spaces, resurrecting it from archaic Roman usage. While there were glazed atrium spaces in buildings before the Regency Hotel, they were not typically known as such: for instance Brown Palace Hotel, a famous atrium building (Denver, Colorado, 1892), called their central space the Rotunda. In 1990, Portman reflected upon his early atria designs:

> I began to realise that what we were talking about was a microcosm of the city as it becomes more dense. Everything up until that time in central cities was really tight. Everything was closed into cells,

---

central space.

[14] Nielson, *Back to Babylon*, 69. This article on the unveiling of the John Portman designed Regency Hyatt House Hotel in Atlanta, Georgia, USA, started a large push towards atrium design. The use of the word atrium to describe a glazed court has since 1967 become a part of common English language usage, and the older definitions of atrium as an open, unglazed courtyard, are now mostly redundant. Typically, architects merely note the space as Void.

> whether they were office buildings or apartment buildings. I started thinking of what I could do as the antithesis of the congestion. I expanded on the idea, already conceived of at Entelechy I [his house], of exploding the cells - to open things up and pull things apart. What the central city really needed more than anything else was public space, urban lungs, inside and out... We have to provide space for people to live, space that enhances the quality of life...[15]

Figure 2.7 The first modern Atrium, Hyatt Regency, Atlanta, 1967. Architect: John Portman. Note wall-climber lifts as physical connections through space, and numerous private balconies enlivening visual connections across space. *Source: Saxon, Atrium Buildings, p8.*

Portman's comments reflect his innate understanding of the need for connectivity and interaction within the atrium space, in order to spaces for people that "enhances the quality of life". Despite being recognized as the 'father' of the modern Atrium hotel, Portman does not excessively analyse the reasons for his atrium designs.

[15] John Portman, in Riani's *John Portman,* 30.

The key driver appears to be simply creating 'public space', implicitly meaning a fully three dimensional form of public space. He does not discuss issues such as circulation or connectivity. Efforts to discuss this directly with Mr Portman have not been successful.

2.6 Atrium types

Open courtyard and covered atrium spaces are evident in many building forms today, as they have been throughout history. An atrium space belongs neither quite to the interior of the building, nor does it belong solely to the outside. It occupies a space that is neither fully inside nor fully outside, and can therefore be examined as both (or arguably, neither) inside and outside simultaneously. Both Bednar and Saxon have recognized and celebrated the importance of atrium spaces with their case studies of international atrium buildings. Shum presents a similar case for the importance of atrium buildings in the New Zealand context. Neither Bodnar, Saxon, or Shum comment on circulation or connectivity within atrium spaces.

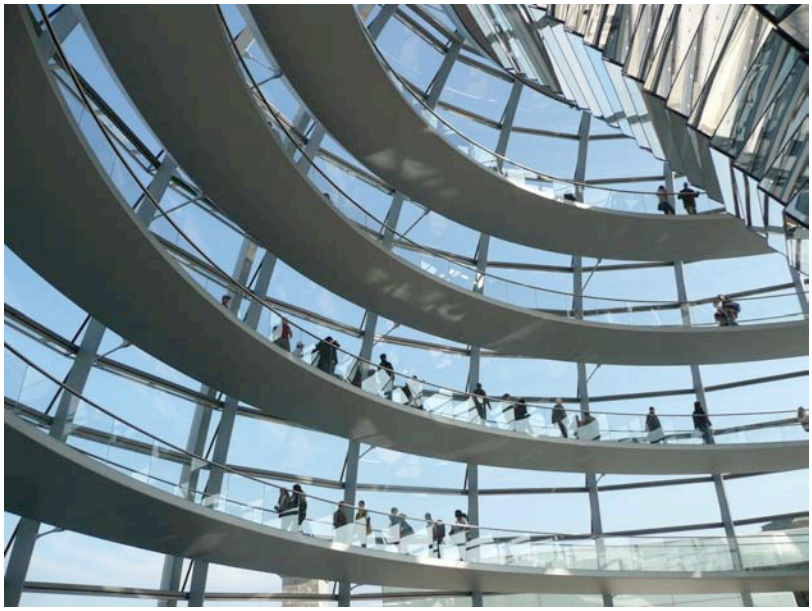

Figure 2.8 Glazed cupola atrium space, Reichstag, Berlin, 1999. Light, fresh air, security, social interaction and plentiful circulation. Visual connectivity to the central debating chamber and heart of democracy below is celebrated via the reflecting cone – while physical connectivity is denied to the chamber, it is encouraged to perambulate around the cupola perimeter. Architect: Foster and Partners. *Source: author (2007).*

Shum notes that "In the New Zealand context, the atrium is a relatively new form that has yet to gain popularity."[16] She notes that "In spite of this, the atrium can offer attractive architectural possibilities that allow

[16] Shum, *Atrium: A Place for Space*.

a reorientation towards people" and proposes that, given time, "the atrium is likely to establish a place for space, the atrium, here in New Zealand."[17] This has not yet happened, except within a few (mainly public) buildings. Shum notes that an atrium is an enclosed place, a hollow of space, being glazed at the top or the side. There are many different forms of spaces used as atria, from a simple form such as a rectangle or cylinder of space, to a more elaborate form of space such as a doughnut, as noted in Saxon's investigation.[18] The physical shape of the atrium and the orientation of the glazing is a key part of what the atrium will look and feel like – in some cases, glazing is quite extensive. Despite varied shapes of space enclosed by the atria forms, the atria are all united by a common feature – namely, that they enclose multi-level volumes of space and are washed with light.

2.7 Atrium usage and function

Saxon notes influences on atria such as urban design, glasshouses, early shopping arcades, building conservation, and Islamic planning; which all contribute to the rise of the modern atrium.[19] Bednar notes a number of common reasons behind the incorporation of atrium spaces in buildings, including that it has often performed a key role in a building as a space for socialising.[20] Bednar categorises 'Indoor Pedestrian Places' (not specifically atria, but largely coincident with them) as existing in two main classifications: refer to Table 2.1.[21]

Table 2.1 Atria – Commercial vs Public In his book *The New Atrium*, Bednar groups atria into only two categories: Public and Commercial, while his other work goes into more detail as shown in this table. *Source: adapted from* Bednar, *Interior Pedestrian Places.*

Commercial places	Public atria
Arcades and Gallerias	Atrium Hotel
Urban Shopping Centres	Office Buildings
Festival Marketplaces	Government Buildings
Multiuse Centres	Museums and Institutional Buildings
	Winter Gardens

[17] Shum, *Atrium: A Place for Space.*
[18] Saxon, *Atrium Buildings,* 74.
[19] Saxon, *Atrium Buildings,* 16.
[20] Bednar, *Interior Pedestrian Places.*
[21] Bednar, *Interior Pedestrian Places.*

While Bednar's breakdown of categories reflects the era it was written in, there has been a move in the 21st century to blurring the boundary between public and commercial spaces. Categories are now more mixed than Bednar suggests, and venues such as Festival Marketplaces is not a prominent category in this century.[22]

Shum's atrial categorisation, by comparison, adds two further categories to Bednar's work and thus offers a simple four part division for building types incorporating atria; refer to Table 2.2.[23]

Figure 2.9 Atrium space (model) to proposed civic centre, Liverpool, 1967. The early date of this atrium proposal indicates that Portman was not the only architect exploring atria at this time. As can be seen, this atrium dealt with sunlight, security, circulation, visual and physical connectivity. Increased access to fresh air is also assumed. Architect: Colin St John Wilson.
Source: Stonehouse, p418.

Table 2.2 Atrium types. *Source: adapted from Shum.*

Offices	Hotels and Accommodation	Retail and Mixed Use	Institutional and Civic

However, while these categories cover a wide range of atrium building types, the list does not recognize the full extent of spatial origins that the modern atrium is descended from. Building on Shum's work, the following

[22] Faniuel Hall in Boston and Covent Garden in London were both examples of what may be termed festival marketplaces, and both exhibit central gathering spaces / atria.
[23] Shum, *Atrium: A Place for Space*, 24.

categories are proposed in which atrium space has been found over the years, in a roughly increasing order of complexity and sophistication:

Table 2.3 Atrium types and examples *Source: Marriage, following Shum (1990). Shum's categories are noted in italics.*

Atrium type	Ancient to pre-modern form	Modern atrium form
Houses	Caravanserai	Courtyard house
Streets *(Retail / Mixed use)*	Souks, Shopping Arcades	Shopping Malls
Arenas	Stadia for sports or theatre	Sports Stadia
Transport	Railway stations	Airport terminals
Hotels *(Hotels / Accommodation)*	Inn	Atrium Hotel
Entertainment	Theatre in the round	Multimedia space and Stadia
Commercial *(Office Building)*	Factory	Office Buildings
Sacred Buildings	Churches, Madrasa etc	Cathedrals, Grand Mosques
Public Buildings *(Institutional / Civic)*	Courts, Palaces	Museums, Art Galleries, Libraries

Of these categories, the public atrium is the focus of this present research, because public atria will become more and more important to New Zealand as its urban environments become denser, its buildings higher, and its economic imperatives more critical. It is in the field of public buildings that the most consistently advanced steps have been taken in the use of atria. Buildings with public functions such as library, art gallery, or museum have increasingly incorporated atrium spaces, especially in recent years. While the architectural style of these projects may vary considerably, one thing unites them: an explorative attitude towards the creative manipulation of space.

2.8 Public atria buildings

Public buildings around the world often express a generous attitude towards space, with vast volumes typical in historic structures and more recently, buildings exhibit a more complex interweaving of space and structure. Building types that have exhibited more spatial complexity include museums, art galleries, railway stations etc.

The provision of large well-lit spaces has been a feature of large buildings for thousands of years – such as the Baths of Caracalla in ancient Rome, the British Museum Reading Room, or the New British Library etc. In part, at the most basic, obvious level, this may have a basis in simple practical logic: a large gathering of people require a large volume of air. An atrium offers an efficient means of delivering air inside a large volume building.

Figure 2.10 Canary Wharf (London Underground Jubilee Line Station), London, 1999. The underground station is based on two levels (trains: lower level; tickets concourse: upper level), in a high, vaulted space, day-lit from above at glazed entries. Visual connectivity between the inside and the world outside is a major factor in the design of all Jubilee Line stations, especially including this station. Physical connectivity is ensured as well with 19 escalators within the station and numerous sets of stairs. Architect: Foster and Partners. *Source: author (2002).*

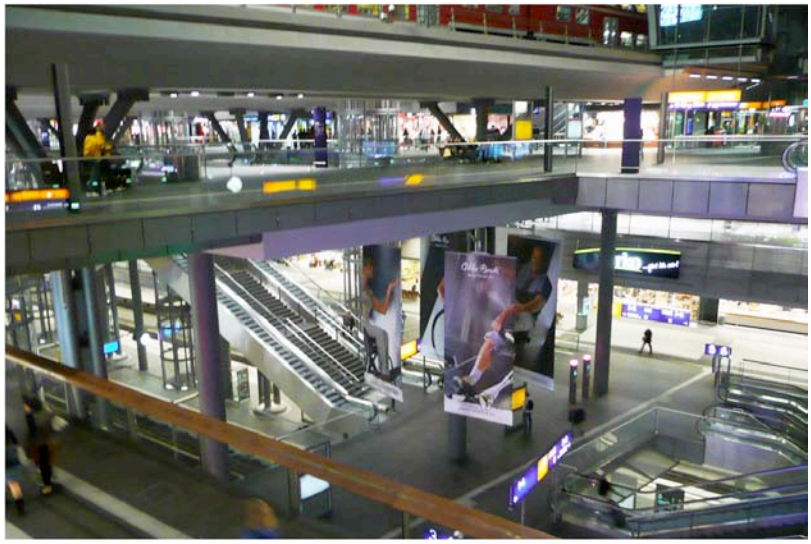

Figure 2.11 Haubtbahnhoff (Central Railway Station), Berlin, 2005. The railway station is based on three levels of trains (note train just visible right at top of photo), and two shopping levels, all within one spatially inter-penetrating structure. This multi-leveled transport terminal achieves very high visual and physical connectivity in its design by means of numerous interconnecting stairs, lifts, and escalators. As a large volume, interconnecting spatial matrix, the Haubtbahnhoff contains more void than solid. Architect: van Gerkan Mark and Partners. *Source: author (2007).*

Another key reason behind the use of a large atrium could simply be the need to orient visitors. Harbison makes this point well when discussing the Victoria and Albert Museum (V&A), where there is no central organizing atrium:

> The floor plan of the Victoria and Albert Museum caters remarkably to the divided mind, and the sense of crowding there is produced by the building not by full floors and walls. .... Floors adjacent do not communicate, giving a feeling of not being able to get hold of what is nearby. The most experienced visitors get lost, or at least confused about what they are looking for....[24]

Harbison's comment that "Floors adjacent do not communicate" is an admission that without the ability to see one floor from another, a lack of coherent understanding can follow. The use of a central atrium is a key means of achieving that spatial orientation. The British Museum also used to suffer from this disorienting effect, but in 2000 incorporated a major new public space: a doughnut of space, as shown in figure 2.12. In contrast to the V&A, Foster and Partners' reworking of Smirke's design for the British Museum had clarity of orientation as a key goal, achieved with this central toroid atrium.

[24] Harbison, *Eccentric Spaces,* 144.

Figure 2.12 British Museum 'Great Court' atrium, London, 1857/1906/2000. Visual connectivity has been maximized in the new Great Court space, while physical connectivity to other level has been retained at a very simple level. The new floor space is a successful social mixing ground.
Architect: Sir Robert Smirke / Foster and Partners. *Source: author (2007).*

2.9 Connectivity – visual and physical

The word connectivity requires definition. Connectivity is "the state of being connected or interconnected" ie the degree to which something has connections.[25] Visual connectivity is therefore the ability to see across a space or series of spaces, to visually make a link and thereby establish a visual connection. Physical connectivity however is something different. On a level surface, such as a single floor building, physical connectivity is much the same as visual: where something can be seen, it can be walked to. On a multi-level building however, such as in an atrium building, there is a disconnection between the physical and visual links. Bill Hillier and others have described this as the visual-accessible paradox; while somewhere may be visible, it may not be accessible. Circulation is a related term. Typically meaning "Movement to and fro or around something, especially that of fluid in a closed system;"[26] in terms of pedestrian movement, circulation describes the movement of people: a very similar meaning to physical connectivity.

The use of a central atrium space for connection and circulation has simple origins, but complex outcomes. It permits vertical circulation to take place in an ordered environment and exposes the user to continuously changing viewpoints. For a building developer, it enhances market value of the building by increasing the social connectedness of the space within. Loss of rentable floor space can be offset against increased rental value for the remaining floor. For a public entity such as a museum or a library, it permits users to orient themselves and

[25] Shorter Oxford Dictionary
[26] Shorter Oxford Dictionary

to explore. It adds vibrancy and opens up the building to exploration. An open atrium space permits visual continuity across the space and presents an intelligent, cohesive plan. While a fully enclosed stair or lift in a non-atrium building may create confusion and disorientation, having the same stairs or lifts in a more open position can enhance connection and orientation. Providing open central circulation enables views, not only across the same floor, but also up or down floors, giving a mental image of how spaces relate in the full three dimensional space.

Figure 2.13 Potsdamer Platz public square and atrium at Sony Centre, Berlin, 2000. Vertical connectivity is prominently displayed via glass lifts. Visual connectivity is mainly one-way, restricted to overlooking, behind mirror-glass walls. Perimeter permeability and circulation is minimal, but see also figure 2.16. Architect: Helmut Jahn. *Source: author (2007).*

2.10 Atrium parameters

While every atrium space is different, there will always be a number of variable conditions that go to making up the composition of that space. These may be defined as the parameters: space is something that can be examined in many different ways, not just in terms of the container, but also the contained, as Marianne Jensen notes:

> We no longer ask what architecture is; we ask what it does. Space is something that unfolds; it is defined through movement, action and creation. It is not only measured in terms of geometry but is closely connected to social, cultural, psychological and behavioral factors and consciousness - and is therefore as changeable.[27]

What are the factors involved in atrium design? Alexander's *Pattern Language* tried to list all the factors involved in the design of a small house, and listed 253 inter-relating factors that should be followed, with an implicit charge that if all these factors could be incorporated, a successful design solution would surely follow. [28] Is this a recipe for successful design of an atrium space? Unfortunately, Alexander's work is disputed. Peter Eisenman notes that Alexander "sort of fell off the radar screen" after their very public clash.[29] Ritu Bhatt's evaluative review of Alexander's work has acknowledged that "critics see [it] as bourgeois and encouraging of complacency."[30] Alexander's works were examined to see if they apply to atria, but very few conditions do so. Additionally, it can be noted that changes in spaces are harder to quantify than changes in solids. There could also be many times more conditions in a very multi-story building than for a simple house. Most importantly, in reality, there are simply too many factors in play in a complex space such as a multi-level atrium for an Alexander-style solution to be proposed without years of additional testing and research, and so therefore only the very strong key elements have been examined. There are a myriad of factors influencing space that cannot be tested in any meaningful way. Jensen advocates that:

> Instead of thinking about how a space should be, focus should be on creating a spatial experience that makes people conscious of themselves, conscious of their presence in the space, and to understand the conditions and relations that inform this experience.[31]

Although Jensen advocates for an analysis of space via an awareness of consciousness, there are design and use factors that are easier to grasp. Certain factors that do influence atrium design must, however, be identifiable. The following part of this chapter discusses what significant factors may be apparent in multi-level atrium spaces.

2.11 Size : Area and Volume

Size is certainly a factor in atrium design, and some atria (such as Portman's) are very large indeed (10, 20, 30 or in some cases over 40 stories in height), but it does not necessarily follow that bigger is 'better.' As Ernst Schumacher noted: small is beautiful. "Today, we suffer from an almost universal idolatry of gigantism. It is therefore necessary to insist on the virtues of smallness - where this applies."[32]

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[27] Jensen, "Space unfolded - space as movement, action and creation," *Mind your Behaviour: How Architecture shapes Behaviour*, 81.
[28] Alexander, *A Pattern Language*, *Timeless Way of Building,* etc. While popular in the 1970s and 1980s, Alexander's philosophy is no longer widely followed today within some NZ schools of Architecture, and while not totally discredited, it is no longer widely endorsed.
[29] Eisenman, as reported in the Alexander-Eisenman 1982 Debate: *Contrasting concepts of Harmony in Architecture*.
[30] Bhatt, *The Journal of Architecture,* 711.
[31] Jensen, "Space unfolded," 85.
[32] Schumacher, *Small is Beautiful*, 54.

Although Schumacher was discussing economics in his influential book, the theme of his conceptual thinking has spread far wider than just that field. The continued drive for large scale, so prevalent in western society, applies to architecture as well as economics and therefore with atria as well as with economics, bigger is not necessarily better. Schumacher notes that:

> "Many theoreticians - who may not be too closely in touch with real life - are still engaging in the idolatry of large size, with practical people in the actual world there is a tremendous longing and striving to profit, if at all possible, from the convenience, humanity, and manageability of smallness."[33]

Volume itself is not therefore an important indicator when it comes to atria, although it certainly can make an atrium more noticeable. Indeed, is size an issue at all? Spatial effects can be observed whether the space is two stories or twenty stories tall. Architect Charles Moore proposes that:

> Space in architecture is a special category of free space, phenomenally created by the architect when he gives a part of free space shape and scale. Its first two dimensions – width and breadth – are responsive mainly to functional imperatives in the narrow sense, but the manipulation of its third dimension – height – grants the inhabitant's mind the special opportunity to develop yet other dimensions beyond.[34]

The 'manipulation of this third dimension' that Moore writes of is a special characteristic of the atrium space, one that produces excitement in the viewer and literally frees the mind. The size is readily appreciated by visual connections to the opposite sides of the space. The height of an atrium may impress by its size, but too big and the visual contact between people gets stretched too far.

2.12 Scale

Consideration of architectural scale is a fundamental part of the design process for any building. Scale (the relative size of one thing to another) is a key determinant of the perception of space. The scale of an atrium relates not just to the building, but also relates parts of the building to the whole. Most of all, to feel human, a space needs to relate to human size. Moore notes that "As shape has to do with the meaning of individual things, scale has to do with their physical size, and therefore their importance and meaning in relation to something else."[35]

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[33] Schumacher, *Small is Beautiful*, 53.
[34] Moore and Allen, *Dimensions: Space, Shape & Scale in Architecture,* 7.
[35] Moore and Allen, *Dimensions*, 17.

Portman notes in relation to his atria designs that: "A grand scale space should be both infinitely varied and meaningfully broken down to a human scale. It should also be active as well as provide serenity, quiet excitement and intimacy."[36] Scale of space is relative: a large building can incorporate large scale spaces while a smaller building needs a small space: Moore notes that:

> Thus scale is not the same thing as size; scale is relative size, the size of something relative to something else.
> Relative to the whole
> Relative to other parts
> Relative to usual size
> Relative to human size[37]

This relationship to human size is a crucial point - the human body being the common factor no matter the era or the culture. Lawson notes that:

> Scale then is not some abstract architectural concept at all, but a meaningful and very human and social idea that even has commercial and political value. It is one of the most fundamental components of the language of space. Scale is in a way as much about people as it is about buildings.[38]

Scale is therefore an important part of the connectivity within atrium space – a need to consider human factors when designing methods of connectivity, and an appropriate scale to atrium design.

2.13 Shape of space

Shape of atrium spaces is always important, and relates exactly (but inversely) to the shape of the building floorplates that surround the space. If a building bulges convexly outwards, the atrium space will be compressed concavely inwards. How important therefore is the shape? Moore notes that:

> Shape calls attention to things and their meanings. … Architects from the beginning have tried to compile systems and formulate rules of proportion and composition which would aid them in evoking responses from the people who saw the shapes they made.[39]

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[36] Portman, in Riani *John Portman*, 31.
[37] Moore and Allen, *Dimensions*, 18.
[38] Lawson, *The Language of Space*, 48.

Atria can be any shape: dictated by site orientation and project economics more than by concern for any inherent potential sociability. While the shape of an atrium space may often, for practical reasons be a simple square, in reality the possible shape combinations are potentially endless. Atria may be glazed at the side wall, on the roof top, or a combination of the two. Glazing, and its ensuing light source, can be from one side, from two sides, or even more, dependant on the shape of the space to be enclosed. Rather than try to describe all the possible permutations of atrium spaces, this research has relied on Saxon's work. Saxon has undertaken a survey of nearly 30 atria that fall broadly into a series of glazing patterns. His diagram, as shown in figure 2.14 groups these 30 as a few key types of atrium spaces.

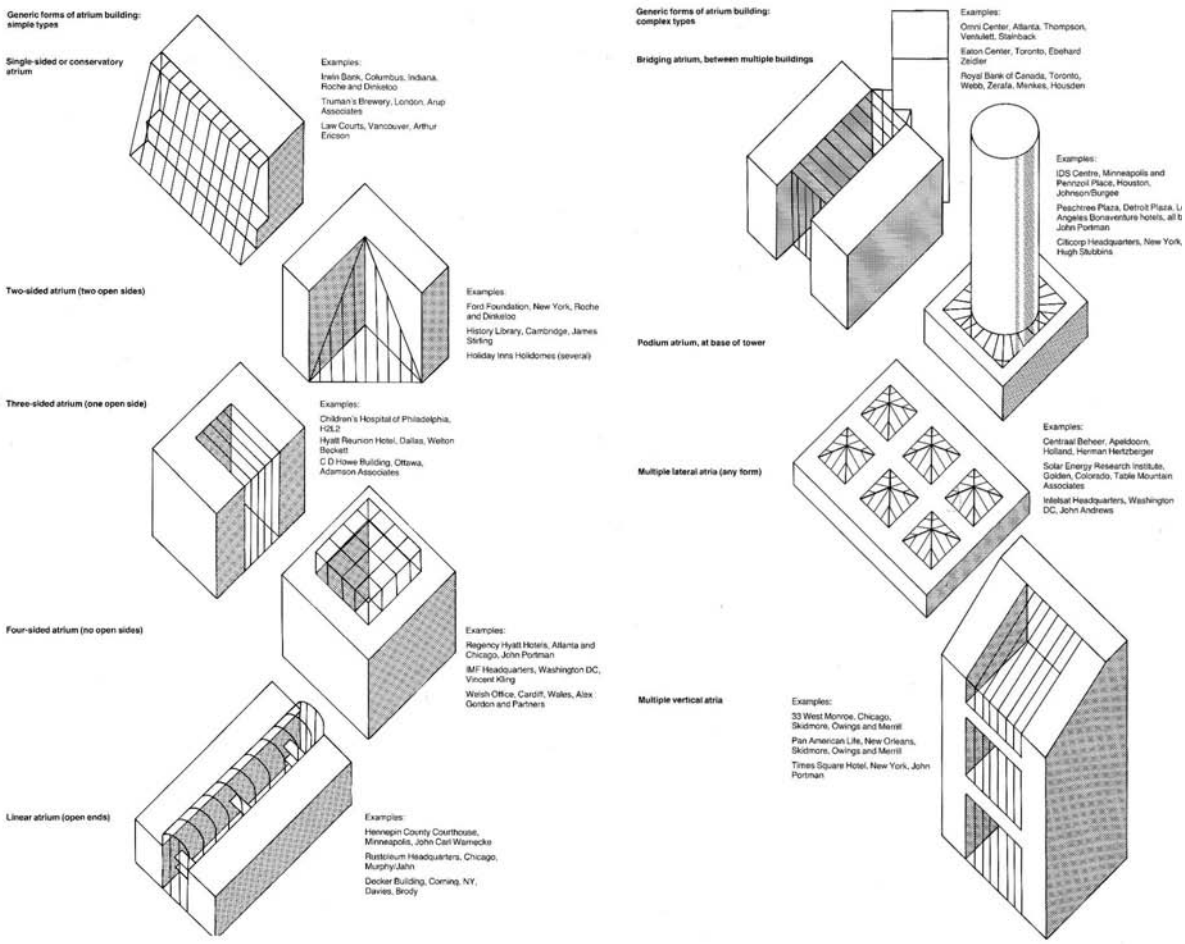

Figure 2.14 Atrium types *Source: Saxon, Atrium Buildings p75.*

Each different-shaped space has different attributes: certain shapes will feel more comfortable than others. A tall, narrow, very skinny space will not engender the same feelings as a broad, flat, wide space. Both of them, however, can provide spatial impulses, and spatial excitement. Position of the viewer within the atrium space can provide additional feedback also. If the long thin space is experienced at the lowest level, it will be a very different spatial experience than if it were visited halfway up or even at the very top. Moore, an experienced

[39] Moore and Allen, *Dimensions*, 11.

architect and teacher, notes that the key to designing a space, no matter what shape it is, is to understand how the space will be used:

> It seems to be one of a number of signs that we, in our pluralism, are finally working clear of the rigid Cartesian grid, with its dictatorship of the right angle, by which Modern architecture has been so firmly gripped. It represents a sign that space is beginning to be understood from the point of view of the person perceiving or experiencing it – not as a mathematical abstraction.[40]

Figure 2.15 Complex inter-penetrating circulation through space, Trocadero, London. Architect: unknown. *Source: author (2007).*

An atrium space does not, necessarily, have to be bounded by solid walls. Indeed it is arguable that perhaps the more perforate and complex the boundaries, the more interesting and vibrant the space will be. Later in this thesis, research is undertaken which examines aspects of this argument (refer chapters 5 and 6).

2.14 Complexity in Space

Spaces can be simple and spaces can be complex. Combining together two or more spatial volumes is not, on it's own, visually apparent. Yet combining spatial volumes, along with ensuing connecting circulation, can produce an architecture of complexity. An atrium may have greater complexity due to increased circulation or structural complexity. Complexity represents the embracing of a range of elements, as Marcus Jatsch notes:

[40] Moore and Allen, *Dimensions,* 9.

> Complexity represents intertwining and connections of every kind and generally characterizes a decision range within whose framework participants are encouraged to respond to the demands of their environment. The object they focus on no longer appears simple and visible at a glance; it appears to be multi-layered and intricate.[41]

Jatsch's theory of complexity in systems creates a possible definition of complexity in architecture. The ability for both a building and a space to be simultaneously complex arises when the two elements are permanently bound together. This complex intertwining of both the structure and the space, especially applies to two key elements of a complex space: the complexity of the structure supporting the perimeter, and also of the circulation running through the space. Jatsch believes there are four criteria for complexity:

- The number of components (elements) that can be distinguished in a configuration,
- The number of possible states that the various components of a configuration can assume,
- The distribution of relative frequencies of possible conditions that the components of a configuration can assume,
- The dependencies of components within a configuration.[42]

Can Jatsch's criteria be applied as relevant constraints for creating a complex space? While there is no requirement for complexity in an atrium space, it is often an outcome of the introduction of complex connectivity. In figure 2.15 for instance, one of the more complex inter-penetrating spatial circulation flows in an atrium (London Trocadero), the complexity of both the circulation and the space have been maximized. While visually exciting, the overall effect was intense – deliberately so - to maximize the rental charges of the retail environment. The numerous methods of connectivity across the (relatively small) atrium space included multiple escalators, an indoor vertical bungee jump and parachute ride, numerous intersecting levels, and extreme levels of intersecting walkways.

The complex interplays under Jatsch's four criteria above show that there could be almost endless possible permutations of connectivity and thereby complexity within an atrium. Jatsch argues that:

> Complexity is a quality that is characterized by the absence of order structures. It refers to the degree that a situation is multilayered, integrated, and followed by consequences. The important factor here is

[41] Jatsch, *Entgrenzter Raum*, 65. Jatsch notes that "The Latin word *complexus* stands for entwining and embracing".
[42] Jatsch, *Entgrenzter Raum*, 69.

> the number and variety of components, the extent to which the components are dependent on each other, and the changeability of the components and their dependency over time.[43]

Certainly the tendency towards increasing complexity can mirror the impression of lack of overall control and order. If handled carefully, this could be an advantage. The complexity of space is also encouraged by Quentin Stevens, who notes that playful spaces can add to a city's vitality. He argues that not all space needs to be used efficiently: "In a sense, good public spaces are always used inefficiently; the space is always wasted."[44] On a strictly financial, dollars per square metre basis, an atrium can be viewed by property valuers as 'wasted space,' and Stevens argument helps back up the view that it can make a good public space.

2.15 Perforated Boundaries

The periphery of any space occurs where space meets wall. Any opaque boundary wall must, by nature, be a solid. Where the boundary is glass, the visual continuity means that the space appears to flow right through the wall, while retaining some sense of physical enclosure to the space. A boundary can therefore be perforated, either with glazed or actual openings. This affects both physical and visual connectivity, as shown in figures 2.16 and 2.17. With a blank, solid wall as the limit to an atrium, neither physical nor visual connectivity can exist between people on different levels of an atrium. With the insertion of windows, however, some visual connections can be made (refer figure 2.17). With the addition of balconies and connecting links to edges (such as walkways, colonnades, etc), physical connectivity is further enhanced in a horizontal direction.

When the boundary to an atrium is enclosed by a perforated wall, the atrium becomes more active, either visually (through windows), or more substantially (balconies or walkways), enabling occupants of the floors to fully experience the edge of the space, and enhancing not only physical connectivity, but visual connectivity as well. With circulation around the periphery of atrium floors, views are available across, down, and up, as well as right through. The space becomes enlivened by the possibility of interaction: of seeing, and being seen. These visual connections through can enhance the social nature of the space.

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[43] Jatsch, *Entgrenzter Raum*, 66.
[44] Stevens, *The Ludic City*, 32.

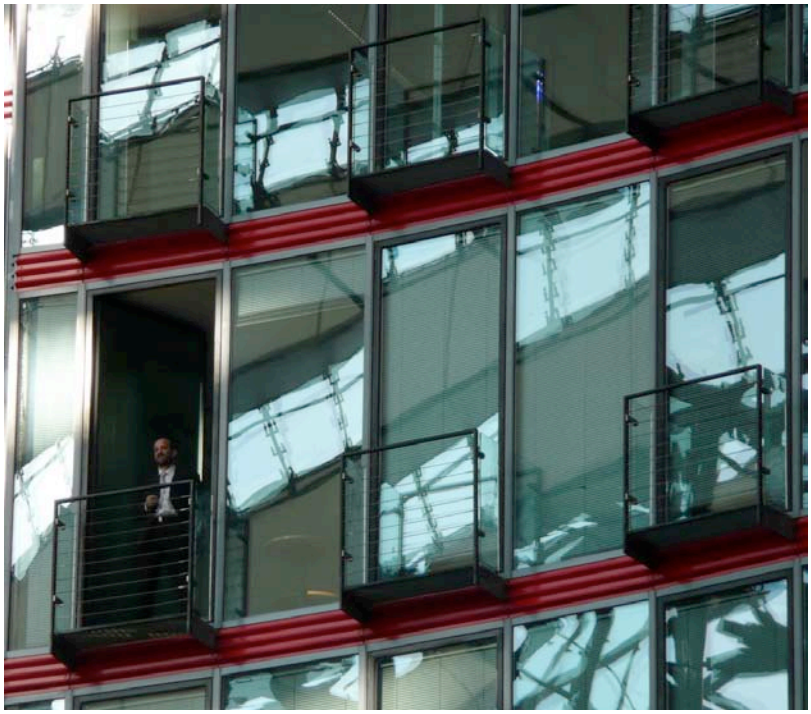

Figure 2.16 Spatially perforated boundary, Potsdammer Platz, Berlin. The smoker enjoying a cigarette from his (tiny) balcony helps to enliven the reflective façade. *Source: author (2007).*

Figure 2.17 Variations on spatially perforated boundary conditions to central courtyard, Bratislava Castle (approx 600AD – 1800AD), Bratislava, Slovakia. Large openings in the picture on the left enable mutual visual and audible interaction with people at ground level and higher levels. In the picture at the right, the adjacent wall has a more solid façade, with less inter-activity and an appearance of overlooking and disdain.
Source: author (2007).

The use of perforated boundaries can also create a vibrant spatial condition, enhancing or revealing issues of privacy, security, processes of hiding and revealing, as well as solving issues of structure and access to adequate daylight, sunlight, and fresh air. All these factors have effects on the people using the atrium, or the floors surrounding it. For the space to work as an interactive social environment, the walls to the atrium need to have enough perforation for people to make contact across the space.

While for fire control reasons the perimeter walls of a space may need to be closed off, or at least glazed over, for the maximal amount of spatial interaction between floors and across the atrium, the walls of the space should be perforated with openings, balconies, or even continuous occupation. This research is not, however, examining atria from the aspect of concerns such as fire safety, and so, without regard to fire control requirements, the opening up of the side of the spatial boundaries creates an intermingling of spatial zones that invigorates the spatial experience.[45]

2.16 Intersections

Intersections are a powerful form of physical connectivity, one that encourages social interaction. Quentin Stevens notes that interconnection - the power of the connections through space – will lead to social intensification likely at an intersection:

> At intersections people are exposed to the greatest density of other people and the greatest range of sensory phenomena and opportunities for action. Where paths intersect, people are bought up close. It is common to encounter strangers who have different trajectories. Because of restricted visibility, these encounters can happen quite suddenly and unexpectedly. Hence intersections can be experienced as a compression of social time and space. This intensification can stimulate playful responses. Intersections also punctuate journeys through urban space. [...] Phenomenologically, space opens out at an intersection. Intersections are thus sites where people can be distracted from instrumental purpose.[46]

This distraction from purpose is not necessarily a bad thing. While Stephens notes that: "The complexity and intensity of social action in urban public spaces generates diverse and haphazard sets of trajectories",[47] this effect is actively sought after by some designers. Stevens "compression of social time and space" is an

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[45] Harrison, *Smoke Control in Atrium Buildings*. Fire control is, of course, one of the most important restricting factors in atrium design, and cannot be ignored or trivialized. It is not a focus of this thesis however, and so discussion of connectivity is without reference to fire-related measures such as fire egress stairs etc.
[46] Stevens, *Ludic City*, 99.
[47] Stevens, *Ludic City*, 65.

observation of the deliberate condensing of chance interventions and random connectivity, actively encouraged within atria by some architects. In particular, Bligh Voller Nield (BVN) Architects encourage this distraction and specialise in this design approach, which they describe as 'bump', encouraging interactions, as noted within their Sovereign Insurance building in north Auckland:

> Bump: Vertical transportation is clearly an essential component of the atrium. Hence the glass lifts and stairs were located central to the building at points of conjunction between floors, the lifts and the floor of the atrium.
> Lunch and major coffee and tea points are located close to the view on the smallest plate - creating constantly used spaces accessed by way of the bridges and stairs. Toilets have also been purposely located on the northeast corner. Location of these services away from the workplace encourages frequent movement enabling *ad hoc* interaction - or 'bump' to occur.[48]

Figure 2.18 Narrow walkways across atrium, Sovereign House, Takapuna, 2009. Architects: Jasmax and BVN. *Source: ASB / Sovereign.*

This tendency to encourage 'bump', whether consciously as noted here, or sub-consciously designed into other architects work, has a different focus when a building is planned for a public use, as opposed to the private organization described here. In a private building, interaction with other staff may want to be encouraged for operational reasons. What is notable is that BVN encourage this interaction by 'bump' in the most visible, public places – ie, the atrium. The design decision to enhance connectivity between people, in sight of a maximum

[48] ASB / Sovereign / Bligh Voller Nield, *From the inside / out*, 36.

number of other people (including those from other floors), may enhance the feeling of teamwork within the building (refer figures 2.18 and 2.19). However, this is a private corporation's offices, not a public building.

In a public or commercial building however, where people do not know each other, bump factor or the "butt-brush effect" may be viewed differently. In some areas, this effect is seemingly encouraged just for the excitement value alone.[49] Humans enjoy the company of other humans, and a successful space will encourage interactions between people.

Figure 2.19 Pedestrian interaction on skybridges across atrium, Sovereign House, Takapuna, 2009. High visual connectivity across the space and to other levels, by stairs, escalators and skybridges, all helps enhance 'bump' between different occupant groups. Architects: Jasmax and BVN.
Source: ASB / Sovereign.

2.17 Pedestrian Circulation

Pedestrian circulation can occur in a space either horizontally i.e. perimeter walkways, balconies etc, and also vertically, ie stairs, lifts, and escalators. These are all key physical examples of connectivity. Whether vertically or horizontally, the more the pedestrian circulation interacts with the space, the greater the chance for experiencing the space through multiple and changing viewpoints. With a strong sense of movement through the space, visual and audible conditions change, evoking the senses, and the ability to physically connect with other parts of the building can be more fully understood. The provision of pedestrian circulation within the void is therefore, a key opportunity to enliven any atrium space, as demonstrated in figure 2.19.

[49] Underhill, *Why We Buy: the Science of Shopping,* 18.

The complexity of space and movement through it has been steadily growing in public buildings over the last two to three decades, both as a means of orientating pedestrian users as well as enhancing spatial excitement, although the description of what is happening was noted long ago by Sigfried Giedion:

> The essence of space as it is conceived today is its many-sidedness, the infinite potential for relations within it. Exhaustive description of an area is, accordingly, impossible; its character changes with the point from which it is viewed. In order to grasp the true nature of space the observer must project himself through it.[50]

Gideon's point, that the observer must project through space to fully grasp its nature, is now being utilized increasingly often as a prime architectural feature in vast numbers of overseas public buildings, and is just starting to be used within a few prominent buildings in New Zealand - mainly commercial examples, such as Sovereign House in Takapuna (ref fig. 2.18 and 2.19), and the new BNZ building in Wellington.

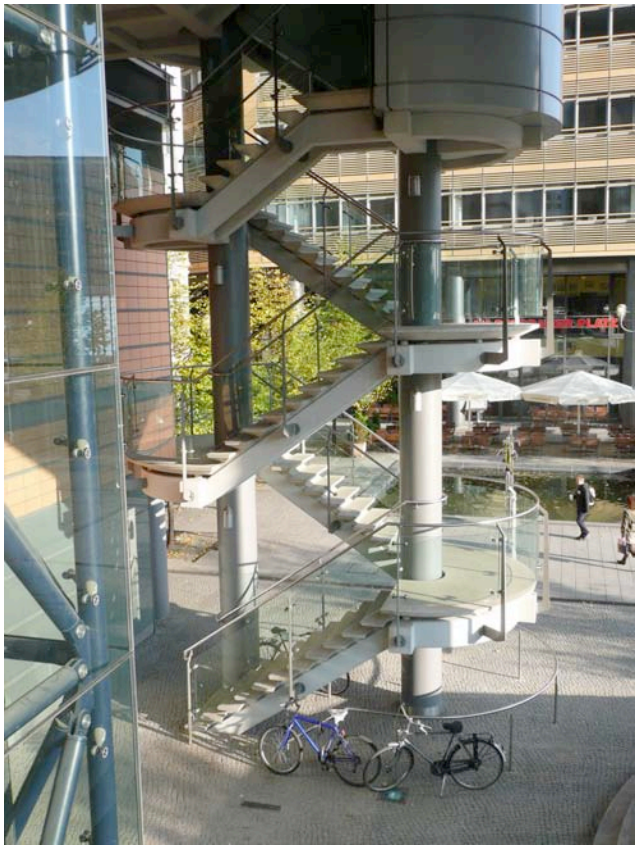

Figure 2.20 External escape stair circulating through space, Daimler Building, Berlin, 1999. These fire egress stairs, while used only infrequently, celebrate their function as areas of vertical circulation and physical connectivity. Architects: Richard Rogers Partnership. *Source: author (2007).*

[50] Giedion, *Space, Time and Architecture - the growth of a new tradition,* 356.

2.18 Vertical circulation: Stairs

In many of the examples shown in Saxon's books on atria, the atrium is often composed of dead space: unappreciated and unappreciable space, with no ability to be visually connected. The use of pedestrian circulation at each floor can enliven these spaces, but merely circling the space level-by-level is not enough. To truly come alive and be fully inter-connected, circulation within the space should extend vertically as well as horizontally, to fully explore the three dimensional aspects of the space created. There are three means of vertical movement possible within a space - stairs, escalators and lifts.

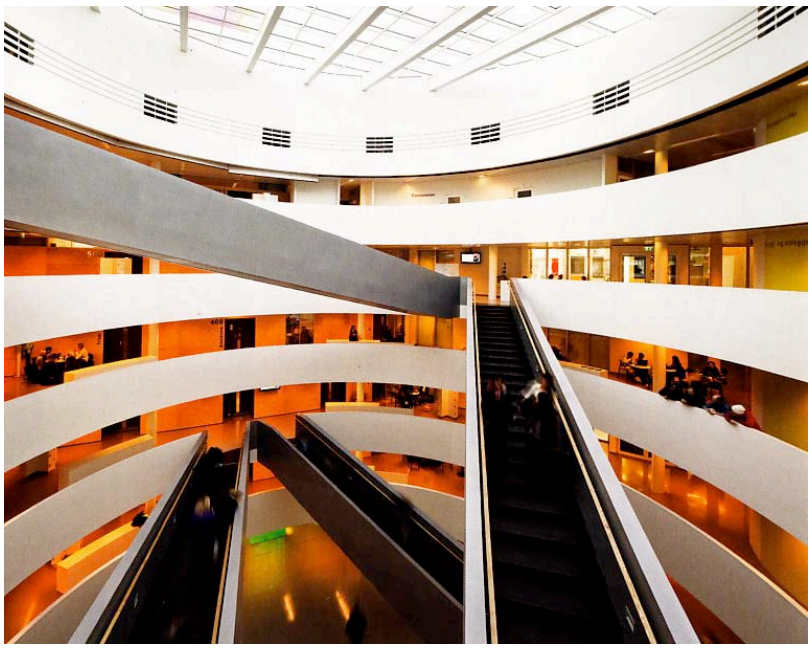

Figure 2.21 Aerial stairs across atrium space, Tangen Polytechnic, Kristiansand, Norway, 2009. The central atrium and connecting stairs acts as the heart of the Polytechnic building. Architects: 3XN. *Source: Jensen / 3XN, Mind your behaviour.*

Stairs are the traditional method of ascending from one level to another, and so are the primary means of movement and physical connection within any atrium over one or two floors. The provision of stairs within an atrium is a natural and common occurrence, from the simple ascension at the perimeter in the original atria and residential courtyards, to the more elaborate staircase configurations of larger and more complex atria in public buildings. It is a good way to experience the space and to interact with other users. Brösamle et al. examine the concept of main "staircaseness" in a building, concluding that the foyer stairs are the most important.[51] Jensen describes a staircase in Tangen Polytechnic (refer figure 2.21), within a recent atrium building by 3XN architects in Denmark:

[51] Brösamle, et al., "What Constitutes a Main Staircase?" 011:3

> A high, circular atrium cuts through all decks in the central part of the building, connecting all levels and letting natural light in down through the entire building. This is the location of the main staircase, which cross-crosses its way up through the large, circular space and also has an important social function. The central area with its sets of stairs acts as a communal space for all students, bringing them together in the heart of the Polytechnic and giving them a feeling of a joint identity.[52]

This is typical of the current rationale for atrium provision within public buildings – to engender feelings of a common heart to an organization. Martine Seedorf notes that in 3XN's building for Orestad College:

> The open space around the large, central staircase is a haven for many students during the short breaks. Like the eye of a hurricane, this space seems to suck students to the banisters on all four floors. They need to relax from constant focusing.... The attraction of this place is difficult to explain, perhaps it's the letting go, the chance to look at something else; perhaps it's the relaxed knowledge that here's a view you can relate to, or the feeling of community.[53]

Controversially,[54] Freud saw the staircase as a metaphor for sexual intercourse by implicating physical action and rhythmical movement.[55] He presented the staircase as a means of exploration - a pathway penetrating through space – which has been discussed elsewhere.[56] It is not a line of research explored in this present study.

2.19 Lifts

The invention of the lift allowed vertically oriented buildings to flourish.[57] In a traditional, non-atrium building, lifts are typically impersonal but efficient means of transport, and a disconcertingly seamless means of changing floor levels. Entering a lift on one floor, there is a seamless change to the doors opening on the next floor, with little sense of movement, and no sense of changing space. The doors close, you move: the doors reopen, and there is a new space before you.

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[52] Jensen, *Space unfolded,* 44.
[53] Martine Seedorf quoted in Jensen, *Mind your Behaviour*, 40.
[54] Hall, 'A cognitive theory of dream symbols', 169-186. Hall notes that according to Freud, climbing stairs is sexualized by "Association by resemblance in action." Hall disputes Freud's theory of dream symbols, and while not directly disputing Freud's analysis of staircases as such, lays some doubt on Freudian concepts.
[55] Freud, *The Interpretation of Dreams*, as noted by Rainer Schonhammer in *Real and Dreamed Staircases – Settings of (not only) Vestibular Arousal.*
[56] Marriage, *Harry Potter and the Prisons of Piranesi.*
[57] Tregenza, *The Design of Interior Circulation.* Lifts were popularised only after Elisha Otis's invention of the safety brake in 1852.

With the planning of a lift in an atrium building, however, careful consideration of the potential of the lift to exploit the spatial situation can result in exciting architectural moments. The use of glass-fronted lifts moving through space (refer figure 2.22) has been seized on by many architects, particularly by Portman in the Hyatt Hotel chain (refer figure 3.17). The sensation of moving through space becomes far more real as the ground rapidly falls away. There is a slight sensation of danger, as the glass wall to the lift allows the occupants to experience elements of vertigo and an edgy excitement, as noted in the 1974 film, *The Towering Inferno*.[58] It is of course crucial that safety of such glass lifts is of paramount importance.[59]

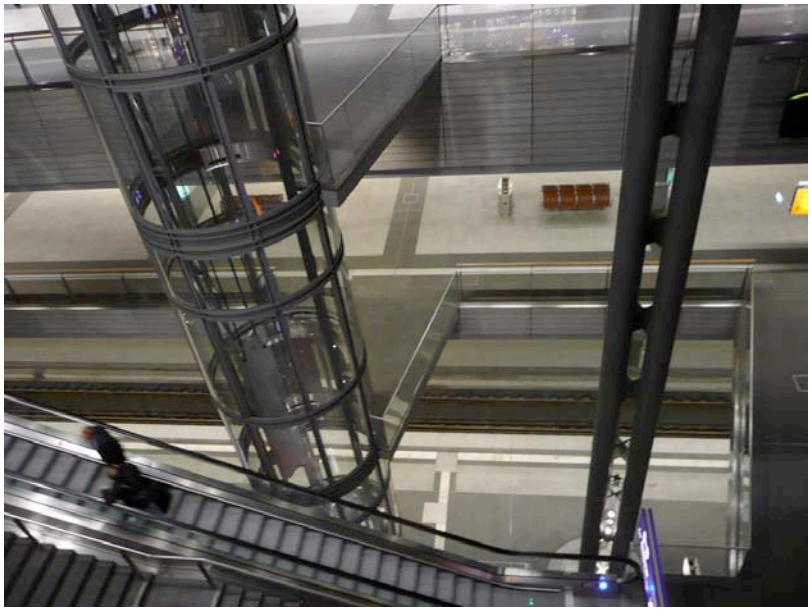

Figure 2.22 Glass lift, Hauptbahnhoff, Berlin, 2005. The experience of a completely transparent, free-standing lift shaft is powerful spatial experience. Architect: van Gerkan Mark and Partners. *Source: author (2007).*

[58] Director John Guillermin (1974). The glass lift breaks free during the inferno and swings outward: an unlikely scenario.
[59] Although film makers play upon the possible dangers, emphasising the possibility that you could perhaps fall to a gory death, should you perhaps be set upon by crazed gun-wielding terrorists - see for example: *Die Hard (1988), Die Hard with a Vengeance (1995).* Director: John McTiernan / Len Wiseman. These movies explore boundaries of architecture and taste, featuring gun battles in lift shafts, in corporate atria, and contain a generally destructive attitude towards modern architecture.

2.20 Escalators

The third means of vertical ascension within an atrium is the combination of stairs and machinery: the escalator.[60] Achieving popularity through its use as a labour saving device (ie saving pedestrian energy), the moving staircase has been installed in public buildings, especially in high traffic areas. This not only permits the safe and continuous flow of people through a building (ie physical connectivity), but has the added advantage of permitting strong visual connectivity by encouraging views into other floors.

Spatially therefore, escalators can have a strong effect on users, both physically and socially. The effortless transportation of each and every visitor through space by the escalator, leaves the user time to look around at the unfolding view as the focus moves from floor to floor.

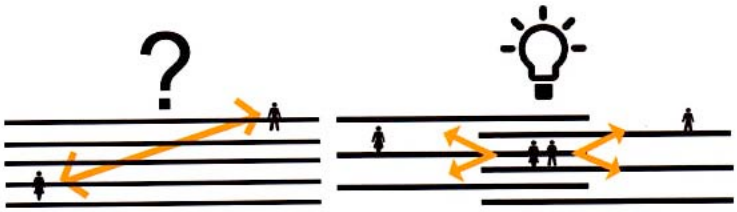

Figure 2.23 Diagram explaining circulation design / wayfinding rationale. This simple diagram shows that (on left) people cannot readily communicate or connect in traditional multi-level buildings, but that with the insertion of a central space and associated circulation, communication is possible through the increased connectivity.
Architects: 3XN. *Source: Jensen / 3XN, Mind your behaviour.*

The layout of escalators, nearly always in pairs (one up, one down), varies from building to building, but with discernable difference between buildings designed commercially (ie typically shopping malls and department stores), and buildings designed for a non-commercial situation.

[60] Escalator invented by Natham Ames in 1859, but first working escalator not constructed until 1896, and popularized by Otis Elevator Ltd.

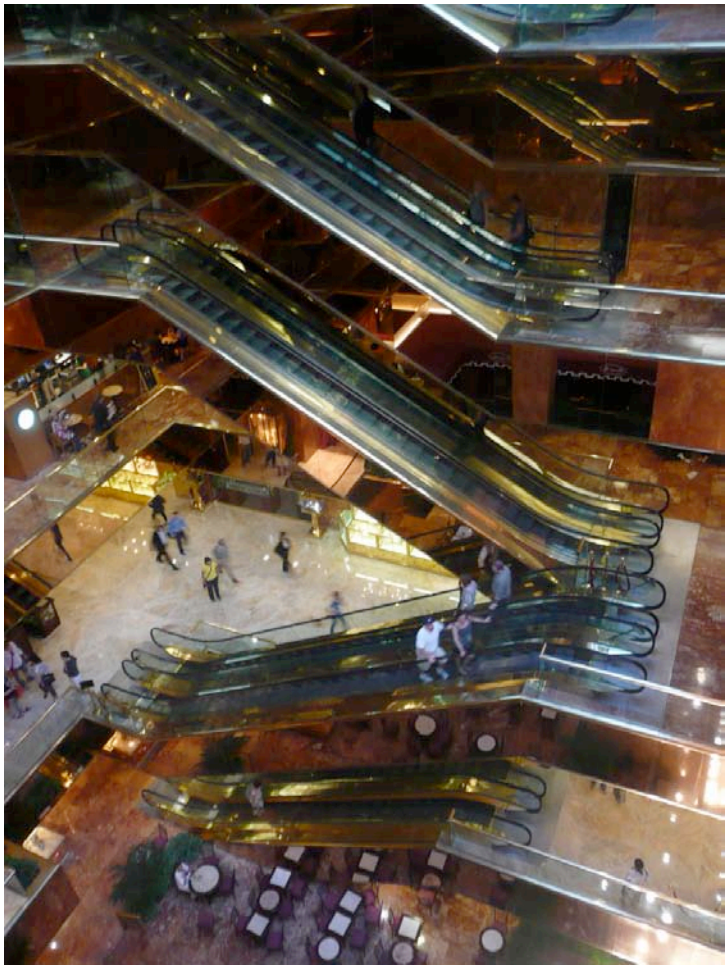

Figure 2.24 Escalators in Trump Tower, New York. Note how escalators 'double back' on upper floors, encouraging shoppers here to stop, shop, look at gilded atrium at each level. The perimeter is designed for social interaction. Architect: Der Scutt / Swanke Hayden Connell and Partners, 1983. *Source: author (2011).*

In the case of a commercial building, escalator layout is often arranged so that at each floor, to gain access to the next floor, the shopper must walk from through merchandise to gain access to the next escalator. By contrast, when the building has been designed for a non-commercial use such as a library, speed and efficiency are of paramount importance, and so users can turn directly onto one escalator from another. Each type of layout is designed to physically optimize economic performance of their tenant's operation.

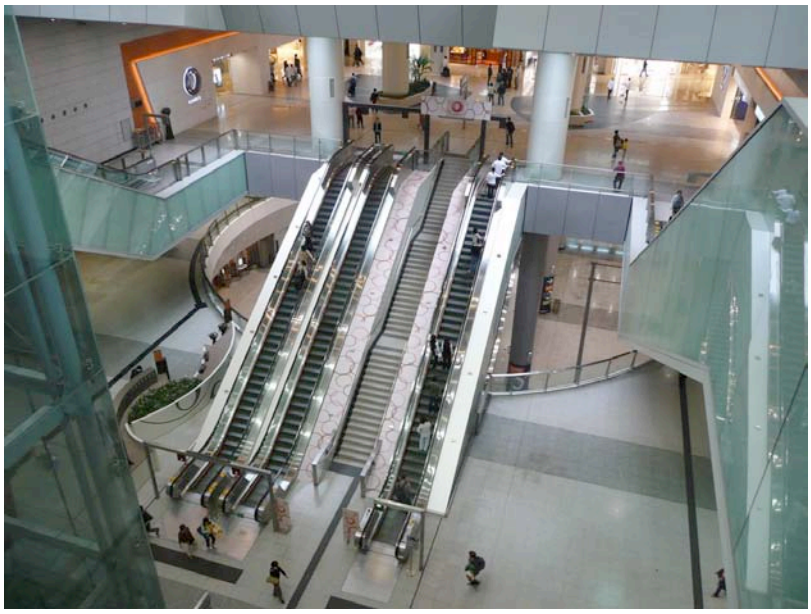

Figure 2.25 Escalators in atrium within transport hub, Kowloon, Hongkong. Designed to lay along transport routes and therefore enhance speed of interchange. Atrium not designed for stopping or socializing. Architect: Sir Terry Farrell and Partners. *Source: author (2007).*

2.21 Sky bridges

Spatial experience is powerful, and can have strong effects on those who experience it. There is perhaps nothing quite like the sensation of crossing a drawbridge, the ability to pause and look over the edge down into the abyss, to experience both the joys and potential horrors of space and gravity.

Concurrent with the use of stairs, lifts and escalators as vertical means of circulation, there has been a rise in the provision of walkways spanning across atria: known as sky bridges (refer figures 2.26 and 2.27).

The spatially invigorating use of sky-bridges has been utilized increasingly commonly in architecture: e.g., the Trocadero, London (1994), The Edge complex, Auckland (1999), Chep Lap Kok airport, Hong Kong (1997), as well as in fantasy films dating back to Fritz Lang's film *Metropolis* (1928). Sky bridges penetrate through space, creating opportunities to experience atrium space from *within* the space, not just comfortably at the edge. They are a highly dynamic method of connections within space.

Figure 2.26 Skybridge across River Spree, Berlin. This example of a skybridge extends from within the nearby government building, through the Spreebogen area, and across the river Spree, for exhilarating spatial experiences. *Source: author.*

Possibly the most influential historic depictions of sky-bridges (refer figure 2.27) in imaginary complex space are Piranesi's series: *Imaginary Prisons (Carceri d'Invenzione)*.[61] These etchings of imaginary prison spaces famously depict a convoluted architecture of bridges, steam, industry, giant stonework, chains, endless stairs and tortured souls; the prints are inhabited by "a mass of human figures tormented by a mysterious ardor."[62] John Wilton-Ely notes that the *Carceri* series "compels the speaker to undergo an optical journey of frenetic motion" by circulatory devices such as "stairs, ramps, bridges, balconies, catwalks and galleries."[63] Piranesi's etchings achieve success not just because of his depictions of murky depravity, but mostly because of his grandiose depictions of vast constructions in space. It may be noted that some modern works of architecture also encourage frenetic motion in the search for encouraging social interaction and heightened physical and visual connectivity (refer figure 2.28 for an example) and to Marriage (2010) for further discussion.

[61] Giovanni Battista Piranesi (born 1720, died 1778). Venetian born artist and architectural draughtsman.
[62] Ficacci, *Giovanni Battista Piranesi – The Etchings*, 37.
[63] Wilton-Ely, *The Mind and Art of Giovanni Battista Piranesi*, 83.

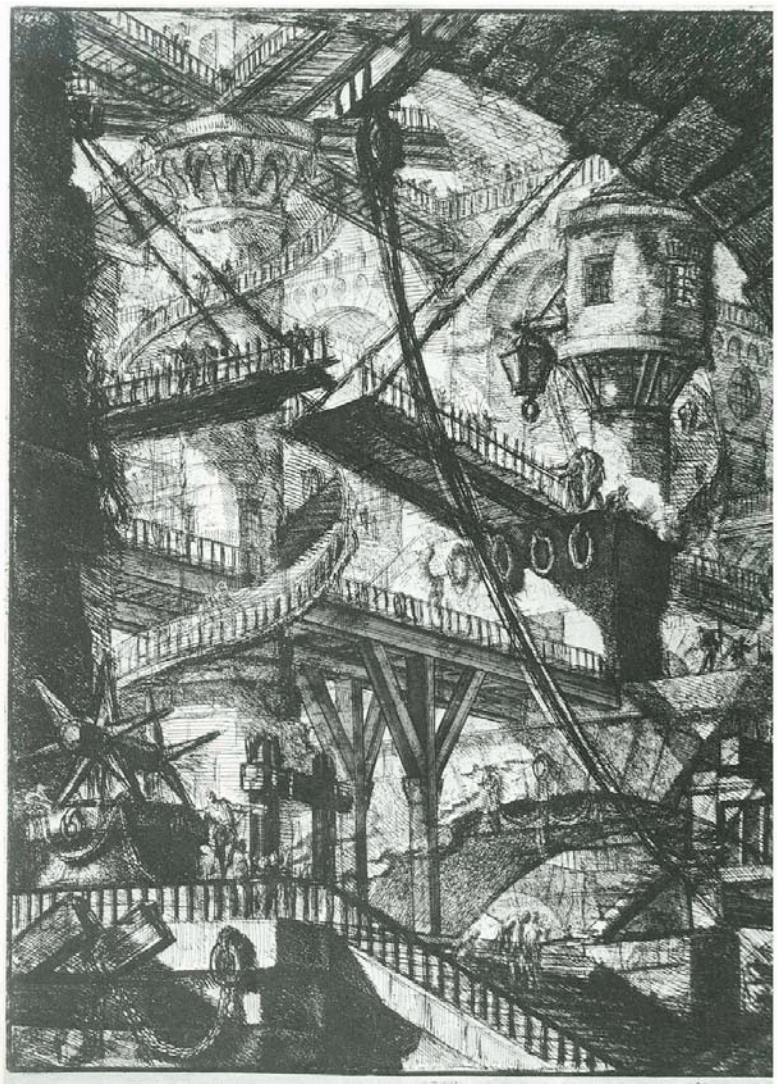

Figure 2.27 Carceri d'Invenzione, depicting bridges, stairs, walkways to nowhere. This space, of high visual connectivity, highlights physical connectivity – some physically linking, some not.
Source: Giovanni Battista Piranesi.

The final word on this subject of atrium features should go to the most experienced designer of atria, John Portman. He notes that:

> ...we also have to think in human terms, not just in physical terms. The idea of an atrium is to create an interior park. Therefore, when you enter the atrium from a busy, noisy, smog-polluted street and move into it, a resort-like image is projected. The atrium is an antithesis to congestion and anxiety. By opening up the interior, several functions can occur simultaneously within a grand atrium space and not impinge on the action within that area. The design becomes a study of space within space. Movement through the atrium creates fun, dynamic, visible activity. In its larger context, we took the elevator, pulled it out of the wall and made the enclosure glass, letting people experience movement through space. it was this kind

of thinking that led to our concept of the hotel design and the atrium. We were addressing the evolution of the City and the relief of congestion by seeking a more humane environment.[64]

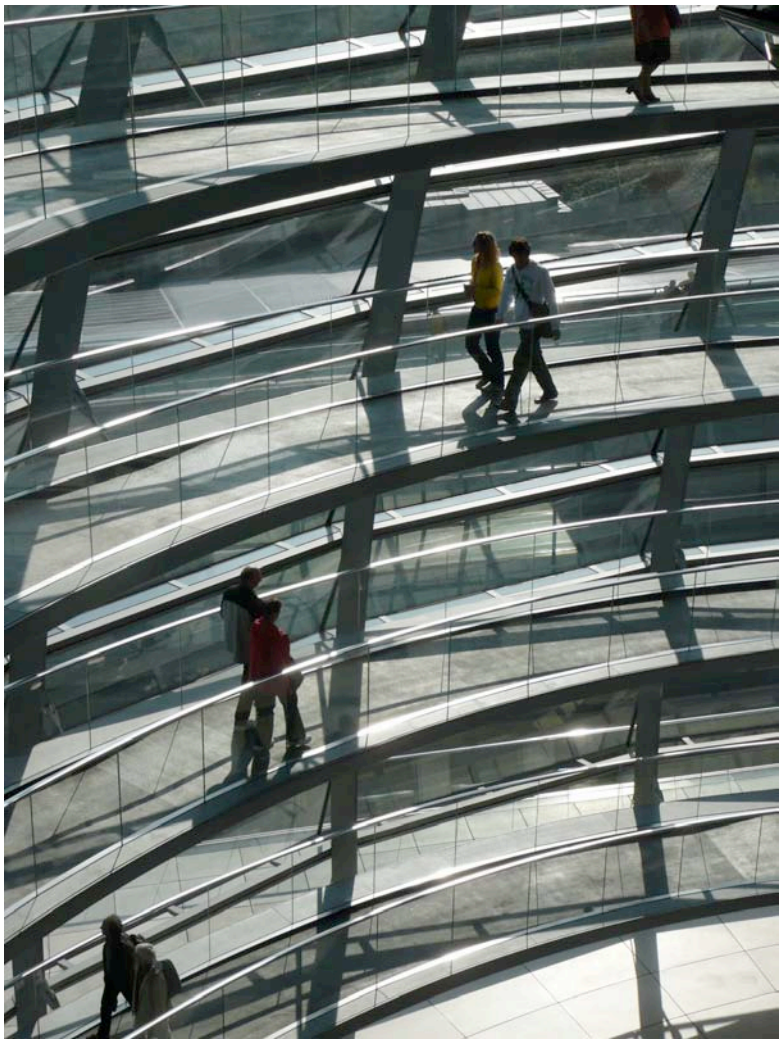

Figure 2.28 Pedestrian circulation movement around atrium cupola, Reichstag, Berlin. This cupola features a helical ramp that wraps around the perimeter, maximizing visual connectivity across the atrium roofspace and out to views of the surrounding city, while restraining physical connectivity to the actual physical bump as you interact with other visitors on the sole path to the top. Architects: Foster and Partners. *Source: author (2007).*

2.22 Summary

The aim of this chapter was to identify and discuss common aspects within atria that actively contribute to social and spatial connectedness. The history of the atrium has been briefly examined, atrium types and various design factors have been discussed, and certain aspects of atria examined in more detail. The atrium space is nominally an outdoor space, yet it still feels enclosed: it is neither quite fully indoors, nor fully outdoors. The atrium contains fresh air, daylight, and often sunlight, yet the temperature and general environment is

[64] Portman, in Riani, *John Portman*, 31.

controlled and contained. Research concludes that atria are weather-protected sources of daylight, sunlight, and fresh air in a secure environment.

Factors

Research confirms that vertical circulation methods are an important part of atrium design. Becoming more common as a design feature despite their fire issues, atria are also notable for their use of perimeter walkways, vertical circulation, and spatial orienting abilities. Movement through the space is encouraged, whether at the perimeter, or vertically within the atrium space. A perforated boundary to the space gains activity around the edge of the space.

Features

The effects of an atrium are individual, but common factors have been shown to exist. The space within the atrium is high, encompassing many stories. The atrium is a place of safety, a secure haven within protected walls, and yet at the same time there is an air of danger about an atrium. There is a frisson of excitement is present when you move to the edge of the space, with the heightened awareness of spatial complexity: the possibility of falling.

Connectivity

Stairs, lifts, escalators, sky-bridges, and the ring of balconies and walkways around the edge of an atrium all add to the general ambiance of the atrium, enabling views that change perspective, movement through space, at speeds often exceeding those of natural movement. Views are available across the space, up to other floors, and down into lower floors, all from the edge of the atrium. The intersection of horizontal perimeter walkways with vertical circulation through the atrium encourages the mixing of people's pedestrian trajectories, and enhance the feelings of being within a large social space, an atrium full of people.

A tendency for atria to be thought of as primarily social space, or a space for meeting, greeting and even purposefully 'bumping' into other people to exchange information and enhance creativity was noted. Atria introduce powerful elements of spatial complexity into structures, permitting the space enclosed to become socially active and to facilitate physical connectivity through an area of high visual connectivity.

The social aspect of an atrium is enhanced by all these factors. An atrium is a special place, a significant space, and most of all, a place of connectivity and sociability. The atrium may be termed a 'significantly social space', where there is a enhanced aspect to its social aspects, as noted by Hillier in 1.1 of this research. Atria have the capacity to enhance retail value, and thereby increase customer satisfaction and shopping 'stickiness'. There

are significant economic opportunities to understanding atrium design as well as those of increasing social imperatives.

Overall, the conclusion of this research chapter is that the atrium has a significant effect on the social relationship of the users of that space: the atrium is indeed a significant social space, and that connectivity is a very important thing for a successful atrium design.

The next chapter will examine spatial theories.

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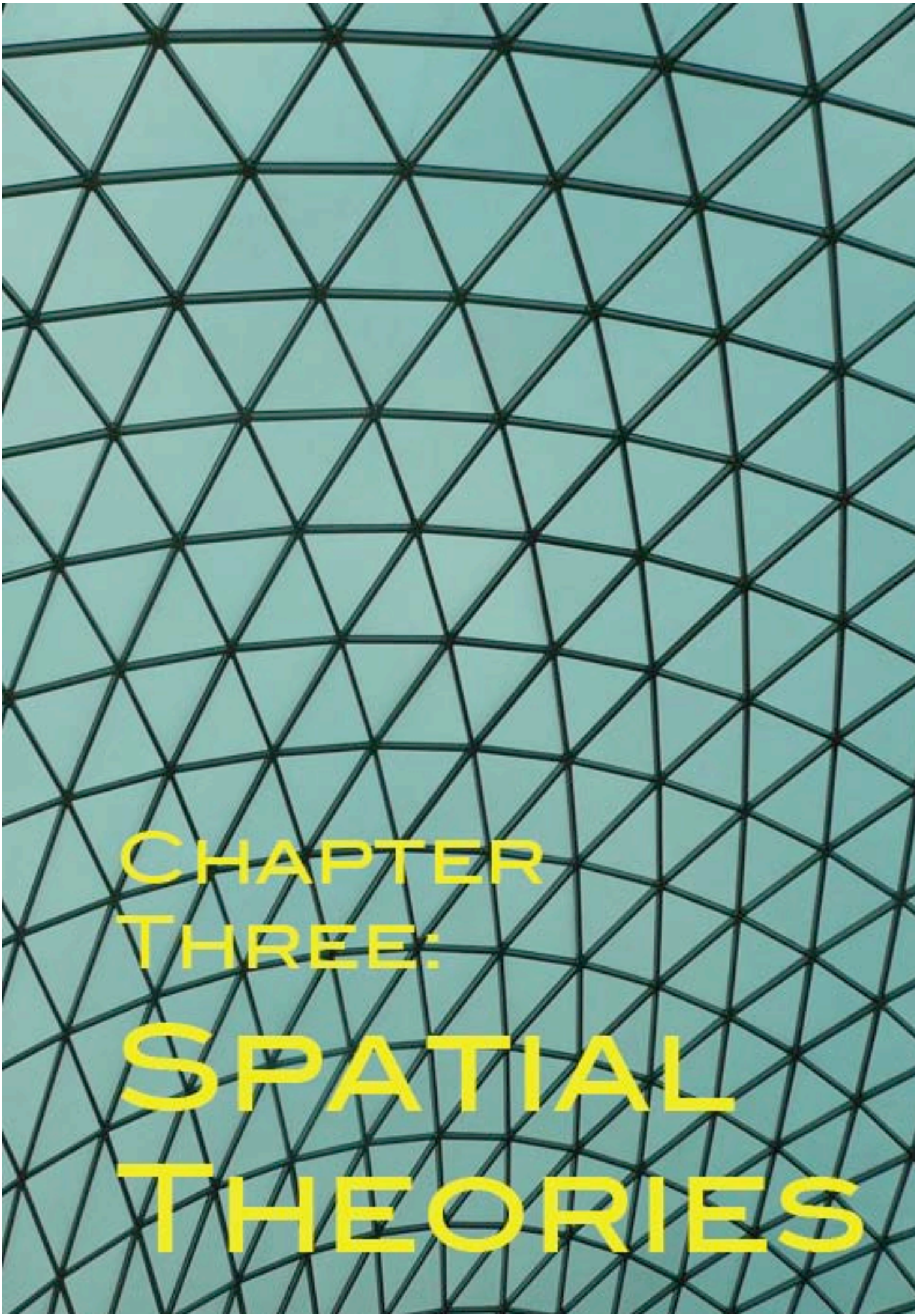

Chapter Three: Spatial Theories

Chapter 3: Spatial Theories

3.1 Introduction

In order to assess how multi level atrium spaces can be analysed for connectivity, this chapter determines the best tools for analysis. An extensive literature review was undertaken in three parts – first a broad examination of space in architectural terms, then a closer examination of atria, and finally a reworking, searching in particular for theories regarding connections within space. The overall chapter structure is set out in the following manner (refer to figure 3.1):

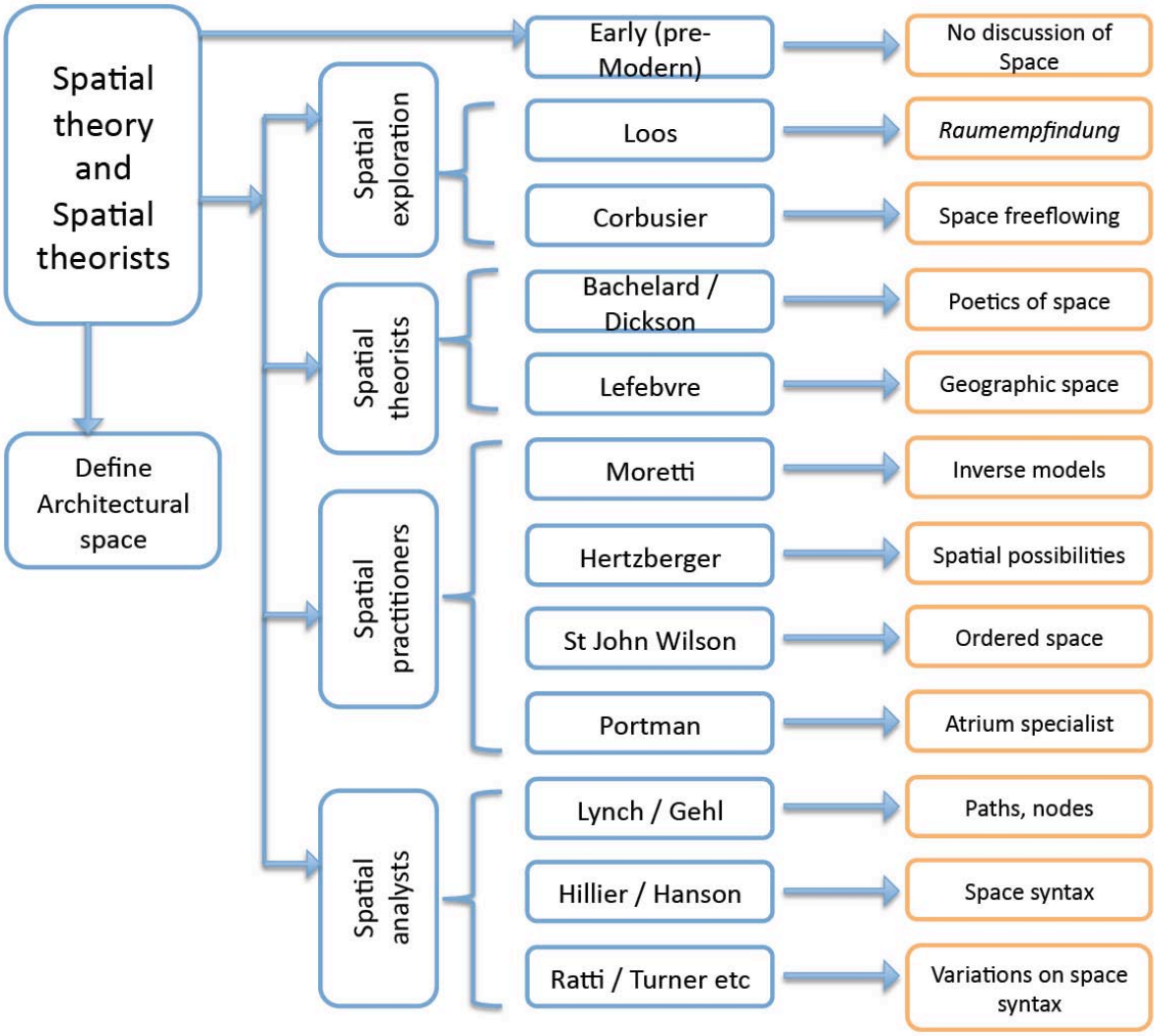

Figure 3.1 Chapter 3 structure diagram. This diagram sets out how the literary review was divided into several broad areas, encompassing fields as varied as spatial theorists, spatial practitioners, and spatial analysts. It is important to note that categories can, and do, overlap – for instance theorists can also be practitioners etc. The Spatial practitioners category includes architects renown for their architecture more than their theory. The initial task was to define space in the form of 'Architectural space.' This chapter broadly meets the second major objective of the research, as noted in section 1.5

3.2 Definitions of space

Space itself has a number of definitions, while architectural space remains undefined. Atrium space in particular is surprisingly unresearched, and theories about connectivity remain largely the focus of one branch of spatial investigation. In this chapter, a brief historical overview of spatial theories is laid out, and reasons discussed for concentrating on the work of certain selected writers as the primary means of focus in this thesis. Methods and tools of analysis are proposed. Further discussion of these tools takes place in chapter 4.

Space is an awkward thing to define: after all, to many observers, there is 'nothing there'. Yet this is overly simplistic. With no solid, visible, or tangible qualities, space has many possible interpretations and multiple meanings. In the *Shorter Oxford Dictionary*, space has 23 definitions: 7 as a verb, and a further 15 definitions as a noun alone, relating to time, area, music and metaphysics. The simple word 'space' can describe something measureable or unmeasureable; limited or limitless; it can mean a distance as small as the gap between two words on a page, or the gap between two stars in the universe - the "Continuous, unbounded, or unlimited extension in every direction" expanse in which all material objects are located.[1] Despite this there is no one single definition that clearly describes what architects would understand as architectural space: as flexible as either a rigid set of coordinates for a definite position within a completed building, or as a loosely undefined substance flowing from one room to another without boundary or location.

A specialist architectural dictionary was consulted, but despite defining over 26,000 architectural terms, the word 'space' is not defined – not even mentioned.[2] Yet space is surely the most fundamental 'building block' of architecture. How can something that is so crucial to the design of buildings be so completely ignored?

Even the way we describe space gives it different meanings. Herman Hertzberger notes that:

> When we in the architectural world speak of space in most instances we mean a space. The presence or absence of a mere article determines whether we are referring to infinite space, to a more or less contained space, or something in-between, neither endless nor contained.[3]

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[1] *Shorter Oxford Dictionary*, 6th edition. Space - *noun*: from Old French and mod. French *espace* from Latin *spatium.*
[2] *Dictionary of Architecture and Construction,* 4th edition.
[3] Hertzberger, *Space and the Architect – Lessons in Architecture 2*, 15.

Architects design conceptually with space, manipulating it on paper and in computers, yet as a concept it evades definition. Architects know that their ability to design lies in the ability to conceptualise a future packaging of space; indeed, as Hertzberger notes:

> If the architect is a specialist anywhere, then it is in orchestrating the spatial resources and whatever they are able to accomplish. He must accept his social and cultural obligations and concentrate on the creating and shaping of space.[4]

Our reticence of describing space as such is a curious omission, given that architects are allegedly masters of space. Space in the architectural sense can be imbued with feelings – it can portray not only a meaningless void to one person, but also a void filled with meaning to another. Do we even need a definition? After all, as Madanipour notes:

> One obvious explanation for such a dramatic absence could be that architects' conception and use of the term space are so clear and universally accepted amongst them that no need has been felt to explain a taken-for-granted term.[5]

But if it is indeed so clear and universally accepted, what would it be?

While architects and academics may think they have an understanding of what space is, in an architectural sense, it seems this may not be universally understood as the same thing, particularly between different cultures. Costa and Sterling note that space means "in America, outer space; in Japan, physical room to live and work; in Europe, an autonomous realm of the imagination."[6] The meaning of the word space can vary considerably both within a language and between other languages, so that one writer's understanding of space may be rather different from another in the following discussions on space involving theorists from around the world. Hertzberger noted this difficulty, stating that: "Space is more an idea then a delineated concept. Try to put it into words and you lose it."[7] None the less, he proposes that:

> The idea of space stands for everything that widens or removes existing limitations and for everything that opens up more possibilities, and is thus the opposite of hermetic, oppressing, awkward, shut up and

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[4] Hertzberger, *Space and the Architect,* 9.
[5] Madanipour, "Urban design and dilemmas of space", 334.
[6] *Metapolis Dictionary of Advanced Architecture.*
[7] Hertzberger, *Space and the Architect,* 14.

> divided into drawers and partitions, sorted, established, predetermined and immutable, shut in, made certain. Space and certainty are strangers. Space is the potential for the new."[8]

Charles Moore proposes that space in architecture is a special category of free space, created by the architect on conception.[9] Marianne Jensen observes that space unfolds, and is defined through movement, action, and creation.[10] For the purposes of this thesis, a simple, straightforward, and very architectural definition for architectural space is proposed:

> the inhabitable volume that exists between walls and floors and ceilings in the interior of any built construction, or that exists outside between elements of the built environment.[11]

3.3 A broad history of spatial theory

There are a number of ways that the subject of architectural space has been examined with many different viewpoints, largely expressed over the last century.

A short summary of the spatial concepts unearthed during the literature search has been compiled regarding the major spatial theories in modern architecture, as well as more relevant minor writings. As shown in Figure 3.1 the spatial theories and theorists have been placed into broad sub-groups, of spatial theorists, spatial practitioners (typically prominent architects), and spatial analysts. These have been summarized in chronological order later in the chapter (refer to Table 3.1), and subsequently reinvestigated for issues of connectivity. Each group has a different way of looking at the same subject: space. Yet, despite the importance of spatial analysis to architects' work, it is at times curiously under-discussed. The lack of architectural / academic discussion of space has been noted by others – with Hillier and Hanson asserting that:

> But in spite of its centrality in the act of creating architecture, and in its recent public pathology, the question of space has failed to become central in the academic and critical discourses that surround architecture.[12]

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[8] Hertzberger, *Space and the Architect,* 14.
[9] Moore and Allen, *Dimensions,* 7.
[10] Jensen, "Space unfolded", in *Mind your behaviour,* 85.
[11] Marriage, 2011, author's own definition.
[12] Hillier and Hanson, *The Social Logic of Space*, 3.

While the more general aspects of architectural space have been written on as a broader topic, despite the unique nature of atria as a space that exists both inside and outside simultaneously, the literature review revealed disappointingly little on the spatial aspects of atria, or on connectivity between spaces. This is clearly an area for further research.

3.4 Pre 20th Century Spatial theories - Vitruvius onward

Early architectural texts such as Vitruvius' *De Architectura libri decem*,[13] or Alberti's *De re aedificatoria*[14] discuss matters such as the length and size of a room, etc, but do not discuss the actual space contained within the walls. Traditional masonry architecture treats each room as a separate space, enclosed by solid walls, linked only by doors, and pierced externally by discrete windows. Each space relates directly to each room. With bricks and mortar, space remains discrete and does not flow.

Sigfried Giedion divides architectural space into three distinct spatial eras, either the ancient world (the "space-radiating volumes" of the Greeks and the Pharoahs), the pre-modern era (the "interior space" of the Renaissance era), or the Modern concept of space as both volume and interior space combined.[15] Giedion argues that the architecture of the Greeks was primarily outwardly focused, as they constructed their temples with columns, and could not create large unified internal volumes. This classification of spatial typologies is strongly tied to the architecture that surrounded the space, as well as the era and epoch of the society that produced the buildings concerned.

3.5 Space and Materials: Steel and glass

Historic changes towards the end of the 19th century with new construction materials such as steel and the transparency of the glass wall (simultaneously environmentally enclosing but visually opening) spelt the end of the structural need for solid walls. Tschumi notes: "Space had rarely been discussed by architects before the beginning of the twentieth century",[16] while Forty notes that "As a term, 'space' simply did not exist in the architectural vocabulary until the 1890s".[17] Concurrent with the birth of modern architecture, modern architectural theories enable space to be thought of separately from its surroundings.

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[13] Vitruvius, *De Architectura libri decem*.
[14] Alberti, *De re aedificatoria* (On the Art of Building).
[15] Giedion, *Space, Time and Architecture*.
[16] Tschumi, *The Architectural Paradox*, 13-14.
[17] Forty, *Words and Buildings: A Vocabulary of Modern Architecture.*

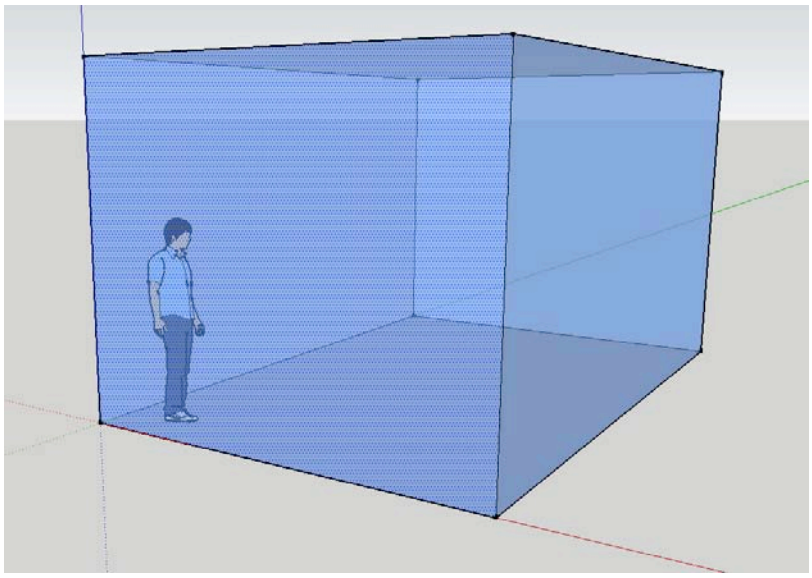

Figure 3.2 Inhabiting the space. This simple diagram shows a person within a space, but they can only be 'seen' courtesy of semi-transparent walls. The spatial experience of the person within will be affected by the enclosing walls, as per Giedion's 'interior space.' It is simplest to visualise a space when you are inside it, as per traditional means of construction. *Source: author.*

Space was no longer confined by walls, and as such, could be conceptually thought of as without, or separate from the walls that surround it, flowing, visually at least, right through the walls of glass that surround it. The ability of architects to think of space (ie, non-visible void) as a three dimensional, moldable object, is therefore a concept primarily recorded in the 20th and 21st centuries.

3.6 20th Century: Modern spatial theories

Loos forward

Adolf Loos' theoretical stance on the role of architecture enabled modern spatial theories to develop. Loos' dislike of unnecessary decoration and his subsequent linking of 'Ornament' with 'Crime', helped free architecture from the role as surface: with a blank wall, architecture could be expressed as volume instead.

> For Loos architecture was not primarily construction, but space with the task of creating effects and 'stimulating human moods ['*Stimmungen*']' .... Loos sees architecture primarily as an arrangement of spaces which became '*Raumplan*' ('spaceplan')...[18]

Loos's concept of *Raum* was closely tied to the concept of *Bekleidung* – ie inter-related concepts of spatial enclosure and cladding, and although he did not develop this into a formal theory of space, "...by 1915 there was the concept of *Raum*, with all its overtones of German aesthetics, and the notion of *Raumempfindung* or 'felt

[18] Kruft, *A History of Architectural Theory – from Vitruvius to the Present*, 364.

volume'."[19] The notion of *Raumempfindung* is an important step forward – an acknowledgment that even if space could not be seen, it could at least be grasped by the senses. This Loosian 'felt volume' or 'space perception' was overtaken by the early 1920s, when "the idea of felt space had merged with the idea of composition to become a three-dimensional continuum, capable of metrical subdivision that could be related to academic rules."[20]

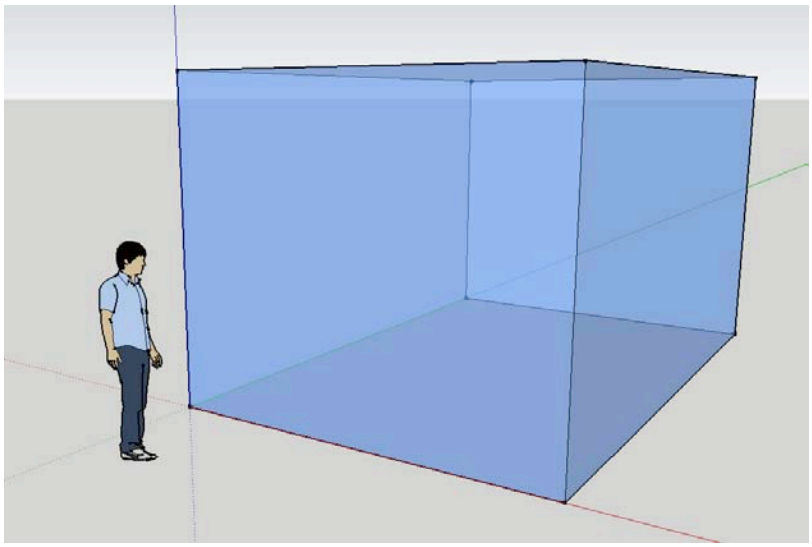

Figure 3.3 Thinking outside the space. This diagram indicates an external view of a space, with the observer situated outside an enclosed volume, in strong contrast to figure 3.2. It is a conceptual leap to visualise a space without the benefit of enclosing walls. *Source: author.*

Space could now be articulated and discussed clearly and separately from the building that encloses it. Hertzberger puts this into words:

> A space is determined, meaning finite, and fixed by its periphery and / or the objects in it. A space is meant for something, offers protection to something or makes a thing accessible. It is to some degree specifically made, maybe variable as regards function, but not accidental. A space has something object like about it, even though it may be the exact opposite of an object. We might then perceive a space as an object but in a negative sense: a negative object.[21]

The concept of this 'negative object' has also been stated by others, notably including architect Luigi Moretti.

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[19] Tschumi, *The Architectural Paradox*, 13-14.
[20] Tschumi, *The Architectural Paradox*, 13-14.
[21] Hertzberger, *Space and the Architect*, 15.

3.7 Early Modern spatial theories

Corbusier

Early modernist architects wrote of the aims and ideals of the modern architecture they espoused. Le Corbusier wrote of his five principles for modern architecture: the *piloti*, the strip windows, the free form plan, the free façade, and the roof garden.[22] Elements such as the use of *piloti* and the free form plan are evident reflections of the fluidity of the space within and beneath Le Corbusier's modern architecture: space flowed freely between the *piloti* of the buildings in his new city designs, and his writings concentrate on the freedom of the plan rather than the capturing of the space and its sequential connections within his free form walls.[23] Corbusier did not write about atria: the modern atrium had not yet been reinvented.[24]

3.8 Poetic spatial theories

Bachelard and Dickson

In strong contrast to those who think of space as a generic nothing, an unfeeling, flowing heterogenous flowing void, Gaston Bachelard viewed spatial void poetically, as either 'exterior' or 'intimate' space. A room could be attributed with inherent subjective or 'poetic' qualities of space, demonstrating that even the empty volume itself has emotional affectations.[25]

While Bachelard's work acknowledges the poetic possibility of space that Gideon does not, John Dickson went further, constructing a spatial theory equating certain forms of enclosure with a certain colour range, via his spatial theories known as the Mastery of Space.[26] Dickson looks at aspects of space such as their enclosing or excluding form, and provides links with atmospheric constructs such as colour and light. and attempts to categorise these poetic responses to qualities of space and rationalize them via a semi-scientific manner. Neither Bachelard nor Dickson, however, examine the connections between spaces, nor do they write about atria.

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[22] Charles-Edouard Jeanneret-Gris, aka Le Corbusier, *Vers une Architecture*.

[23] Le Corbusier, *Oeuvre complete: Volume 1, 1910-29*, quoted in *Corbusier le Grand – English translation companion volume*, p3: "The open plan. Until now: load-bearing walls; rising from the basement, they are overlaid on each other, making up the first floor and the stories, up to the roof structure. The plan is the slave of the load-bearing walls. Reinforced concrete in house-building brings the open plan! The stories no longer stack up separately. They are free. Real savings in building terms, with rigorous use of each centimeter. Real savings in money terms. Easy logic of the new plan!"

[24] Le Corbusier, in *Corbusier le Grande.* Despite this mammoth volume of Corbusier's collected life's work, the atrium is not mentioned in this work.

[25] Bachelard, *The Poetics of Space*.

[26] Dickson, *The Mastery of Space*.

3.9 Post-structuralist spatial theories

Lefebvre and Zevi

While Bachelard argues for a theory of emotional spatiality, others such as Bruno Zevi argue that space itself is completely homogenous: merely a void that flows from room to room.[27] Zevi argues strongly for the inclusion of time as an element of architecture, noting that architecture can only really be experienced by the process of walking through it: "Architecture, however, does not consist in the sum of the width, length and height of the structural elements which enclose space, but in the void itself, the enclosed space in which man lives and moves."[28]

When discussing space in an architectural sense, it is difficult to ignore the (mainly French) philosophers who have written on the use of space, such as Foucault, Derrida, Deleuze, and Lefebvre. Foucault's influence throughout the architectural world was common in certain fields of architectural philosophical theory through the last two decades, and Derrida is still quoted often in undergraduate architectural work (although seldom in completed architectural projects). Jacques Derrida's discussion on the literary role within philosophy has led to his work becoming a key text in subjects as diverse as literature, metaphysics, historical hermeneutics, sexual and moral ethics, as well as deconstructivism and architecture. Although he does write about space, he does not write on the subject of atria. Lefebvre importantly proclaims that the production of space is a political act,[29] and that any space is therefore inherently political from the fact of its mere creation.

This viewpoint that space is political has considerable resonance with the growing field of human geography, whereby the word space is frequently used, eg gay space, lesbian space, German space, etc. This cross-over between terms used in both architecture and geography should be viewed cautiously. Geography's boundaries of study are widening – it is split between physical geography and human (cultural) geography, as Linzey notes:

> From what I understand about the discipline of geography, it appears that it is thoroughly riven and divided into two sub-disciplines, namely physical geography and cultural geography... A faultline runs through the middle of the world of geography... Academics form themselves into sub-cultures, with distinctly different kinds of mental outlook, and different criteria for making judgements about what is acceptable and what is unacceptable evidence. None more so perhaps than geography.[30]

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[27] Zevi, *Architecture as Space*.
[28] Zevi, *Architecture as Space*, 22.
[29] Lefebvre, *The Production of Space*.

The crucial difference between an architectural understanding of space, and a human geographer's understanding of space, is that for the architect, space must always be thought of in at least the third dimension. As far as interiors go, space is conceptually confined to the space between the walls, occasionally leaking out windows or through glass walls. By contrast, geographers and human geographers are studying the world from the point of view of a two-dimensional mapping exercise, where walls are absent, eg the edge of a space may be the political boundary between, say, France and Germany. This is a strictly non-architectural use of the word space, and its use in the human geographic sense throws doubt on the relevance of theorists such as Lefebvre whose work is closely followed by human geographers. The common use of the word space in human geography certainly has little relevance to spatial connections within atria as noted in this research. Yet, the absence of any differentiation between three-dimensional architectural space, and the very different two-dimensional, more geographical use of the same word, renders it very difficult to ascertain whether the same phenomena are being discussed. For these reasons, Deleuze, Derrida, Lefebvre et al. are not seen as reliable or relevant literary sources to this area of study.

3.12 Sequential spatial theory

Moretti

Luigi Moretti examined the joining sequence of individual volumes of space within a building, noting their positioning in relation to other volumes, and indeed to the entire sequence of movements from one volume to another. [31] Moretti also articulated a vision of spatial inversion where a void is rendered as a solid (figures 3.4, 3.5 and 4.2).

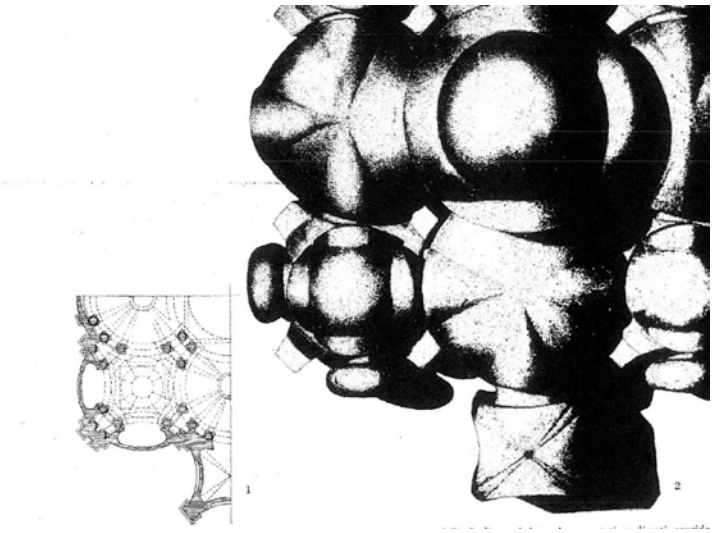

Figure 3.4 Analysis of spaces within church of St Filippo Neri, analysis by Luigi Moretti. Moretti has taken the plan at left and created a 3-D volume of the interior, at right. For the full model, refer figure 4.2. Source: Bucci and Mulazzani, in *Moretti.*

[30] Linzey, *The Point of Te Papa,* 231.

[31] Luigi Moretti, an Italian architect who completed works for Mussolini in the Second World War, was one of the chief protagonists and writers for a short-lived Italian magazine of the 1950s, *Spazio*, which existed for only 7 issues between 1952 and 1955.

In his article *Structure and sequence in space,*[32] Moretti examines spatial sequencing in architecture and recognised the difficulties of using a 2D paper-based system to represent an inherently 3D physical and physiological representation of the void. In an effort to represent the form and sequence of spaces, he crafted out of plaster molds a series of spatial inverts. With the building subtracted from view in these depictions, the space itself was on view, molded as a solid ie a three-dimensional (3-D) positive solid modeling of those spaces, enabled the visualization of space to be understood more simply.[33] Moretti's methods of spatial inversion provide a useful approach to advance spatial analysis which is considered later in this thesis.

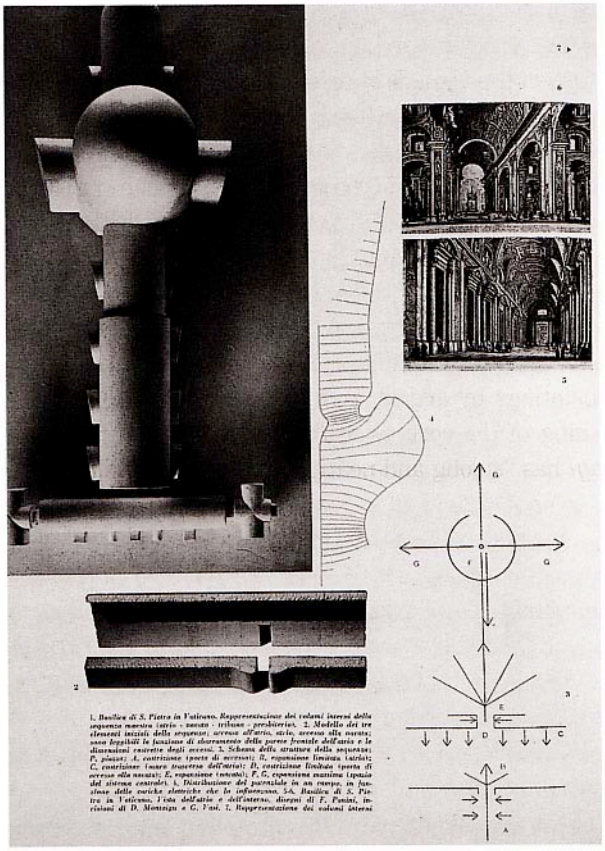

Figure 3.5 Analysis of spaces within St Peter's basilica, Rome, by Luigi Moretti. The diagrams at lower right depict the 'compression' of the space at an entry point into the Basilica. The photo at upper left shows the subsequent very different model of the interior. Source: Bucci amd Mulazzani, *Moretti,* p147.

[32] Luigi Moretti, originally published as *Strutture e sequenze di spazi,* in *Spazio.*

[33] Bucci and Mulazzani, *Luigi Moretti – Works and Writings.* As a result of his strongly pro-Fascist tendencies and non-denunciation of Fascism (one of the projects that Moretti undertook was the personal gymnasium of Il Duce, Mussolini), Moretti was subsequently

3.14 Practising architect's spatial theories

Practioners and Pracademics

Key architects who have analysed and published their own work as theorists and as educators are reviewed below.

Herman Hertzberger

Hertzberger, a key figure in the Netherlands architectural scene in both building and teaching, is one of the few architects who actively discuss space, including connections within collected spaces. Hertzberger and his practice have been awarded many prestigious awards,[34] with numerous houses, schools, and social projects such as old age homes, urban design studies, theatres, libraries etc, and commercial buildings, including Central Beheer (a seminal Dutch example of office building).[35] Hertzberger incorporates public atrium space to the heart of his building designs and thus air and light to the heart of the workplace in the Netherlands. He writes knowingly on the importance of architectural space, addressing the creation of space as an almost poetic reaction. Hertzberger's understanding of the subject matter has helped with understanding the complexities and possibilities of space, but his assertions - while based on feelings and intuition - make little explicit reference to visual or physical connectivity.

Colin St John Wilson

St John Wilson has an impressive record of work on schools and housing, but in particular his speciality of libraries. He also writes thoughtfully about the importance and articulation of architectural space. He is most well known as the architect of the new British Library at St Pancras in London, a project taking 36 years.[36]

St John Wilson's work with library design, in particular the large internal spaces within the new British Library, has provided a precedent for the thoughtful design of atrium spaces in public buildings.[37]

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shunned by the post-war Italian architectural press. In recent years his work, both written and constructed, has enjoyed a resurgence in popularity; this English translation of his collected works, has made his collected work available to a wider audience.

[34] Hertzberger, *Projekte 1990-1995*, 70-71. Hertzberger has lectured at the Academy of Architecture in Amsterdam since 1966 and is a visiting professor at Delft, Geneva, and various American and Canadian universites. Hertzberger's awards include the AJ van Eck Prize in 1980, the Merkelbach prize in 1985, the Richard Neutra Award for Professional Excellence in 1989, the Premio Europa Architettura / Berlage vlag / BNA-kubus / Beton Prijs in 1991 and the Prix Rehan in 1993.

[35] Hertzberger, *Projekte 1990-1995*, 70-71. Particularly notable projects include the Benelux Merkenbureau office building in the Hague (1990-1993), and the Centraal Beheer office building in Apeddoorn (1968-1972, and extension 1990-1994).

[36] St John Wilson, *The Design and Construction of The British Library*, 13. St John Wilson and Leslie Martin were selected for the British Library project in 1962, following a 1951 proposal to relocate the Library of the British Museum away from the British Museum. The British Library project had numerous changes both internally and externally: the project continued to be refined over 35 years, and was a spatially sophisticated project on completion, with carefully crafted internal spaces.

[37] Stonehouse, *Colin St John Wilson – Buildings and Projects.*

Figure 3.6 British Library atrium – architect: Colin St John Wilson. The British Library reading room shown here offers a generous supply of fresh air, large amounts of filtered daylight, high levels of security, a mixing of different research groups via the influx of circulation routes, and a social place to gather. As the culmination of over 35 years of design decisions, this space is an exceptionally well-considered atrium. Top lit from heavily filtered and reflected indirect daylight, circulation links several floors together, enabling connectivity in both the physical and visual sense of the word. It culminates in a series of spaces that encourage use of this space as a social gathering place. *Source: Stonehouse, Colin St John Wilson buildings and projects, p339.*

With the completed British Library opening in 1997 the internal spaces of the British Library have extremely well-considered spaces:[38]

[38] Stage 1 of the British Library opened in November 24, 1997. Sir Colin Alexander St John "Sandy" Wilson (b.1922, d. 2007) received a huge amount of flack from both the public and the establishment, with the Prince of Wales likening the British Library to a

the vision has been realised with some of the most marvelous interiors of 20th- century British architecture. These spaces, starting with the entrance hall, are literally sensational, visceral, and a reminder that great architecture, like music, can have an immediate emotional impact, that sublime sense of amazement and of being momentarily overwhelmed.[39]

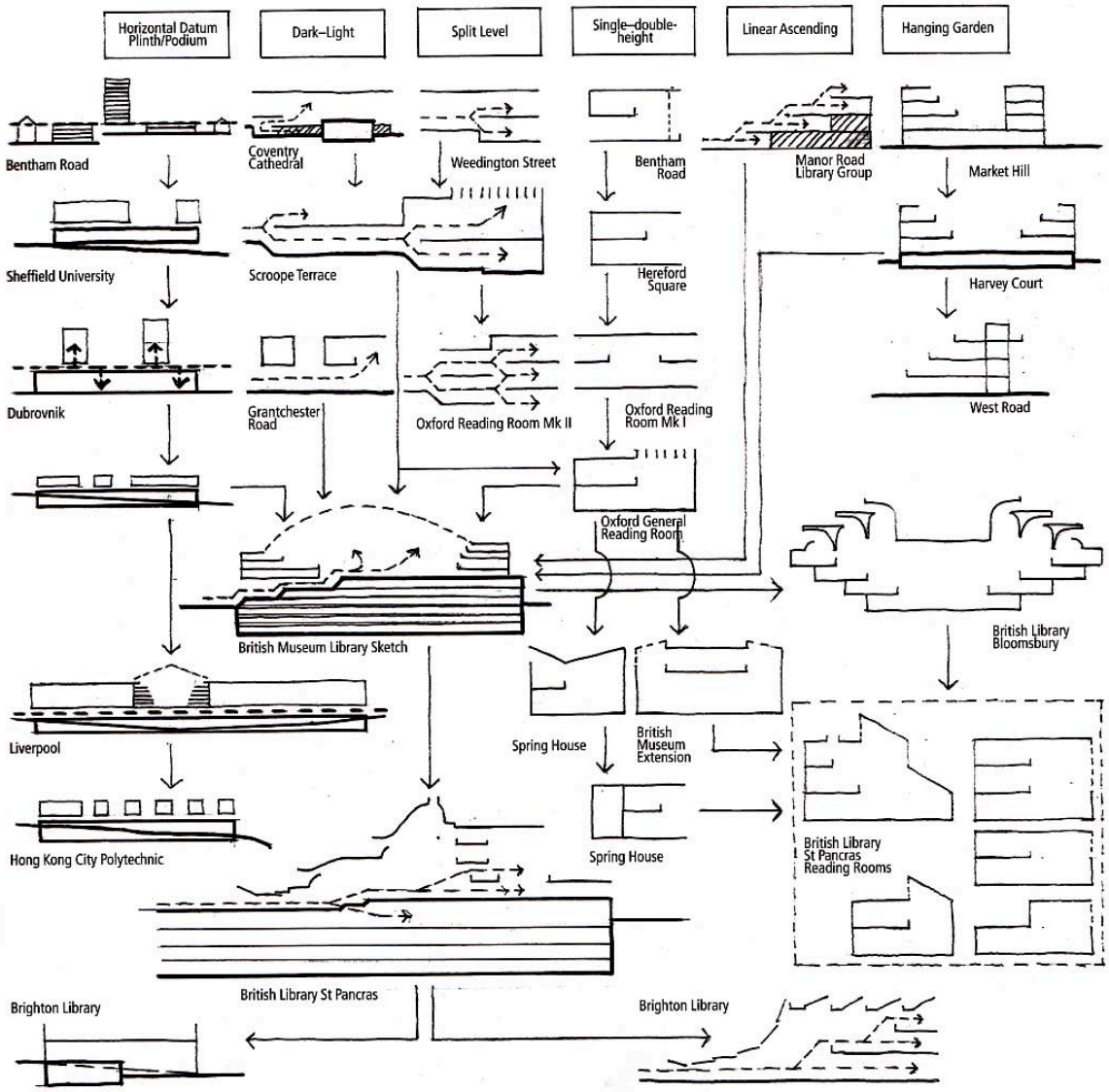

Figure 3.7 Section Genealogy – of all major projects by Colin St John Wilson. This sketch shows his emphasis on circulation routes through a wide variety of buildings, and their treatment in terms of spatial volumes enclosed and connectivity of the pedestrian routes as a means of experiencing the buildings. Although St John Wilson does not describe his work in these terms, this genealogy of

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"vast municipal fire station" and as "an academy for secret police" before the Library was opened to the public. Since the opening however, there has been recognition and admiration both for the building (short-listed for the Stirling Prize in 1998) and for Wilson (knighted in 1998 for services to Architecture).

[39] Richard McCormack, in Obituary: "Sir Colin St John Wilson, Architect who endured 'thirty years' war' before his scheme for the British Library was finally built", *The Independent*, Saturday, 19 May 2007 http://www.independent.co.uk/news/obituaries/sir-colin-st-john-

work clearly shows a progression towards increased connectivity between major public spaces, and a sequential linking of spaces via circulation. *Source: Stonehouse, Colin St John Wilson buildings and projects, p37.*

St John Wilson, during the decades of library work, also produced two key books[40] detailing his personal architectural philosophy, and unfortunately died before he could finish his magnum opus, a volume of his collected works (posthumously completed by Stonehouse).[41]

The simple grading of his projects via tables and sketches, such as shown in Figure 3.7, has allowed complex issues to be simply understood, and this was also helpful for this research study on atria. It is from these three volumes that key information is drawn about his work and his design beliefs that he incorporated into his completed works.[42]

John Portman

Portman, the architect / developer whose projects brought the word atrium back into common usage, and arguably the 'inventor' of the modern atrium, is a strong proponent for atrium space within hotels and public buildings.[43] Portman has, like most architects, mainly published his actual built projects but has also written about the space within.[44] Raini, his biographer, states that he is: "…one of the most important, if not the most important American architect of recent years, and one of the most significant voices in international late modern architecture." [45] Raini further notes that the "heroic dimension so characteristic of Portman" has sources of inspiration that : "…could well come straight from Piranesi's prints (bridges and balconies, with successive volumes crossing over the spaces), as well as from Rockefeller Centre…"[46] Portman notes his design rationale for an early atrium space:

> Vast interior spaces re-propose the concept of the square in American cities, where people go to "see and be seen". These covered spaces are at times quite large, but are usually connected by pedestrian walkways, seating areas, and intermediate areas, all linked together in a succession of surprisingly rich, and in most parts well-proportioned perspectives. The concept of community space is broken up into a

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wilson-449460.html "The library, in particular the humanities reading room, is the construction of the ideas Wilson set out in his essay "The Natural Imagination", one of a series of seminal essays in his book *Architectural Reflections* (1992)."

[40] St John Wilson, *Reflections*, and *The Other Tradition*.

[41] Stonehouse, *Colin St John Wilson: Buildings and Projects*.

[42] Stonehouse, *Colin St John Wilson.*

[43] Regency Hyatt House Hotel in Atlanta, Georgia, USA, in 1967 started the push towards modern atrium design. Hyatt (and their chief architect John Portman) used the word Atrium to describe the large glazed spaces, resurrecting it from archaic Roman usage.

[44] Portman, *John Portman projects.*

[45] Portman, *John Portman*, p13.

> large number of smaller spaces where people can meet in small groups and where one person can find a suitable place to be alone. Thus it is not a question of large, empty, lifeless spaces....[47]

Clearly Portman understands the importance of space as a place for the connection of people, but he does not elaborate on his methods of design. There seems little doubt that Portman knows how to maximize the excitement potential of atrium spaces from the aspect of sheer massive size: his projects range up to 20 or 30 stories tall, but appear from pictures to be blandly anonymous and full of life only on the ground floor. The opportunity to enliven upper floors with activity has not typically been taken. The limited scope of this research project means that no personal visits to Portman's atrium spaces have been made, and as such, a subjective view on what the ensuing spaces may 'feel' like cannot be made.

3.10 Urban Design spatial theories

Lynch, Gehl and Bentley

In contrast to the more philosophical aspects of two-dimensional space mapping in geography noted earlier, other areas of study appear more relevant. Crucial to the focus area of this thesis, some urban design studies have concentrated on the connections between the spaces concerned. While Jane Jacobs was highly influential in starting the discussion and developing understanding of the role the city plays in our urban lives,[48] Kevin Lynch's seminal urban design writings on the connections within a city are of most relevance to my research. Lynch notes that cities form in predictable ways, with orientation through a city via paths, edges, districts, nodes and landmarks.[49] People and thus street space travels along paths, and cities focus activities at the connecting nodes between the paths. This emphasis on connections within the walls of city streets has parallels with connections within walls of atrium buildings, which supports this thesis's underpinning assumption regarding the importance of physical and visual connectivity. Landmarks can and do exist within atria, and can guide people to their destination across the space. Atria are traversed along their edges, where spatial intensity is the strongest. This significant point is therefore raised: can atria be examined using urban design theories?

Ian Bentley and Jan Gehl have expanded on Lynch's urban design theories, and both have also published on the importance of public space within a city framework. Bentley notes the crucial importance of public space to the successful functioning of the modern city, which reinforces the need for enclosed public spaces, such as atria, to successfully function as social venues, as well as an answer to more prosaic programmatic needs.[50] Gehl's work

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[46] Portman, *John Portman*, p13.
[47] Portman, *John Portman*, p17.
[48] Jacobs, *The death and life of American cities*.
[49] Lynch, *The Image of the City*.
[50] Bentley, *Urban Transformations*.

in particular focuses on aspects of habitability, emphasizing place more than space, and is having a large effect on a number of cities around the world, as he brings his practice to work on projects in a most practical manner.[51]

The work of Lynch, Gehl and Bentley is primarily focused on the connections between buildings rather than the space within them, but in these urban design conditions, the connector is the space. While within a traditional building two spaces may simply connect through a doorway, in the city the connecting element between two spaces is a street – a space in itself. Their work has become a mainstay of urban design analysis of space and further research may be able to extrapolate elements of their work methods into analysis of large-scale atrium spaces. All three of these urban design specialists concentrate on turning space into place, allowing the simple expanse to gain personality and character, and thereby improving its amenity to the people who use it.

3.11 Spatial syntax theories

Hillier and Hanson

Following on from Lynch's work on paths and nodes, the techniques of Bill Hillier and Julienne Hanson use spatial plan analysis to analyse the social outcome of linking spaces.[52] The key texts on this subject are Hillier and Hanson's *The Social Logic of Space*, and Hanson's later work *Space is the Machine*. Hillier and Hanson's initial works considered the spatial arrangements between huts in an African village as a network of socio-spatial representation. They have since developed this understanding into a computerized scientific approach known as space syntax.[53] A number of other key researchers have written in the same field, supporting the theories that Hillier and Hanson had, and the study area is now treated as a means of spatial and geographic analysis through mathematical science, with an extensive field of published research. A more extensive review of space syntax methodology is made in the next chapter, in sections 4.4, 4.5, 4.6, and 4.7.

Space syntax focuses on the sequence and layout of the spaces encountered, rather than the buildings that surround the space. Space within buildings is not viewed politically, but focuses upon how it is occupied socially. This recognition that buildings are, above all, a means of assembling a social order is key to the understanding of space syntax. Hillier and Hanson note that: "The ordering of space in buildings is really about the ordering of

[51] Gehl, *Cities for People*.
[52] Hillier and Hanson, *Social Logic of Space.*
[53] Space Syntax is also the name of his research company, founded at the Bartlett in London but now with offices in various countries across the globe. To differentiate between the subject, and the company Hillier has formed of the same name, in this thesis Space Syntax will refer to the registered company, and space syntax (lower case) will refer to the field of study.

relations between people. Because this is so, society enters into the very nature and form of buildings. They are social objects through their very form as objects."[54]

Hillier argues, however, that "Architecture is not a 'social art'", recognizing that not only do we shape buildings, "simply because buildings are important visual symbols of society", but also because, "through the ways in which buildings, individually and collectively, create and order space, we are able to recognise society: that it exists and has a certain form."[55] Hillier argues that the creation and ordering of space is central to the social functioning of our populations, and helps create our society.

The analysis of space can be likened to a grammar of architecture, broken into a series of components which relate together. These are then represented by mapping tools that describe the connections between spaces, and are represented as networks. While the initial experiments in space syntax were with inter-connected dwellings in a small African village, space syntax has evolved now to resolve complex urban planning issues. The more well-connected a space is, the better the space will be in terms of human social interactions. Used extensively in recent years in large scale urban design projects, it can provide an accurate indication of spatial success of urban environments via extensive computer modeling.[56] Hillier and Hanson note the reluctance of architects to discuss space as a series of connections:

> When space does feature in architectural criticism, it is usually at the level of the surfaces that define the space, rather than in terms of the space itself; when it is about space, it is usually at the level of the individual space rather than at the level of the system of spatial relations that constitute the building or settlement.[57]

Space syntax has been developed to note this and to resolve the impasse. Space is described mathematically, and graphically, rather than solely via reproduction of enclosing walls. Hillier observes that: "The concept of 'spatial enclosure' for example, which describes space by reference to the physical forms that define it rather than as a thing itself, is the commonest architectural way of describing space."[58] This common architectural form may be the space between a collection of buildings, or the arrangement of rooms within a building. Hillier notes the deeper underlying significance of his work:

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[54] Hillier and Hanson, *Social Logic of Space*, p2.
[55] Hillier and Hanson, *The Social Logic of Space*, p2.
[56] Hillier and the Space Syntax team were instrumental in resolving the re-planning of the pedestrian links in London at Kings Cross and Trafalgar Square.
[57] Hillier and Hanson, *The Social Logic of Space*, p3.

> We should therefore in principle expect that the relations between people and space, if there is one, will be found at the level of the configuration of space rather than the individual space. This is confirmed by common sense. Individual spaces place little limit on human activity, except for those of size and shape. But the relation between space and social existence does not lie at the level of the individual space, or individual activity. It lies in the relations between configurations of people and configurations of space.[59]

While proving to be influential in modern town planning terms, Hillier and Hanson's space syntax language currently offers the most relevant means of analysis of atrium spaces in terms of connections between spaces either internal or external. It is a system which has been applied in universities throughout the world: in situations oriented towards a simple two dimensional planning of spatial connections.

As yet it has not been made to work seamlessly with the more fully three dimensional spaces of atria: as such, it is conflicted. It may not work at all. But potentially, as Psarra notes:

> Investing on how buildings and cities are understood as parts coming together to construct wholes, space syntax is not so far away from a theoretical tradition of how mind and body interact through abstract relations. In the absence of a theory and a method that relates geometrical to spatial properties, we have buried the physical attributes and the intelligibility of form into the notion we are analytically strong, that is, embodied space, as the only feature of architecture and configuration.[60]

As one of the few found works linking architectural space and social space, **space syntax becomes the primary means of examining atrium design in this present study.**

3.12 Emerging spatial theories

Leupen, Stephens and van Schaik

Recent spatial theories widen the current thinking upon architectural space. Bernard Leupen notes that with the prevalence of modular methods of buildings, and frame methods of construction, habitable void can be thought of as a Generic Space that flows between the frames.[61] The flexibility of these Frames defines Alterable space and therefore make possible Extendable space. While his thinking of space as a generic void has more in

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[58] Hillier, *Space is the Machine*, p27.
[59] Hillier, *Space is the Machine*, 29-31.
[60] Psarra, *The Ghost of Conceived Space.*
[61] Leupen, *Frame and Generic Space*.

common with Gideon and Zevi than with the politically charged arguments of Lefebvre, it acknowledges that the use of frames can conceptually capture space without full boundaries being necessary.

Leon Van Schaik proposes a system of spatial intelligence, as he describes it, where our memories and understanding of space may remain separate from the space itself.[62] Van Schaik's theory is a small step rather than a giant leap forward, but does acknowledge the role that the imagination and memory can play in the conceptualizing of space.

By comparison Quentin Stevens has a lighter approach to spatial theory and notes that the 'ludic' qualities, or playfulness of a space, can be acknowledged and utilized to enliven our cities.[63] This is has potential to create dynamic new ways of interacting with space in the city, especially in the realm of public space, but is not pursued in this thesis.

3.13 Atria spatial theories

Bednar, Saxon, and Shum

The few examples of analysis of the space within atria are disappointingly functional. There are two key writers on the subject of public atria spaces, residing either side of the Atlantic – Michael Bednar (American)[64] and Richard Saxon (British).[65] Both writers are architects in commercial practices, who focus on practical issues of atrium design rather than theorized space.

Saxon writes informatively on the subject of atria and their classification of uses, but analyses them exclusively from the point of view of the building type, without attributing any qualities of the atrium to the space itself. Bednar also writes on the practicalities of atrium design, forgoing considerations of the space within. They focus on strictly practical matters such as means of escape in a fire: neither Saxon nor Bednar acknowledge that there are any particularly special spatial qualities of their chosen topic. More disappointingly, neither examine issues of connectivity within atria spaces. Shum, whose undergraduate report on the history and future of atria is an excellent resource especially with its relevance to the New Zealand condition, seizes on the special qualities of atria to a greater extent than either Bednar or Saxon. Shum argued that the time had come for a greater use of

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[62] van Schaik, *Spatial intelligence – new futures for architecture.*
[63] Stevens, *Ludic Space – exploring the potential of public spaces.*
[64] Bednar, *The New Atrium.*
[65] Saxon, *Atrium Buildings.*

atria, but it seems she was disappointingly premature in her prediction. [66] Atria are still uncommon in New Zealand.

Further work on atria has been published, but mainly on subjects peripheral to the study contained in my thesis. Work that deals solely with the practical aspects of atrium design such as daylight, air flow through atria or the requirements for vigilance in fire design is not a prime area of my research and so has not been included here.[67] Overall however, there is a lack of analytical, academic discussion of atria from a social or spatial point of view. Despite the exciting nature of spatial experiences within atria, the topic sits exposed: it is not a subject to yet have been seriously broached by scholars. It is therefore an area ripe for exploration.

3.14 A spatial theory table

Key spatial theorists investigated

The following table (ref table 3.1) sets out a brief summary of the key spatial theorists, analysts, and practitioners investigated in the course of this research. Although it may appear to some eyes to present a smorgasbord of architectural theory, it is not. It is a heavily and exhaustively researched list of a number of leading spatial theories and theorists, primarily from the last 100 years, according to the use and concept of space as a moldable 'object.' It is ordered chronologically, relating to when the work was first published in its native language. Please note that translations into English may have taken place some time later for some of the works, and that the translation date is shown in parentheses.

Table 3.1 Spatial Theories and Theorists, chronologically

Author	Title	Published (translated)	Summary of Spatial Concepts	Connect ivity
Giedion	Space, Time and Architecture; [68] Architecture and the Phenomena of Transition[69]	1941	Three primary space conceptions: space-radiating volumes, interior space, architecture as both volume and interior space.	no

[66] Shum, *Atrium: a place for space.*
[67] Schmitz, *Tageslicht im Atrium.*
[68] Giedion, *Space Time and Architecture.*
[69] Giedion, *Architecture and the Phenomena of Transition.*

Moretti	Spazio[70] – magazine articles published	1953	Examines the structure, sequence and form of space, demonstrated spatial volume via an inverting of solid and void.	yes
Kahn	various	1954	The street is a community room.. Its ceiling is the sky. A well-respected architect and also a teacher, Kahn argued that light is space.[71]	n/a
Zevi	Architecture as Space[72]	1957 (1974)	Abstract space can be political, or institutional, but it is still homogenous, and flows from room to room.	no
Bachelard	The Poetics of Space[73]	1958 (1994)	Space has qualities, and classified as intimate space, exterior space, and poetic space.	no
Lynch	The Image of the City[74]	1960	Cities are composed of paths, edges, districts, nodes and landmarks	yes
Lefebvre	The Production of Space[75]	1974 (1991)	Argues that the production of space is a political act. Note that while Lefebvre discusses space, this is not specifically architectural space.	no
Arnheim	Dynamics of Architectural Form[76]	1977	Space is empty and does not generate influence on its own.	no
Dickson	The Mastery of Space[77]	1982	Space has a poetic dimension and	no

[70] Moretti, *Strutture e sequenze di spazi.*
[71] Lobell, *Between Silence and Light: Spirit in the architecture of Louis Kahn.*
[72] Zevi, *Architecture as Space: How to Look at Architecture.*
[73] Bachelard, *Poetics of Space.*
[74] Lynch, *The Image of the City.*
[75] Lefebvre, *The Production of Space.*
[76] Arnheim, *Dynamics of Architectural Form.*
[77] Dickson, *The Mastery of Space.*

			can be represented by colours and vectors as a means of understanding the mastery of space.	
Hillier and Hanson	The Social Logic of Space;[78] Space is the Machine[79]	1984	Space is treated as a computational algorithm and can be analysed as networks, using isovists, axial space, and creating convex space.	yes
Saxon	Atrium Buildings[80]	1983	Discusses atria	no
Bednar	The New Atrium[81]	1986	Discusses atria	no
Gehl	Life between buildings;[82] New city spaces;[83] Cities for people[84]	1987, 2000, 2010	City spaces to be crafted to suit people	yes
Portman	John Portman[85]	1990	Discusses atria	no
Shum	Atriums: place for space[86]	1990	Discusses atria	no
Hertzberger	Lessons[87]	1991	Advocates that space is the opportunity for the unexpected, and acknowledges that space is special.	yes
St John Wilson	Reflections[88]	1992	Acknowledges that enclosed space has special qualities, and that enclosed space can be enhanced by building structures within a	yes

[78] Hillier and Hanson, *The Social Logic of Space*.
[79] Hillier, *Space is the Machine*.
[80] Saxon, *Atrium Buildings Development and Design*.
[81] Bednar, *The New Atrium*.
[82] Gehl, *Life between buildings*.
[83] Gehl, *New city spaces*.
[84] Gehl, *Cities for people*.
[85] Riani, John Portman.
[86] Shum, *Atrium: a Place for Space.*
[87] Hertzberger, *Lessons*.
[88] St John Wilson, *Reflections*.

			space.	
Rowe and Slutzky	Transparency[89]	1997	Shallow space and phenomenological transparency via visual characteristics of overlapping spatial volumes	no
Benedikt, Turner, Batty, Ratti, Modello etc	Various papers at Space Syntax Symposia	1999-2012	Discusses isovist analysis and other space syntax methods	yes
Bentley	Urban Transformations[90]	1999	Pushes the urban design theory that public space is crucial to the success of a city.	no
Leupen	Frame and generic space[91]	2006	Frames define Alterable space, extendable space, and Generic Space that flows between the frames.	no
Stevens	Ludic space - exploring the potential of public spaces [92]	2007	Notes that other aspects of space should be considered, such as the playfulness of space, and proposes that this be known as Ludic space.	no
van Schaik	Spatial intelligence[93]	2008	Proposes a theory of Spatial Intelligence.	no

3.15 Useful spatial theories

What theorists are useful?

The summary in the final column of Table 3.1 gives an indication whether connectivity of any form is acknowledged and encouraged within the spatial theory presented. Lack of any discussion of connectivity within the theory or work presented has meant that further investigation of that particular research method has not

[89] Rowe and Slutzky, *Transparency.*
[90] Bentley, *Urban Transformations: Power, People and Urban Design.*
[91] Leupen, *Frame and Generic Space.*
[92] Stevens, *The Ludic City – exploring the potential of public spaces.*
[93] van Schaik, *Spatial Intelligence.*

been carried forward. Conversely, there are also some positive leads regarding connectivity with table 3.1 identifying some key theorists, with highly relevant theories to follow further. St John Wilson and Hertzberger both write of the special nature of the large interior space, but operate on feelings and intuition rather than an applicable system of analysis suitable for atria. Lynch's work has led towards urban design wayfinding theory. The most useful methods appear to be Moretti's spatial inversions, and most importantly, Hillier and Hanson's methods of space syntax. These methods will be examined in greater detail in the next chapter.

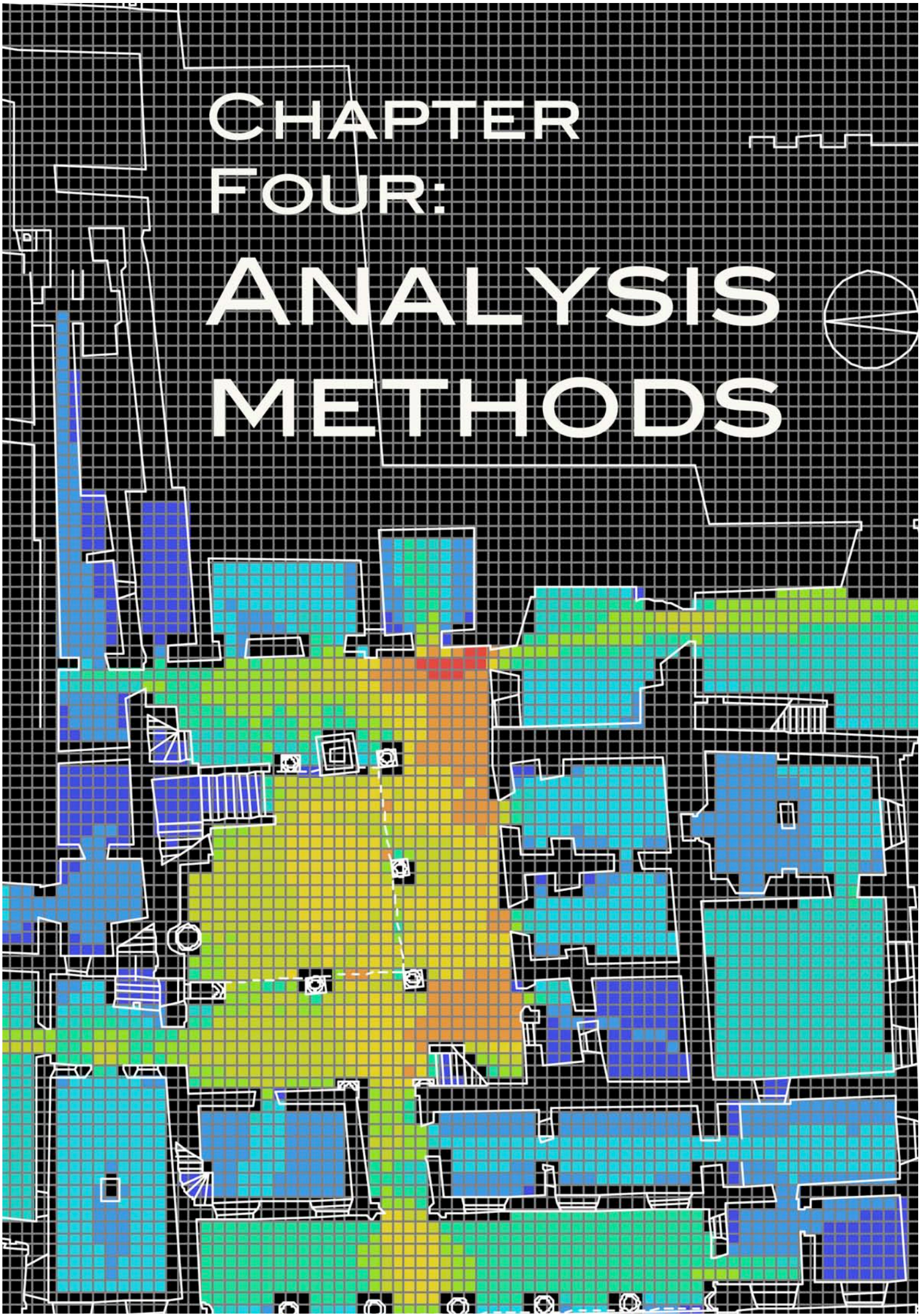
3.16 Summary

In this chapter a lengthy review of theorists and theories regarding spatial analysis has been undertaken. The aim of the chapter was to search for means of analysis key to the successful planning of atrium spaces. In particular the work of the selected relevant theorists, Hillier and Hanson, and Moretti stand out as most relevant, particularly in regard to connectivity within space.

While Moretti uses the physical model and drawn diagrams to draw attention to the spatial sequencing being undertaken in the buildings he selects, Hillier and Hanson's system of identifying connectivity via space syntax has been widely tested and proven in two dimensional mapping, but has not yet been developed into three-dimensional spaces such as the atrium spaces proposed in this research. Moretti, and Hiller and Hanson write of the importance of connection and sequence in spatial forms. All of these authors therefore acknowledge the importance of connections within space, which supports the underlying assumption of this thesis.

In the next chapter these selected methods of analysis will be examined in greater detail.

Chapter Four: Analysis Methods



Chapter 4: Analysis methods

4.1 Introduction

In the previous chapter, a short history of spatial theories was outlined, and their applicability to the research on connections within atria was discussed. It relates to Objective 3 of the major objectives as set out in section 1.5. Some theorists were acknowledged as relevant, particularly Moretti's spatial inversion technique, and Hillier / Hanson's space syntax methods. The aim of this chapter is to explore which spatial analysis tools work within atrium spaces and how can they assist a search for connectivity. How can 3-D digital tools provide a more robust analysis Most importantly, how do they address the key research question: *How can multi level atrium spaces be analysed for connectivity?*

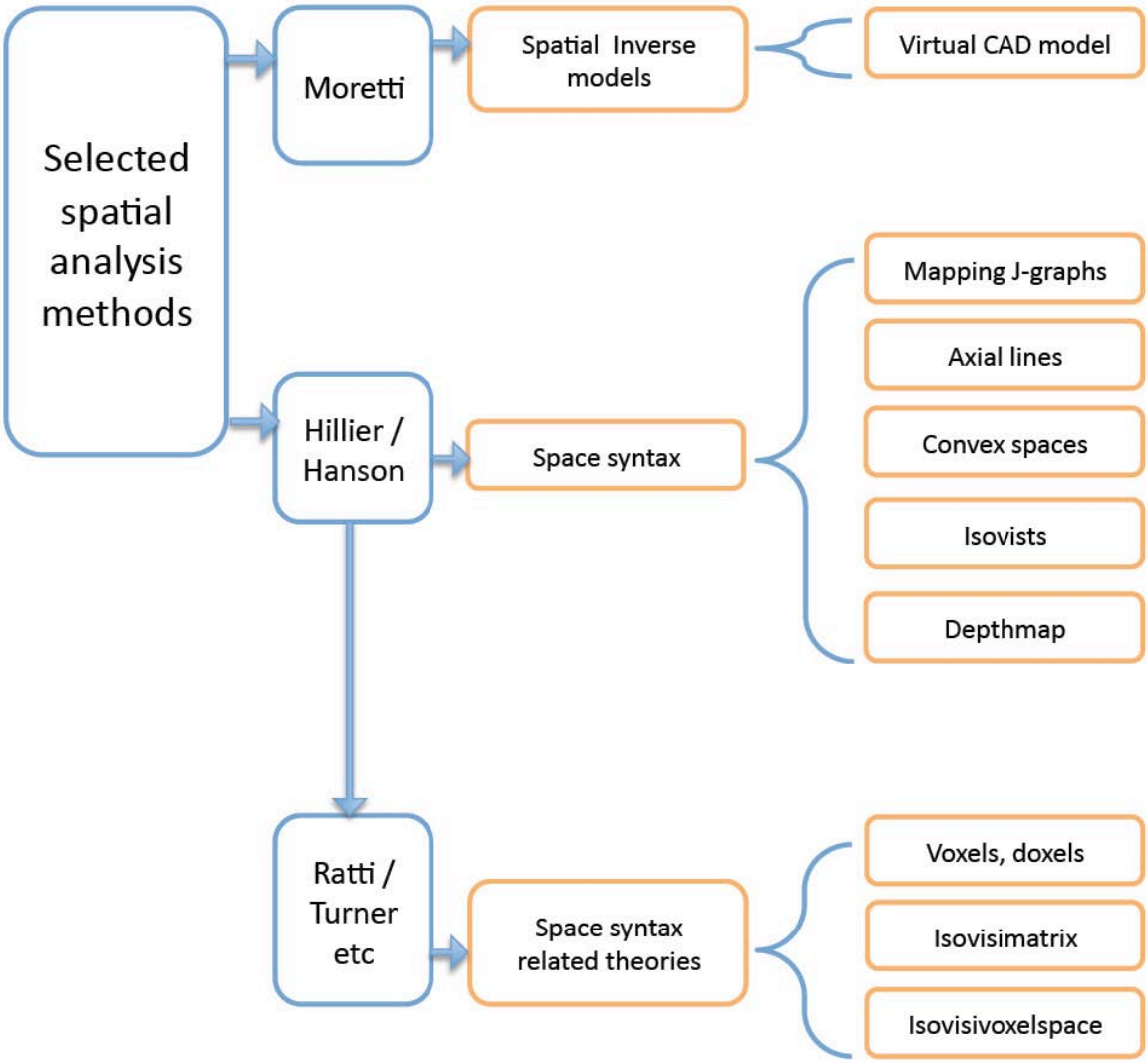


Figure 4.1 Chapter 4 structure diagram The diagram here shows the different type of analysis methods that are examined in this chapter. Each specialist theorist is introduced and then their analysis methods examined.

The main methods selected are in the field of space syntax, a fast-growing but still-emerging field. Space syntax is an important area to investigate, as it allows space to be evaluated in the design phases of a building. The thesis tests existing methods of spatial analysis as an application of contemporary technology, onto a growing area of technology within New Zealand's built environment. Old and new methods of space syntax are trialed, in particular isovist field analysis is considered to be the most relevant to location of connections and circulation within atria, isovist field analysis is focused on in particular. Space syntax is of crucial importance here because issues of spatial and social connectivity are instilled into the very basis of the syntactic system. New and emerging methods of space syntax analysis are also discussed. The methods selected are applied to case studies in chapter 5, with the results of these tests discussed in chapter 6. 2.9

4.2 Differences between physical and visual connectivity

As previously noted under aims and intents (ref 1.3), this research examines physical and visual connectivity. Connectivity, introduced and defined in section 2.9, refers to the amount of connections that one place has to another, as well as the ease of the connection. The type of connections may vary: visual connectivity refers to how much one place can be viewed from other places, while physical connectivity involves actual physical connections. A strong physical connectivity implies the number of, or directness of the physical connections.[1] By comparison, a weak physical connection may refer to an indirect route, perhaps through other intermediary spaces, or even other intermediary floor levels.

The key difference therefore between analyzing a single-level building and a multi-level building, is the variation between areas of physical and visual connectivity. When on a single level, the physical connection paths can co-exist on the same paths as the lines of visual connection, ie where you can see (visually connect), you can walk to (physically connect). This does not apply in an atrium. You can see (visually connect to) a lot more than you can possibly walk (physically connect) to. Therefore, a key concept for understanding atria is the concept of connectivity.

In an atrium there may well be physical connections such as stairs - to physically connect one space to another. Visually, however, this is quite different; from the edge of an atrium, physical and visual worlds no longer coexist. Visually, from the edge of the atrium, whole new vistas open up down or up to multiple other levels, all visibly connected at once. The use of a simple plan, denoting both visual and physical connectivity, is not clear-

[1] Marshall, 2005. *Streets and Patterns*. As defined by Marshall, "connectivity" refers solely to the *number* of connections to and from a particular place, whereas "permeability" refers to the *capacity* of those connections to carry people or vehicles.

cut in the case of an atrium. A plan showing physically accessible space will be restricted compared to one that recognises space as a purely visual phenomena.

Writing on problems associated with space syntax analysis of multi-level wayfinding in a test case building, Holscher et al. discussed the importance of positioning of stairs:

> In general, stairways should help to integrate vertical information while exploring multilevel buildings and they should aid spatial experience of the layout with respect to the building as a whole. When planning the design of staircases, architects generally have to take into account two key design parameters. First, the constructional and representational form of its appearance have to be highlighted with respect to the function of the building, and second, the position of the stairway has to be optimised in relation to the user's activity within the layout. The positioning of the stairs in the building is critical.[2]

The concepts noted here are just as important, and arguably more so, for atria rather than stairs. Indeed, the word stair could be replaced with atrium throughout that paragraph, and it makes the concept highly relevant to this study. The position of the *atrium* is indeed critical to aid the spatial experience of the building, as well as the position of the stair *within* the atrium.

4.3 Application of Moretti's spatial theories to this work

Moretti's work outlined in his *Spazio* articles in the 1950s brought a fresh approach to spatial analysis.[3] Moretti notes the great enfilade of spaces in Roman Catholic churches, a hierarchical solution suitable for the church's ritual concern with progressively more sacred altars. His simple plaster models of the spatial inverse of churches in Rome simply and effectively showed the volumes of space within the church, and clarified their sequential relationship to each other. His technique modeled the invisible space as solid plaster. Once seen, it is relatively simple to conceptually visualize for certain other buildings, although increasingly spatially complex buildings would require increasingly complex casting techniques. Artist Rachel Whiteread has used a similar technique for her art, although she models spaces at full size, rather than as a scale model: and her subject matter is normally simpler spaces: under a chair, an entire small room, and in one case, an entire house.[4]

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[2] Holscher, et al., *Challenges in multilevel wayfinding,* 13.
[3] Bucci and Mulazzani, *Luigi Moretti Works and Writings*.
[4] Whiteread's works include *Ghost* (modeling of the 'negative space' within interior of a room – 1990), *House* (the interior of a Victorian-era terrace house – 1993), *Untitled – One Hundred Spaces* (resin casts of the area beneath 100 chairs – 1997), and the *Holocaust Monument: Nameless Library* (a work of cast books and bookshelving – 2000). Her work is celebrated as a commentary on the traces that humanity leaves on ordinary rooms or objects.

Complex models would be much easier to replicate with modern technology. The Moretti method of plaster molding, while appropriate to the 1950s, could be reproduced relatively simply by constructing a 3-D CAD model of the building, and then subtracting that building from a solid: leaving a positive model of the void. The resultant model would be the spatial inverse of the original building, and could be viewed on screen and visually rotated and manipulated.

This Moretti method has some simple, intriguing possibilities. In a further step, the spatial inverse model could be then printed out via a CAD-CAM driven 3-D printer, and thus actually reproduced in the full three dimensions - dimensionally scaled, but proportionally accurate. Small simple spaces could be easily created by this method, and whether rendered on screen or printed as a 3-D object, they would be relatively simple to comprehend.

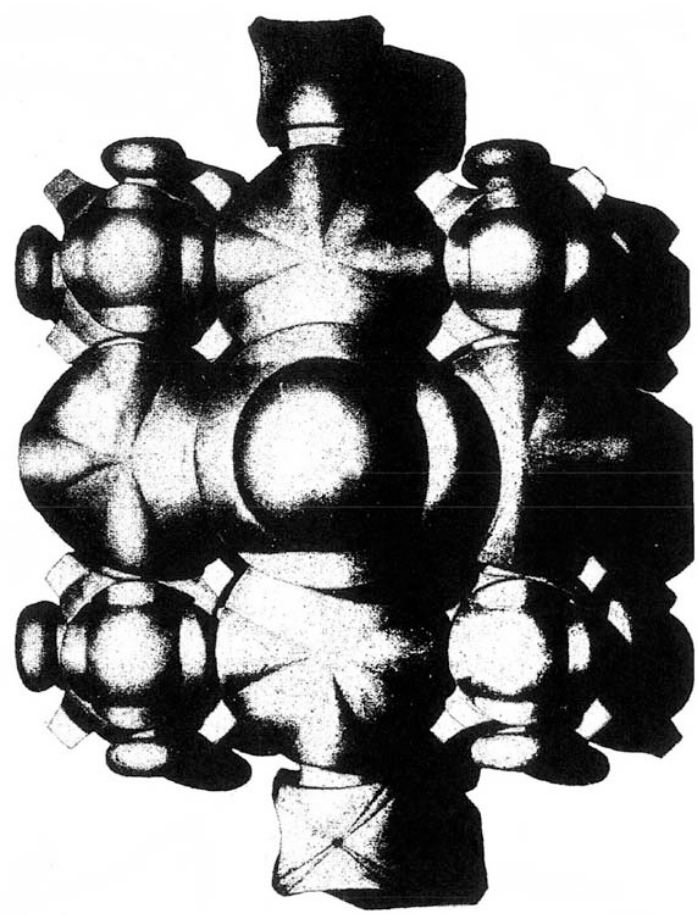

Figure 4.2 "Volumi degli spazi interni della chiesa di S.Filippo Neri, modello costruito sul progetto,"[5] Overall model of church shown here. For plan of source, refer figure 3.4. *Source: Strutture e sequenze di spazi,* in Evans, *Projective Cast.*

As far as can be discerned, Moretti's methods have not been used since the 1950s, and so there is not a body of literature to review regarding his work. There is however, a strong similarity to the work of Rachel Whiteread,

[5] Moretti, Spazio, *Strutture e sequenze di spazi, (Structure and Sequence of Space)* translation: the constructed model project of the volumes of the interior spaces of the church of St Phillip Black.

although if there is a link back to his work from hers, it is unstated. Whiteread's intention is to create art: to express the space within or between or beneath objects, rather than to try and reveal any possibilities of connectivity. Although casting the negative space in exactly the same manner as Moretti, her purpose appears very different. Unlike Moretti, her boundaries can be illusory rather than factual (the model of the space of the underside of a chair, for instance, has artificial boundaries imposed at the legs of the chair). The key, possibly only text regarding Moretti is the large volume on his life's work, by Bucci and Mulazzani. In this volume, two long essays on his architecture and his life are written, but little is said about his theories and work on sequential spacing and connectivity.

While this resulting inverted space of a simple single-level void could be understood, the complexity of something like a multi-level atrium space may well be difficult to comprehend as a positive model of a void. On the more intricate spaces, such as the case studies being looked at in chapter 5, the process would be difficult and the resulting 3-D rendered 'spatial inverts' may take some time and considerable money to complete. Furthermore, with complex spaces the resulting forms may prove unintelligible, as issues around the exact extent of boundary perforation render the precise edge of the atrium indistinct. This research acknowledges that the Moretti technique holds promise. Moretti-style 3-D virtual CAD models have been trialed for the case studies (refer Figure 5.1.21), but for cost and practicality reasons as noted above, this route has not been pursued exhaustively in this thesis research.

4.4 Application of space syntax theories to my work

Hillier and Hanson's space syntax theories and other's subsequent work in this field, appear to be the most relevant to this thesis. The methods and procedures of space syntax have been debated at length over many years and there is a considerable volume of literature and discussion around every part of their suggested processes. As noted previously, the key texts are their own *The Social Logic of Space* and *Space is the Machine*, but there is also strong topic-related publication within the journal of *Environment and Planning B*, and within the last few years, an online *Journal of Space Syntax* has also been established. It is especially with Hillier's "relational schemes of space" that the designing and ordering of buildings is inherent:

> Spatial patterns in buildings also arise as elaborations on primitive logical emergents from the physical act of building. ...The origins of relational schemes of space lie somewhere between the ordering capacities of the mind and the spatial ordering inherent in the ways in which social relationships are

> realised in space. [...] The passage from the simple space to a configuration of space is also the passage from the visible to the intelligible.[6]

This crucial point – not only making the invisible (space), visible (via space syntax), but also making the unintelligible, intelligible – is what drives the success of the space syntax methodology. Hillier notes that:

> Space is, however, a more inherently difficult topic than physical form, for two reasons. First, space is vacancy rather than thing, so even its bodily nature is not obvious, and cannot be taken for granted in the way that we think we can take objects for granted. [...] Second, related spaces, almost by definition, cannot be seen all at once, but require movement from one to another to experience the whole.[7]

The use of Hillier and Hanson's system of syntax allowed the space of city streets, building corridors, and suburban footpath networks to become visible, and by that means, for the city, to become understood. Their observation that movement from one space to another is a key means of experiencing space itself is a key part of the focus of this thesis – that connection and therefore circulation through space, are key ingredients of successful spatial functioning. While analysis of external constructed spaces is known as alpha analysis, the corresponding analysis indoors is known as gamma analysis.[8] Space syntax therefore is the most relevant method to use in this research on connectivity in atria.

However, it is noteworthy that some researchers who regularly use space syntax acknowledge it has some shortcomings. As Kerstin Sailor and Alan Penn remark,

> ..it could be argued that Space Syntax in general falls short of appreciating the particular, and more specifically, has mostly missed considering the more qualitative aspects of the relationship networks of people, organisations and space.[9]

Carlo Ratti also notes that increasingly complex analysis is available via new computer techniques, and "might throw a deeper insight into one of the fascinating questions that traditional space syntax has helped framing: what is the influence of urban configuration on social life?"[10] Ratti further proposes that space syntax has some inconsistencies, ie …topological representation of the city, application of space syntax to urban design, natural

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[6] Hillier, *Space is the Machine*, 18.
[7] Hillier, *Space is the Machine*, 18.
[8] Julienne Hanson, personal communication, regarding my query on space syntax terminology and some discrepancies in naming.
[9] Sailor and Penn, *Towards an Architectural Theory of Space and Organisations,* 8.
[10] Ratti, *Space Syntax: some inconsistencies,* 498.

movement and an unequally loaded urban grid, the visibility paradox, etc[11], and he suggested some alternative proposals. Hillier and Penn were quick to rebut these points, but the issues regarding certain conditions of axial line analysis have not yet been fully resolved.[12] Michael Ostwald discusses interpretations of justified plan graph theory, and poses the important question: "What does this really say about social patterns in space?"[13]

4.5 Space Syntax - Main conceptual ideas

The original method of space syntax was:

• Permeability analysis

The current focus of space syntax utilises three main concepts of space:

• Axial line analysis (straight line visibility, ie a possible path following a sight line),

• Convex space analysis (an occupiable void, ie where all points within a space are visible to all other points within the space),

• Isovist analysis (a visibility polygon, ie the field of view from any particular point).

These methods are discussed in more detail in the following paragraphs.

Permeability analysis and gamma analysis

Early space syntax discussion centred on relational aspects of permeable village settlement patterns, and was known as 'alpha analysis'. Later works in houses - examining room spaces - is a process known as 'gamma analysis', represented by relational graphs of permeability / connectivity. Hanson explains their analysis of interior space:

> Gamma analysis is… a method for splitting the building up into its component rooms and other spaces/areas (not all of which will necessarily be rooms, especially in an open plan building, but also in the circulation areas of a cellular building)… Unlike a settlement, buildings tend to have an envelope that separates the interior world from the exterior. That's why we gave the analysis a different name. To remind people that space in buildings usually serves a different social purpose from space in

[11] Ratti, *Space Syntax: some inconsistencies,* 498.
[12] Hillier and Penn, "Rejoinder to Carlo Ratti," 487-499.
[13] Ostwald, "The Mathematics of Spatial Configuration," 462.

> settlements.[14]

The permeability graphs lead to a concept known as the 'integration' of space – ie how far removed one space is from another. The shorter the path from a room back to the outside (or in this case, an atrium), the more well integrated the room is with the atrium space. Spaces that are hierachially nested - deep spaces - are denoted as being shallowly integrated. Space syntax goes further, and assigns numerical values to each level, so that every room can get an integration value but as this research is focusing on the atrium, rather than the rooms surrounding it, this research concentrates on this first step only. As a basic, simple, and relatively straightforward means of spatial analysis, graphs of spatial integration have been undertaken in this case studies. In order to make these more understandable, a process known as 'justification' is undertaken, and so 'justified permeability graphs' (or, J-graphs) of the room relationships are produced for comparison.[15] Hanson explains:

> A J-graph or justified permeability graph is a graph that plots either of these kinds of spatial relations (alpha or gamma) with each of the various spaces considered as nodes and all of the access points between them considered as links. A justified graph is made from a specific node i.e. place in the graph - any node can be the root. The reason for taking the outside, in the case of a building, is that usually it is informative (to a designer anyway) to see how a building modulates space for anyone coming into it from the outside.[16]

Michael Ostwald provides a clear explanatory diagram for the construction of a gamma plan, and a J-graph in his recent paper:[17]

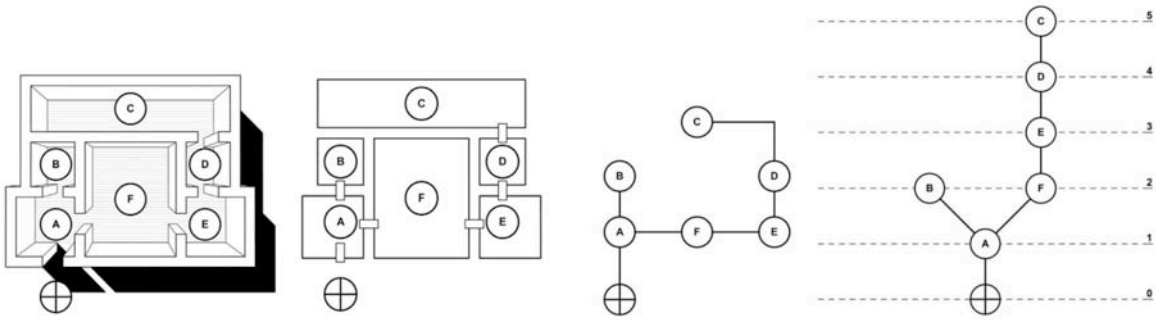


Fig. 3. Villa Alpha, cut-away view of the Architectural Plan

Fig. 4. Villa Alpha, view of the Convex Plan

Fig. 5. Villa Alpha, view of the Plan Graph

Fig. 6. Villa Alpha, view of Justified Plan Graph (exterior carrier)

[14] Julienne Hanson, personal email communication, 10 April 2012.
[15] The justified permeability graph (or as others, including Ostwald, put it: justified plan graph) is one in which the room relationships are stratified to similar visual levels, to enable depth of the space to be ascertained. This is demonstrated in examples in the case studies – refer chapter 5.1
[16] Julienne Hanson, personal email communication, 10 April 2012.
[17] Ostwald, 'The Mathematics of Spatial Configuration: p450-451.

Figure 4.3 Developing the justified plan graph (JPG), this simple four-step process clearly describes the process to derive a J-graph of a building interior. Some of the naming conventions vary. *Source: Ostwald, 2011.*

Other concepts such as the 'beadiness' of the connecting paths (number of rooms or places along a connecting path) or 'ringiness' (the propensity for connected spaces to link back to the start and create a ring of interconnected spaces) have been demonstrated by Hillier and Hanson to work well on (2-D) plan for urban situations such as a village, but would not work as well in a single large interconnected space such as a multi-level atrium due to the 3-D complexities inherent in an atrium. The possibility of multiple dimension ringiness in three dimensions means that these analyses have not been taken onward to that next level of complexity.

4.6 Axial Line analysis

Axial line analysis is highly relevant in a 2-D world where all floors are at the same level. The straight sightline implied by an axial line strongly indicates a possible and likely pedestrian path (refer figure 4.5). Numerous space syntax papers address the issues of computerizing the generation of axial lines, so that lines of visual and physical connectivity can be numerically analysed and values assigned. It works well on the primarily flat streetscape between buildings, and has been adapted to solve urban design issues (refer figure 4.3). It does not, however, translate well to 3-D spaces.

The generation of axial lines across an open atrium, where physical connection is vastly different from visual connection, almost immediately negate this as a means of 3-D analysis. Ratti also notes the drawback that that "The axial map discards not only metric information about the city plan, but also all 3D information. The height of buildings never appears in space syntax analysis."[18] In an extensively 3-D environment such as an atrium then, the axial map is not the best way forward.

[18] Ratti, "Space Syntax: some inconsistencies", 492.

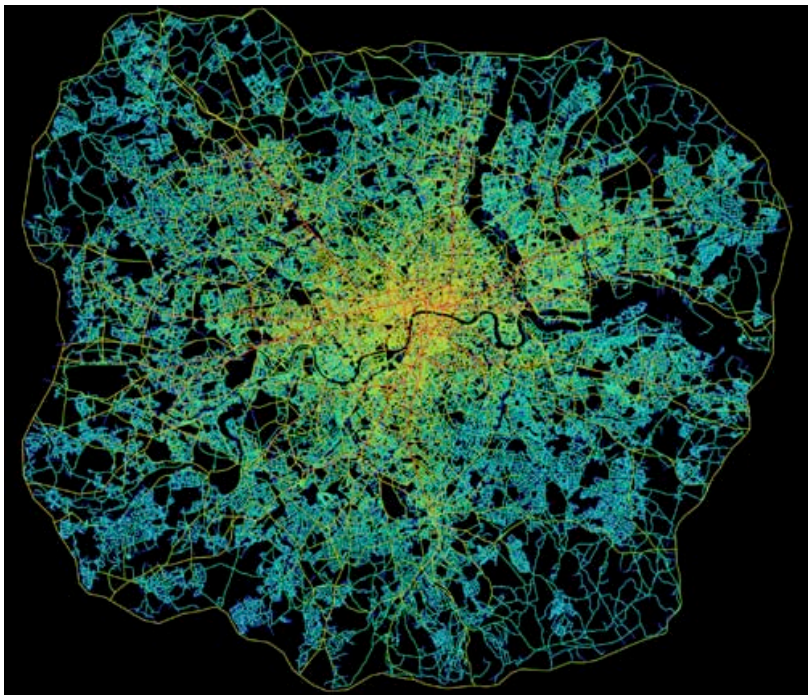
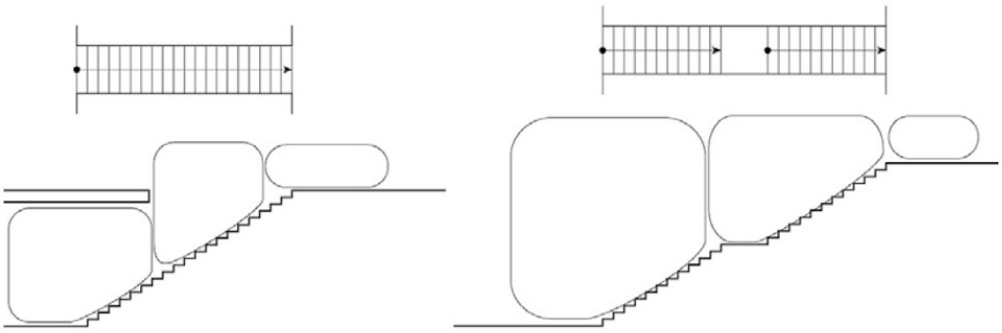


Figure 4.3 Axial map of London, street network of entire Greater London urban area, with roads analysed for their axial connectivity. Roads with more connectivity are shown in red or orange, while peripheral roads (used less) are green or blue. *Source: Spacesyntax.net*

4.7 Convex space analysis

Described as "the minimal set of shortest and fattest non-over lapping convex polygons covering a space", convex spaces are relatively simple to draw on a plan of a building. As a concept it is closely aligned with axial line analysis and works relatively well with 2-D flat space (refer figure 3.5).[19]

Although Koch has examined methods of analyzing convex space on staircases,[20] it is not a straightforward method to apply to a 3-D space such as an atrium (refer figure 4.4). For this reason, this means of analysis has not been pursued in this thesis.



[19] Parvin, et al., "Multilevel Pedestrian Movement: does visibility make any difference?", *040:0.*

Figure 4.4 Convex section diagrams through stairs. Koch's attempts to summarise the extent of convex spaces halfway down a staircase or escalator are one means of assigning convex spaces in 3-D. An attempt to assign spaces within different floors in a complex-shaped atria would not be a simple matter, with many possible interpretations of where spatial 'boundaries' were. *Source: Koch, Architectural Fashion Magazines.*

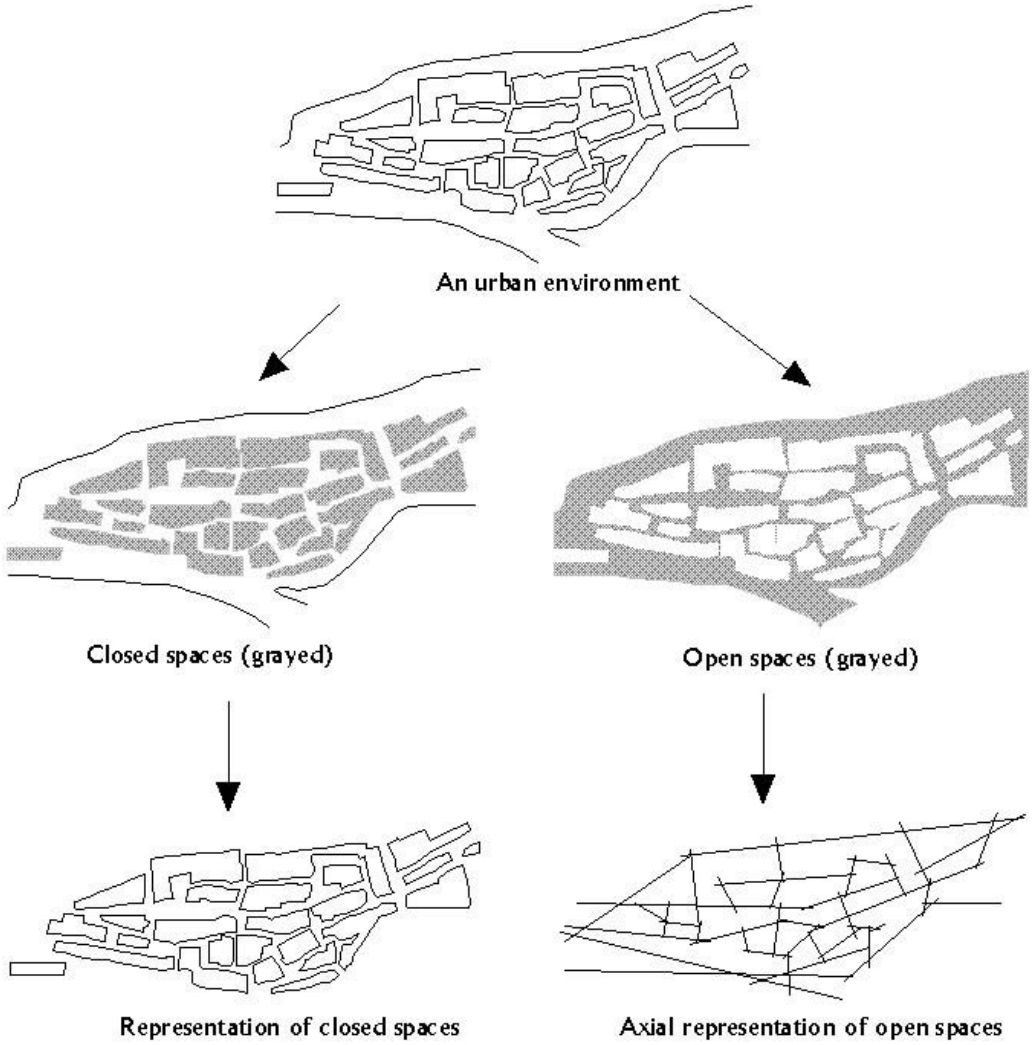


Figure 4.5 Similarities between Convex space (bottom left) and Axial lines (bottom right). *Source: Bin Jiang, http://www2.sis.pitt.edu/~cogmap/ncgia/jiang.html*

4.8 Isovists

The conceptual basis behind the isovist "has had a long history in both architecture and geography, as well as mathematics".[21] The use of isovists (a term first used by Tandy in 1967) [22] was strongly championed by Benedikt, an influential researcher in the field of space syntax, who first utilised isovists as a method of

[20] Koch, "Architectural Fashion Magazines", 057:05.
[21] Turner, et al., *From isovists to visibility graphs,* 103.
[22] Tandy, *The isovist method of landscape survey*, 9.

architectural space analysis.[23] This extends from Gordon Cullen's concepts of 'serial vision' which allowed the landscape to be defined as a series of related spaces.[24] Closely aligned with 'viewshed analysis' in landscape architecture, isovists also have parallels with a similar means of analysis used in GIS systems within geography. What is being seen in an isovist is only a 2-D plan depiction of a 3-D field: a moment in time, analysed as a thin, flat plane floating in space; rather than the full, 3-D immersion that is undertaken when a person walks within and fully experiences a space.

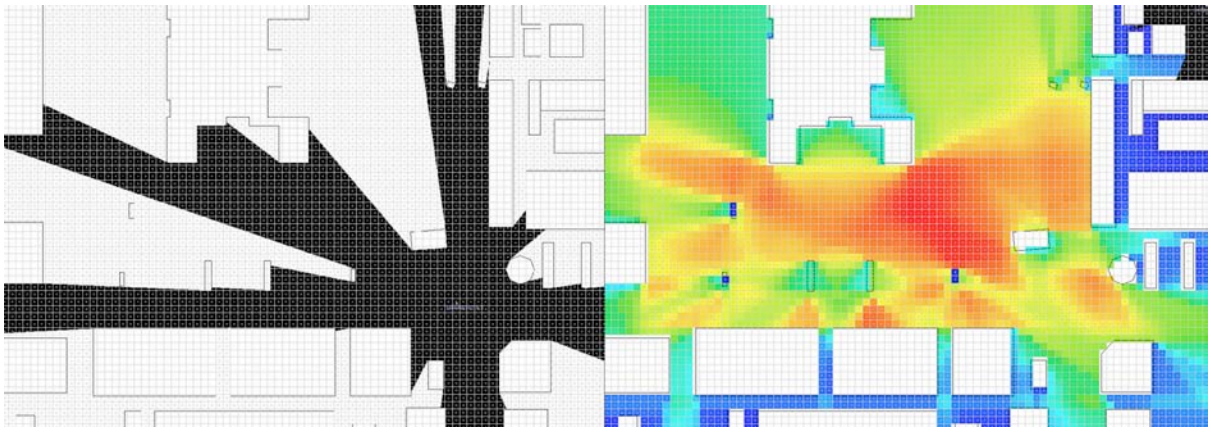


Figure 4.6 Isovist (black and white, at left) and visibility graph analysis (VGA) of isovist field (coloured, right). Both views are of the same urban space between buildings. The isovist shows the extent of views possible from a single point in space, while the VGA analyses the entire space for connectivity and plots the results in a coloured graph to depict where areas are hot (ie well-connected, shown in red) or cold (ie poorly connected, shown in blue).
Source: Karol Wawrzyniak, http://system.asknow.eu/users/s_karolwawrzyniak/

Despite this, there is also a strong relevance to its use in architecture. Turner et al note that:

> ...isovists are an intuitively attractive way of thinking about a spatial environment, because they provide a description of the space 'from inside', from a point of view of individuals, as they perceive it, interact with it, and move through it. As such isovists have particular relevance to architectural analysis.[25]

They further note that there are some limitations to their use in architecture, in particular their current inability to be depicted in 3-D:

> ...there is little in the way of a theoretical framework to allow one to say how isovists relate to social or aesthetic matters. To overcome these limitations we introduce a broader methodology, one that

[23] Benedikt, "To take hold of space: isovists and isovist fields," 47-65.
[24] Cullen, *The Concise Townscape*.
[25] Turner et al., "From isovists to visibility graphs," 103.

> embraces how visual characteristics at locations are related and one that has a potential 'social' interpretation.[26]

This broader methodology is to "use isovists to derive a visibility graph of the environment - the graph of mutually visible locations in a spatial layout."[27] While 'social and aesthetic matters' identified by Turner et al have still to be addressed, the more immediate issue in this present study remains: how to deal with the transition from 2-D to 3-D.

4.9 Paradox – 2-D or 3-D

While space syntax has become an invaluable tool for some architects and city planners, who use it to analyse how possible variations to roads and buildings can help facilitate better urban environments to cities, its use has so far been confined primarily to 2 dimensional arrays – ie that of the X and Y dimensions only. As Peponis et al note: "The analysis is limited to two-dimensional (2-D) planar relationships even though the ideas presented can potentially be extended to deal with three dimensions or be applied to an analysis of sections."[28] The system can therefore (theoretically at least) be extended to the third dimension.

Space Syntax 3-D developments

Visiting the Space Syntax laboratories in London in 2007, I enquired if their success with two dimensional (2-D) mapping was to be extended to three dimensional structures (such as the atria examined in this thesis). Staff there confirmed to me that, due to the complicated nature of fully three dimensional space, an analysis using space syntax in the third, Z dimension, had not yet been undertaken. Prof Michael Batty, of the Bartlett's space syntax program, has subsequently noted that "space syntax has never moved into the third dimension and there isn't much that figures in that domain" and "in general I am not so sure that there is anything that takes space syntax type stuff into 3D except the whole solid geometry route which is rather different."[29] This 'solid geometry' may be thought of as similar to Moretti's methods.

Dr Kerstin Sailor, a graduate now working at the Space Syntax laboratory, also noted that 3D mapping of spaces using Space Syntax was (in 2010) not yet possible with current technology, but was quite positive about the need for a method to be evolved:

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[26] Turner et al., "From isovists to visibility graphs," 104.
[27] Turner et al., "From isovists to visibility graphs," 104.
[28] Peponis et al., "On the description of shape and spatial configuration inside buildings" 762.

> Your question on 3D analysis is indeed an interesting one, but I fear there is no easy answer to it. I am also teaching in the Space Syntax related MSc Advanced Architectural Studies at UCL and some of our students bring up this topic repeatedly, but due to software/technical issues it is not easily resolved. We simply don't have any models to work with 3D at the moment, and it doesn't look as if anything like that would be available anytime soon. This doesn't mean that it's impossible, or undesirable. Quite the contrary, we'd love to be able to analyse interior spaces with 3D - but the state of the software is not there yet.[30]

This opens up avenues for possible future research. Members of the space syntax community are also aware of this. Penn suggests that 3-D analysis may lead to a better understanding of intelligibility in three-dimensional environments.[31] Chung and Penn examined the South Bank Centre in London, noting the difficulties of intelligibility in multi-layer environments.[32] Parvin et al "conducted several studies in the high-density context of Hong Kong, where they used space syntax methods and found significant correlation between the configurational properties and density of movement."[33] Rashid also notes similar matters in his study of the Peach Tree Centre in Atlanta.[34] Gabay and Aravot note that "From the problems of the Barbican, the South Bank… and the Peach Centre… "it is clear that the issue of intelligibility is crucial in multi-layer environments."[35]

As a proposed solution, Holscher et al. noted that, it "appears highly relevant to model carefully the vertical connections in a set of space syntax analyses of the building..."[36] and their paper notes the methods taken. Their linkages are in the form of simple connecting lines denoting staircases, but do not take into account of the staircase space itself, such as a staircase in an atrium. Desyllas studied the visual fields of the interior circulation spaces in the multilevel system of the Wales Millenium Centre. He "applied the VGA tool to link all floors of the complex so as to transform the multilevel system into a graph of one spatial system…"[37] A similar linking of floors through vertical circulation paths have been attempted in the case studies, but the results were not convincing. Further work is needed to truly take circulation into account.

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[29] Michael Batty, email dialogue, 27 January 2009.
[30] Kerstin Sailor, email dialogue, 12 May 2010.
[31] Penn et al, 1997, as noted in Gabay, Ra'anan; Aravot, Iris; 2003, "Using Space Syntax to understand multi-layer, high-density urban environments"; p73.4
[32] Chung and Penn, "Integrated multi-level circulation.."
[33] Parvin et al., "Multilevel Pedestrian Movement: does visibility make any difference?*," 040:03*
[34] Rashid, "Revisiting John Portman's Peach Tree Centre..."
[35] Gabay, Ra'anan; Aravot, Iris; 2003, "Using Space Syntax to understand multi-layer, high-density urban environments", p73.2
[36] Holscher, Brosamle, and Vrachliotis, "Challenges in multilevel wayfinding", 3.
[37] Desyllas 1999 as referenced in Parvin, Ye, and Jia, "Multilevel Pedestrian Movement: does visibility make any difference?" *40:03*

Significantly, Wang et al. explore the correlation between Lynch and Hillier, acknowledging the influence that Lynch's seminal principles still have on the field of urban design, and its extension into space syntax. Wang et al. conclude that they are "highly correlated and supplement each other."[38] Wang et al. further note that "Current space syntax fails to express and explain such a three-dimensional change in space. So it is an inevitable direction for space syntax to integrate the three-dimensional information to analyze urban space configuration."[39]

While the 'traditional' space syntax methodologies are therefore somewhat limited when it comes to analysis of more complex three-dimensional spaces, methods of analyzing 3-D spaces are already being examined in multi-level floor systems. Key researchers agree then, that 3-D analysis is a relevant method to explore, and advancements in this field are discussed shortly.

4.10 Establishing isovist fields

Having resolved that the best way of analyzing atrium space may be the isovist field, there is a further choice as to how this may be done. Benedikt "identified six geometric measures from which isovist fields could be established" according to Batty: [40]

- area,
- perimeter,
- occlusivity (or length of occluding boundaries within the isovist),
- variance and skewness of the radial distances around each vantage point,
- a measure of compactness called circularity, defined as the ration of the square of the perimeter to area.[41]

Batty identifies six key promising areas regarding isovists, which he believes are worth exploring further:

- better measures of shape,
- morphologies of moving viewsheds,
- scale variation,
- boundary effects,
- partition problems,
- influence of isovist theory in design.[42]

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[38] Wang, Zhu, and Mao, "The Three-Dimensional Extension of Space Syntax," *048:03.*
[39] Wang, Zhu, and Mao, "The Three-Dimensional Extension of Space Syntax," *048:02.*
[40] Batty, "Exploring isovist fields", 127.
[41] Benedikt, "To take hold of Space".
[42] Batty, "Exploring isovist fields", 149.

Georgiadou identifies several analysis techniques which enable space syntax to analyse social potential:

- convex map representation,
- selected local and global connections,
- concept of mean depth and the justified depth map,
- isovist analysis occurring in areas with high human density,
- viewability of integrated spaces from staff areas,
- concepts of reversed buildings,
- weak and strong program buildings.[43]

All of these analysis techniques are been arrived at separately, but there are considerable overlaps and similarities between some of the techniques. Some are more relevant than others. Aims are still essentially similar: to clarify the accuracy of space syntax methodologies. While Holscher et al note that space syntax can be used for wayfinding behavior, establishing that it is "necessary to capture the properties of *path sequences* rather than looking only at the spatial properties of single points or areas",[44] Sailor has also used space syntax methods in conjunction with way-finding techniques, but so far she has restricted this to examining single level floors.

Finally, while Gabay notes that stairs etc are an issue, he has not considered the case of atrium space. "Often, escalators, stairs, ramps and lifts are removed from the main axis, and not always visible."[45] In atria, to ignore vertical means of circulation such as stairs or lifts, would negate the very thing this research is trying to analyse. In order to concentrate on the analysis methods with the greatest apparent degree of subject overlap with the research method aims, and assessing the methods available, it was resolved to trial Batty's suggestion of "morphologies of moving viewsheds" in order to highlight the visibility of vertical circulation points such as stairs and lifts - it appears to offer the most relevant approach in terms of a visitor approaching a circulation path within an atrium.

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[43] Georgiadou, "The question of social potential in space use"; references Hillier and Hanson 1984, Hanson 1998, Peponis 1991, 1993, 1999, Benedikt 1979.
[44] Holscher, Brosamle, and Vrachliotis. "Challenges in multilevel wayfinding," 3.
[45] Gabay and Aravot. "Using Space Syntax to understand multi-layer, high-density urban environments", 73.5.

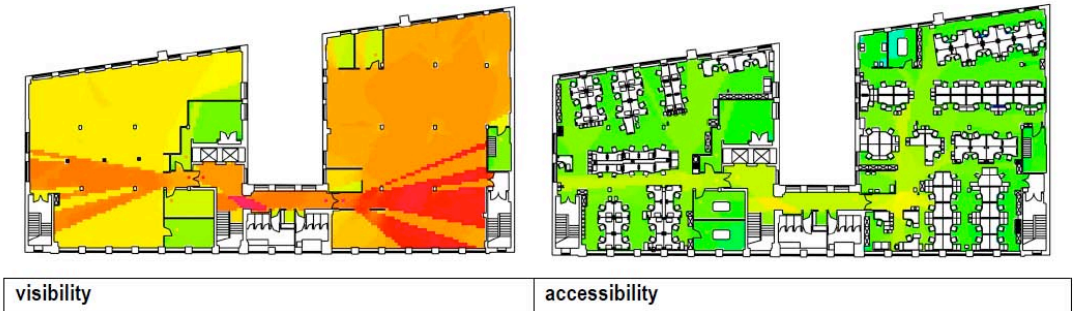

Figure 4.7 Visibility vs Accessiblity within a single space. This illustrates the difference between visibility and accessibility in a single-level environment (furniture present in the right hand plan provides a physical barrier not present in the visual gaze of the plan on the left).

Source: Sailor, *the Space-Organisation Relationship,* table 5-10.

4.11 Isovist fields, visibility graph analysis, and advanced methods

In recent years however, significant progress has been made on 3-D analysis of space by certain academics involved in the field of space syntax. Ratti and Richens examine the prospect of Digital Elevation Models (DEM) of the city,[46] Dalton and Bafna attempt to translate Lynch's theory into digital automatic parameterisation using the space syntax techniques,[47] and Fisher-Gewirtzman et al. developed an automatic spatial openness awareness index (SO).[48] Papers describing these methods were examined for applicability, but the relevance of these methods to atrium analysis did not appear to be high.

More relevant appears to be the work of Morello and Ratti reexamining Lynch's traditional five elements of urban analysis in the light of 3-D isovists.[49] Morello and Ratti add to existing terms such as isovist and isovist field, with new concepts such as *voxel* (a volumetric picture element ie a visual pixel), *isovisimatrix* (an isovisimatrix contains the values of visibility for each voxel), and extrapolate these to derive an *isovisivoxelspace* (which assigns a value of visibility to every voxel). This is further extended into the concepts of a *doxel* (dynamic voxel), which is a 4-D dataset or image sequence that represents 3-D space together with another dimension such as time. This would allow representation and analysis of space-time systems, and would be a useful means of analyzing atria if it were possible to access the software. Such a project is beyond the scope of my present study. There does not appear to be, as yet, any critical reviews of the work of Morell and Ratti. There may even be a deliberate attempt not to focus attention on the USA-based Ratti, following his publicized clash with

[46] Ratti and Richens, "Raster Analysis of Urban Form."
[47] Dalton and Bafna, "The syntactical image of the city."
[48] Fisher-Gewirtzman, "Using the Spatial Openness Metric.."
[49] Morello and Ratti, "Digital image of the city."

Hillier.[50] Ratti's work on isovimatrix etc does not appear to have yet been reviewed by the more 'traditional' space syntax research team in the UK.

While Morello and Ratti's paper does indeed provide a means of analyzing 3-D spaces, their analysis as shown is taken in a primarily 2-D area of Milan (ie single level), and as such extensive further work would need to be undertaken to fully analyse a more fully interactive 3-D space such as an atrium. Their integration with Lynch's simpler basic concepts of paths, nodes, districts, edges and landmarks show that isovist analysis is indeed a possible way forward. Creating an *isovisimatrix* of each space and cross referencing to Lynch's paths etc., could indeed give graphical or numerical values to connector elements such as stairs and elevators.
However, the advanced computer analysis methods available to Ratti (Head of Architecture at MIT) are not yet publicly available, so his approach has not been pursued in this thesis. Instead, what has been undertaken is an analysis using more established methods of space syntax based on isovist fields, such as VGA. Put simply, VGA "analyzes the extent to which any point in a spatial system is visible from any other."[51]

4.12 Resolving methods to be attempted

A common concept arising from these recommendations is the creation of a series of isovists following along a path sequence, to create a field. A similar series for each case study has been produced, from the front entry to each building, running up and into the atrium space. While this does not solve the 2-D / 3-D issues completely, it does address the issue of movement through a space to some degree. Isovist fields have also been produced in section as well as in plan, to test how well they can work in a fully 3-D environment such as a multi-level atrium.

Dalton and Dalton note some of the difficulties and some solutions for mapping atrium spaces: "in a multi-storey building with an atrium which permits the direct perception of spaces on the second… story but not provide direct access to them."[52] They note that the "ability to potentially be observed and interact with others is a component of a social space and yet in representational terms the two spaces have a large accessibility distance between them."[53] This is a spatial concept inherently core to the atrium paradox – that while visual connectivity can be extensive, physical connectivity is restricted.

Brosamle et al. examine issues of 'visitability', noting that: "The concept of "visitability" nicely condenses the

[50] Ratti, "Space Syntax: some inconsistencies, 487. Hillier and Penn, "Rejoinder to Carlo Ratti" 499.
[51] Parvin, Ye and Jia, "Multilevel Pedestrian Movement: does visibility make any difference?" *040:03.*
[52] Dalton and Dalton, "Solutions for Visibility Accessibility and Signage Problems" 23.1.

troika of functional, spatial and user group aspects."[54] They propose that "The underlying reasoning is always about making crucial parts easily visible from key points (like entrances or foyers) or to provide overview in important areas,"[55] further stating that:

> To actually measure the quality of a design solution implies to agree on certain criteria of evaluation. Based on the argumentation of Brösamle et al (2007) a straightforward way to measure mainstaircase-ness would be to look for the most integrated staircase with respect to the horizontal layout. …Another line of argumentation would emphasize functional requirements like the staircase that best connects all floors.[56]

Based on the many possible methods suggested above, it was resolved to create isovist fields based on a simple, direct route from entry to atrium and up the main stairs, in the sense of Batty's morphology of moving viewsheds. Batty's approach is obviously the most relevant because it highlights the visibility (or lack of visibility) in vertical circulation systems such as stairs, lifts, and escalators.

Some objectives for identifying connectivity were devised:

- Does the method identify visual connectivity – ie can it portray limits of sight?
- Does the method identify physical connectivity – ie can it be made to recognize staircases etc?
- Does the method actively identify these connective routes, or does it involve human agent intuition?
- Does the method produce feedback visually in some intuitive manner?

4.13 Depthmap

Late in the research period, authorisation was granted by Space Syntax's London base for this research to use UCL Depthmap, a computer-based software package developed by Turner in order to analyse the integration of spaces.[57] This software, licensed for use on this research project by UCL, is widely used by space syntax researchers around the world. It is not the only software available, but it is one of two that are readily available from UCL for non-commercial use. Other related or similar forms of software are being developed by other research teams, and in some cases the intellectual property and licensing of these other products is closely held by the Universities and commercial bodies concerned. Software such as that proposed by Ratti in creating

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[53] Dalton and Dalton, "Solutions for Visibility Accessibility and Signage Problems" 23.3.
[54] Brösamle, Mavridou, and Hölscher, "What Constitutes a Main Staircase?" 011:9.
[55] Brösamle, Mavridou, and Hölscher, "What Constitutes a Main Staircase?" 011:7.
[56] Brösamle, Mavridou, and Hölscher, "What Constitutes a Main Staircase?" 011:4.
[57] Turner, UCL Depthmap 10.

isovisivoxelspaces is still conceptual - and if it has been created, it has not been released on the market. For this project, the use of Depthmap was more than sufficient.

It was resolved to test this software on plan and section of the atrium case studies, and to compare it with the other methods noted here in this chapter. The Depthmap software is straightforward to use:

- input a DXF file of floor plan or section,
- assign a scale for the grid to cover the scope of the plan drawing,
- 'fill' the space with empty squares,
- set it to run the analysis.

The software mathematically analyses the connections and relative integration of each individual grid square highlighted within the plans, derives a number based on how many connections it has to neighbouring cells, and then depicts results by means of a colour band based on a sliding scale. This VGA plan output is the traditional form of space syntax output, more commonly seen on single storey buildings.

This system works well for 2-D spaces, and produces outputs with highly visible intuitive feedback in a rainbow of colour. Areas of increased connectivity are, by nature, 'hot-spots' and as such are depicted in warm reds and orange. Cooler, less active areas are marked with a dark blue colour. Intermediate activity areas are yellow and green. The resulting plan clearly indicates where the space is active, and where it is inactive.

4.14 Conclusion

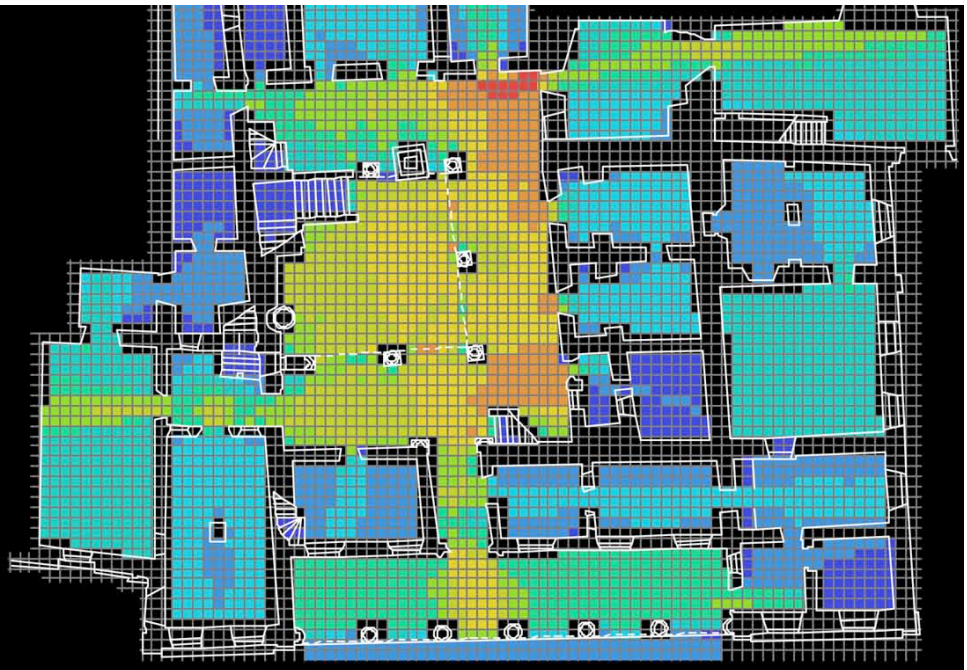
The aim of this chapter was to ascertain what methods of analysis are the most appropriate to the study of 3-D atrium spaces within the scope of this thesis project. A number of avenues were uncovered and while some of these methods are far beyond the reach of this thesis, a useful body of work involves the use of isovists and associated methods. These are used in the case studies in a later chapter, depicting the movement from the entry, towards and up the stairs, and hence taking a major role in identifying both visual and physical connectivity. This takes precedents from Batty's 'morphology of moving viewsheds', investigation of 'way-finding in multi-level spaces' by Holscher et al. (2009), visibility in multi-level spaces by Parvin et al. (2007), and determining what makes a main staircase by Brosamle et al. (2009).

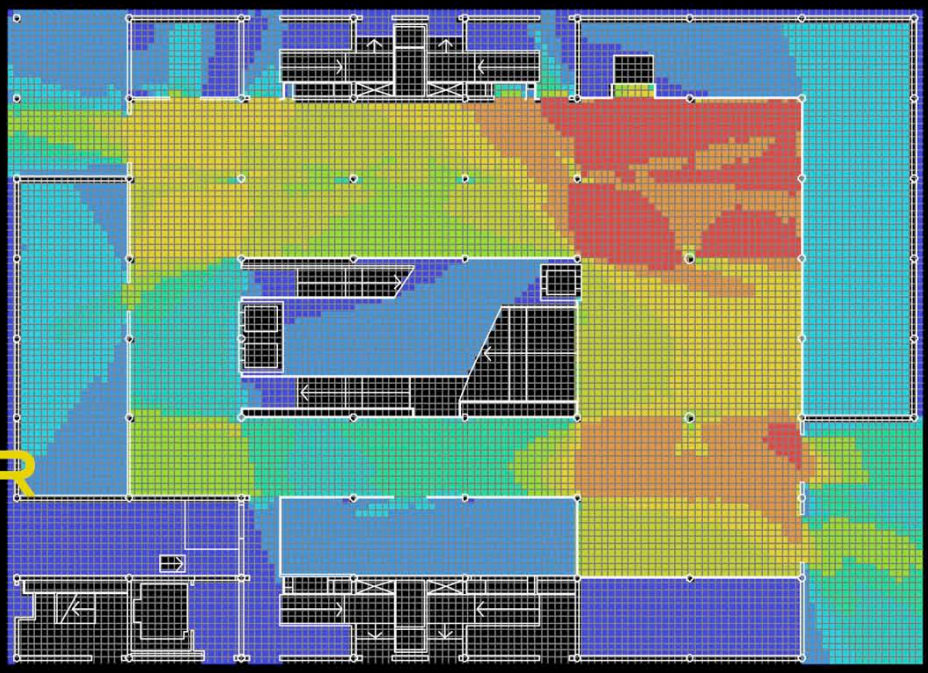
While a number of 'traditional' methods, such as Lynch's work, clearly identify a strong link between physical and visual connectivity, the use a single ground plane renders it difficult to be applied in a multi-level environment such as an atrium. Alternatively, the strong visual feedback of the completed isovist fields and the associated

VGA give a strong indication of connectivity within, by nature of the (largely self-explanatory) colour selection of the VGQ graphs.

Key objectives for this research were to identify a means by which each space (inherently invisible) could be made visible. Means of measuring connectivity are more readily identifiable if they are visually self-explanatory. To that end therefore, it was resolved to use methods that feedback to the user with visible and inherently self-explanatory manifestations of spatial connectivity. A system of objective criteria to compare different methods for measuring connectivity was produced.

The next chapter looks closer at three case studies of key examples of atrium design, utilizing selected spatial analysis tools to look for common factors within those spaces, in particular: their connectivity.





Chapter Five:

Case Studies

Chapter 5 - Case Studies

5.0 Introduction

In earlier chapters factors common in atrium design have been discussed, as well as the use of atria as places to admit daylight, fresh air, etc. The use of atria as a place to house and control the physical circulation of people within the building has been examined, and the use of the atrium as a social gathering place has been noted. Possible methods of analysis of atrium space have been proposed, and are utilized in this chapter. Both this and the following chapter meet the fourth major objective of the research study, as set out in section 1.5.

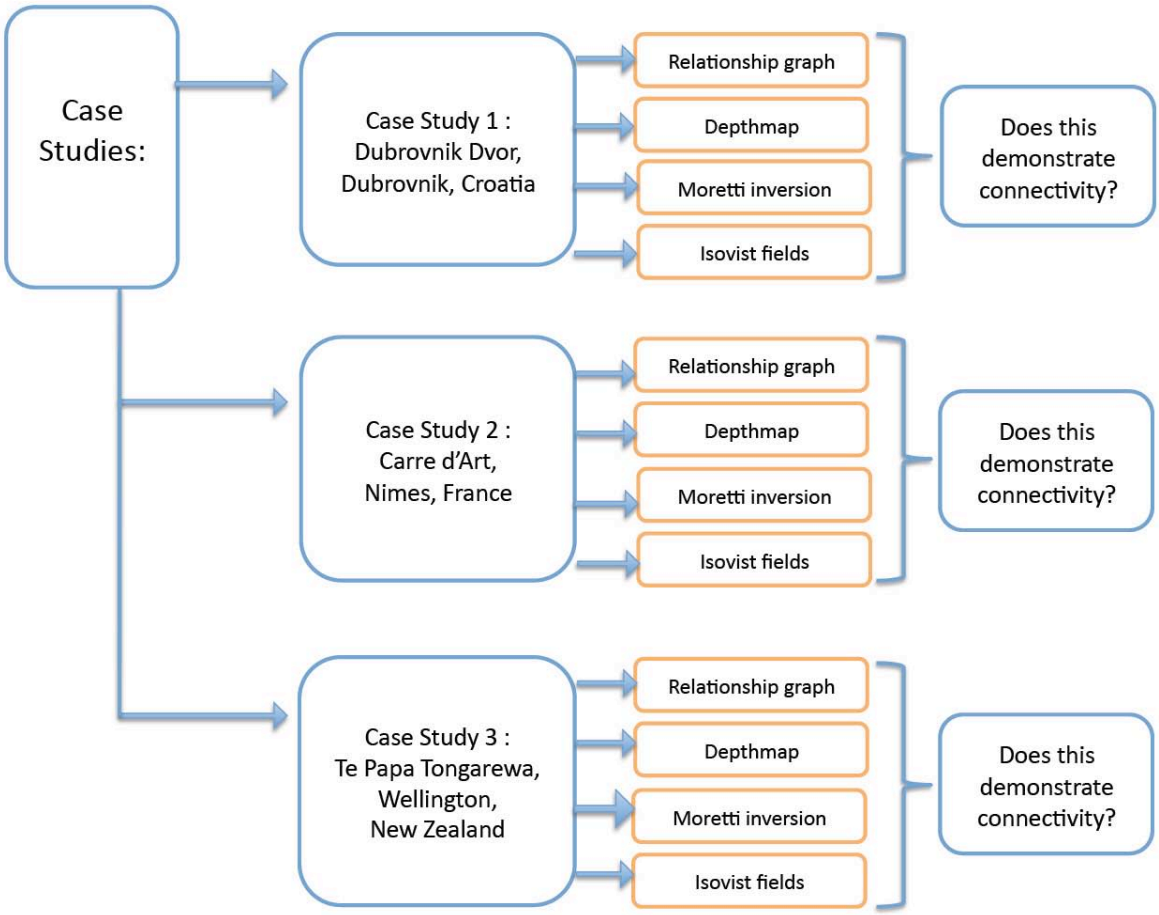


Figure 5.0 Chapter 5 structure diagram

The aim of this chapter is to examine three representative examples of public atria within public buildings, in particular to see how the treatment of circulation is handled within their respective atria, and how the space performs socially. As noted in chapter 2, only public atria are being examined as case studies. It is also an opportunity to test out how theorists' spatial analysis techniques perform on real life examples. Three case studies are examined, to give an overview of the issues encountered with atrium analysis.

Methodology of Case Studies

Wang and Groat note the primary characteristics of the case study as an investigation into the complex intersecting dynamics of a real-life example, dependent on its context and its setting.[1] They note that interpretive-historical and qualitative strategies can also add causality, and thus for this exercise, the research has a linear-analytic purpose, as explanatory, descriptive, and exploratory. Wang and Groat note that the five "particularly salient characteristics" of a case study to be:

1) a focus on either single of multiple cases, studied in their real life contexts;
2) the capacity to explain causal links;
3) the importance of theory development in the research design phase;
4) a reliance on multiple sources of evidence, with data needing to converge in a triangulating fashion; and
5) the power to generalize to theory.[2]

This approach has been taken. As noted in chapter 1 (section 1.7), these three public atria buildings have been very carefully selected from the very wide range of atria buildings that have been visited as part of this research exercise. The theory developed in the research design phase was that the connectivity within these atria would indicate increasing sociability. The method of assessing this was to find methods of identifying connectivity linkages within.

The case studies have been selected from buildings that are clearly open to the public, and where a public factor has always been part of the design. The three case studies were selected to represent three diverse types of atrium buildings. Two are in Europe, one is in New Zealand; two are modern, one is old. All have exceptional atrium qualities of one form or another.

Case Study One

The first case study is the Dubrovnik Dvor, or Rector's Palace in Dubrovnik, Croatia. This ancient courtyard fortress and civic, palace building has now been turned into a museum and performance venue. As a public atrium space in the true old Latin sense of the word, this is a traditional courtyard style atrium, open to the sky above, and representative of the many Medieval / Gothic / Renaissance palaces across Europe with courtyards at their centre. As a case study, the Dvor has been selected because of the unique thalassocratic political situation of Dubrovnik, as one of the first really civic seats of power in Europe, and thus the Dvor has a rare

[1] Wang and Groat, *Architectural Research Methods*, 346.
[2] Wang and Groat, *Architectural Research Methods*, 346.

claim to being a truly 'public' building. This particular building was also selected because of the exceptional quality of the architecture, developed over a number of years by a number of different architects.

Case Study Two

The second space examined is the Carré d'Art in Nimes. More than just a library, it is a médiathèque, a venue for public information and even artistic performances. This Foster and Partners design, with a central staircase in the atrium, and spatial complexity and interactivity has received much critical acclaim. It is a highly successful public building, designed around a central atrium space that strongly features horizontal and vertical pedestrian circulation, as well as extensive physical and visual connectivity between floors. This case study has been selected for a number of reasons, including the strong circulation and connectivity, the world-class combination of daylighting and stairs in the one place, the cleverness of the modern design, but above all, the public nature of the displays within the building. Everything appears on display, everything is discoverable. As a public building, it appears to be a premiere example.

Case Study Three

My third case study, Museum of New Zealand Te Papa Tongarewa, is a large, modern New Zealand museum, with large, tall, exciting atrium spaces within.[3] As New Zealand's arguably most important public building (aside from the Beehive), Te Papa has attracted a lot of press coverage since it's opening in 1998: it has been criticized for both its external appearance and its internal circulation.

This research case study has been included for a number of reasons. Firstly, so that a New Zealand building could be compared on a similar basis to an international building. Secondly, that the New Zealand building should be the most prestigious public atrium building available.[4] Lastly, because Te Papa has extensive public open circulation space, with extensive physical connectivity in the entry foyer and main atrium space. This case study was specifically selected in order to determine if that connectivity correlates, at least in part, to perceptions of spatial success.

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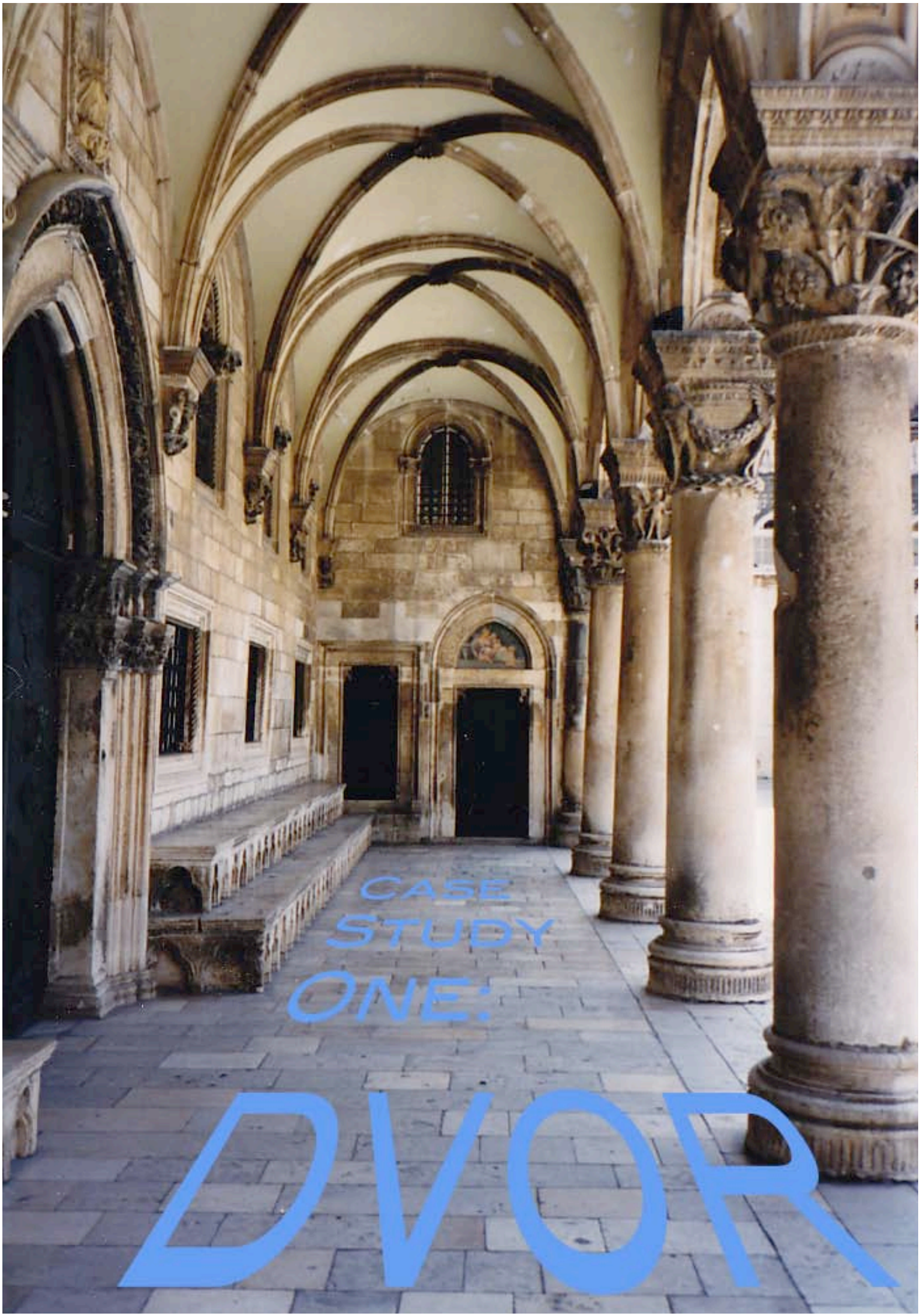
[3] Te Papa as it is more commonly known. (architect: Bossley / Jasmax, completed 1998).

[4] In Auckland, there are two prime cultural buildings: the Auckland War Memorial Museum and the Auckland Art Gallery. Given that the Auckland Museum has recently infilled its atrium, and that the Auckland Art Gallery was still under reconstruction at time of writing, the third and final atrium case study is therefore Te Papa. Christchurch and Dunedin do not have public atrium buildings to the same extent.



CASE STUDY ONE: DVOR

Case Study One – Dubrovnik Dvor

5.1.1 Introduction

This first case study is the *Knežev Dvor* (known in English as the Rector's Palace), situated at the heart of the old town of Dubrovnik in Croatia, which was visited on two occasions: in 1998 and in 2007.[1] The Dvor was selected because of a number of reasons, including the exceptional quality of the internal courtyard atrium space.

> On the whole, the Rector's Palace is one of the most interesting and beautiful buildings in Dalmatia… Its graceful design, perfect proportions and its many charming details of stone work make the palace a worthy rival of many of the famous *'palazzi pubblici'* of some Italian towns... the Rector's Palace in Dubrovnik is in its way a small masterpiece.[2]

Furthermore, however, the atrium space in this building has an elaborate and intriguing origin tied up intimately in the political history of the city itself.

Figure 5.1.1 Early depiction of Ragusa, from *Peregrinatio in Terram Sanctam*, pub 1486, by Bernard von Breydenbach and Erhard Reuwich (illus). The Dvor's walls and towers may have still been standing (right hand edge of city wall) at the time of illustration, but are relatively indistinguishable from the surrounding fortifications. Ragusa was, if nothing else, very famous for the strength of its city walls. *Source: croatianhistory.net/gif/dbr.jpg*

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[1] The Serbo-Croatian name Dubrovnik is a Slavic-originated name bestowed formally only in the Twentieth century by the Yugoslav nation, but is now the commonly accepted name by English speaking countries. For most of its life as an independent city-state, it was known by the west as Ragusa or Ragusium. The term Argosy, named for a water-based flotilla of merchant ships, is directly derived from the city of Ragusa. For this study, I use the name Dvor to refer to the Rector's Palace, as the word Palace has connotations of luxury which this building does not possess.

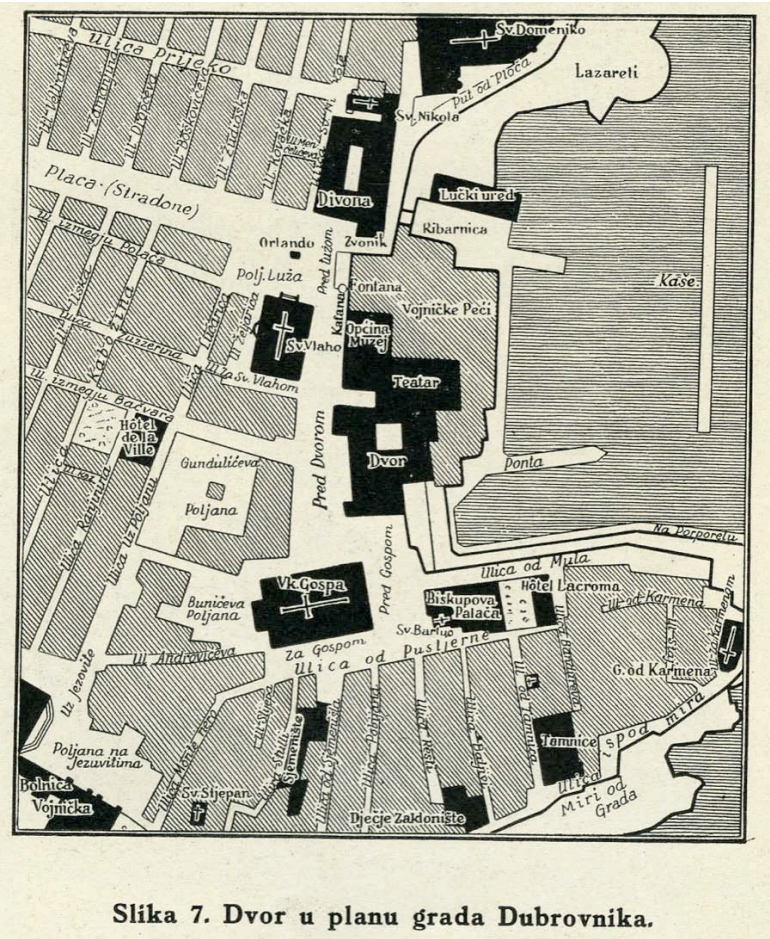
[2] Carter, *Dubrovnik (Ragusa): A Classic City State,* 456.

5.1.2 Dubrovnik: Background

Dubrovnik (known for most of its life as Ragusa) was established on a small island site of a Roman outpost [3] around AD 265,[4] the last city and large harbor in the Adriatic before the open seas of the Mediterranean.[5]

5.1.3 Dubrovnik / Ragusa's political system

Ragusa was an unusual thalassocracy, ruled by a market-driven, non-hereditary, governing elite of noble mercantile families.[6] An understanding of the political background to the city is helpful – indeed, imperative to an understanding of the building, and for this reason therefore, an extensive background on Dubrovnik has been included in the appendices.



Slika 7. Dvor u planu grada Dubrovnika.

Figure 5.1.2 Part street plan of city, showing Dvor. Source: Cvetkovic. *Dubrovacki Dvor.*

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[3] Grujic, *Cultural Heritage of Croatia in the war 1991/92,* 63.
[4] Anon, *A True Relation of the Terrible Earthquake Which happened at Ragusa,* 1.
[5] Krekic, *Dubrovnik in the 14th and 15th Centuries,* 5.
[6] Whilst not a true democracy (it was a plutocracy) and thalassocracy (meaning a water-based political system), it was a stable form of government; not reliant on the hereditary vagaries of a monarchy that so many countries still have today.

5.1.4 Dvor History

Typical in many ways of the many Mediterranean medieval palaces that dot the countryside and cities of Italy and the edge of the Adriatic, the Dvor is a (deceptively) simple building with a central courtyard space open to the sky. The Dvor is now used as a small museum by day and a venue for musical / theatrical performances in the central atrium on summer nights: clearly used as a public building.

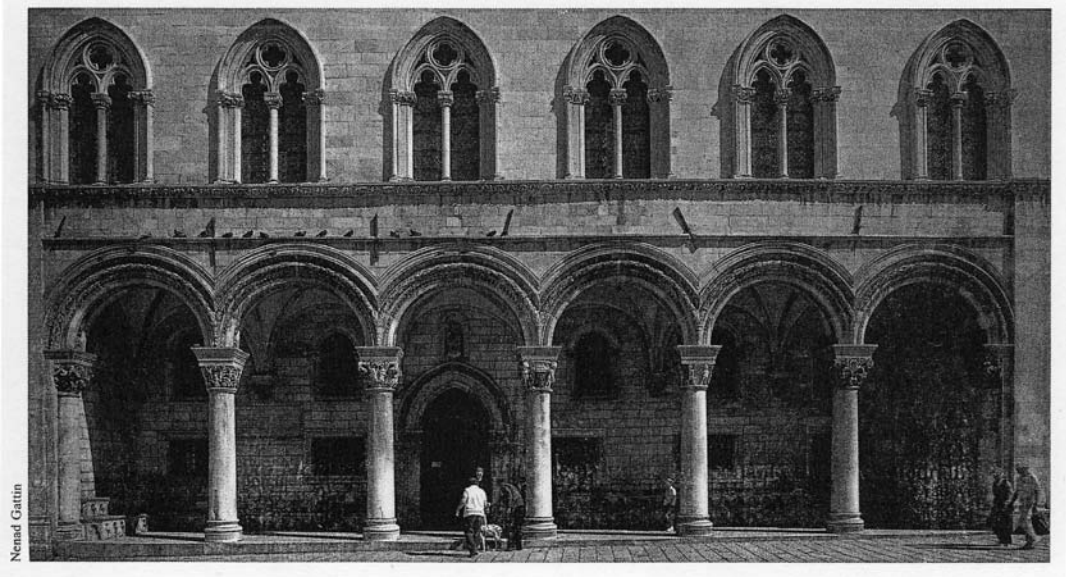
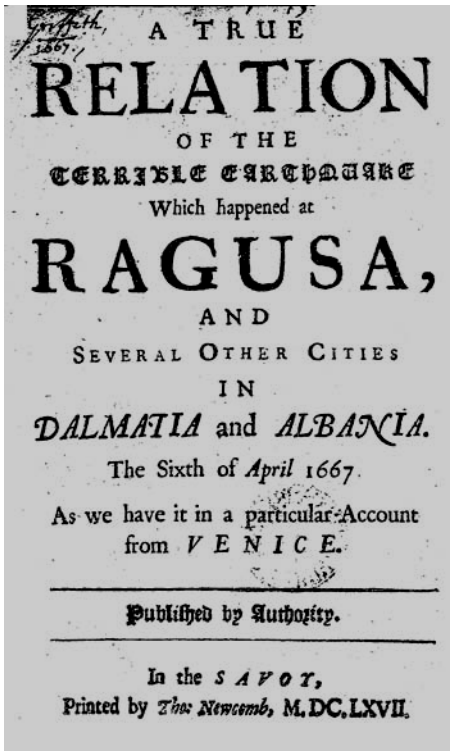


Figure 5.1.3 Front elevation of the Dvor. Source: Cvetkovic, *Dubrovacki Dvor.*



A TRUE
RELATION
OF THE
TERRIBLE EARTHQUAKE
Which happened at
RAGUSA,
AND
SEVERAL OTHER CITIES
IN
DALMATIA and ALBANIA.
The Sixth of April 1667.
As we have it in a particular Account
from VENICE.

Published by Authority.

In the SAVOY,
Printed by Tho: Newcomb, M.DC.LXVII.

Figure 5.1.4 Eyewitness report, Front cover image of eyewitness report of the earthquake, 'Published by Authority'.
Source: http://books.google.co.nz/books?id=Cx1SPgAACAAJ

The old city of Dubrovnik is a UNESCO World Heritage site. Despite this, in 1991 it suffered heavy shelling from Serbian forces. The Dvor was damaged, but along with the rest of the city, has since been restored. A more complete history of the building can be found in the appendices and in research from 2006.[7]

Figure 5.1.5 Loggia of the Dvor. Translation: "The play Dubravko before the Court, by V Bukovac." The loggia is being used as a covered venue for entertainment. The street outside is effectively the stage. The Court, a member of the clergy, and possibly the Rector, are in the foreground.

Source: Vlado Bukovac, 1894. Original painting is in Szepmuveszeti Museum, Budapest. This image from Cvetkovic, Bozo. *Dubrovacki Dvor.*

[7] Marriage, *Dubrovnik Dvor: Contested Citadel.*

Figure 5.1.6 Rector's Palace, modern view of exterior (2003).
Source: gallery.nen.gov.uk/assets/0510/0000/0483/Rector_s_house_DOT.jpg

5.1.5 Dvor Courtyard

Although the building started out as a medieval gothic fortress design, the central courtyard as existing now is a feature typical of Renaissance Italianate courtyard design, a common feature in the palazzos of the time. These courtyard spaces were not designed as public spaces – but they did fulfill most of the requirements of atrium design. They admitted daylight, fresh air, provided security against invaders, and acted as a social focus (refer 2.4). The four key functions of an atrium are therefore provided by the courtyard atrium of the Dvor.

In terms of the key factors of the atrium addressed in Chapter 2, this atrium courtyard is a relatively small, traditional four-sided structure, with daylight only through the top according to Saxon's classification (refer to figure 2.14). While the opening to the sky is approx 10m across, the colonnades enlarge the space enclosed to approx 20m across, thereby quadrupling the area enclosed. The open loggia seen on the external façade (refer figures 5.1.15 and 5.1.16) that addresses the street, is balanced internally by a colonnade on two levels (refer figures 5.1.11 and 5.1.12), that acts as a heavily perforated boundary (refer 2.15 and 2.17). Visual connectivity between ground floor and first floor colonnades is therefore high.

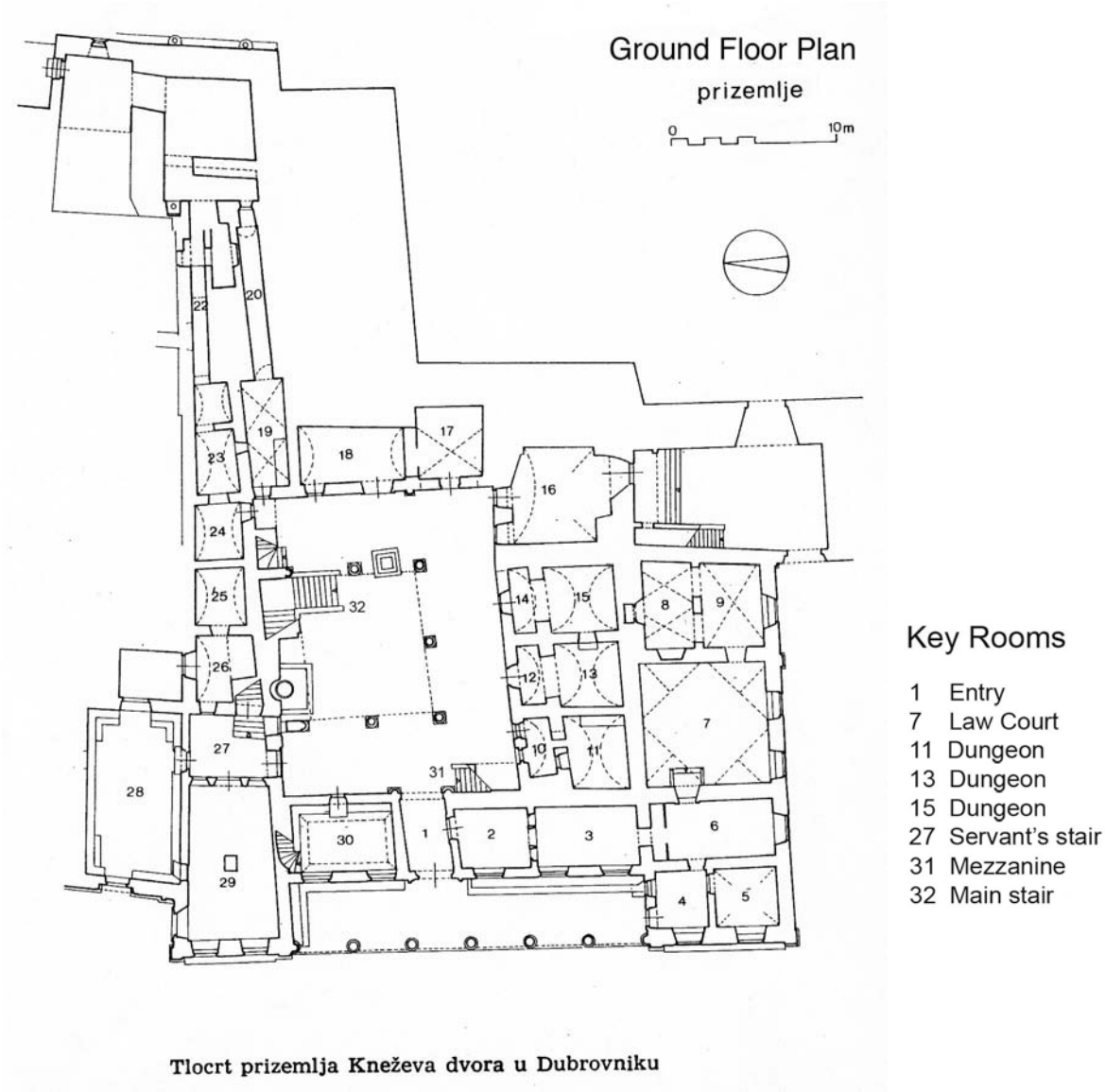


Figure 5.1.7 Ground floor plan of the Rector's Palace in Dubrovnik *Source: Plans provided courtesy of Nikola Radic, Zagreb, and Ivan Tensek, Institute of Art History, Zagreb.*

Entering from the public square off the main street, Stradun, a short passageway takes the public directly through to the courtyard at the heart of the Dvor: the civic centre of Dubrovnik. The entry doors are aligned directly with the statue of Miho Pracat (1522-1607), whose placement at the end of the small entry colonnade leads you in to the central open courtyard, enclosed by two tiers of round arches enclosing two arcades.[8] The courtyard is welcoming, the space is interactive, functioning now (and then) as a venue for theatre and music, as well as a separation of informal nature between the ruler and his people.

[8] Knzevic, *Obnova Dubrovnika 1979-1989 (Restoration of Dubrovnik),* 74-76.

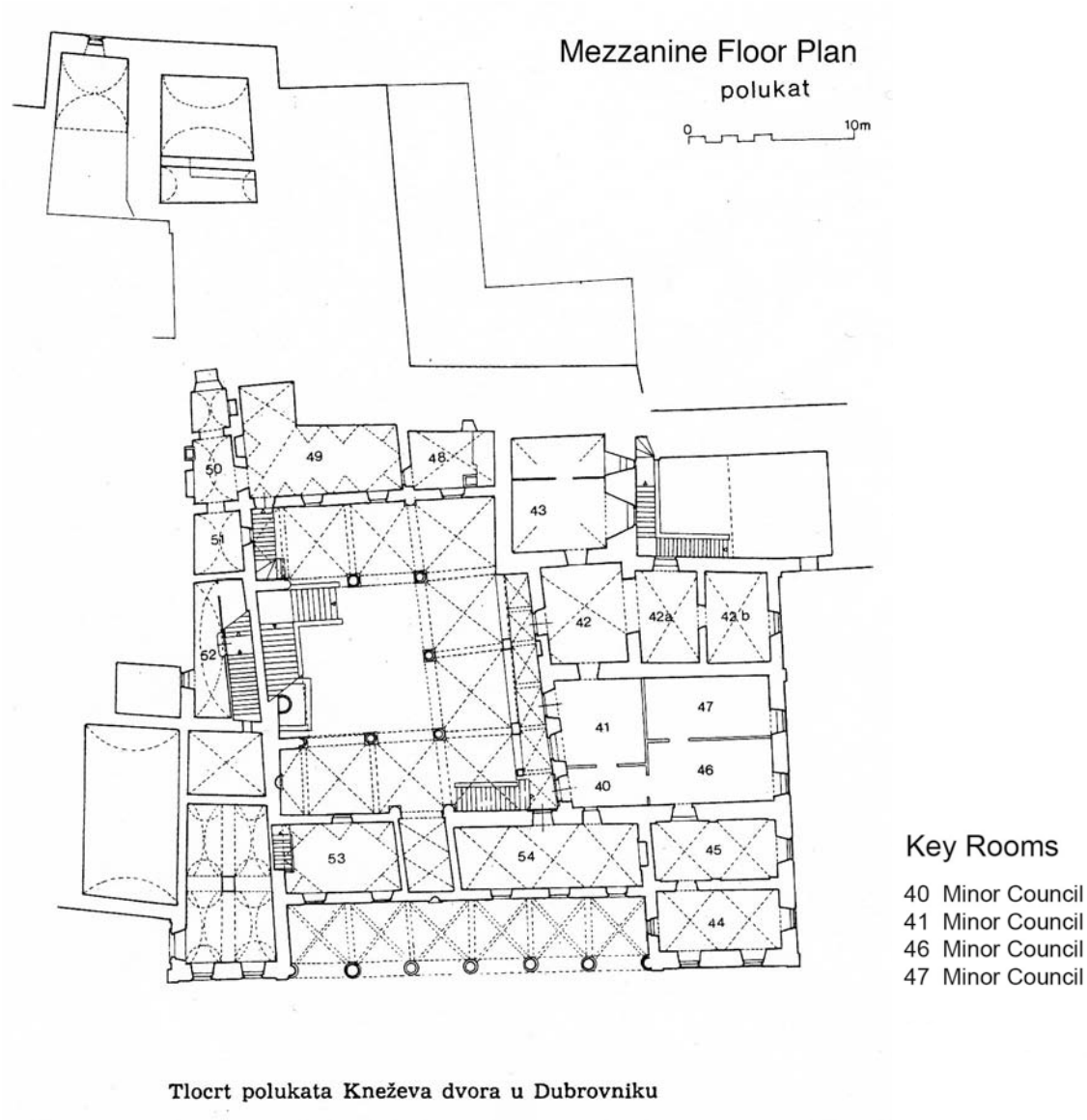


Figure 5.1.8 Mezzanine floor plan of the Rector's Palace in Dubrovnik *Source: Plans provided courtesy of Nikola Radic, Zagreb, and Ivan Tensek, Institute of Art History, Zagreb.*

Due to the age of the Dvor, and the piecemeal nature of its construction over a course of several centuries, there is no information available of the architect's original intentions with regards to the building design. What can be gleaned from the building as it stands, is that the primary staircase - in the centre of the courtyard – acts as the social circulation hub of the building. The atrium performs not only the general functions as noted in 2.4 but through the provision of one main stair, ensures that for important people (users of the main stair), a high degree of connectivity is likely travelling both in and out of the building. The back stairs, and other passages leading away from the main atrium, would enable a more private, non-processional route to be taken to gain access to the port, or to either of the Council Chambers (refer also to 2.17 and 2.18).

The central courtyard in the Dvor is a focal point, an organising centre, a prime circulation route within the building, a social mixing pot, and at times a public meeting venue (functioning as a prime intersection site as noted in 2.16). The arcading of the perimeter corridors to the courtyard is prominent and readily accessible, with colonnades to all four sides of the central courtyard, perforating the boundary of the colonnade / courtyard spatial interface.

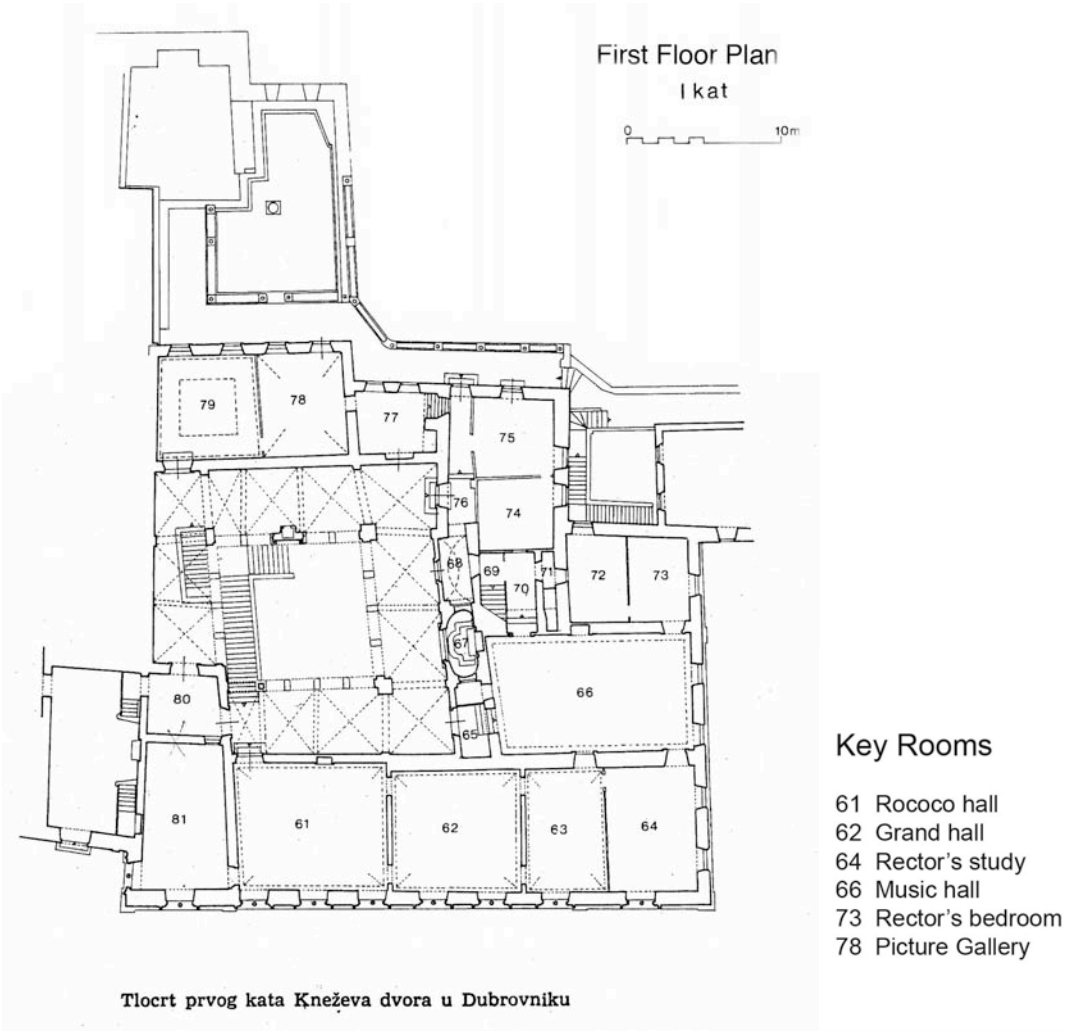


Figure 5.1.9 First floor plan of the Rector's Palace in Dubrovnik *Source: Plans provided courtesy of Nikola Radic, Zagreb, and Ivan Tensek, Institute of Art History, Zagreb.*

At the Dvor the open colonnaded walkways and grand sweeping stairs combine to make the visitor feel welcome. It is, overall, an informal place; more welcoming than the Medici's palazzo (also by Michelozzo), reflecting the less rigid political structure present in Dubrovnik. It is arguably the ancient equivalent of a modern corporate atrium, an ameliorating, welcoming social space that is neither fully public, nor fully private.

The remodeled Dvor does not get much mention amongst Michelozzo's work, perhaps because it was an adaptation: although Murray notes that his work "is indicative of the part he played in spreading ideas derived

from Brunelleschi outside Tuscany."[9] Coming near the end of Michelozzo's life's work, the remodeled courtyard in Dubrovnik is an extremely pleasant, well-proportioned space.

Slika 23. Dvorište dubrovačkog dvora sa scala scoperta. Desno spomenik Miha Pracata; lijevo ispod stuba česma. U vrhu galerija prvoga kata.

Figure 5.1.10 Atrium view translation: "Dubrovnik Palace Yard with monumental staircase. Right: monument of Miha Pracata; left: fountain under stairs. At the top is the first floor gallery."
Source: Cvetkovic, *Dubrovacki Dvor.*

Circulation

There is a total of six stairs at ground floor, with the dog-legged primary stair being a major ceremonial staircase that ascends from ground to the nobleman's quarters at first floor,[10] directly accessing the arcade that surrounds the perimeter of the courtyard (figure 5.1.10). This concentration of circulation is unusual in a building that is only two to three stories tall: there are more staircases than are required for circulation and the design precedes modern fire safety regulations. Clearly the extra stairs are included for other reasons. This

[9] Murray, *Renaissance Architecture*, 26. Michelozzi's Palazzo Medici Riccardi in Florence, also has a courtyarded interior, with a central square and colonnades on the ground floor only (overlooking windows to upper floors), but all 3 sets of staircases are off to one side, behind the colonnades, while at the Dvor the grand stair ascends in the open air of the atrium.
[10] *Pianterrano* to *piano nobilo*, the first floor: in this case, literally, the floor of the nobles.

thesis research argues that the preponderance of staircases is primarily social. The main stair is not the original but the general effect is large and stately (refer also 2.20); to the right, a smaller flight leads to the mezzanine floor and the hall of the Small Council.[11]

Figure 5.1.11 Colonnade view from upper floor. Note how the small size of the atrium enables personal contact to be visually maintained across the atrium, despite lack of a direct physical link. *Source: author (1998).*

While the use of a central courtyard was common on the Italian mainland, the feature of having the staircase ascend within the courtyard was more unusual: "The Gondi Palace, by Giulano da Sangallo (1445-1516) is the

[11] Carter, *Classic City State,* 454.

first palace in which the staircase is made a prominent feature of the colonnaded courtyard."[12] When at the top of the grand stair, the colonnade continued around to encompass the other openings off, including the more formal and private chambers of the Rector.

The upper colonnade has pairs of columns that add a lightness and delicateness to the upper floors, with colonnades similar to the Florentine Palaces.[13] As Carter notes, the "arches on the upper storey are twice as numerous as those of the lower, while the lower arcade rests on plain cylindrical columns with square plinths. The capitals are of a well-known Renaissance type..."[14]

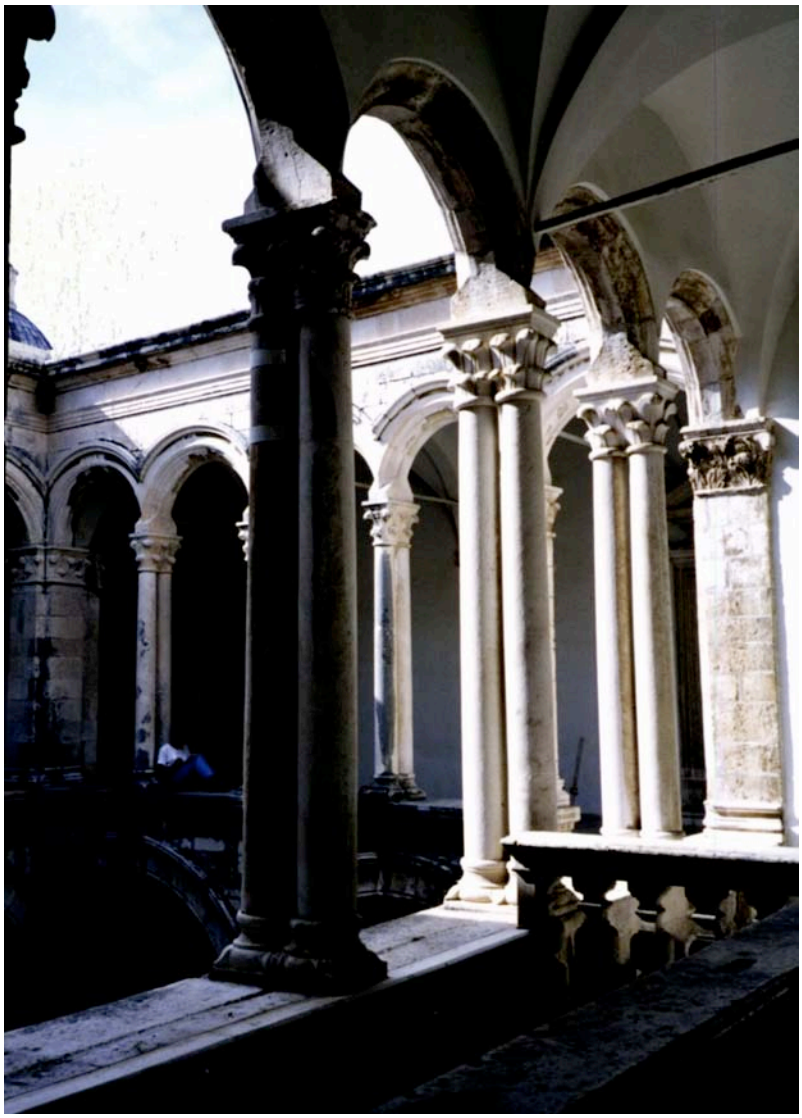


Figure 5.1.12 Oblique view of upper colonnade. Double columns add strength and lightness to the atrium facades, but also increase the amount of solid obstructions in the perforated façade. The balustrade to 'back of house' staircase is visible in lower right of photo. *Source: author (1998).*

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[12] Hughes and Lynton, *Florentine Palaces,* 36.
[13] Portolan, "Izvjestaj o nalazima pri obnovi Knezeva dvora u Dubrovniku" (Report on the findings made during Restoration of the Rector's Palace in Dubrovnik),154-157.
[14] Carter, *Classic City State,* 454.

While this main stair was the official, primary means of ascension, there are, as befits a building run by a hierarchy of bureaucracy, a number of other stairs for other minor tasks and minor task-persons. There is, for example, a secondary stair that rises the same height, presumably for less important personages to access the same spaces and another four minor staircases throughout the ground floor (refer to Figures 5.1.7, 5.1.8 and 5.1.9).[15] The staircases that punctuate the space also animate it, allowing inter-minglings of space as well as social strata.[16]

The central courtyard of the Dvor therefore became, intentionally or not, a political symbol: one that exhibits the flexibility and impermanence of the office of the Rector and portrays the open nature of the building to discuss matters of trade and politics that was central to the Republic's longevity. The spatial connectivity analysis was undertaken to find if the openness and accessibility of the political framework was reflected in the construction of the atrium courtyard space.

5.1.6 Room sequence analysis

Using space syntax methods to evaluate the atrium, a Permeability map was created showing connections between room spaces (refer Figure 5.1.13), a system that Hillier and Hanson developed to show the permeable interface between rooms in a town (refer figure 3.5). The Permeability map was then converted into a justified permeability graph or J-graph (refer figure 5.1.14).

Rooms have been depicted by dots, which have been coloured in some instances to depict special functions, which also assists in understanding the plans – refer to the key. Connecting paths have been shown with a purple line, and stairs depicted by a zig-zag symbol denoting the walk up to the next floor. These colour-coding conventions are repeated in the other case studies for clarity.

[15] While it could be simply an indoor stair in case the main stair is being rained on, this is presumed unlikely. It is considerably steeper in pitch and narrower in width.
[16] *Katalog izlozbe "Zlatno doba Dubrovnika" (Catalogue of Exhibition "Golden Age of Dubrovnik")*, 49.

Figure 5.1.13 – Ground floor plan. Gamma analysis with room permeability / relationships mapped.

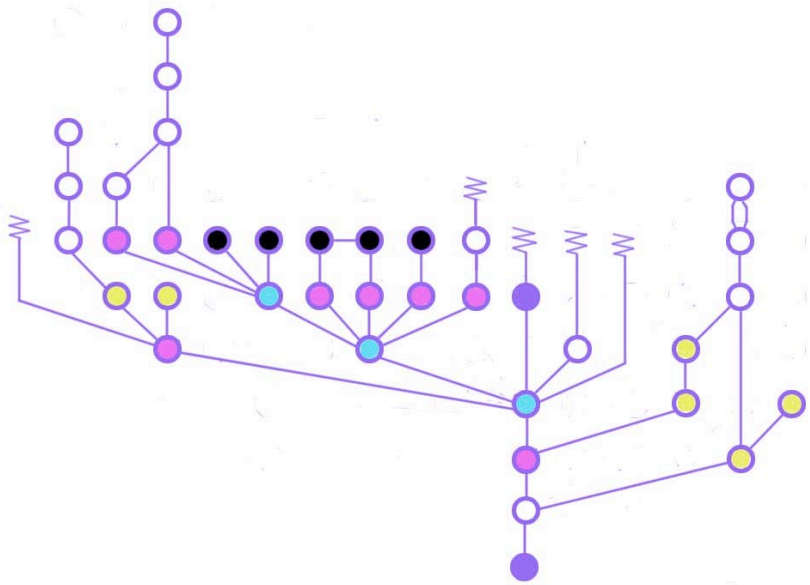

Figure 5.1.14 – Ground floor plan: justified permeability graph taken from figure 5.1.13. The results show that while most of the areas at ground floor can be accessed directly from the atrium, there are some small areas of hierarchy in the legal rooms (denoted by yellow dots), and the link at the rear to the harbour entry gate.

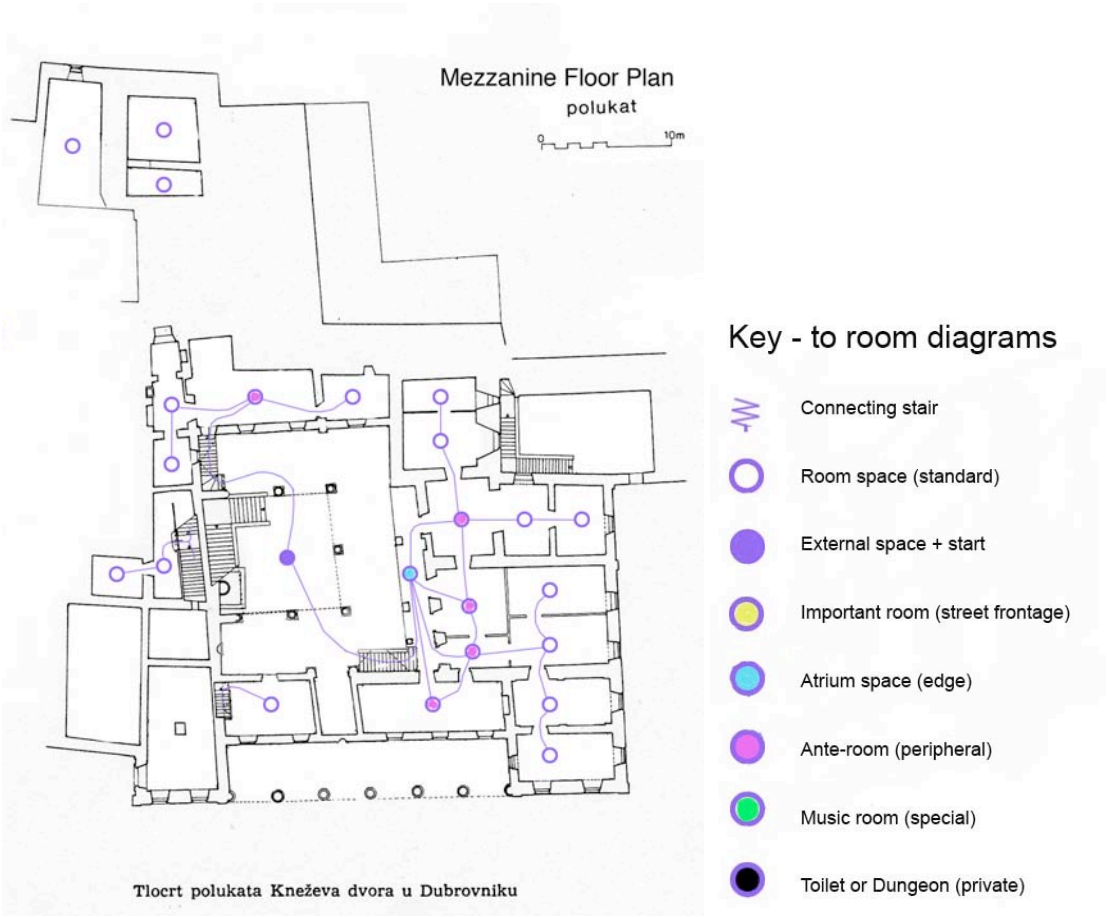

Figure 5.1.15 – Mezzanine floor plan Gamma analysis with room relationships mapped

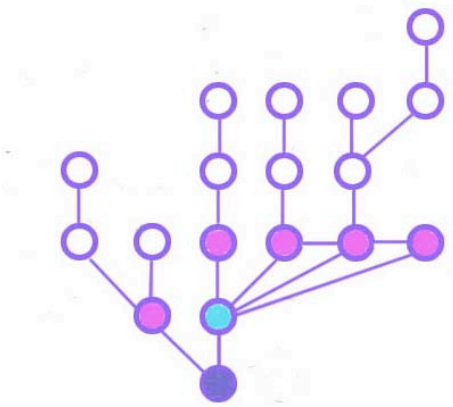

Figure 5.1.16 – Mezzanine floor plan: justified permeability graph taken from figure 5.1.15. Some hierarchy is evident – from the atrium (pale blue dot), some rooms are removed by four spaces – these were official Council meeting rooms, so a degree of hierarchy is expected here.

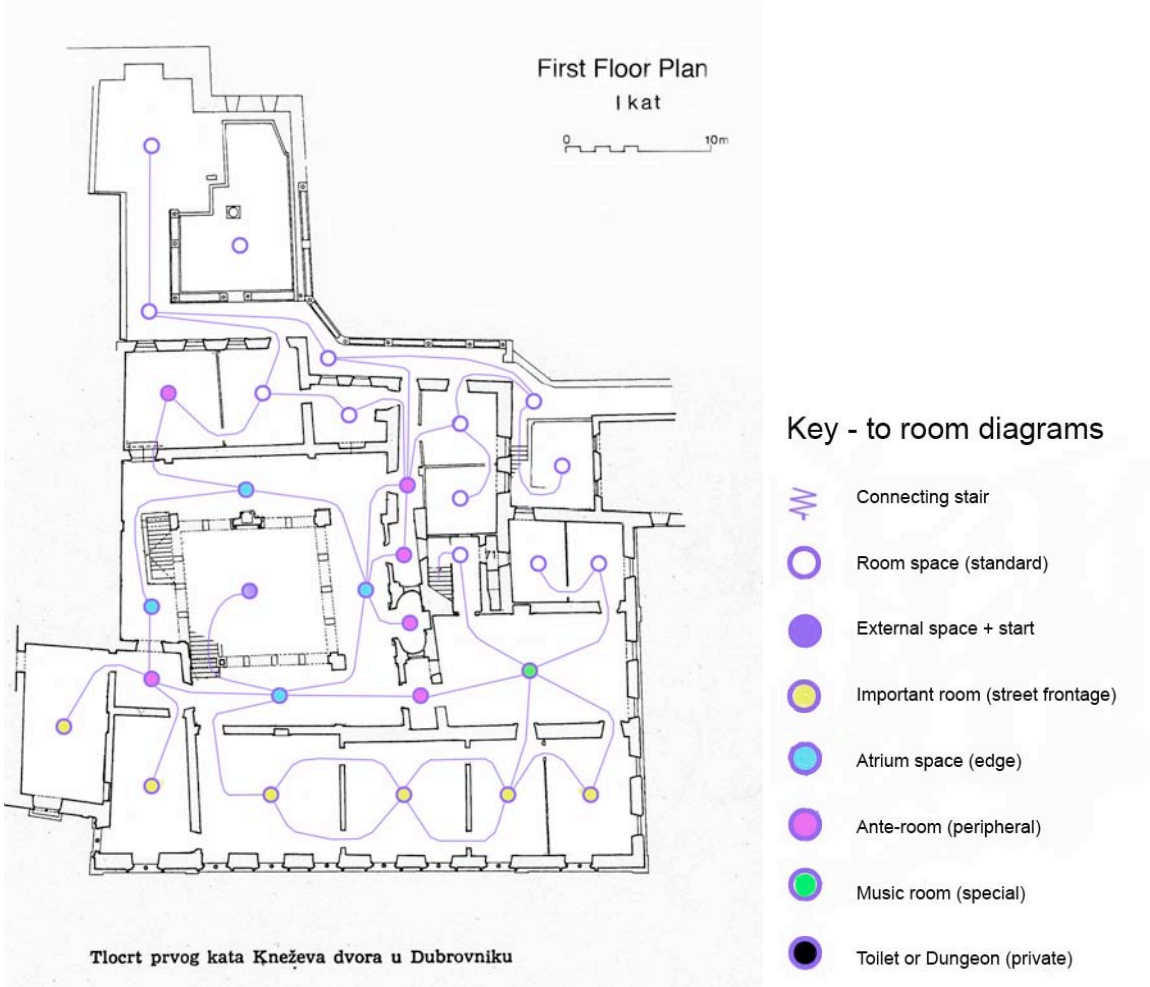

Figure 5.1.17 – First floor plan Gamma analysis with room relationships mapped

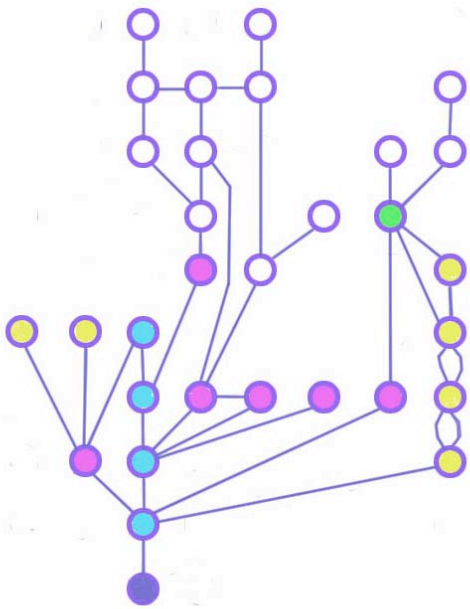

Figure 5.1.18 – First floor plan: justified permeability graph from figure 5.1.18. A large amount of hierarchy is exhibited here is the sequence of state rooms. Nonetheless, most functions are immediately accessible via the colonnade of the atrium space.

The hierarchy of the spaces concerned is revealing. Most rooms are exceptionally 'shallow' in space syntax terminology, and thus are 'well integrated' ie they are not located in hierarchical space. The old dungeon cells are prominent – incredibly so, as they are situated only just off the main public space of the atrium courtyard (figure 5.1.13). This indicates the public prominence given to wrong-doers – not hidden as we do in our modern society, and perhaps indicates also the special political nature of the city and the building.

By comparison, at the upper floors, there is some small evidence of hierarchy especially around the Rector's private chambers and the state rooms. In spatial terms this is not so well integrated. Accessible primarily by an enfilade of rooms to imply hierarchical importance, the Rector's study is also easily accessible via a side door into a room of the upper colonnade: the bedroom, curiously, is accessed directly off the Music Hall.

5.1.7 Sequential spaces

In terms of Moretti's sequential spatial analysis, a full physical 3-D model was not made, as it was felt likely not to add significantly to the knowledge already at hand. However, a 3-D SketchUp virtual model was created of the building, by Eli Nuttall, and then inverted to create a modeled space, in order to try and ascertain if this was a path worth pursuing.

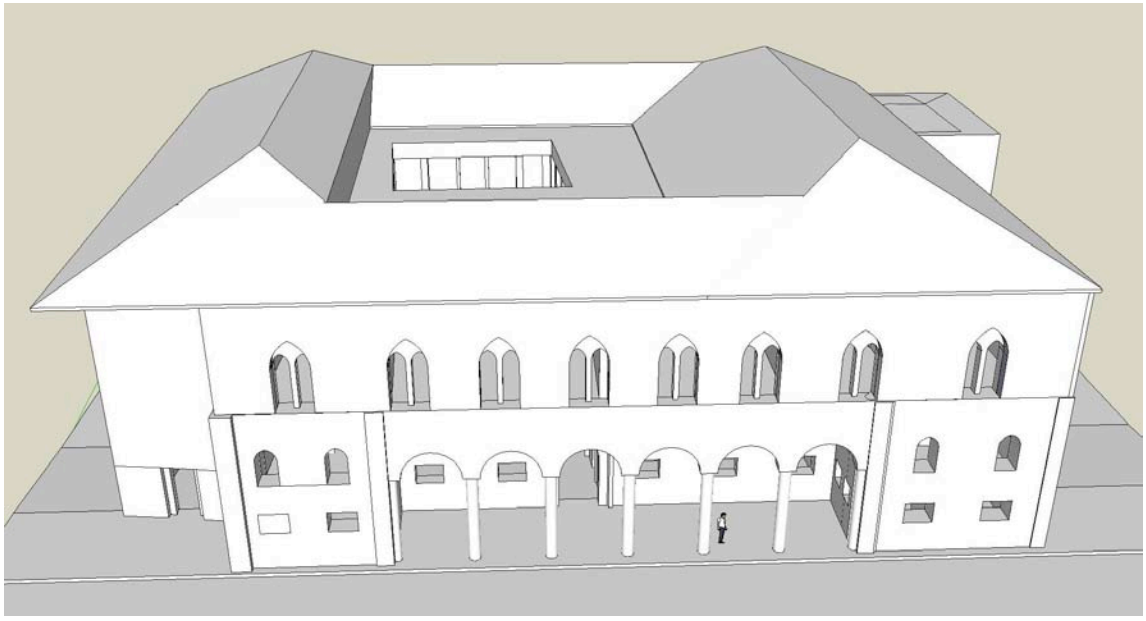

Figure 5.1.19 – SketchUp model of Dvor, *Source: Eli Nuttall*

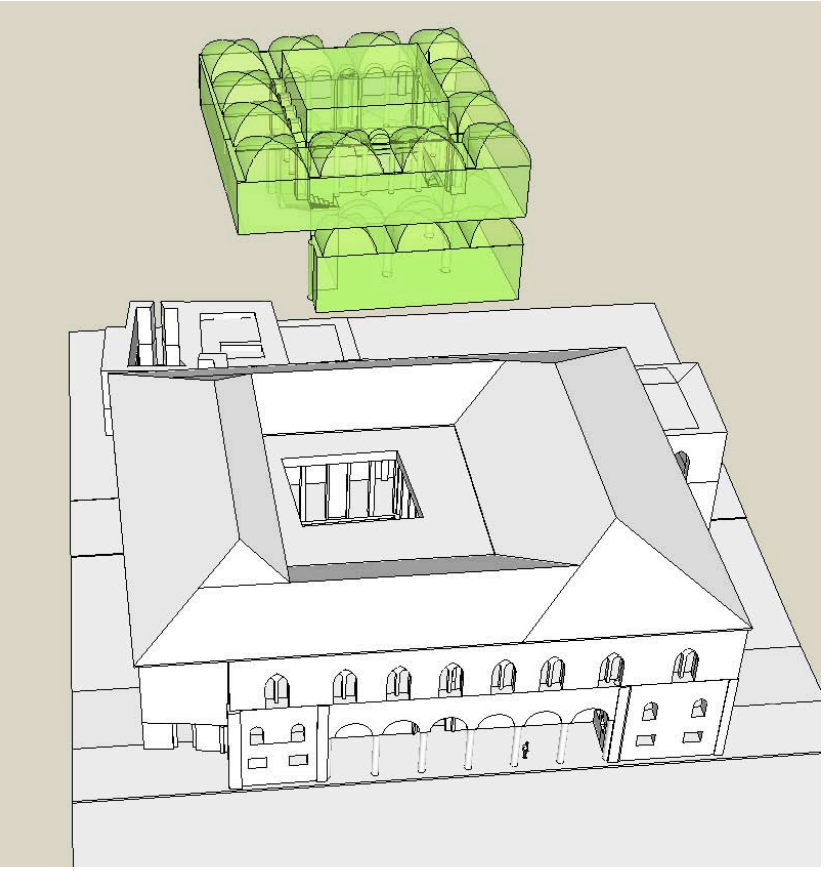

Figure 5.1.20 – SketchUp model of Dvor, with atrium space being subtracted. *Source: Eli Nuttall*

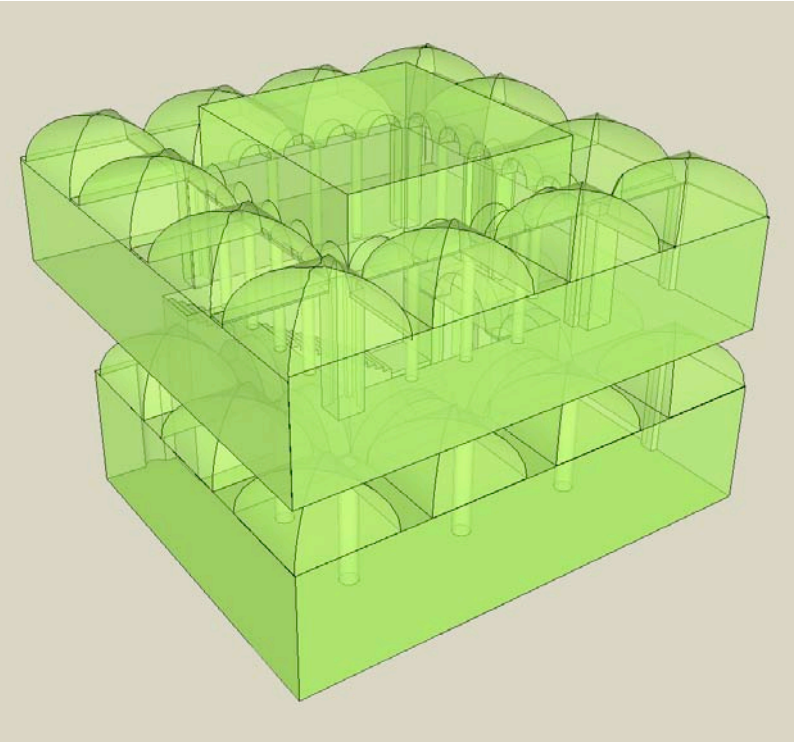

Figure 5.1.21 Moretti-style spatial inversion SketchUp model of atrium, *Source: Eli Nuttall.*

While it can be noted that there is a sequence of spaces around the atrium colonnade, the sequential pattern is unclear and the connecting staircases are not prominent.

Although it is modeled in a semi-transparent medium (here, represented as a form of green 'jelly'), from the angle shown here, the stairs are not particularly visible. This is, of course, not a concern when actually inside the 'real' atrium, where the stairs are highly visible (ref figure 5.1.10). With the main staircase hard up against the side of the atrium, on the 3-D virtual model, the spatial invert shown here can be simply rotated to expose the stair's imprint on the other side (refer figure 6.3). However, as a 2-D paper-based representation of the full 3-D virtual model experience, the resulting 2-D image limits the usefulness of this method. Issues, for instance, such staircases spanning directly across the space (which does not happen here), would be even harder to pick up as a Moretti-style inversion, as they would be contained within the modeled 'jelly' – indeed, if the 'jelly' was solid instead of semi-transparent, any transgressing objects would not be visible at all.

What this trial appears to be showing is that the Moretti method may be limited in its application to relatively more simple test cases. Refer to the other case studies contained here for a comparison.

5.1.8 Depthmap

As noted in chapter 3, Space Syntax's London base authorised this research to use Depthmap. This computer-based software package has been developed by Turner in order to analyse the integration of spaces.[17] It is commonly used, and is free available to licensed researchers. It is relatively simple to use, and runs off a simple DXF plan of a single floor.[18] The software divides the space into regular units, mathematically analyses each piece for connections and integration into the overall building, and depicts this as a coloured plan. The outgoing VGA can be viewed as a representation of how well a space is related, or connected, to other spaces or parts of the space.

[17] Turner, UCL Depthmap v10.
[18] DXF stands for Drawing Exchange Format, a commonly used computer graphic standard / CAD file format developed by AutoCad for enabling data interoperability.

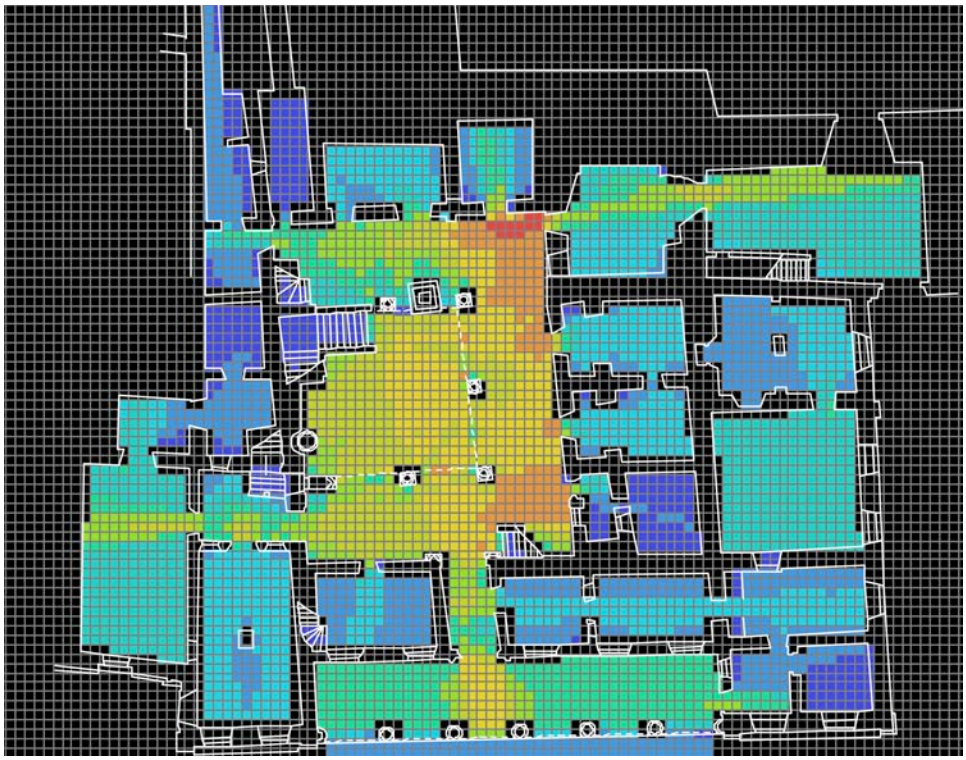

Figure 5.1.22 Depthmap VGA of Dvor - Ground floor plan. While some inaccuracies may be attributed to the non-rectilinear nature of the walls, of more concern is the non-recognition of staircases as prime areas of circulation. Note that the stairs in this image are dark blue, indicating low connectivity. *Source: author.*

While this analysis confirms that at the ground floor the atrium is the most integrated space in the building, it does not pick up the importance of the stairs.[19] Instead, the Depthmap highlights the south-east corner of the atrium as being more integrated. This is a surprising result, as in reality this corner of the atrium is a largely inconsequential back of house route. The reason this is highlighted, however, may be that Depthmap utilizes axial lines and convex spaces to analyse spatial integration, and has picked up the axiality of the aligned door openings in this area. Until Depthmap has been refined to reliably pick up the importance of vertical circulation elements such as stairs, it is unlikely to show significantly reliable results for analysis in 3-D.

[19] As Sailor has noted, this feature has not yet been added to the software. Refer chapter 3.

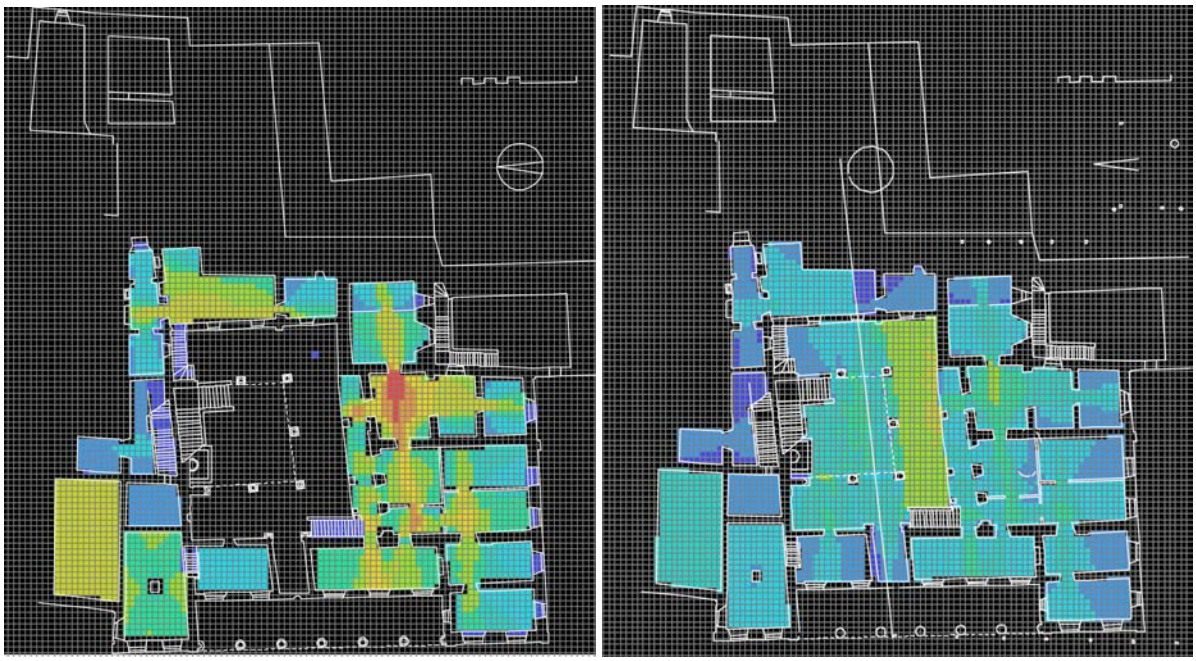

Figure 5.1.23 Depthmap VGA of Dvor - Mezzanine floor plan. Note how, on the left, the simulation has been run with the atrium omitted ie where physical connections only are possible. On the right, the atrium was included, to depict where visual connections are possible. However, in neither case was significance or recognition given to the staircases. The random generated line through the centre does not appear to be having a significant effect. *Source: author.*

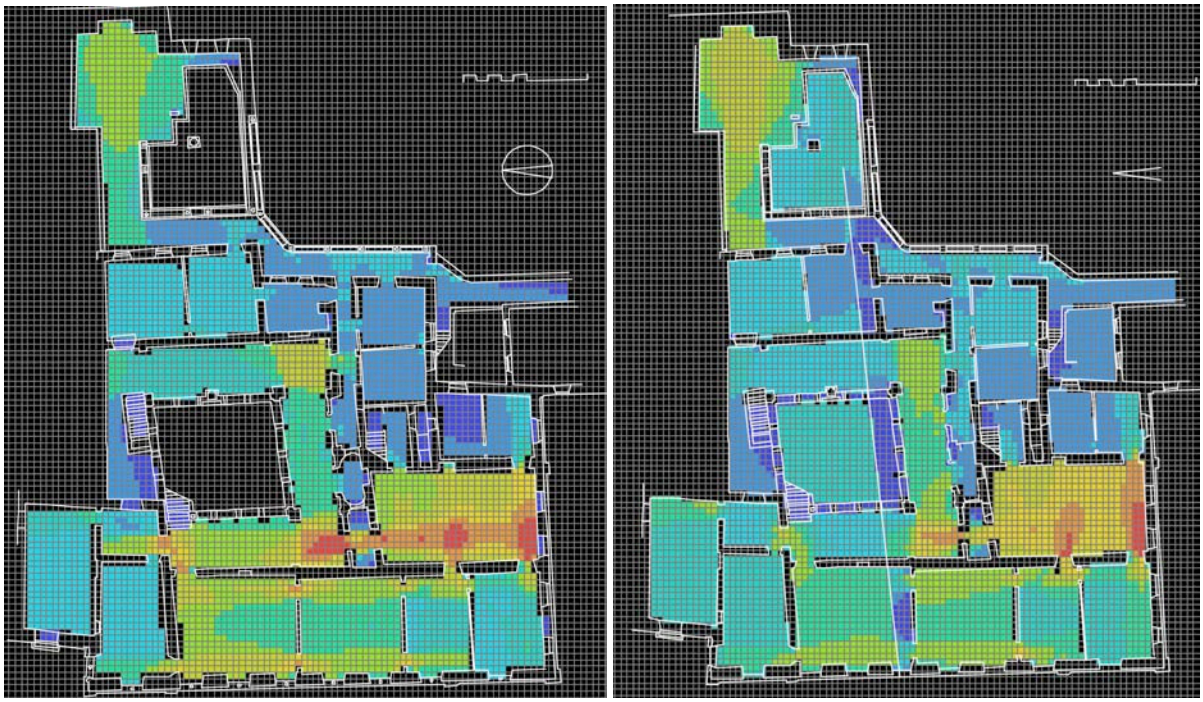

Figure 5.1.24 Depthmap VGA of Dvor - First floor plan. On the left, the simulation has been run with the atrium omitted ie where Physical connections only are possible. On the right, the atrium was included, to depict where Visual connections are possible. In this case, the similar random generated line is having an effect, but it does not appear to be that significant. *Source: author.*

A file of the section through the building was also run through the Depthmap program. Initial runs at this attempt had lines for the vertical elements such as columns (visible in the distance) retained, but these were interpreted by Depthmap as being solid obstructions, so this result was ignored, the columns removed, and the resulting file re-analysed in Depthmap (refer figure 5.1.25).

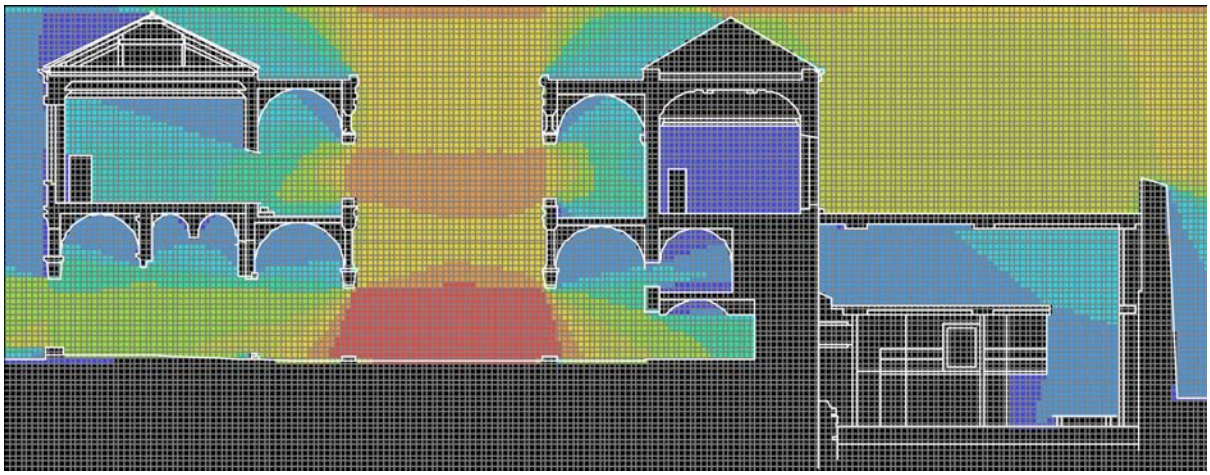

Figure 5.1.25 Depthmap VGA of Dvor - cross section. The result does reflect the intersection of the horizontal and the vertical elements within the atrium, highlighting the intensity of spatial experience at the base of the atrium. *Source: author. Section provided courtesy of Nikola Radic, Zagreb, and Ivan Tensek, Institute of Art History, Zagreb.*

5.1.9 Isovist plan analysis

In order to more properly assess the qualities of the atrium, a decision was made to hand-create a series of isovists generated at regularly spaced intervals and assemble them to form an isovist field that follows a path from the main entry gate to the Dvor, into the central courtyard, and up the primary stair to the *piano nobile*. To test for connectivity, the visibility of vertical connection features (ie staircases) was noted. A series of individual isovists were drawn in a journey from the entry doors of each case study, up the main stairs to the next floor, through the atrium at the heart of the building. The accumulated isovist viewsheds were then combined via a series of semi-transparent layers, using Photoshop software, and produced as an overall isovist field. A darker blue colour shows an area that has received more views, whereas a pale blue shows that this area has been visible for only a small part of the journey. Clear white space indicates an area that is not visible at all on this journey.

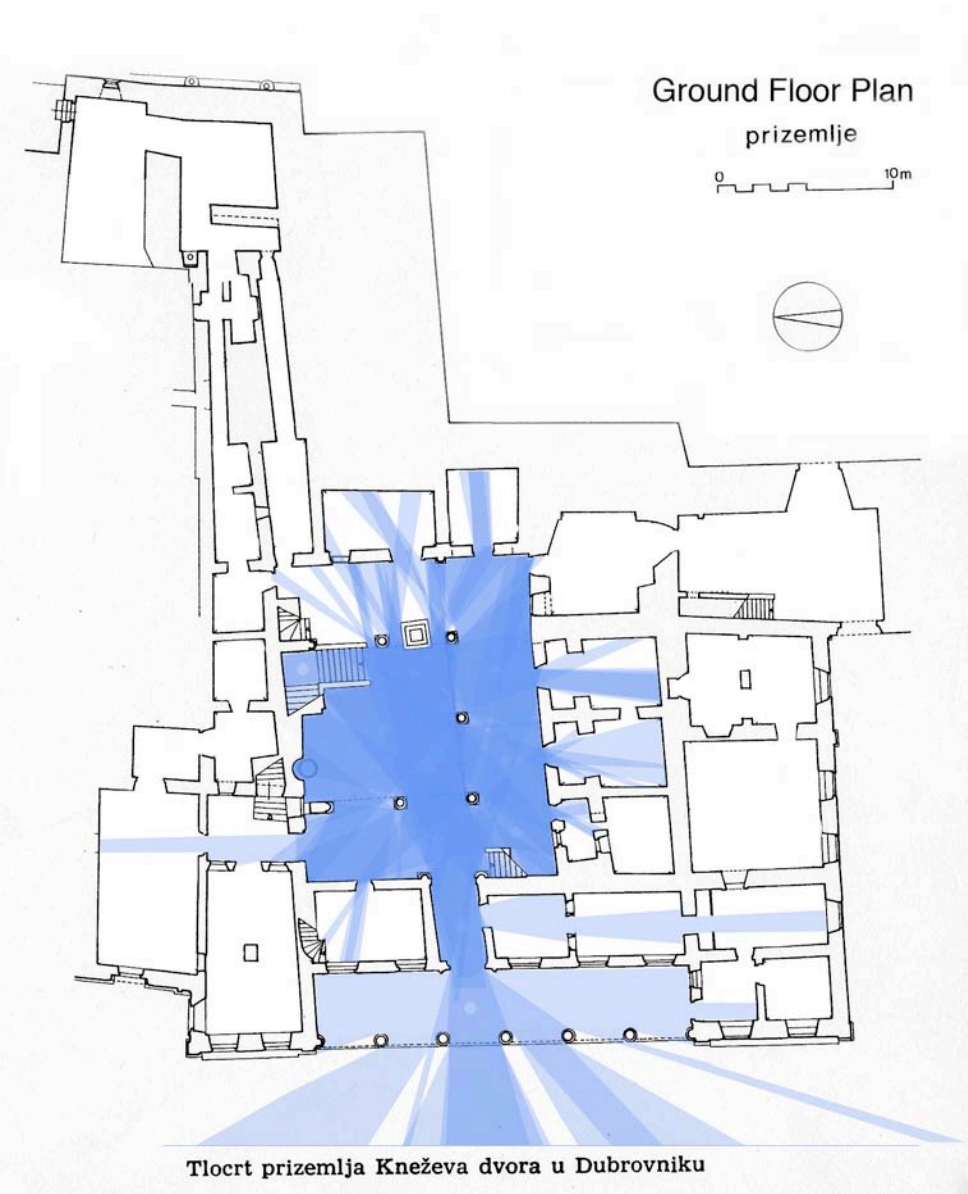

Figure 5.1.26 – Isovist field of Ground floor plan. Source: author.

At the ground floor the isovist fields produced show that the two main stairs in the atrium are highly visible, but the other four stairs are hidden from view. This is understandable due to their back-of-house nature as connection routes for political subalterns. Although just as direct (and in some cases, possibly even more so) to the upper floor, their discrete planning position reflects their role as secondary circulation routes. Strong visual and physical connective links are enabled to the primary stair in the atrium.

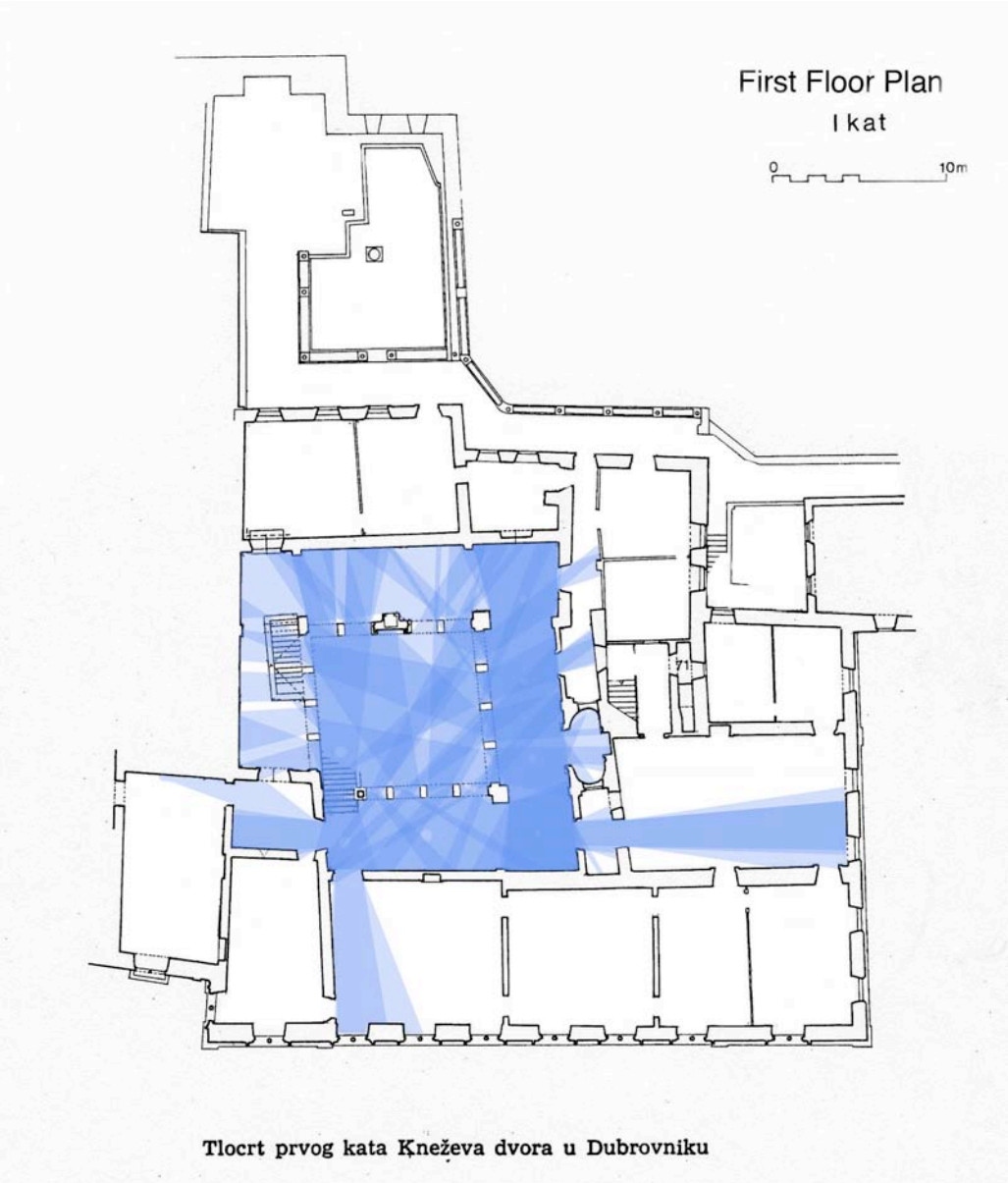

Figure 5.1.27 – Isovist field of First floor plan. *Source: author.*

By comparison with the Depthmap VGA, large differences can be noted. While in the Depthmap analysis all spaces are evaluated equally (a logical outcoming from a process which assesses the integration of each pixel in relation to each surrounding pixel), the use of an isovist field allows for the isolation of just the visual connections within a space. The highlighted results from the isovist field at First floor shows that visual connectivity is centred mainly around the central atrium, and there are just some viewshafts penetrating into the surrounding rooms – in this case, the rooms noted in the guidebook as Rococo Hall (lower left) and the Music Hall (middle right).

A series of individual isovists were drawn in a journey from the entry doors of each case study, through the building and up the main stairs to the next floor. In all cases this involved a journey through the atrium at the

heart of each building. The accumulated isovist viewsheds were then combined via a series of semi-transparent layers, in Photoshop software, and produced as an overall isovist field. A darker blue colour shows an area that has received more views, whereas a pale blue shows that this area has been visible for only a small part of the journey. Clear white space indicates an area that is not visible at all on this journey.

5.1.10 Isovist section analysis

Again, in a move to test isovists applicability to the analysis of 3-dimensional space, a series of isovist diagrams were created in section as well as plan.

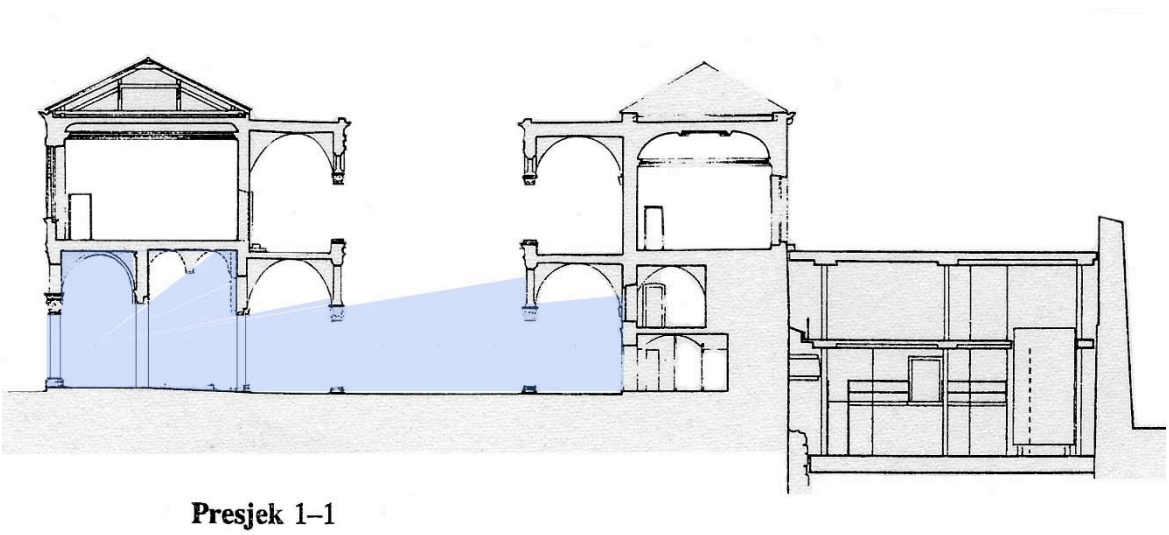

Figure 5.1.28 – Isovist fields from entry, taken from section. *Source: author.*

As can be seen from section views (figure 5.1.28) and internal atrium photos (figure 5.1.10), the isovist field shows the great exposure that much of the upper floor of the Dvor had to the public eye. Visual connectivity between ground and first floors is strong. Once inside the impregnable walls, views through to the upper floor were open to view from the central atrium.

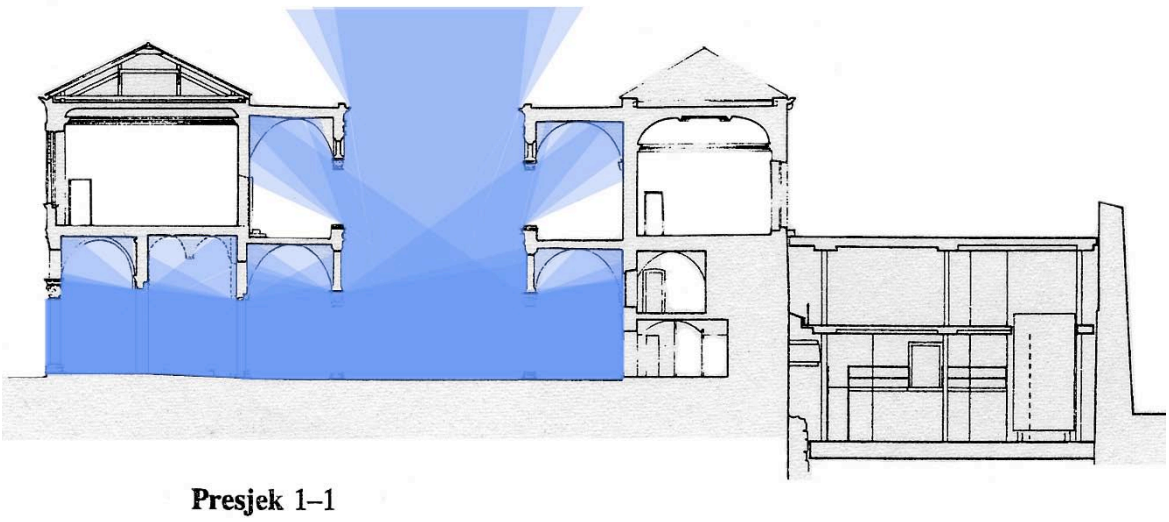

Figure 5.1.29 – Isovist fields through atrium, taken from section. *Source: author.*

5.1.11 Conclusions

The atrium in the Dvor is a well-connected space, with strong visual connections between upper and lower floors. Analysis undertaken shows that the atrium space is an essential link in the fabric of the building, being a key place to circulate and socially interact with others, as well as providing staples such as fresh air, daylight, a high degree of security, and the key route for circulation within the confines of the Dvor.

The isovists clearly show that the visual presence of the atrium is a key role in its use within the building, and this is reinforced by the main stair providing a prominent physical link. Physical connectivity is divided between the highly prominent (main public stair and mezzanine stair) and the 'back of house' almost quietly invisible stairs that would appear to have been the preserve of servants, or at least lesser administrators.

The prominence of the public stair is deliberate, and appears to reflect the openness of the political system – at least, the openness compared to other medieval political systems. The availability of at least one main route up to the *piano nobile* – ie the main public stair – is presented simply and honestly to the visitor to the Dvor. The physical connectivity is therefore almost as open and simple as the visual connectivity, within this atrium space.

The next case study is a very different building.

CASE STUDY TWO: CARRÉ D'ART

Case Study Two – Carré d'Art

5.2.1 Introduction

The second case study is of a modern public atrium building in Nimes, France: the médiathèque known as the Carré d'Art. Reasons why it was chosen as a case study are stated in section 5.0. The Carré d'Art precinct is a world-renowned example of successful civic design.

Nimes

On the south coast of France, the city of Nimes was established in Roman times, and is now a large, modern city, proudly hosting a Roman temple in the centre of the city, the Maison Carrée.[1]

Figure 5.2.1 **Aerial photo of Maison Carrée and Carré d'Art.**
Source: Nigel Young, Foster and Partners

Site

The site, opposite the Roman temple, was formerly occupied by a 19th century classical revival theatre, which burned down in 1952. After a number of years sitting empty, the site was redeveloped as the result of a competition to create a media library for the modern age, and British architects Foster and Partners were the successful entrant (completed 1993). Uncompromisingly modern, despite its setting next to the ancient Roman temple, the function of the building is primarily an audio-visual media library, but also includes a popular café that overlooks the Maison Carrée and the public square outside.

[1] Nimes pride and joy: the Maison Carrée is over 2000 years old and is widely acknowledged to be the most complete / perfectly preserved Roman temple in the world. Built c16 BC by Marcus Agrippa, dedicated to two sons of Augustus Caesar, and then used as a church, stables, city meeting hall, and finally a museum. The name Carrée refers to the long rectangular shape.

Figure 5.2.2 Public Square outside Carré d'Art.

Source: Nigel Young, Foster and Partners

5.2.2 Carré d'Art

The building features a very thin row of columns facing the public square, echoing the columns of the Roman temple, and defining the built environment. Foster notes that: "The line of those columns defines a kind of invisible wall: it encloses the space. It's a space-making device."[2] The external paving to the public square and the thin columns joins the two buildings together in a strongly linked composition.

The médiathèque's siting incorporates a prime public walkway routed through the building, a recurring theme in Foster's work such as the HKSB, the Great Court at the British Museum, and the Sage building at Gateshead. This "concept of routes through buildings to encourage their development as social hubs" [3] ensures that the public continually interact with the building and gives it a life outside the strict requirements of the brief. This enables the public to gain a sense of ownership over the building as they move through it – it becomes a truly social space, especially on their way to the upper floor café. Spencer de Grey, the director for the project at Foster and Partners, commented on this, noting that "there are a number of common themes running through our work, which are:

1 the urban context, which embraces the "physical context" as the "spirit" of the place;

2 the social context, which acknowledges the fact that architecture is about people;

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[2] Norman Foster, in Quantrill, *The Norman Foster Studio - consistency through diversity*, 46.

[3] Cattermol, *Buildings for Tomorrow – Architecture that Changed our World,* 171. "The [Sage] building occupies a steeply sloping site at the river's edge, with a road running immediately in front of the façade. The canopy acts as an additional layer of sound insulation against traffic noise and has entrances at both ends to form a raised covered concourse populated with cafes and bars open to the public sixteen hours a day. This concept of routes through buildings to encourage their development as social hubs is a recurring theme in Foster's recent work and has been successfully applied at the Great Court in the British Museum in London (2000)."

3 lighting, especially natural lighting, which is one of the really dominant themes; it is the poetic dimension of architecture;

4 design clarity, which ensures that the building concept is reinforced by the use of appropriate materials and the attention to detail throughout the work;

5 reinvention of the building form - as Norman puts it: "our buildings reinvent the building type"[4]

All these themes are evident in the finished building of the Carré d'Art.

Design

The design requirements were for a significantly larger amount of floor space than was available on site, and other entrants proposed tall buildings. So that the new building did not overshadow the old, Foster's design recessed half the bulk of the médiathèque into the ground, with 2 ½ floors above ground and another 5 floors below ground. In order for the lower levels of the médiathèque not to feel like a dank, dark basement, Foster used the full depth and height of the section to bring daylight deep into the interior, filtering down through the building via a top-lit atrium. Even at the lowest public basement level, the space is still lit with daylight.

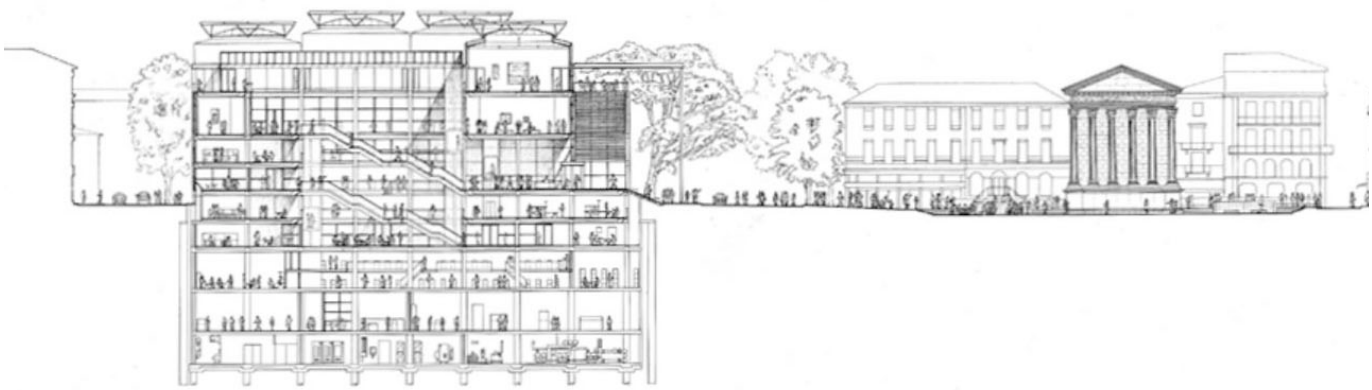


Figure 5.2.3 Cross section through Carré d'Art. This section shows the overall relation of the building to the urban environment, including the Roman temple. An enlarged version of the section appears in 5.2.16 *Source: Foster and Partners*

5.2.3 Atrium

The large central atrium is used as the primary circulation space, and is a key feature of the interior of the building. This atrium is effectively a three-sided structure according to Saxon's classification (refer to figure 2.14), with daylight through the roof, through the front wall, and through the stairs as well, with frosted glass

stair treads to all flights of stairs contained within. The central atrium space is the origin therefore of both circulation and light, each spilling down the stairwell. The building is in effect designed around the atrium space, with rooms arrayed off the central stair over 5 different levels. It contains three central stairs (refer 2.20) and a total of four lifts (refer 2.18), enabling high physical connectivity to all parts of the atrium.

Figure 5.2.4 Carré d'Art, central atrium and staircases Strong sunlight can be seen falling onto the frosted glass stairs, which filters the light down to the lower floors, within the central atrium. Connectivity is demonstrably physically abundant, as shown here. *Source: Nigel Young, Foster and Partners*

Walls to the building atrium are primarily glass: either clear, frosted or opaque to enable maximum transparency. The aim of a frosted glass Foster atrium is that light (and thereby space) plays an important role

[4] Quantrill, *The Norman Foster Studio - consistency through diversity*, 34.

in the design.[5] As Malcolm Quantrill notes about the design of a Foster and Partners atrium, "…the architecture itself has been dissolved in light and air and space. And all that is left, floating in a limpid interior, are some vestiges of lineamenti, the last traces of a web of disentanglement."[6]

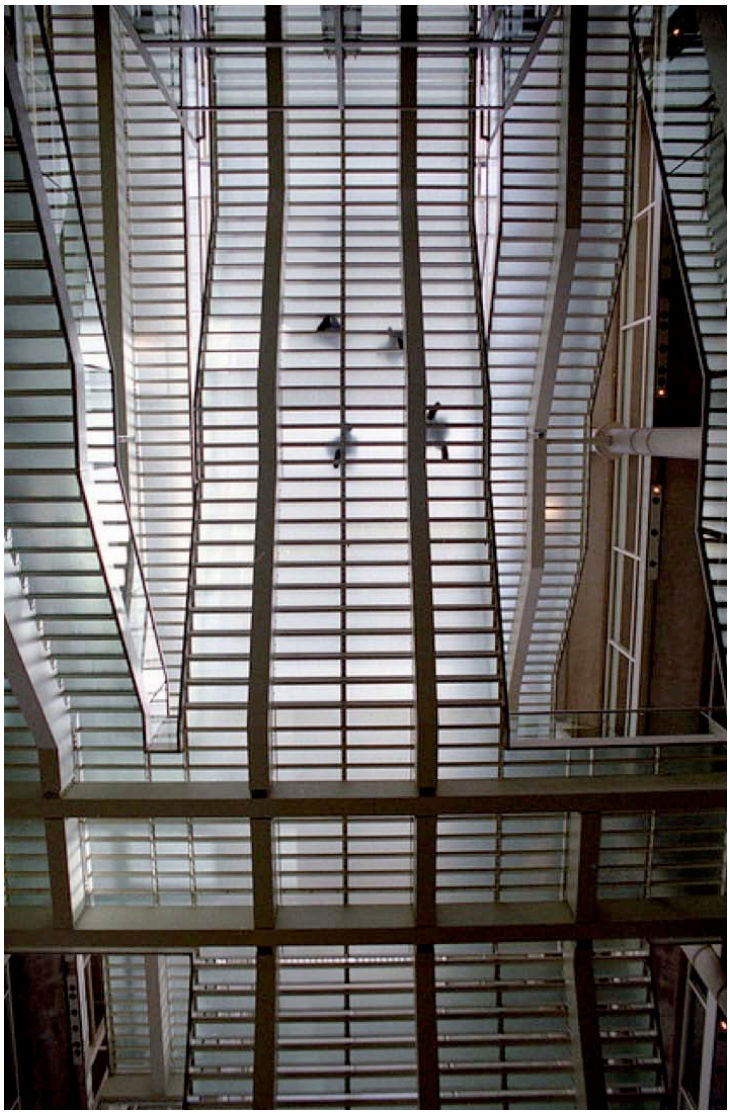


Figure 5.2.5 Carré d'Art, central atrium and staircases. Staircases seen from below indicate that daylight filters strongly through, while obstructions (people) do not cause a significant blockage. Connectivity is also visually enhanced by the interfloor staircase links made of translucent structural glass: users can simply see where the stairs may go.

Source: Addison Godel, flickr.com/photos/doctorcasino/2729070624/

[5] This design device can be seen in numerous Foster buildings. An early project was the Staircase and Lift project at the Royal Academy, where light spilled down a small infill courtyard, through glazed stairs and a glazed balcony floor, to bathe the statuary in soft white light.

[6] Quantrill, *The Norman Foster Studio - consistency through diversity*, 82, although discussing here the Willis Faber & Dumas building in Ipswich, it seems highly relevant to a description of Nimes also.

The perimeter is not only largely transparent but also movable in parts (with some sliding wall panels), so it has a high degree of visual perforation (refer 2.15 and 2.17) and strong visual connectivity to many of the rooms within the building.

Circulation

As noted, the central atrium is the site for all public circulation, ensuring strong physical connectivity throughout the building. There is a large, wide, major stair going up (refer 2.18), another major stair going down, and four public lifts, targeted to different floors.

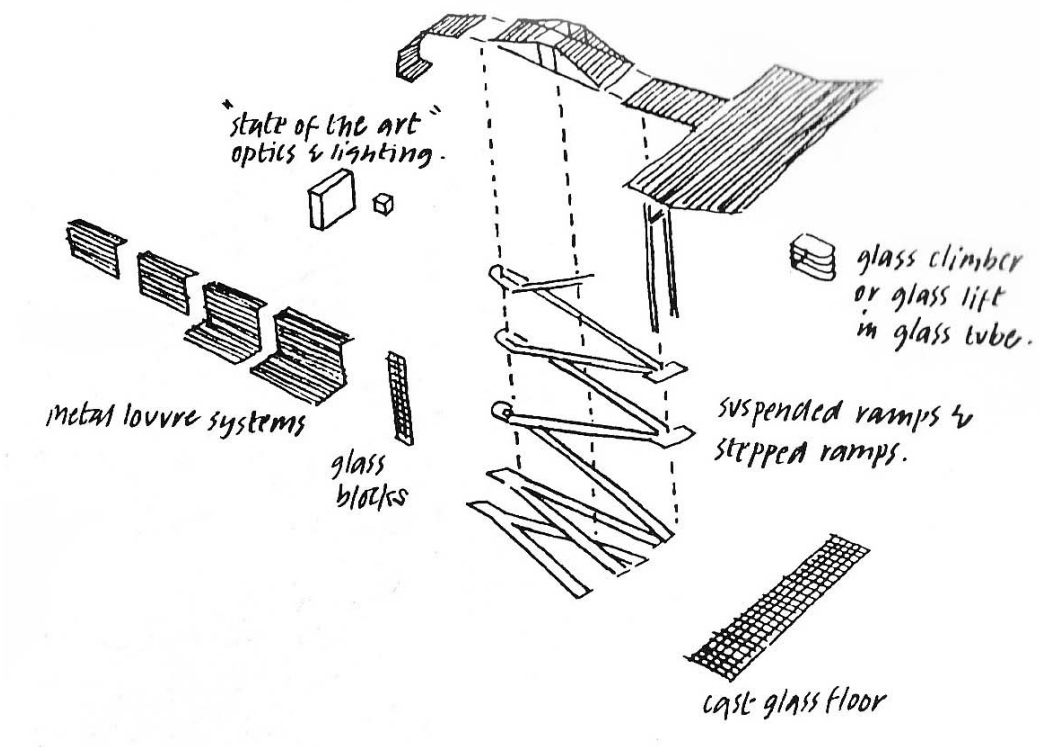


Figure 5.2.6 Carré d'Art, central staircase diagram by Norman Foster.
Source: Norman Foster, Foster and Partners

There is also a number of other minor stairways – mainly fire escape stairs – and a goods lift. These other stairs would not be used by the public under normal circumstances, and so have not been factored in to the analysis. From the main stairs alone, however, the connectivity can be noted as strong, both physically (refer figure 5.2.5) and visually (refer 5.2.4). Although there are no escalators in the building (which of course would have blocked out considerable amounts of light), there is a small sky bridge linking to the stairs across the atrium at level C. The atrium is approx 8m wide x 18m long, and 20m high, and while in plan is mostly filled with the stairs, as can be seen from the cover photograph to this chapter, it is mainly a large empty volume.

5.2.4 Room sequence analysis

Using space syntax methods to evaluate the atrium, room connections were mapped to depict permeability and connections (refer figure 5.2.7). As with the previous case study, coloured dots are used to depict certain types of rooms, with the addition of a dotted line used to depict connections that are visibly overlooked, even if they cannot establish a direct physical connection.

Due to the number of floors, and the need to correctly understand their relationship to each other, the floor plans are shown here ordered with the highest level first, running down the page to the lower floors. While the upper floors appear highly symmetrical, there is slightly more asymmetry and complexity on the lower floors.

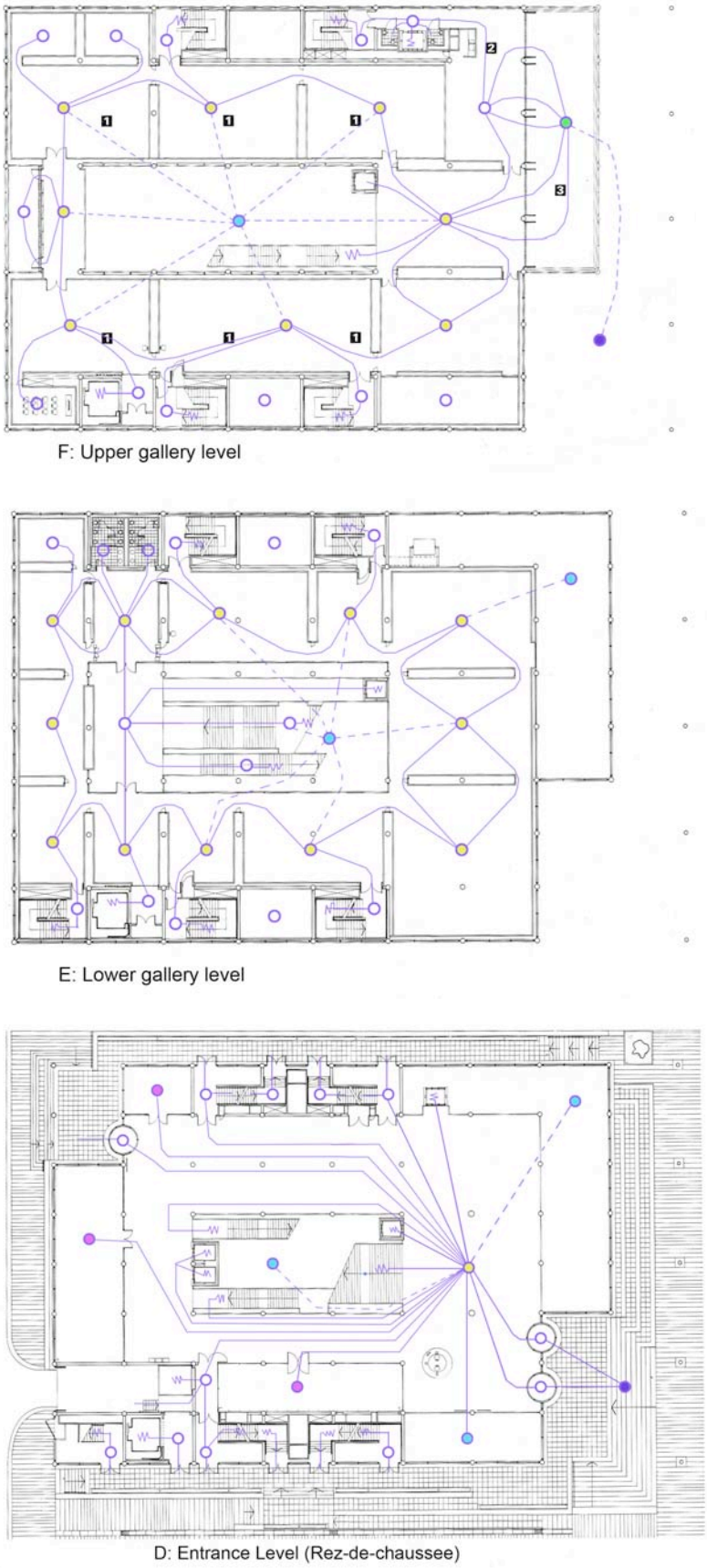


Figure 5.2.7 Upper floors – gamma analysis, *Source: author*

Figure 5.2.8 Lower floors gamma analysis, *Source: author*

This layout was then depicted as a justified permeability graph (refer to J-graph in figure 5.2.9), which shows that this building is very shallow in terms of connections: rooms are not hidden away behind other rooms, but are immediately accessible off the central atrium space. All spaces in the building are open, well integrated, (spatially shallow), and therefore highly accessible to the public.

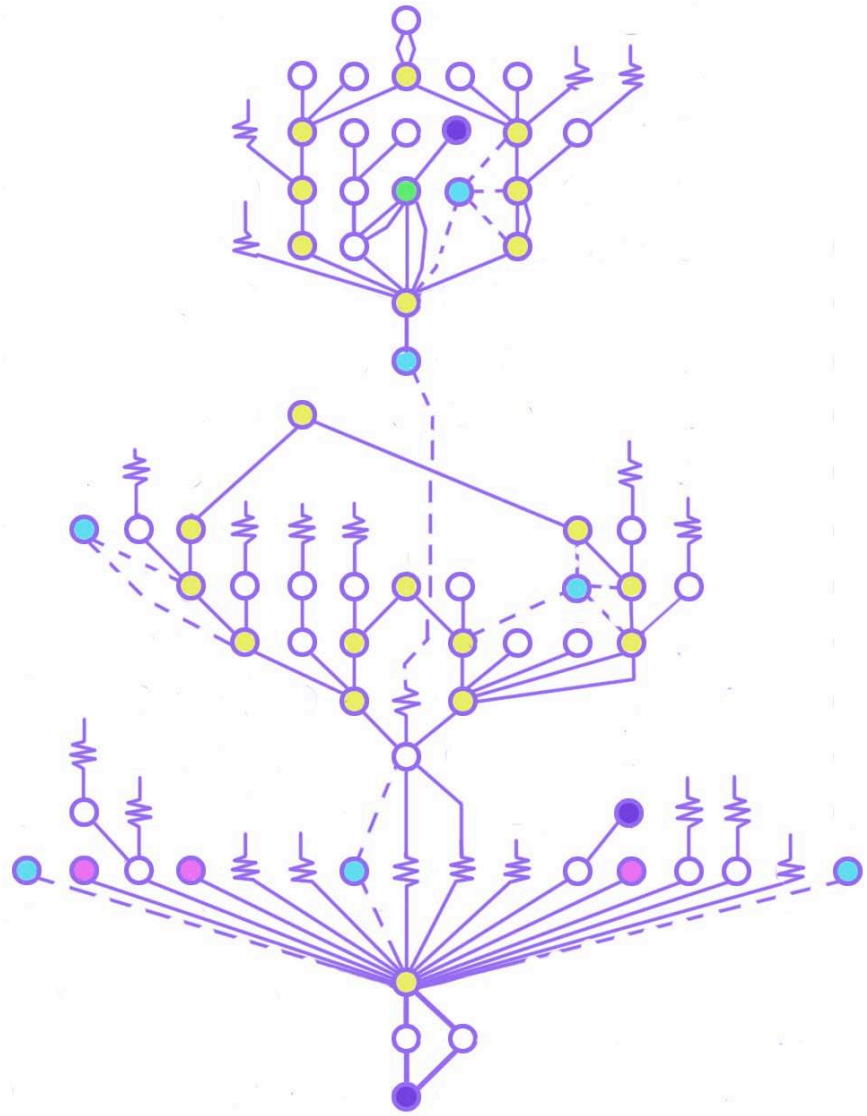


Figure 5.2.9 Upper floors - justified permeability graph, based on figures 5.2.7 and 5.2.8. Note that the ground floor shows an almost complete lack of hierarchy. Upper floors, by contrast, exhibit some ringiness as users work around the perimeter of the atrium space, but there is still very little hierarchy except to access fire escape stairs. This implies that the building is very open, and is well-planned for accessibility. *Source: author*

From the instant of entering the building (and probably before that, given that the external walls are also highly glazed), connectivity is maximized. Every means of vertical circulation is immediately accessible from that ground floor space (level D plan, ref figure 5.2.7). In space syntax terminology, this shallow integration shows that the building has an almost total lack of hierarchy: a good, accessible solution for a public building.

This J-graph has been produced from the ground floor upwards. A similar result (uncharted) extends downwards into the basements below, although this will be more tangled and less clear, as can be seen from the room connections (refer figure 5.2.8).

5.2.5 Sequential spaces

A Moretti style 3-D model was made for this case study, by Eli Nuttall, and two different versions of the spatial inversion are shown here.

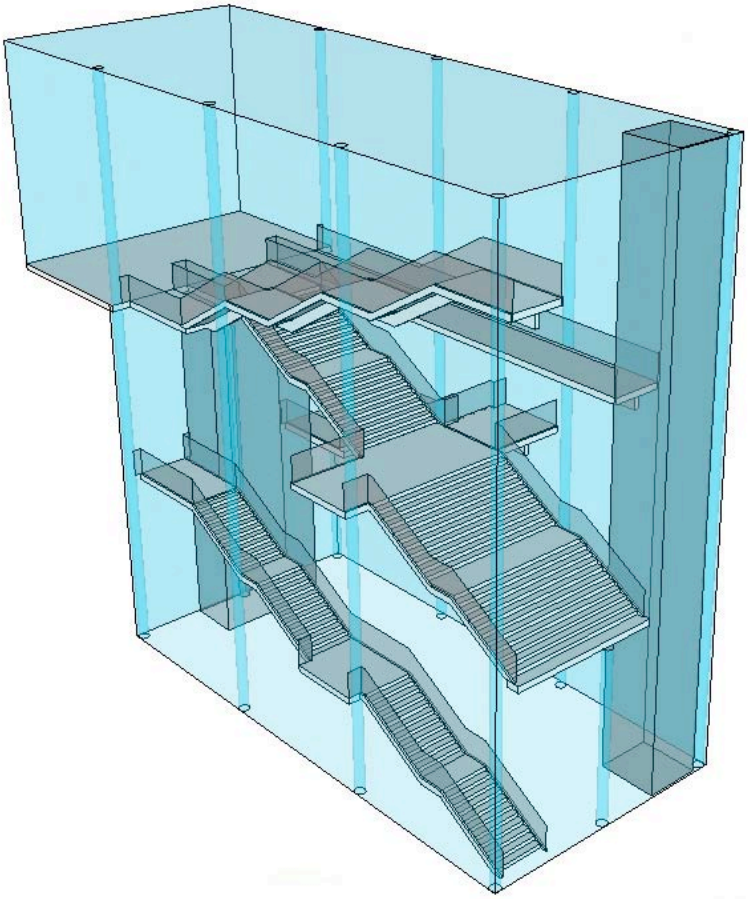


Figure 5.2.10 Moretti-style spatial inversion SketchUp model of Carré d'Art atrium core. A spatial imprint of the stairs are visible through the 'jelly', indicating the paths of visible connectivity.
Source: Eli Nuttall (2012).

The first is a straightforward modeling of what may be thought of as 'the atrium', as a tall thin discrete 'object' (figure 5.2.10). Stair and lift connections can be easily observed passing through the space: the physical connectivity of the space is compact and centrally located.

By comparison, the second model (figure 5.2.11 - shown from a similar angle) shows the true extent of what is actually directly visible from within the atrium – not including rooms opening off the atrium. Rooms visually connected within this building are extensive. While the building itself is considerably larger below ground, the extent of visible space as shown here extends from the front of the building right through to the rear.

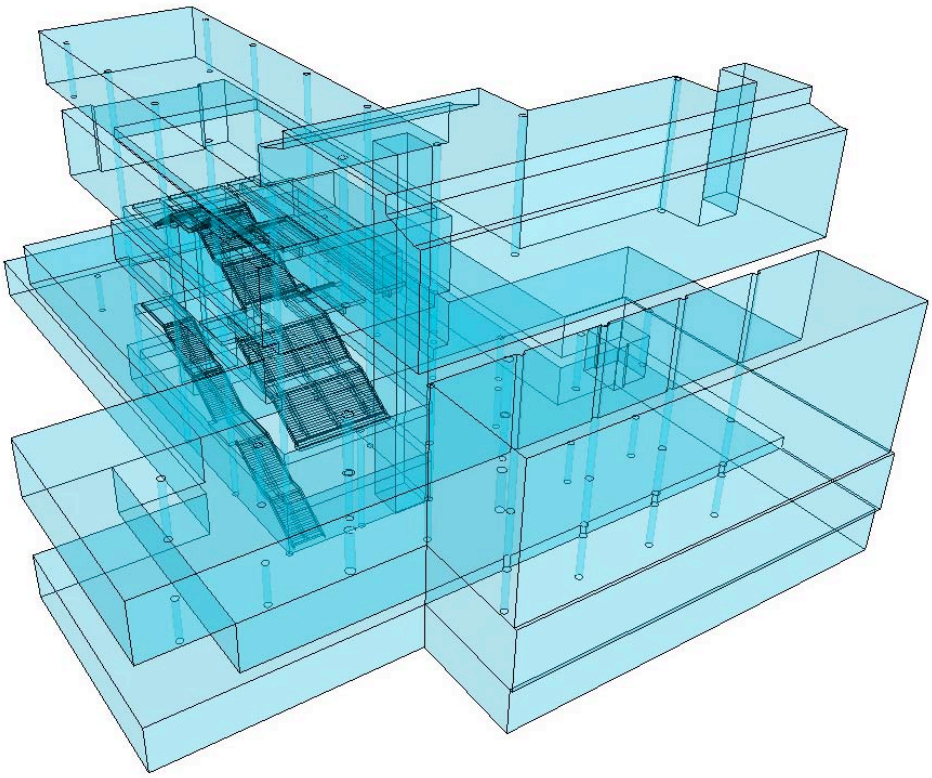


Figure 5.2.11 Moretti-style spatial inversion SketchUp model of Carré d'Art atrium full extent. The atrium is much less confined – space 'flows out' from the core. *Source: Eli Nuttall (2012).*

In terms of Moretti's sequential spatial analysis, there is a very non-sequential series of spaces in this building. It can be seen from both the J-graph and the Moretti model that nearly all spaces are just one room removed from the central atrium and its stairways. Although this stair is separated out over six different levels, if the atrium is perceived as just one, unified space, then no room is more than two steps removed – and in most cases just one step removed from the public zone. As an example of openness of information, the building works extremely well. As an exemplar for explaining and illustrating connectivity however, while the J-graph is good (if non-intuitive), the Moretti model is not that useful.

5.2.6 Depthmap analysis

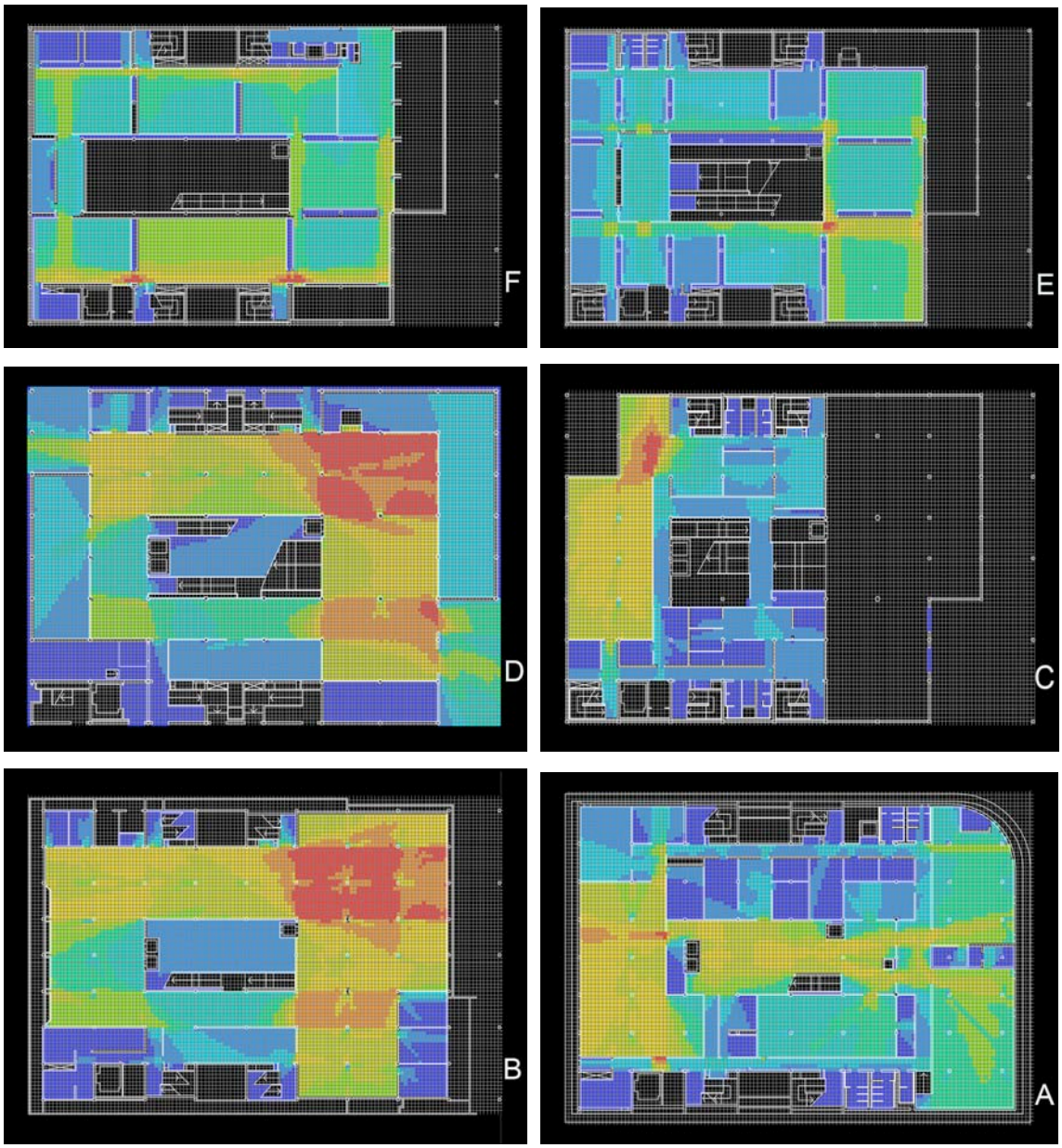


Figure 5.2.12 Depthmap VGA: Carré d'Art floor plans. Note that in plan D (ground floor) the simulation has indentified the top right corner of the plan as being the most integrated, near the lift to the roof top café. *Source: author.*

In the Depthmap trial, the six upper (public) floors were modeled and analysed (figure 5.2.12). Of the results, the most interesting is the main ground floor entry at level D. While the Depthmap VGA shows a high degree of connectivity at the ground floor, especially around the entrances to the lifts to upper floors (including the route to the café), the software again does not recognise the importance of the stair connections. Other floors were modeled and similar odd results observed. While this is a shortcoming of the software, it does appear to work well on an individual basis for each floor.

The brightly coloured areas on map D and map B reflect that at these two locations, an almost panoramic view of the space is available to the occupant of the space. Anybody in these zones will be visually well connected to almost all other areas on that floor. This means that, while waiting for the lift up to the café, an observer in this position has maximum potential to make visual and social connections with other users – ie it will be highly socially active. So, while the software has not recognised the importance of the stairs as the main route up through the atrium, it has nonetheless recogised that Foster's design has incorporated the physical linkage to the café at a highly appropriate location, to maximise the connectivity within the atrium.

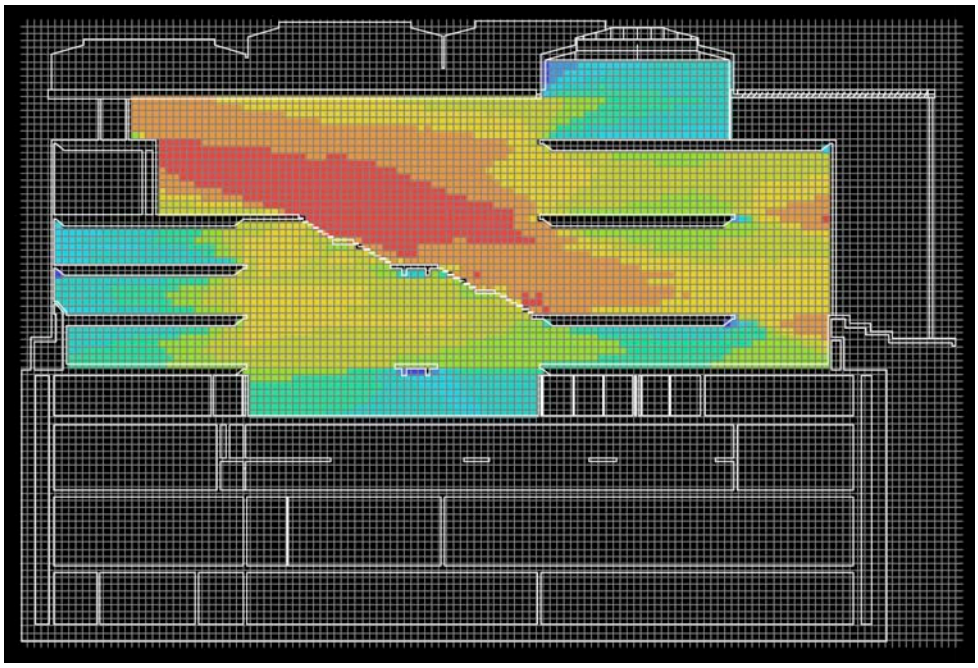


Figure 5.2.13 Depthmap VGA: Carré d'Art section through Atrium stair. The software has identified the top of the staircase as highly connective. *Source: author.*

A pared-back version of the cross section was also run through Depthmap, and the results are shown here in figure 5.2.13. While this appears to identify the top of the stair as the most connective part of the atrium, in reality the stair does not take up the full width of the space, and the whole of the atrium is more likely to be active. A second VGA (figure 5.2.14), with stair treads removed, shows how this alters the analysis considerably – highlighting the upper centre of the atrium as the most connective part of the atrium space.

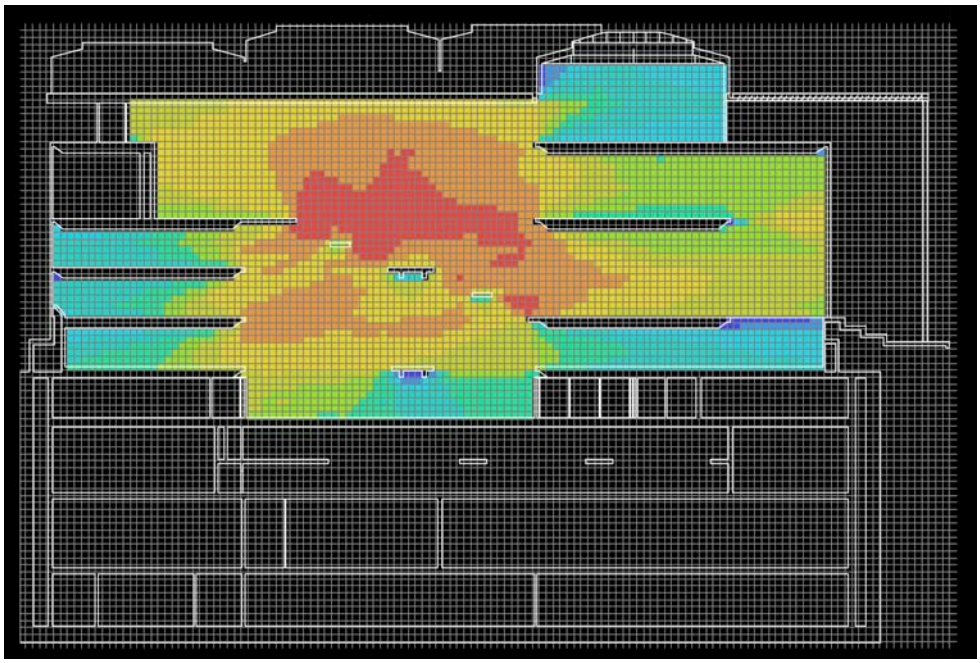
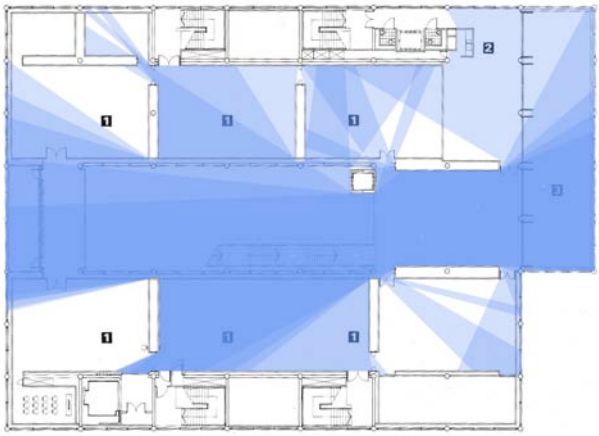


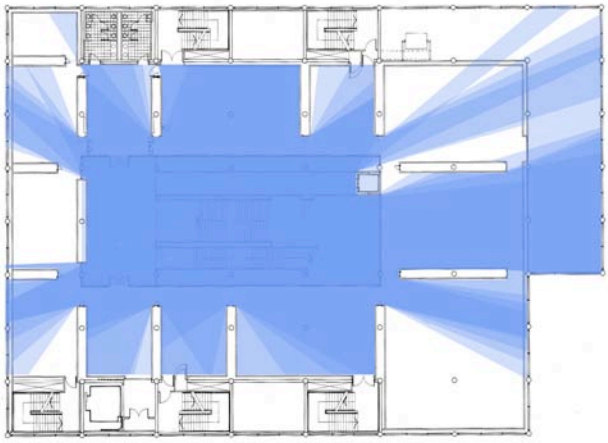
Figure 5.2.14 Depthmap VGA: Carré d'Art section through Atrium stair. In this version, the actual stair treads have been removed, simulating the situation of the atrium with just the key landings retained. *Source: author.*

5.2.7 Isovist plan analysis

To test the isovist field analysis, a series of isovists were drawn, on the trail of a person walking from the front door of the médiathèque, past the reception desk, and up the primary stair towards the upper levels (figure 5.2.15). Walls have been treated as non-transparent, even if they are glazed or translucent: physical continuity is being treated as dominant over visual continuity, even to the clear glazed walls to the outside. What is noticeable here is that from the entry doorway, there are clear visual connection paths to three of the main stairs, the two main lift points, and routes up, down, and through the building.



F: Upper gallery level



E: Lower gallery level

D: Entrance Level (Rez-de-chaussee)

Figure 5.2.15 Upper floors: isovist fields, *Source: author*

The isovist field reinforces the findings from the J-graph, that all vertical circulation is accessible from the entry space. With the exception of some of the back of house fire escape stairs, all public stairs and lifts are visually identifiable right from the front door.

Upper floors are slightly different. While the spaces are diagrammatically sequentially linked, implying that integration is not good (with poor physical central connectivity), in reality the space is visually strongly integrated due to the excellent visual connectivity to the atrium and across the central atrium.

5.2.8 Isovist section analysis

Again, in a move to test isovists applicability to the analysis of 3-dimensional space, a series of isovist diagrams have been manually created in section as well as plan.

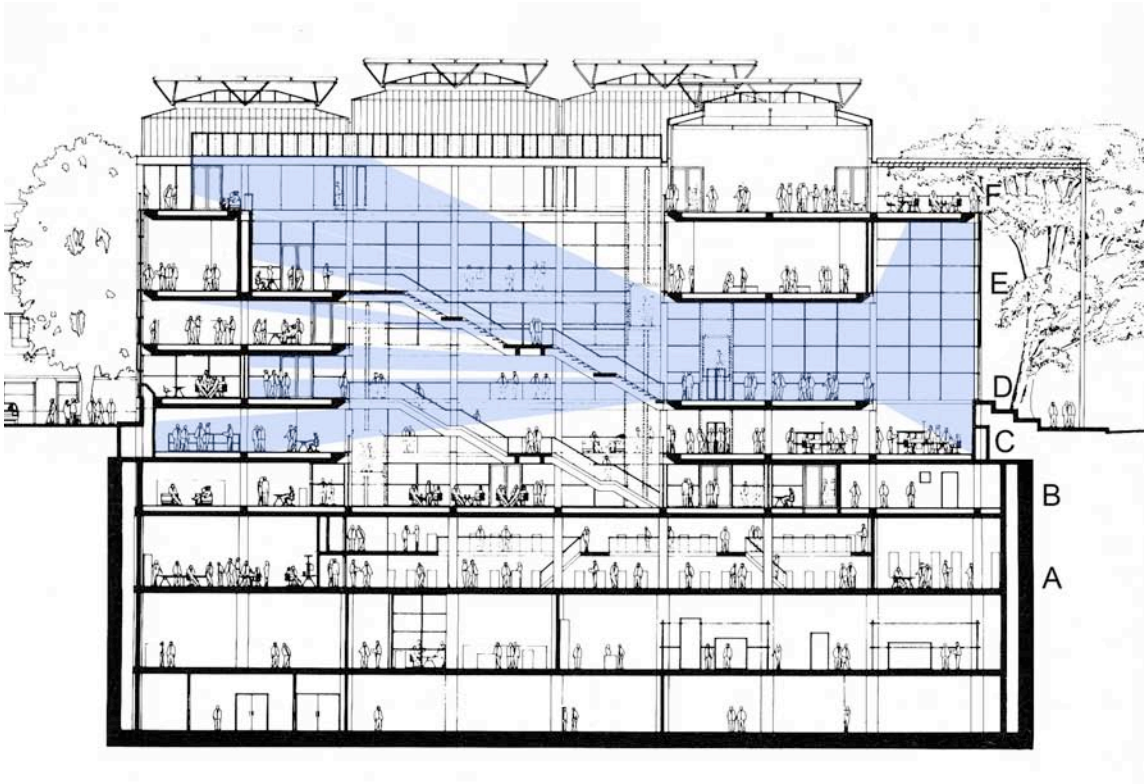


Figure 5.2.16 – Isovist from Entry, section through central stairway. Ground floor entry (level D) is from external stairs at right, on a glazed bridge over a basement level - from this point sky can just been seen through the walls at the top of the main stair (top left of section). *Source: author.*

The resulting diagrams show what we know: the physical connectivity of this building is strongly tied to the central atrium and closely parallels the visual connectivity seen in the plan isovists. At the top of the stairways within the building, ie the most removed from the front entry door, the café is situated outside on the roof deck. This physically connects the most intimate part of the building directly back to the outside environment, and visually connects it directly back into the urban context of the Maison Carrée's ancient authentic structure.

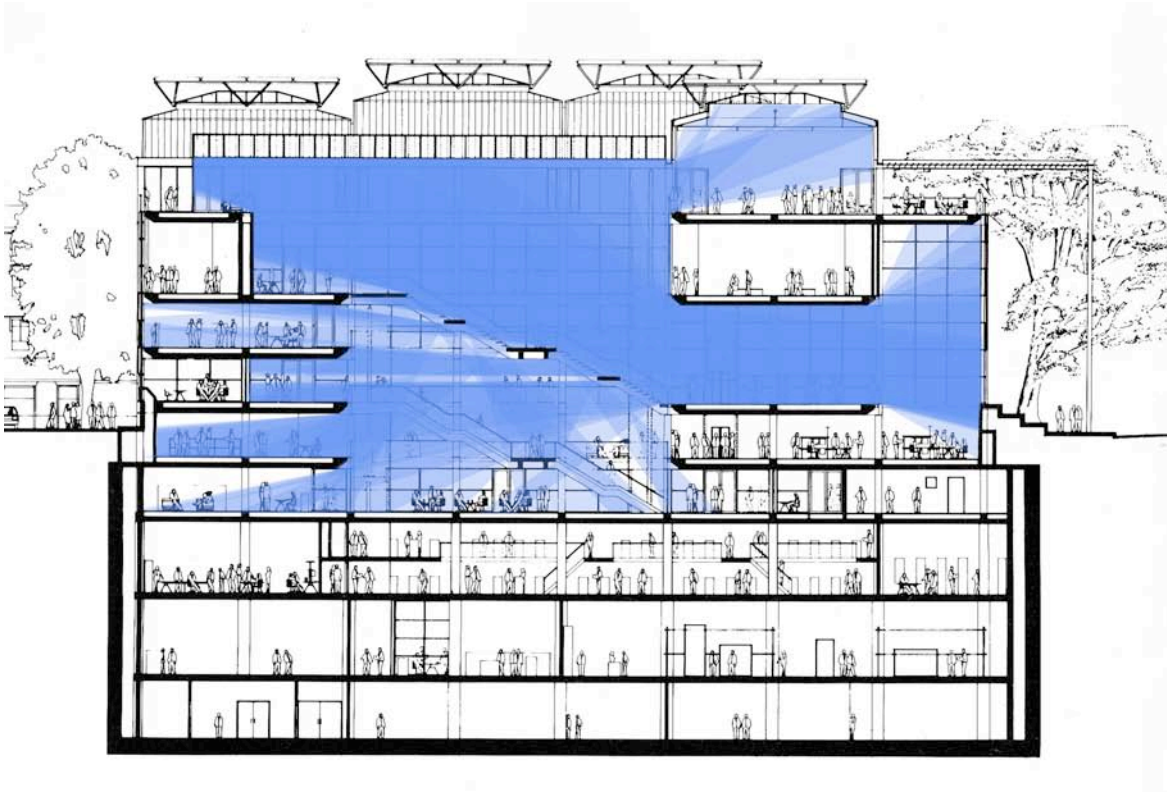


Figure 5.2.17 – Isovist field from entry to atrium, section taken through central stairway.
Isovist field as section expresses the saturation of views available to the occupant, as they ascend from ground floor up the main stairs. Although stairs and landings are glass, they have been treated for the most part as if solid. Transparency of this void is likely, if anything, to be even more transparent than is shown here. Views would not stop, as shown here, at internal glazed walls, but would extend out even further into the surrounding built environment. *Source: author.*

5.2.9 Conclusions

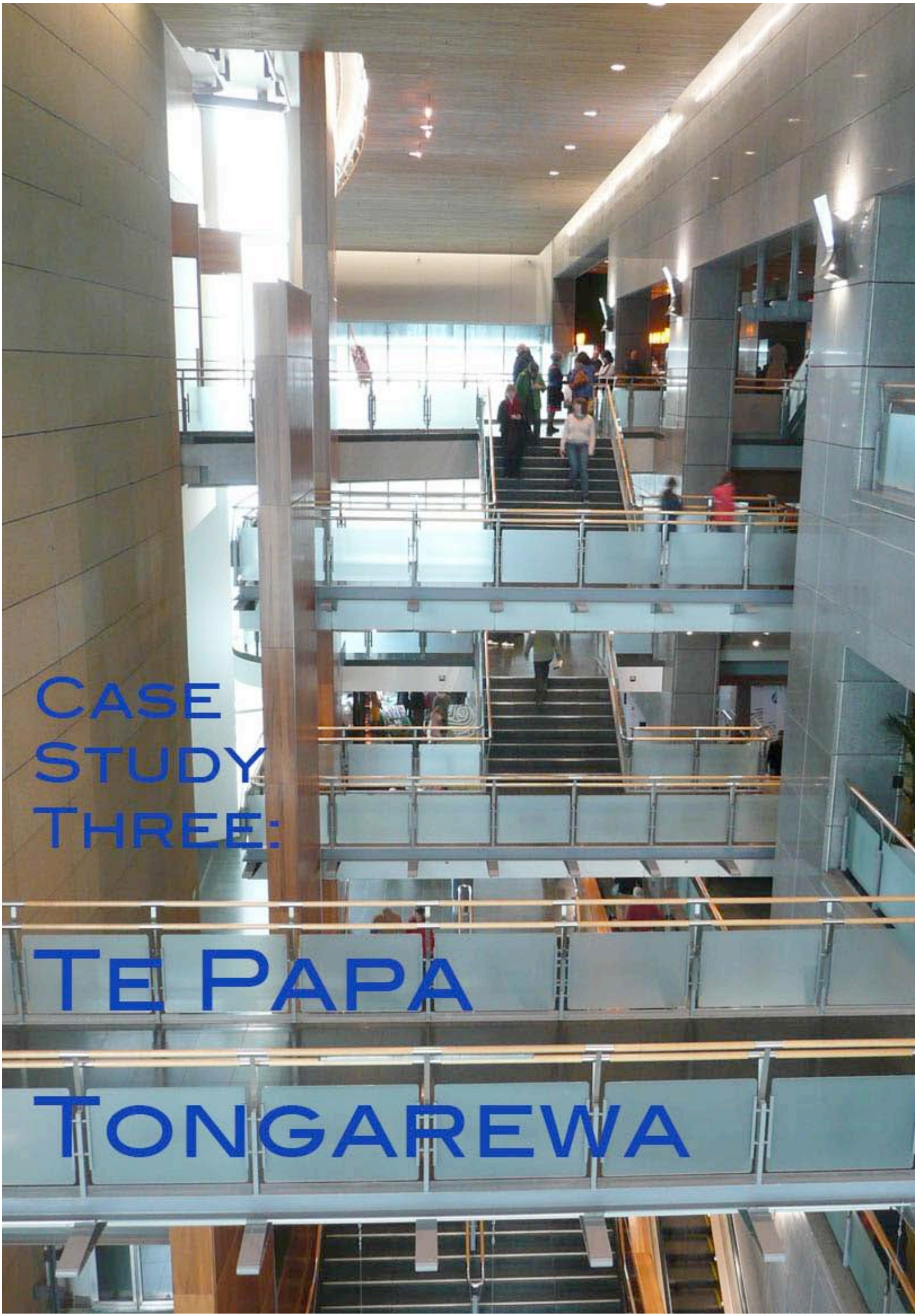
It can be clearly seen in this analysis that Foster's emphasis on the urban context and the social context is highly successful in this building. The building relies on a strong connection to the public zones via the transparency of the external façade, the columns to the roof and the placement of the cafe, and reinforces that through the heavily public, social nature of the atrium circulation and its internal transparency to the activities within. The relationship mapping points to the amount of hierarchy in this building as almost zero, reflecting its strongly public, open nature. What is most apparent here from the isovist fields is that from the moment a visitor enters the building from the front door – and even from the back and side doors – multiple means of vertical circulation are apparent. The main stair is highly visually prominent, but so is the stair down, the lifts up and down, and a number of emergency escape stairs as well. This building is thoroughly perforated with circulation and interconnection, as well as strongly bathed in light.

The analysis by isovist fields show that the atrium space allows visual connections to other floors but also enhances the straightforward visual links by correspondingly linking with multiple physical connections.

Figure 5.2.18 Carré d'Art, rooftop café overlooking square. Visual, audible, and probably even olfactory connectivity is established between the café clientele and the city dwellers in the square below. Physical connectivity is kept close by, in the atrium just behind the café.
Source: Nigel Young, Foster and Partners

The end result is not just a building that is open, but also one that is transparently obvious with circulation. Despite the large amount of knowledge stored within the walls, the J-graphs indicate that it appears all readily accessible to the public. The siting of the café on the top floor roofspace is also a strong drawcard for the médiathèque, with a well-sited lift within the building, pulling visitors through the public spaces on the way up to the roof top. This ensures that research scholars and casual café visitors are mixed, and that the productivity of the casual social interchange is maximized via the bump factor.

The central mixing point for both sets of visitors is fully coincident with the central vertical circulation of the central glass staircases. The building, as a result, is a strongly social building, acting as a social hub for the city. As a significant space within the city and as a highly successful social space, the spatial analysis indicates why this atrium can be considered a significant social space.



Case Study Three:

Te Papa Tongarewa

Case Study Three – Te Papa Tongarewa

5.3.1 Introduction

Te Papa Tongarewa is a large, 6 storey high public building with a central atrium, on the foreshore of Wellington's harbour (refer figure 5.3.1). It houses the collections of the Museum of New Zealand (MONZ), and the National Art Gallery of New Zealand (NAGNZ). It was chosen as a case study by means of it being New Zealand's most preeminent public building, with extensive atrium spaces within. Te Papa "is New Zealand's most successful cultural project", according to an official Briefing document to the incoming Minister for the Arts.[1] For other commentary on Te Papa, refer to the Appendices.

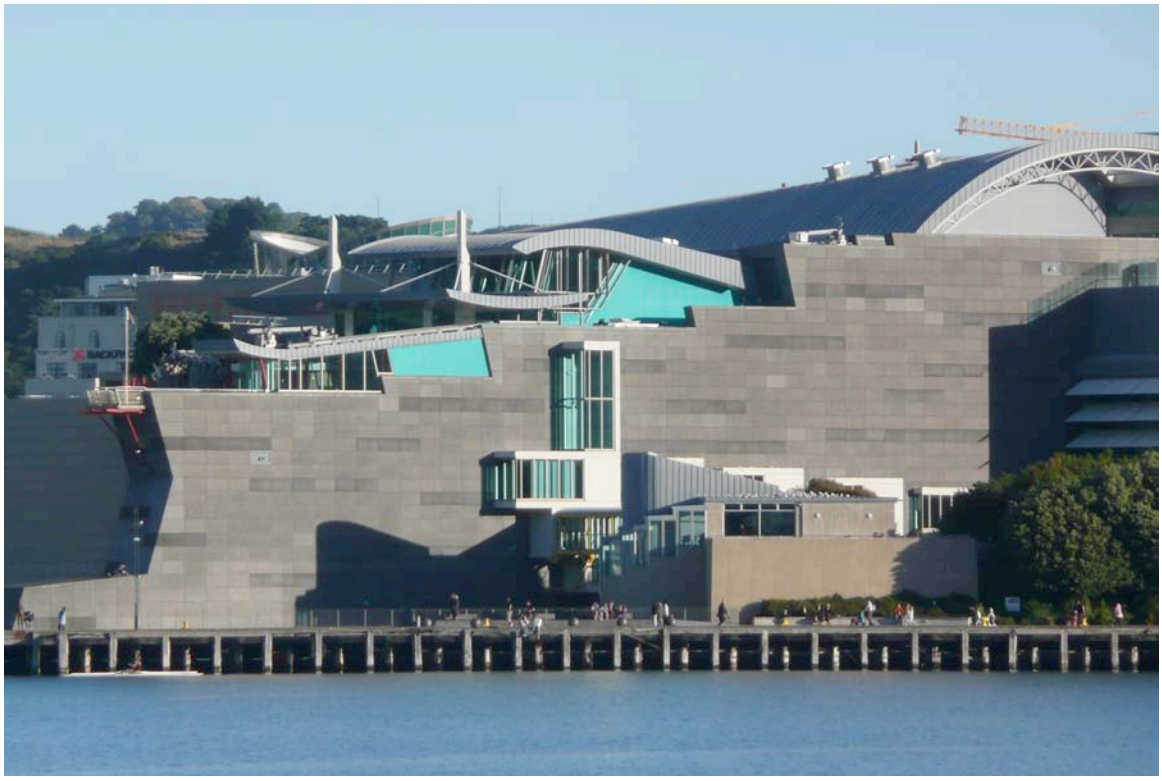


Figure 5.3.1 Te Papa - primary city view, featuring the grey paneled 'faultline wall'.
Source: author (2010).

5.3.2 Background: competition and design origins

Te Papa's origin was via an architectural competition held in 1989. The selection committee included a former New Zealand Prime Minister, Wallace Rowling, amongst others.[2] The resulting competition included several international entries[3] and was won by Jasmax.[4]

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[1] Museum of New Zealand Te Papa Tongarewa, *Briefing to the Incoming Minister*, 2011.
[2] Bill Rowling, the former Labour Prime Minister, was not known for any particular design sensibility and was therefore perhaps an ill-chosen committee figurehead for a design competition jury. Hamish Keith notes that "the fault lay in the brief and the process that

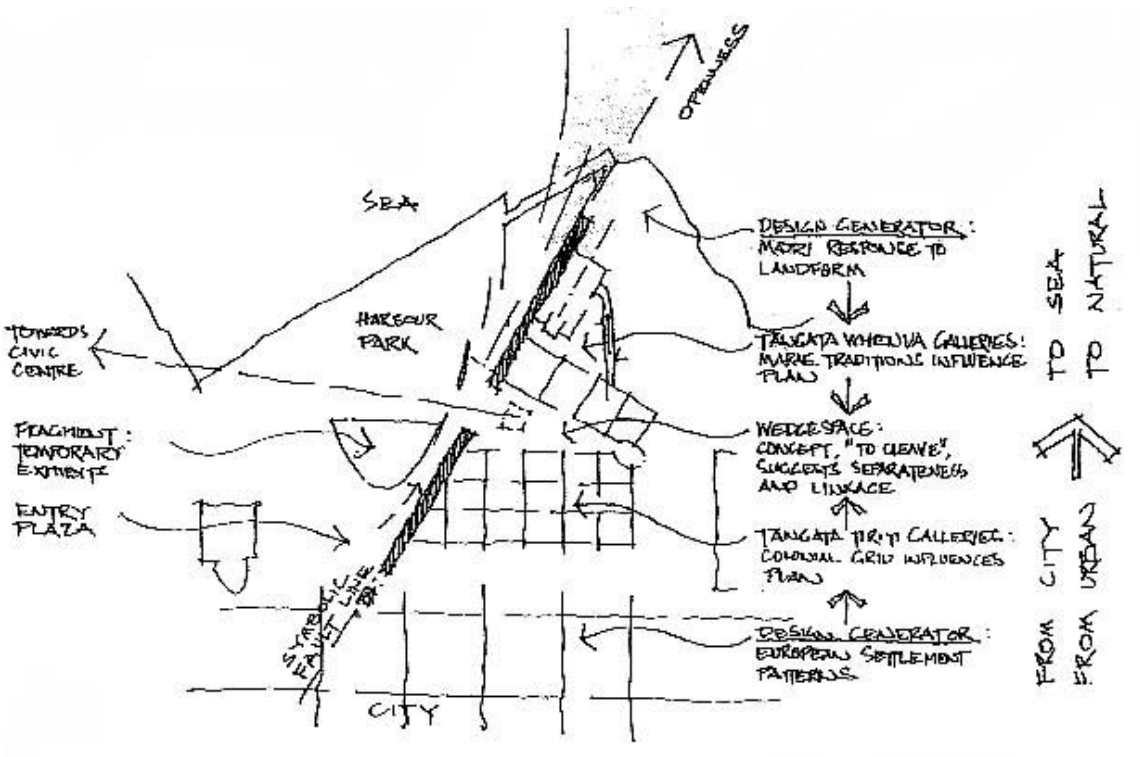

Figure 5.3.2 Bossley/Jasmax design rationale. Concepts noted here include the 'symbolic faultline' wall, a 'wedge space' intended "to cleave", and maori / pakeha settlement grid patterns. All are still present in the finished building. *Source: Architecture New Zealand, Feb 1998.*

The story of the competition process and the complex brief is described by Pete Bossley, the lead design architect on Te Papa:

> Not only did the document present extremely demanding functional requirements (over 350 separate spaces to be co-ordinated), it also called for the architecture to powerfully represent the total culture and national identity of New Zealand. The building had to express the bicultural nature of the country, and the contributions made by people of diverse ethnic origins.[5]

Bossley notes that this complex brief suggested a uniquely New Zealand framework (refer to figure 5.3.2):

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arrived at that particular design" and that "the sub-committee lost the plot and went ahead and selected a building anyway." (Keith, "Te Solution").

[3] Entries received included a giant paua shell, and a combined entry from Frank O. Gehry Associates and Athfield Architects. Gehry went on after Te Papa to design the now famous Guggenheim Bilbao art gallery, and there is a view that Wellington could have had an iconic structure such as the Bilbao Guggenheim. This point has been raised repeatedly by critics.

[4] Jasmad teamed up with Pete Bossley for the competition and to reflect the enlarged team, renamed the company as Jasmax, a name it still retains despite Bossley leaving the company later.

[5] Bossley, *Te Papa, An Architectural Adventure.*

> The brief suggested a conceptual framework of Papatuanuku/land, Tangata Whenua, and Tangata Tiriti. We at Jasmax were determined to express, at the very heart of the building rather than at the level of decoration, the differences between the two cultures, and the common ground of conversation between them. We searched long and hard for an appropriate architectural expression of these cultural issues, and finally found that reference to the settlement patterns of Maori and Pakeha gave us a valuable basis for the design.[6]

From the day that it opened at a dawn ceremony on 14 February 1998, Te Papa has attracted record visitor numbers when compared to the former Dominion Museum.[7] Attendance has increased more than ten-fold, an impressive achievement for a city the size of Wellington.[8] However, the architectural fraternity, as well as public commentators, have at times criticised the museum.[9] Further criticism is noted in the Appendices.

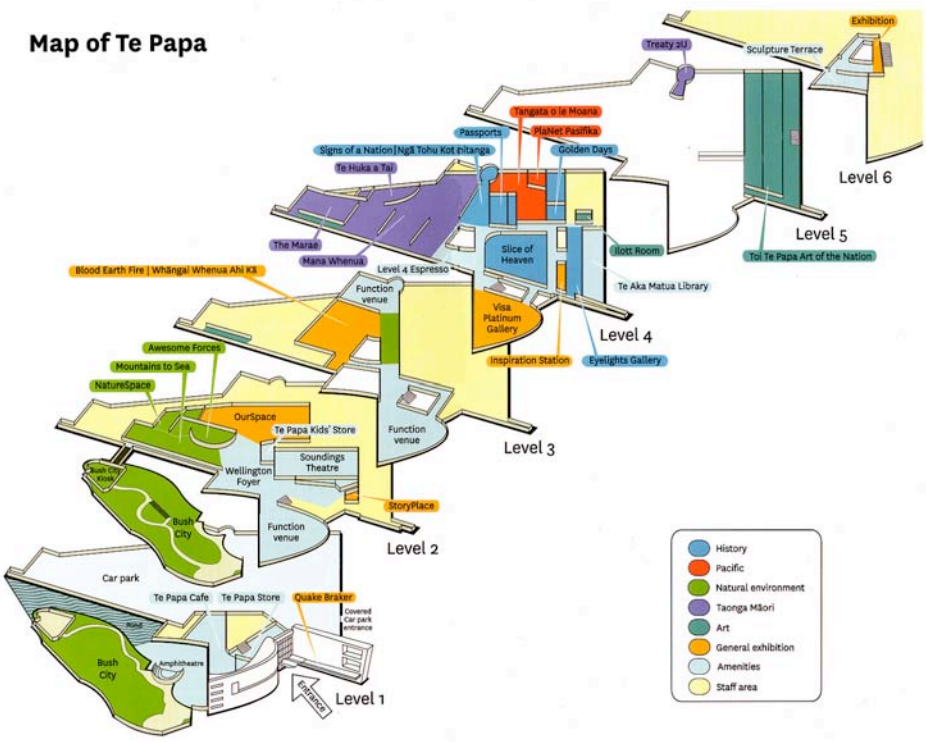

Figure 5.3.3 Map of Te Papa, official guidebook. Note that the atria within Te Papa are not highlighted as part of the system for understanding the building. The usefulness of this diagram as a guide for visitors is doubtful. *Source: Te Papa - Your Essential Guide.*

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[6] Bossley, *Te Papa, An Architectural Adventure*.

[7] Architect: Gummer and Ford, 1936; converted to College of Design, Fine Arts and Music, Massey University by Tetrad Design Group in 2002).

[8] The Art Newspaper publishes an annual ranking of top 'art museums'. In the latest version (April 2012, no 234, p35-37), Te Papa comes in at 33rd place, with 1,368,100 visitors annually. The top ten places include the Louvre in first place for visitors (with 8,880,000 annually), followed by MoMA in NY, the British Museum in London, National Gallery, Tate Modern etc. Te Papa's 33rd place listing is higher any museum in Australia. www.theartnewspaper.com/attfig/attfig11.pdf accessed April 2012.

[9] The building is not popular with architects. Upon its opening, it received a local NZIA Award for Architecture, but not a National Award. For a major building such as Te Papa not to gain a National Award from the NZIA can be seen as a strong measure of disapproval with the design.

5.3.3 Public criticism

The building was launched with a special issue of *Architecture New Zealand* in February 1998, which sported a record 38 pages on the building, spread amongst at least 10 authors.[10] Comments were mostly complimentary.

Most critics since then, however, believe that Wellington has missed out on a rare opportunity to create an 'icon' building. The focus of this research however is on the interior of the building (refer figure 5.3.3), and does not concern itself with the external appearance of the museum.

5.3.4 Te Papa – the building

With the prime waterfront site located on recently reclaimed from the sea, risk of destruction by earthquake was a real concern to the architects and engineers. The main body of the building is raised high above ground level to avoid devastation by tsunami, and the structure is set on seismic base isolators to protect the precious contents. As the Museum of New Zealand and as a storeroom of thousands of precious taonga and artworks, the building necessarily resembles a fortress.

The exterior appearance is composed of a number of shapes and roof forms clad in grey zinc, and the walls are finished in a tan-coloured precast concrete panel system. One wall, facing the local street network, is clad in multi-coloured glazed panels: Giles Reid cautiously noted that this "frequently criticized elevation to Cable Street is the most successful,"[11] (thereby implying that other elevations were less successful). The 'settlement patterns' that Bossley discusses include the prime factors for the design - the interface between two separate town-planning generators: the european urban grid, and the angular, more open Maori generators, at odds with the other.[12] Museologist Paul Williams recognizes this, and notes that the:

> "spatial dichotomy constructs the indigenous and Western in a highly familiar scheme that situates the natural world against the built form, the spiritual against the material, and ecological harmony against capitalist development."[13]

Conflicts are therefore inherently part of the planning of Te Papa, including the debate on the biculturalism of New Zealand. Following the lead of this biculturalist approach, internal planning is set out according to two

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[10] February 1998, *Architecture New Zealand.*
[11] Giles Reid, 'Museologic', in *Architecture New Zealand*, 34.
[12] Bossley, *Te Papa, An Architectural Adventure*.

different grid patterns (as indeed most of Wellington city is), and is further split from side to side with a shear wall 'faultline' architectural feature (refer figure 5.3.4).

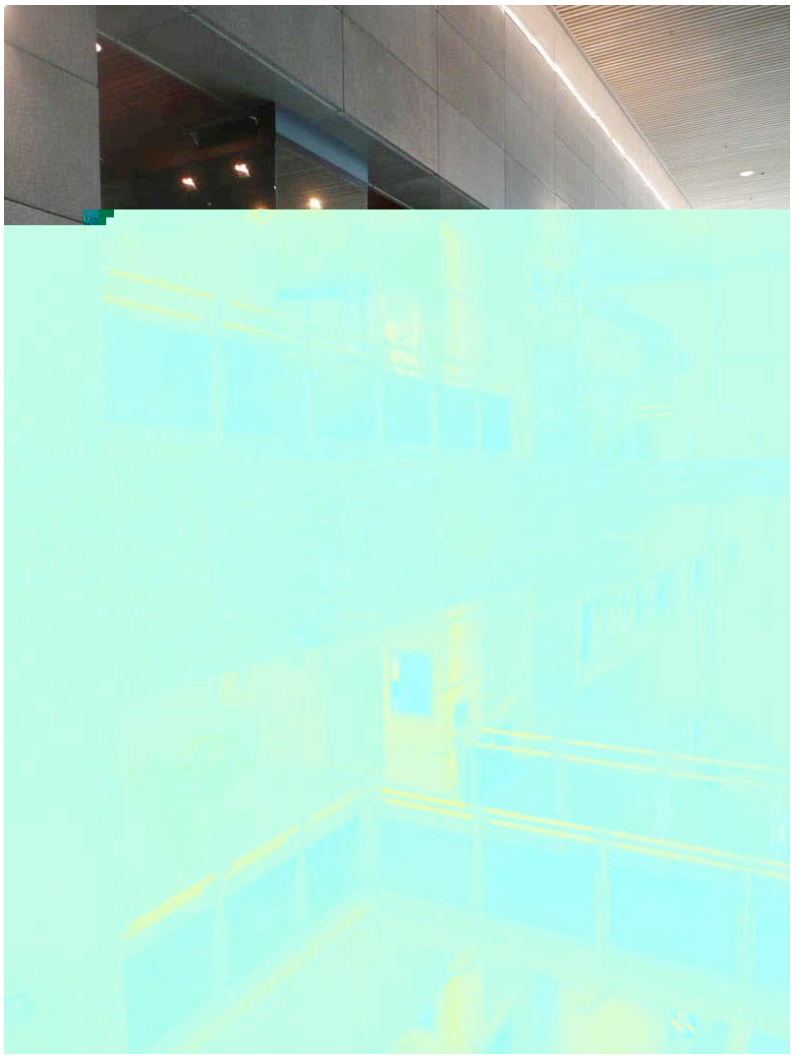

Figure 5.3.4 The mytho-poetic 'Faultline' wall, pierced with openings. It is more prominent from outside. Connecting sky bridges span across the atrium's void. The second ground floor lift can just be made out nestled within the wall. *Source: author (2012).*

The 'faultline', noted by Linzey as a "metaphorical play between architectural tectonics and plate tectonics", is lined with a dark grey concrete panelled grid and helps set up what Linzey terms a "mytho-poetic interior space in which these tectonic forces are revealed..."[14] While it does present a strong metaphor to Linzey, to the casual visitor the result is less than clear.

5.3.5 Te Papa's Atria

[13] Williams, "A breach on the beach: Te Papa and the fraying of biculturalism," 84.
[14] Linzey, "On the Name -Te Papa", 471.

Spatially, Te Papa features a number of voids - some glazed and therefore atria – and others which are more hidden from the light (refer to figure 5.3.16). On Te Papa's original building consent plans, all these spaces are just noted as 'void'. In a public building, the atrium space has been frequently noted as the 'heart' of the building. Te Papa, however, arguably has three atria, and one heart.

This is one of the prime differences to the other case studies – that there is more than one atrium, and that the boundaries between these atria are blurred. This causes spatial confusion. Also significant is that the atria actively try to avoid sunlight, or even daylight, and this results in the atria losing some of the critical social qualities of the gathering space by doing so. These are significant differences not just to the other case studies, but also to atria as they are generally used in public buildings.

As noted in Chapter 2, an atrium typically allows daylight, access to air, security from the outside, a zone for circulation, and a focus for socializing. While some of these points (such as security) are applicable within a museum, others - such as daylight, sunlight, and fresh air - are discouraged by modern exhibition designers. With an atrium at the core of the building, a design clash is initiated between the building's architects (wanting air and light via an atrium) and the exhibition designers (wanting a darkened "black box").

The entry atrium (a true, window wall atrium some four stories high) is aligned parallel to the metaphorical faultline wall, and is glazed at the south end above the entry. This main atrium does not fall neatly into Saxon's classification (refer to figure 2.14) as it is a cross between a linear atrium and a bridging atrium, between two buildings, as the west part of Te Papa is structurally separated from the eastern bulk of the building. The atrium has one side heavily perforated as part of the fault-line (refer 2.15 and 2.17), and the other side is largely blank (refer figure 5.3.5). The light enters only through the end walls, not through the roof.

This entry atrium contains entry to the shop and café, along with access primarily up to level 2, which acts as the real ground floor of the museum.[15] Docents greet visitors at levels 1 and 2, waiting to inform them where building features and exhibitions are, in case these are not readily apparent (refer figure 5.3.6). This atrium is gently washed with daylight and full of action, as Bossley notes:

> …a dramatic promontory projects us out towards the dramas of sea and sky, before the marae atea draws us in towards the wharenui. The stairs suspend us in the 26 metre-high entry space, then take us on upwards, to the exhibition floors above. The promenade leads us in and through the exhibitions.[16]

[15] *Te Papa Explorer – Find your way at our place.*
[16] Bossley, *Te Papa, An Architectural Adventure.*

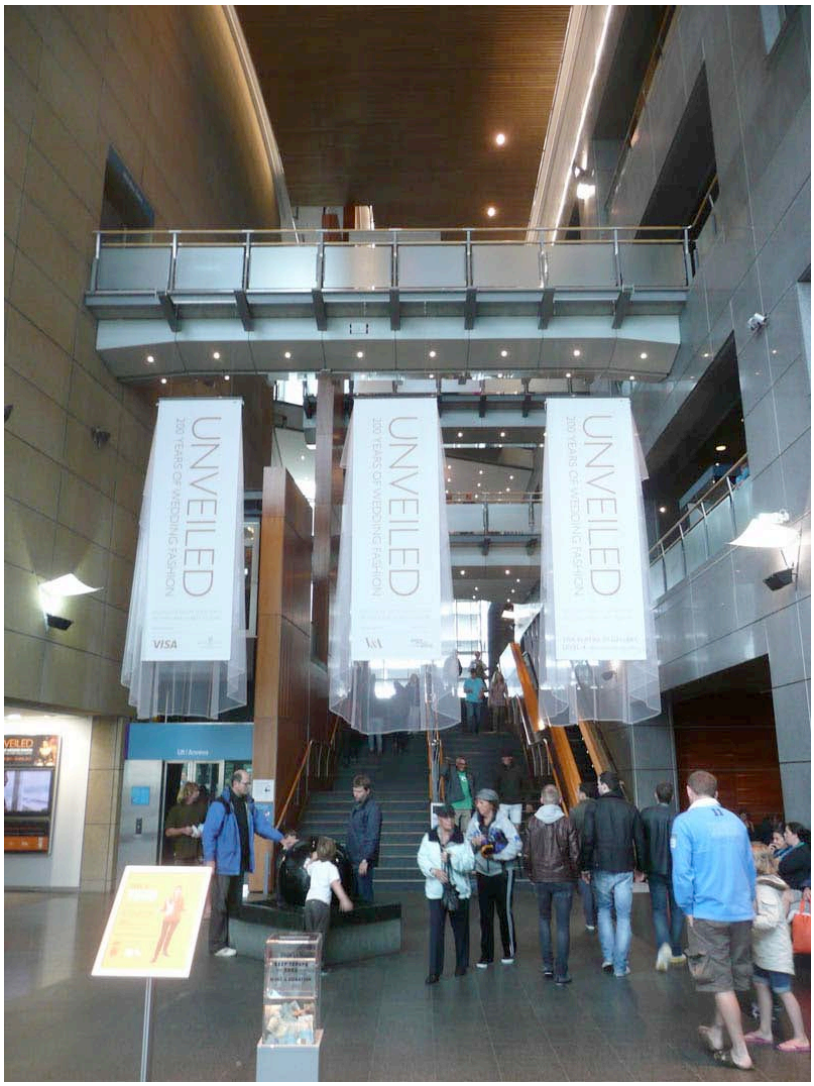

Figure 5.3.5 Entry atrium, lit primarily by south-facing windows above entrance. Advertising banners obscure the connecting staircases above. Lift from level 1 to 2 is at left. *Source: author (2012).*

The atrium contains two lifts (refer 2.20 and 5.1.5), two or more sky bridges (refer 2.20) and one escalator (refer 2.19). It can be described as a very complex circulation system, and therefore comprises a rather complex space as well (refer 2.14). Most importantly, this atrium contains the main stair from level 1 to 2, and other stairs from levels 3 to level 4. The stairs, intentionally or not, maximize intersections (refer 2.16 and figure 5.3.14). The stair from level 2 to level 4, however, is behind the faultline wall (refer figure 5.3.28).

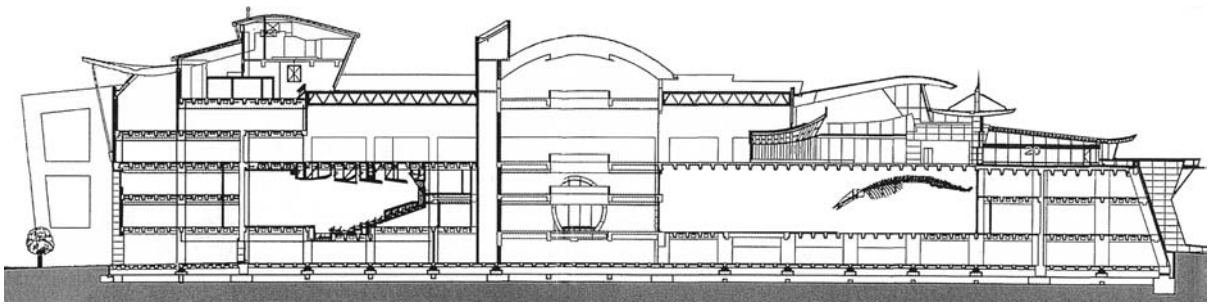

Figure 5.3.6 – Long section through Te Papa, taken through art void / ihonui (centre), with auditorium visible at left, and whale skeleton hanging in display space centre right. Entry is behind wall on far left. Harbour is to far right. The official marae is in room at far right / top. *Source: Jasmax.*

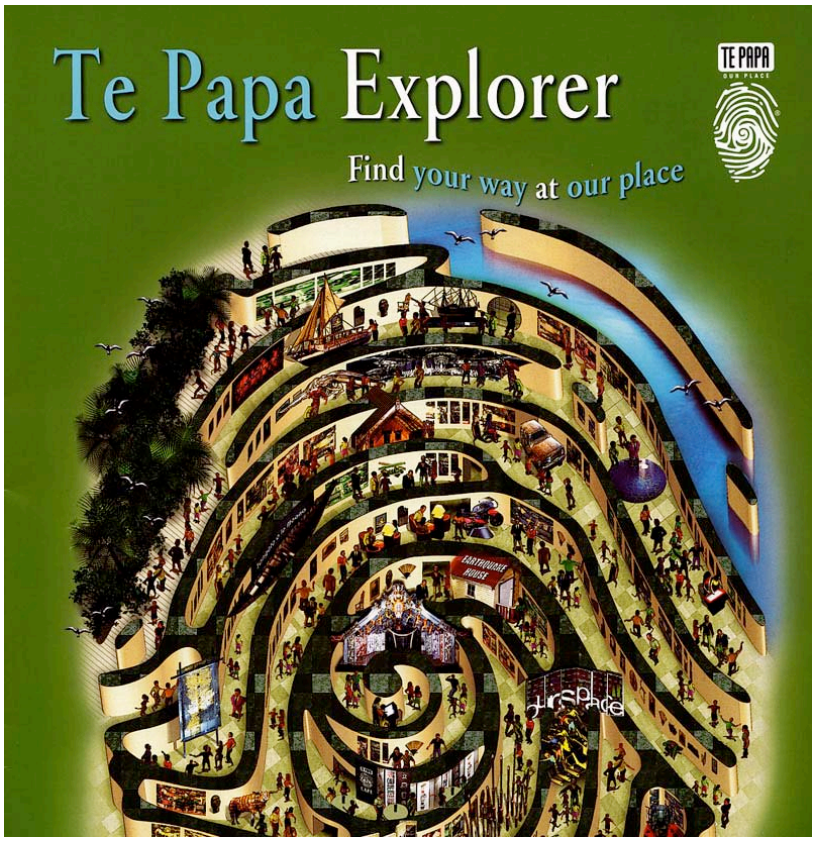

Figure 5.3.7 Te Papa Explorer, guidebook front cover. Te Papa appear to actively promote that their space is a labyrinth of discovery. *Source: Te Papa Press (undated).*

When arriving at level 2 at the base of the faultline in the entry atrium, the reception desk adjacent to a large circular circular window, or oculus (refer figure 5.3.8), views out to the harbour and also adjacent to the art void (Bossley's original 'wedge space'), described as the "ihonui (core)" on Te Papa's signage (refer figure 5.3.9).[17]

[17] *ihonui* translates directly as "corner and floor space on the left on entering a *wharenui*." (Maoridictionary.co.nz). But *iho* on its own means both "down / below", and "heart / kernel / essence" while *nui* means big. *Ihonui* could therefore also refer to the space as the 'big heart'. The plaque naming the art work states:

Figure 5.3.8 Oculus, viewing back over city, heavily shaded. The building takes the opposite viewpoint to light that Foster's media gallery at Nimes. Here, direct sunlight is banned, and daylight is actively avoided. *Source: author (2012).*

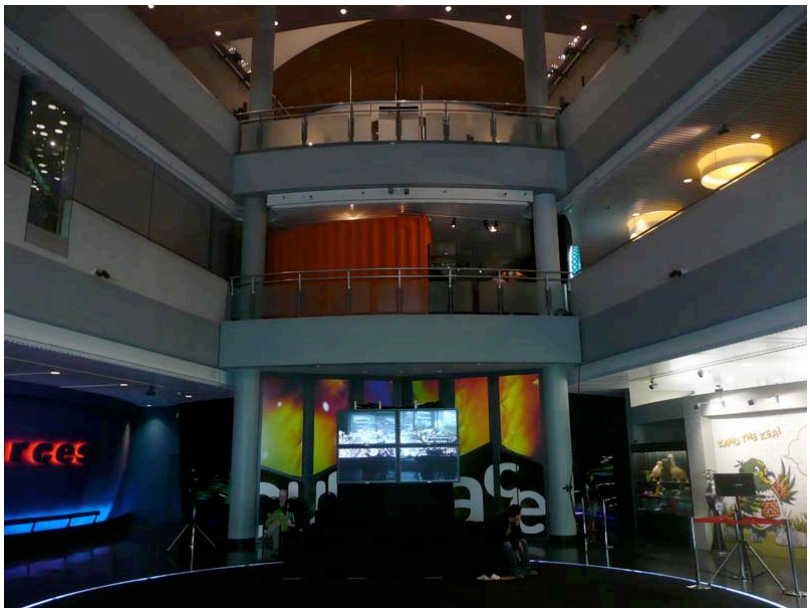

Figure 5.3.9 Art void / ihonui, looking into the 'heart' of Te Papa. *Ihonui* refers not to the art work, but to the space it is in. Note lack of activation of edges due to exhibition layouts, particularly at level 3, where blank walls and even a container have been situated. Black circle on the floor (and ceiling above) is *Te Kore* (the Void), 2006. Bill Culbert, Ralph Hotere.
Source: author (2012).

"VOID was commissioned by Te Papa for the open space between Levels 2 and 6, which forms the Museum's ihonui (core)… In Maori, void can be translated as Te Kore. In Maori creation stories, Te Kore is where the stirrings of creation began. Te Po, the darkness, filled the void, from which emerged Te Au Marama, the world of light. With the presence of VOID, the ihonui has become a space that suggests both emptiness and the vast possibilities of creation."

The ihonui, a large square hole in the concrete floor slab of level 4, rises from level 2 to the underside of the roof above level 6. This void is not truly an atrium as it has no access to natural daylight, in line with museum exhibition designers' guidelines, but it has significant height and volume over many levels.

A bridge at level 3 traverses this ihonui, allowing linkage between one side of level 3 and the other. Regretfully, exhibition designers have positioned blank walls facing into the art void on two sides of the void at level 3, stopping any possibility of the atrium edge activating the void (refer figure 5.3.9). A large sculpture / artwork in the form of a painted black Ralph Hotere artwork on the floor and ceiling links the space between level 2 and level 6, although this largely un-noticed by many (possibly most) visitors (refer figure 5.3.10). The casual visitor, the tourist, the outsider, and to a large extent, many New Zealanders, will not recognise this work as a Hotere artwork, but may feel the blackness at the heart of Te Papa. If this is a 'heart', it is a 'black' heart. The potential for this space to link the floors together is largely unrealized, even with Hotere's work. Connectivity here is limited to visual connections to other floors, but even these are blocked off by the exhibition design. There is no physical connectivity vertically up through the art void.

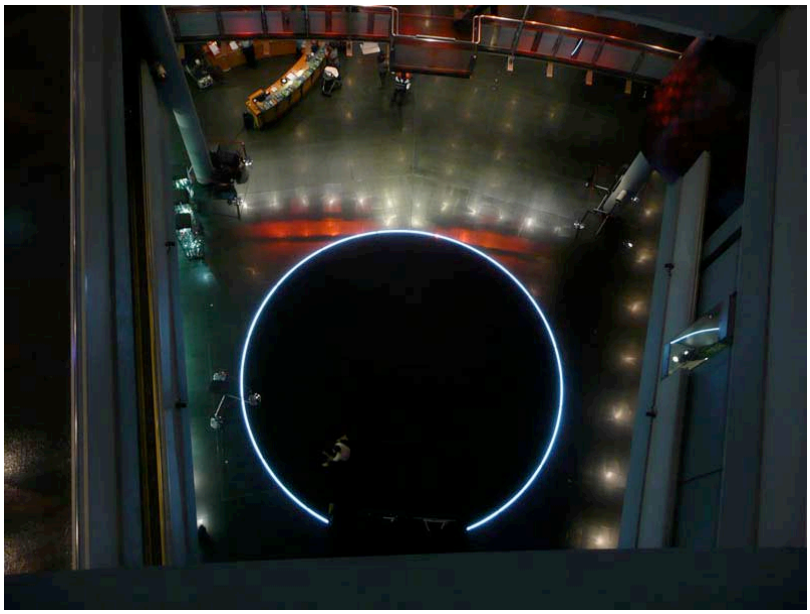

Figure 5.3.10 Art void / ihonui, looking down into void, featuring artwork by Ralph Hotere (mirrored by a similar circle on the ceiling 4 floors above). *Source: author (2012).*

The treaty court, as it is known, is the third key void within Te Papa (refer figure 5.3.11). With its floor at level 4, rising up to the ceiling at level 6, the treaty court is triangular in plan, with a window pointing out to Mt Victoria, away from the faultline. In many ways the metaphorical heart of the building, at the fulcrum pivoting point of Bossley's wedge space, the treaty court is suitably reverent in its invocation of nationhood. Amidst significantly gloomy darkened light levels, it contains two greatly magnified replica copies of the Treaty, and an enlarged

fragment of the torn and stained treaty, captured behind glass and exhalted as an almost holy relic - the founding document of New Zealand. It is however largely connected only to other exhibits at level 4, and shares little in the way of physical or visual connectivity with the other atrium spaces. The treaty fragment on display is a fabricated replica, and therefore the absence of light from this space is entirely theatrical.

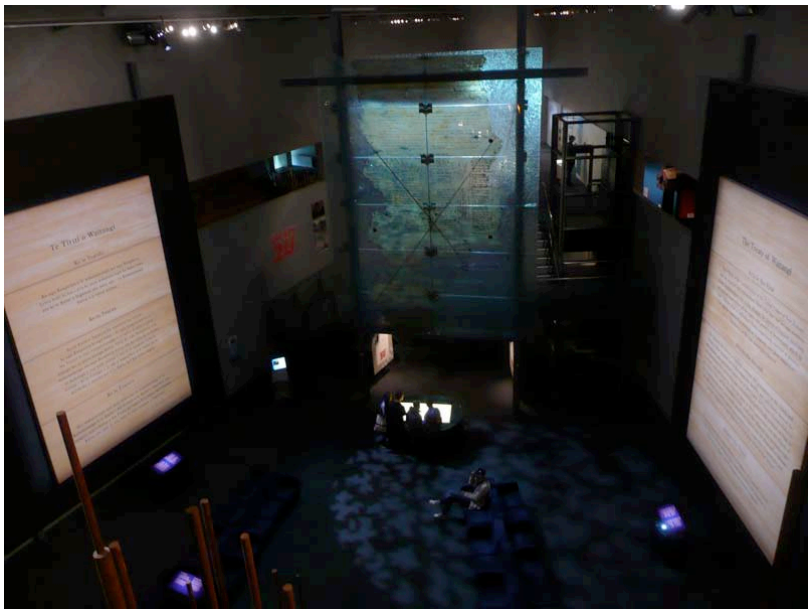

Figure 5.3.11 Treaty void, looking down into void; two versions of the Treaty facing each other across unlit atrium space, enlarged fragmentary remains at end. This is only a replica – the real treaty is kept in the National Archives. *Source: author (2012).*

By contrast, the marae atea, which the museum management describe as the heart of the building, occupies an ancillary space at the edge and lies (seemingly abandoned) at the end of a long stepped ramp from level 2. This is a significant difference to other atria buildings, where the atrium is described as the 'heart' of the building. A heart, in a building design sense, is the area where people circulate together, to gather as one. In Te Papa, despite having at least three atria, none of these are described as the heart. A multitude of hearts does not assist that centrality of purpose. Having a spiritual heart that the public do not recognize as such, completely separate from the physical centre of the building, only confuses matters further.

Lastly, the art collection of Te Papa, the former National Art Gallery of New Zealand, lies off to the south side, in a completely separate area of the building at level 5. This area, constructed in 2004, is an improvement on the original plan (a much smaller area for art), but the atrium skylight windows are blanked off and the volume has no appreciable sense of space. Below this, at level 4, is the library.

Te Papa's own figures show that less than 5% of visitors used the library: many people simply cannot or do not find either the art gallery or the library. After ten years of exceptionally low use, the library has now been closed

to the public and is now available only by appointment only. The failure of the library can be attributed directly to the complete lack of visible connectivity from any other major space. The art gallery is suitably quiet, in part from lack of visitors. This research proposes that this is due to the lack of visibility of connecting circulation paths.

5.3.6 Circulation

The 26m high entry atrium space (refer figure 5.3.5) is the primary zone of circulation, with stairs, an escalator and two lifts. One lift is readily visible, ascending from ground to second; the other, reaching to level 5, is hidden within the feature wall and thus completely hidden from view upon entry. At level 2 the primary stair ends, and upon turning 180 degrees a secondary stair ascends within / behind the wall to levels 3 and 4 (refer figure 5.3.28), largely hidden from the atrium space except for window views through. Bridges span across the void to gain access to the separate structure on the other side of the faultline at level 3, 4, 5.[18] Only one of these aerial routes is usable by the public; the two solo sky bridges are reserved for Te Papa staff or private visitors (refer figure 5.3.12).

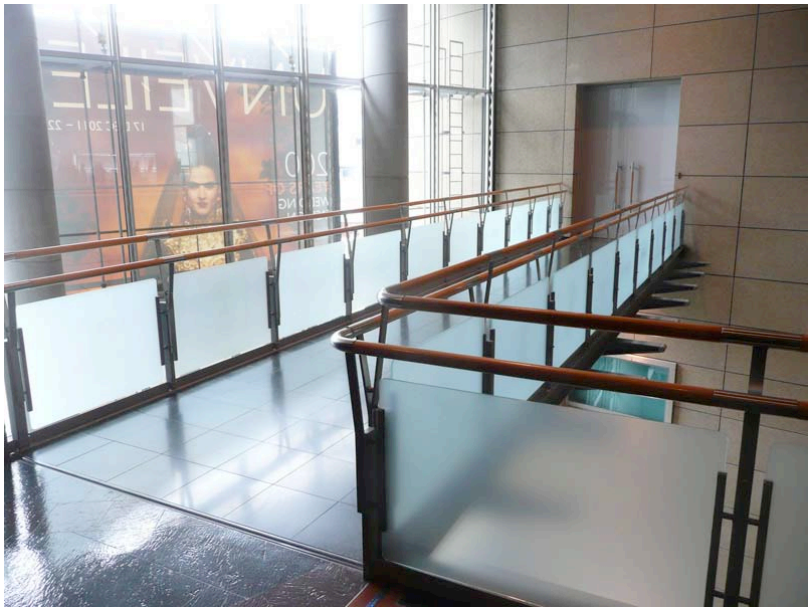

Figure 5.3.12 Unused sky bridge, level 5, looking across entry atrium, at blank wall and locked door. Skybridge is unused by public, and so as design feature, is inactive. *Source: author (2012).*

[18] Although metaphorically this may be part of the Southern Alps, the area west of the faultline void has been designated as room for temporary exhibitions. As touring exhibitions have often to be charged to recoup costs, this manifests itself as west side = chargeable, east side = free.

Bridges and stairs at level 3 head both up and down simultaneously (refer figure 5.3.13), reflecting the myriad possible routes available to explore the building. While Jasmax may have designed this intentionally to excite the visitor, the result is undoubtedly confusing to many (refer figure 5.3.14).

Level 5, the zone reserved for the National Art Gallery, is accessible only via lift, or a small separate walkway from level 4 (refer figure 5.3.33). Some seemingly public stairs are completely closed off to the public, which adds further to the confusion, while other stairs which are open, appear to lead nowhere (particularly the secondary stairs to the national Art Gallery on level 5).

Jasmax do not speak in particular of the staircases as a means of finding national identity, and there is nothing to lead me to believe that the staircases are anything more than an effort to offer choices to visitors. At any point in the Te Papa 'story' the visitor may make a choice: to go left, or to go right. To go up, or to go down. To explore the national identity, or your own identity (refer figure 5.3.5).

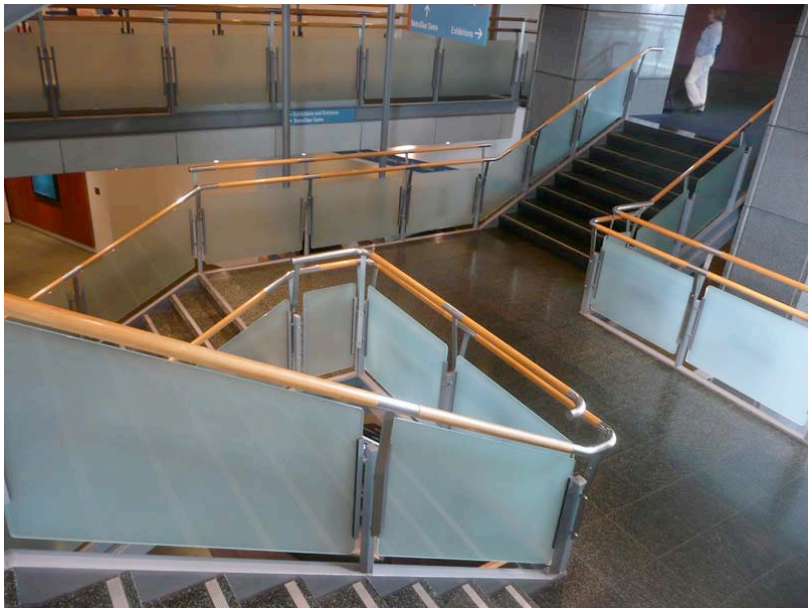

Figure 5.3.13 Stairs within entry atrium, landing at level 3 features two alternative directions to go up, poised in mid-air above the atrium. Which route should a visitor take? *Source: author (2012).*

However, while exhibitions can (and do) get changed, as exhibition design trends come (and go), elements such as staircases are more permanent. The exploration intent inherent in the design documentation remains on show in Te Papa as a system of confused and unhelpfully divergent circulation. It contrasts strongly with methods of spatial orientation used in more traditional museum buildings, as Sophia Psarra notes in *Architecture and Narrative*, where she observes that traditional museum layouts such as London's renown Natural History Museum are 'transpatial', in that the spatial logic of the museum was "embedded hierachically

from the whole to the smallest component" and that "knowledge of the building could be built by a deduction of relationships". Psarra calls this characteristic "intelligibility", where the local isovist connectivity informs the more "global spatial properties".[19] Clearly, Te Papa is working to a different museum model.

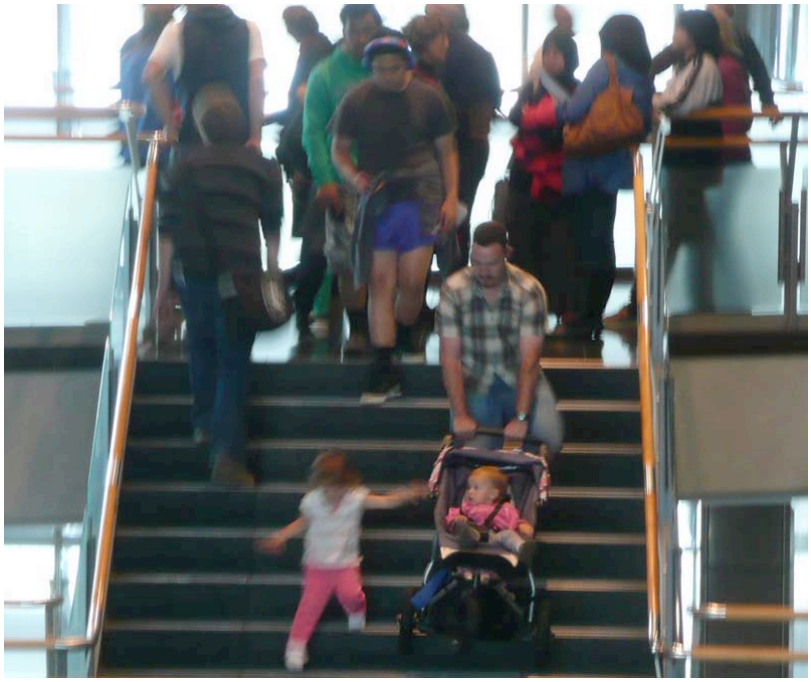

Figure 5.3.14 Stairs within entry atrium. The circulation is confused: despite lifts nearby, this visitor attempts to take a push-chair down stairs in the atrium. His child looks worried. *Source: author (2012).*

5.3.7 Te Papa Circulation diagram

A diagram has been prepared to try to simplify and outline the spatial and circulation systems of Te Papa (refer figure 5.3.15).

[19] Psarra, *Architecture and Narrative,* 149.

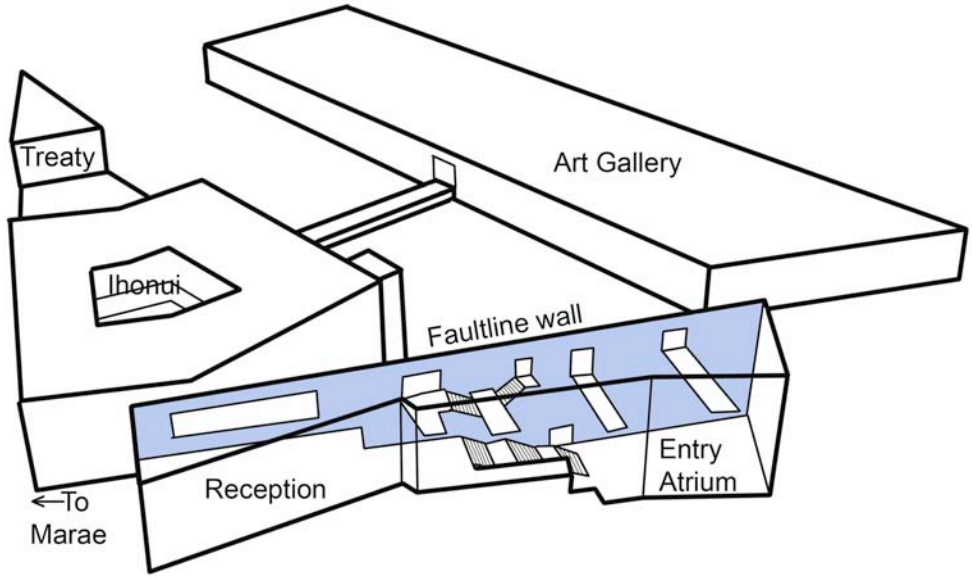

Figure 5.3.15 Stairs within entry atrium. *Source: author.*

5.3.8 Moretti model

As in the previous two case studies, a Moretti-style spatial inversion model was created of the atria at the centre of Te Papa. Once again, difficulties of depicting a complex spatial 3-D system in a 2-D medium give an awkward result.

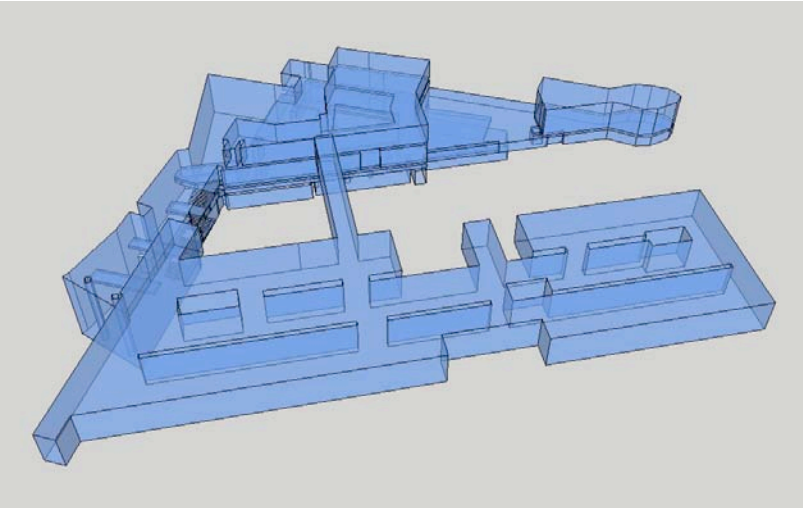

Figure 5.3.16 Te Papa Moretti style spatial inversion model, showing three key atria and art gallery off-shoot at level 5 in foreground. *Source: Eli Nuttall.*

What is clearly visible here however is that the circulation within Te Papa is not coincident with the alignment of the atria spaces that make up the volume (if not the heart) of the building (refer figure 5.3.16). All circulation is in the main entry atrium. Links to other spaces are tenuous and negligible, with the majority of physical connections available from level 4. If the heart is where people gather, is the heart in level 1, level 2, or level 4?

5.3.9 Room sequence analysis

Room relationships within Te Papa were mapped in the same manner as previous case studies. While rooms in Te Papa are not as clearly defined as they are in older museums such as The National Gallery or Tate Britain (both of these London-based institutions are frequently used to test or demonstrate space syntax software on), the spaces involved can still be mapped in this basic, simple manner. The result, however, is anything but basic and simple.

Relationships between exhibition spaces and atrium spaces in Te Papa are complex. The J-graph of Te Papa indicates the multi-branching complexity of the exhibition spaces (refer figures 5.3.17 to 5.3.23 inclusive). Gamma analysis and room mapping of the museum is presented, as in previous case studies, from the top of the building working down. At each floor, physical connectivity is identified, as before, by zig-zag symbols denoting stairs, lifts, or escalators. Only public stairs are shown (fire stairs, and staff only, back of house stairs are omitted for clarity). Overlooking visual connectivity is again noted by the use of dashed lines.

Level 4 in particular (refer figure 5.3.19) has numerous smaller sub-branch groupings of spaces, as well as a degree of ringiness, indicative of the inter-connected nature of the exhibition spaces, and not dissimilar to that of a small village.

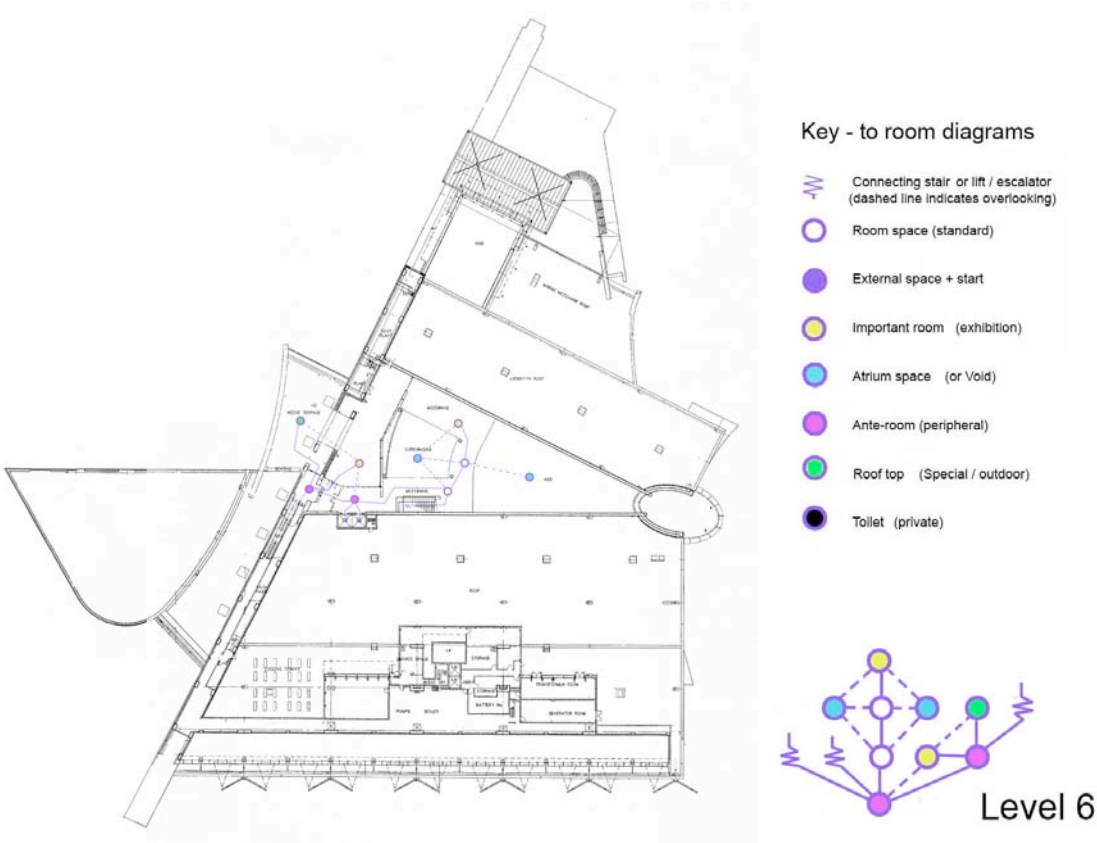

Figure 5.3.17 – Level 6 floor plan gamma analysis with J-graph. *Source: author.*

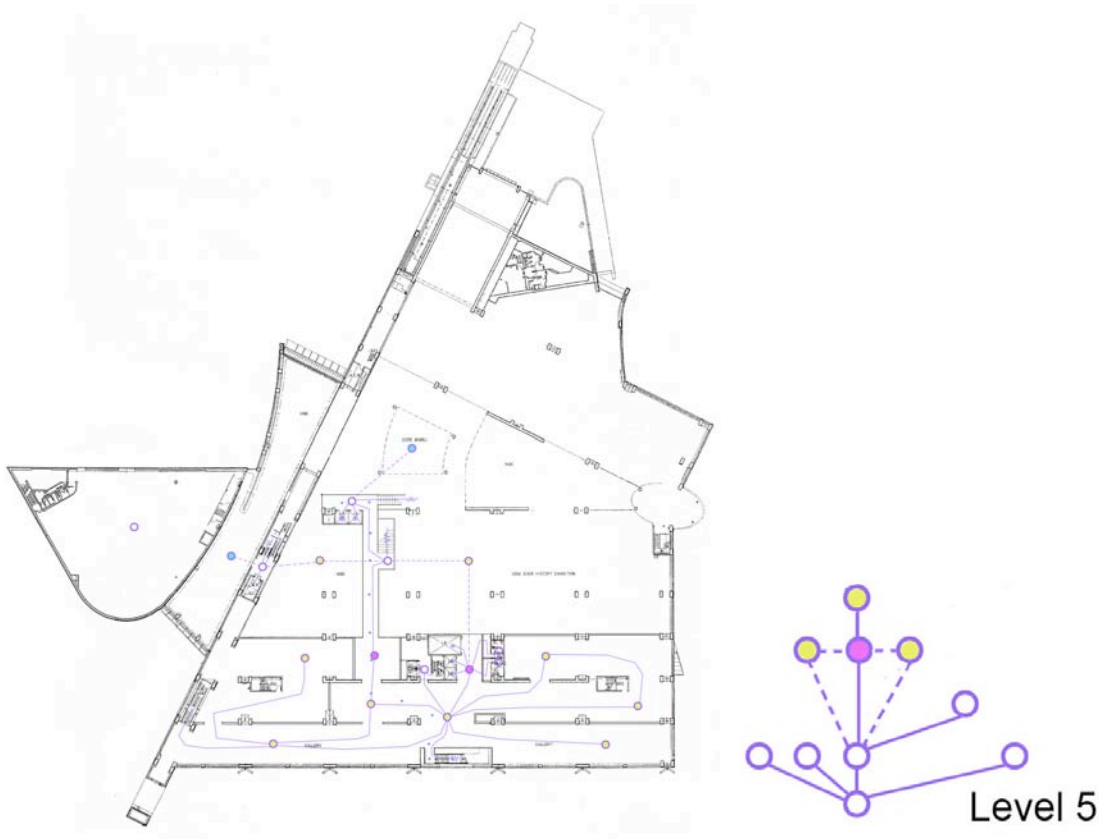

Figure 5.3.18 – Level 5 floor plan gamma analysis with J-graph. Visual links down to level 4 are dotted. *Source: author.*

Figure 5.3.19 – Level 4 floor plan gamma analysis with J-graph, indicating a number of sub-centres. *Source: author.*

Figure 5.3.20 – Level 3 floor plan gamma analysis with J-graph. *Source: author.*

Figure 5.3.21 – Level 2 floor plan gamma analysis and J-graph. *Source: author.*

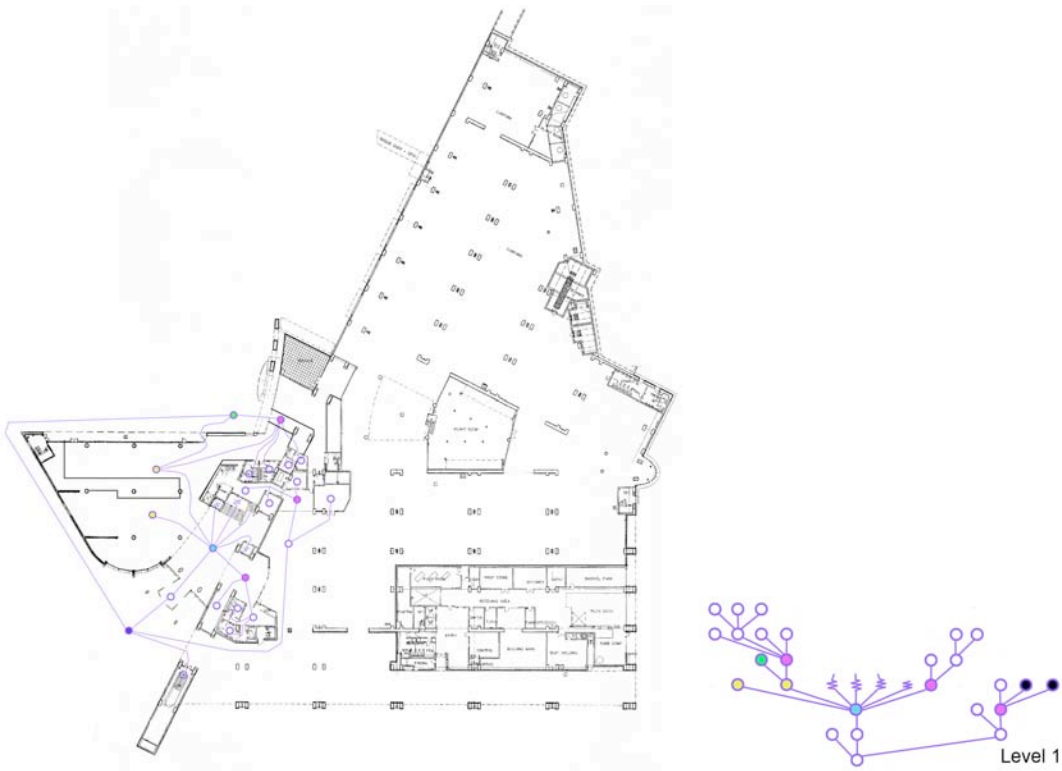

Figure 5.3.22 – Level 1 floor plan gamma analysis and J-graph. *Source: author.*

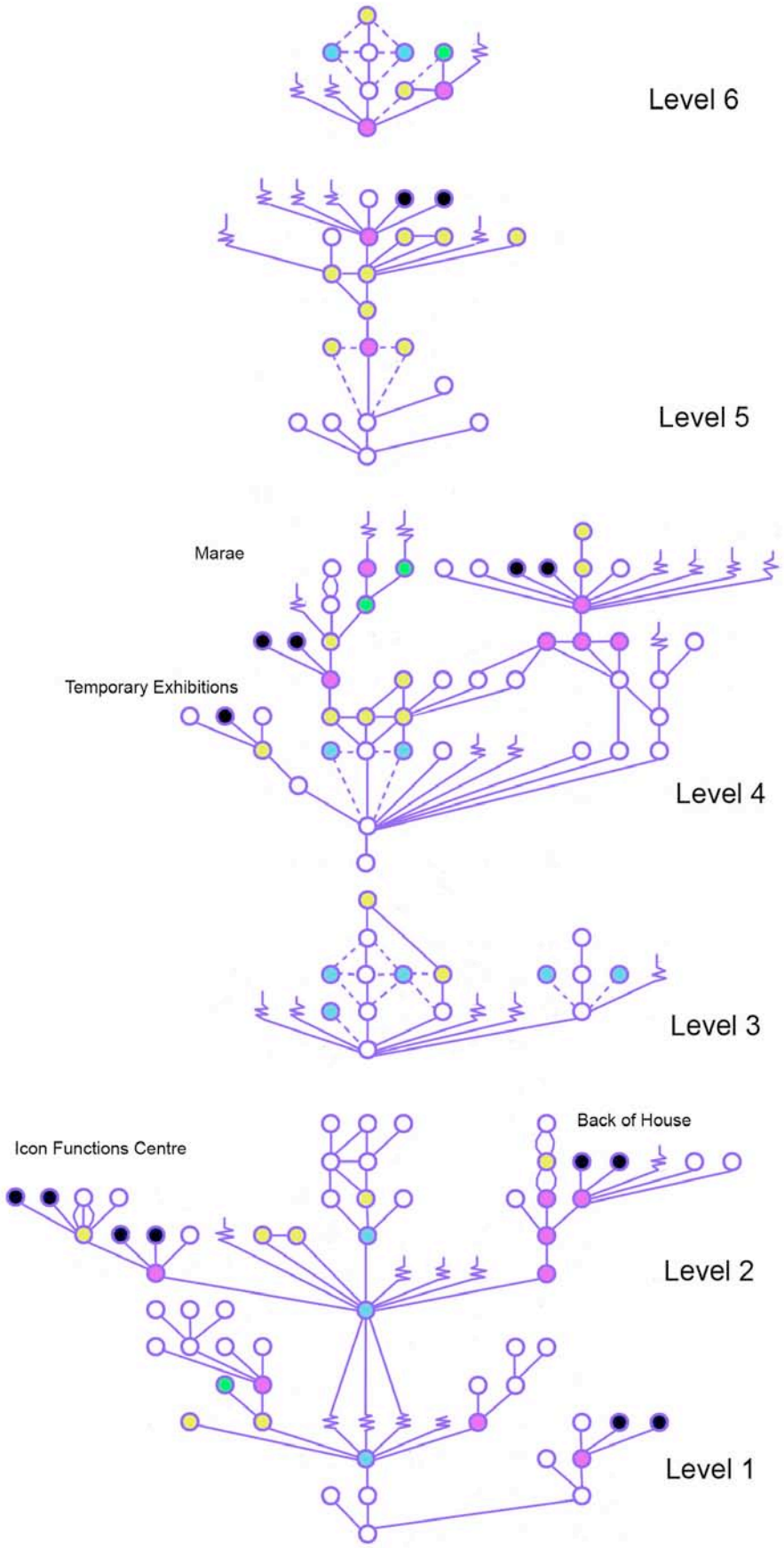

Figure 5.3.23 Levels 1-6 justified permeability graph. *Source: author*

Some further comments can be made regarding these J-graphs. Level 1 reveals a number of separated sub-groups, indicative of the need for several different functions here: general public entry, school groups, shop/café visitors, and back of house deliveries (refer figure 5.3.22). Level 3 shows little in the way of significant exhibition space, and that the main focus here appears to be visually interconnect with other atrium spaces (refer figure 5.3.20). The J-graphs are useful in revealing the branching of subgroups, and the relative lack of ringiness in the planning, with major rooms often only at the tail end of visits and therefore not part of what may be a regular circuit of exhibition spaces. The marae, and art gallery in particular, are both victim of this planning.

What the assorted J-graphs lack is any semblance of 3-D. Within Te Papa, a series of physical links are established, from floor to floor, in the form of stairs and lifts. This diagram does not readily show this, although the vertical links have been retained in the same relative position wherever possible. While it clearly identifies the many rooms and spaces arrayed as branches of a tree, it does not plot them in any 3-D array to help understanding. Any such 3-D array needs a medium more multi-dimensional than the 2-D plan here on paper.

5.3.10 Depthmap analysis

Depthmap was used for spatial analysis over the full range of six floors (refer Figure 5.3.24). Floor plans were digitized and the area of public atrium zone has been stripped of all extraneous data. Although the floor plates are large, open-plan areas, the exhibition fitout within these spaces typically goes above eye level, but not as far as to the ceiling. Nonetheless, as far as visibility and accessibility in Depthmap goes, a wall above eye level is effectively as good as a totally solid wall, breaking the space in two. These walls have therefore been treated as if they were indeed solid walls, and so established a perimeter to the public space: indeed, supporting structure to the building is via a series of double columns, strongly evident at level 4.

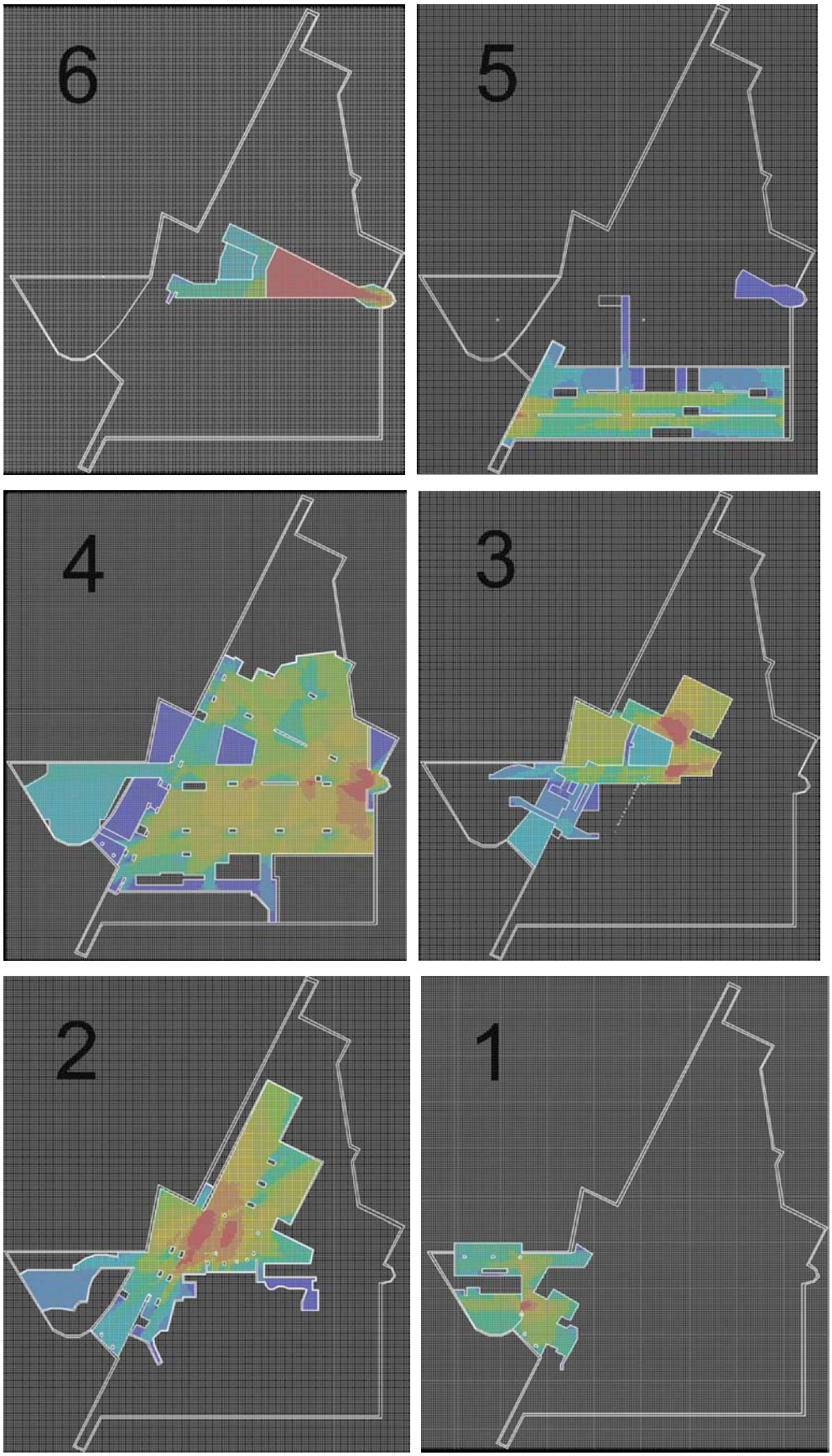

Figure 5.3.24 Depthmap VGA of Te Papa. The six levels of Te Papa were analysed using UCL's Depthmap software. Results discussed in the text at 5.3.8. *Source: author.*

Because of the double-height nature of the space at level 4 (unlike any other floor), the exhibition walls have been omitted, allowing the full scope of the public zone to be realized. What the level 4 plan therefore shows is a red glow to the right hand side of the plan: the end of the treaty court. This indicates that the core design principle of Jasmax's design, the wedge shape, has excellent connective possibilities and suggests that it is at this end, not the main atrium end, that should be a logical place for connectivity throughout the building.

To test the ability of Depthmap to respond to sections, two sections were created and run through the software – one in each direction - a long section through the entry atrium (figure 5.3.25) and a cross section through the ihonui and the oculus (figure 5.3.26).

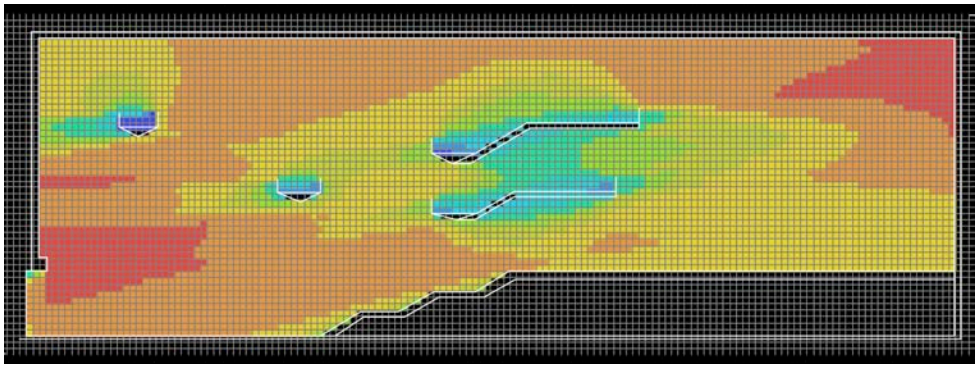

Figure 5.3.25 – Levels 1- 6 isovist field long section. Depthmap has identified that the stairs crossing over present a visual obstacle, but has failed to interpret this as the key connectivity zone for the entry atrium. Instead it has identified an area near the door (bottom left) and at the top of the wall (top right). This is unhelpful. Clearly the Depthmap program is not currently suitable to intelligently analyse sections: no person can be floating at the top of the wall. *Source: author*

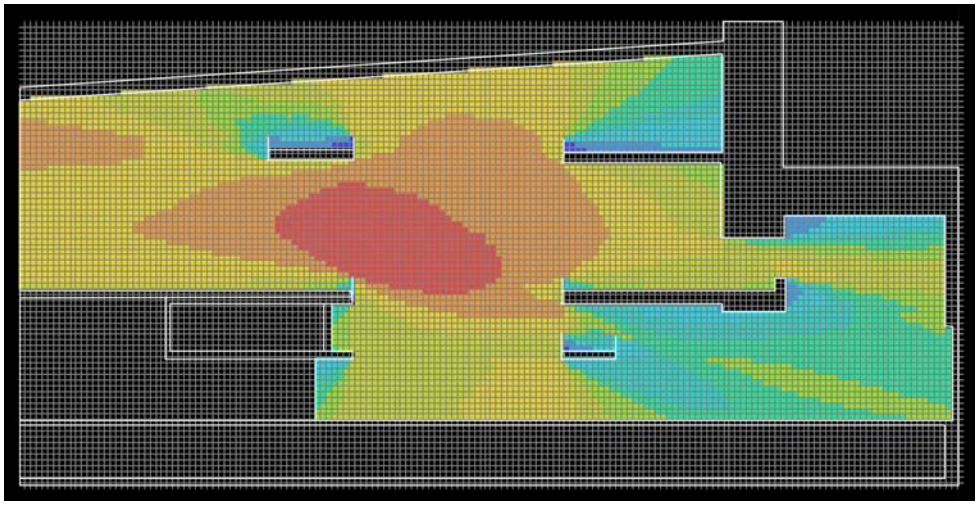

Figure 5.3.26 – Levels 1- 6 isovist field cross section. In this image, Depthmap has highlighted the connections at the centre of the ihonui at level 4. This is in strong contrast to the result at figure 5.3.25 *Source: author*

Results from this section analysis are mixed. While the long section is clearly incorrect, the cross section looks highly relevant. But how can one section be relevant in its results, if the other section is not? Either the results from Depthmap can be trusted, or they cannot. Again, what is happening here is that Depthmap is designed to identify the areas with the greatest number of long axial lines, and is not identifying the cross bridges in 5.3.25 as anything more than obstructions. Without considerable further investigation, all that can be confirmed at this stage is that Depthmap is not reliable at identifying the connectivity within 3-D atrium spaces.

5.3.11 Isovist plan analysis

As in the previous two case studies, a series of isovists were drawn to identify the visibility field on the journey from the entry up into the building (refer figure 5.3.27). This quite clearly shows that the visibility of certain key vertical circulation elements is poor. Discussion of these points follows the plan figures at 5.3.27.

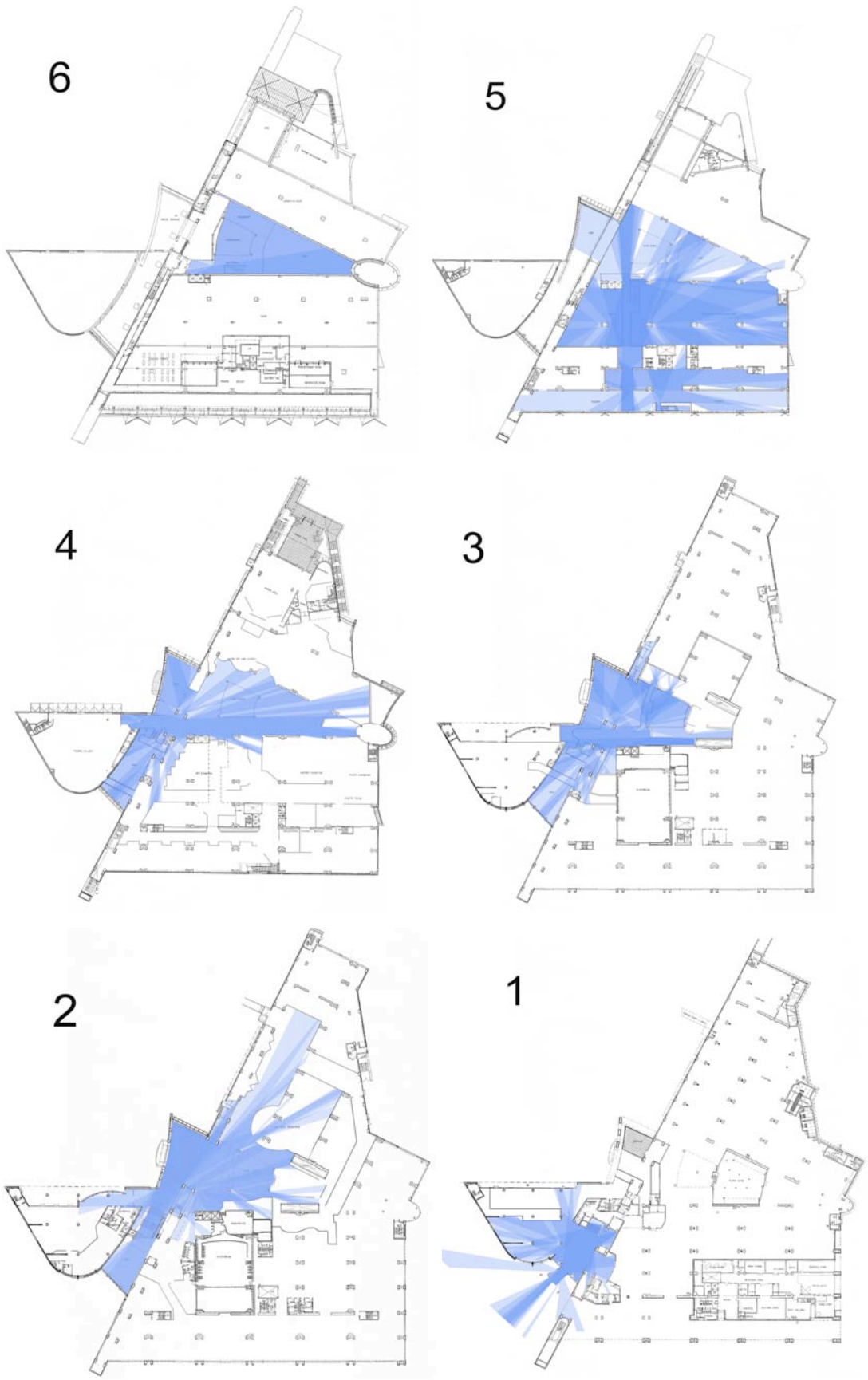

Figure 5.3.27 – Levels 1- 6 isovist field plans. Discussion follows in text. *Source: author*

• On entry, the lift that is prominently visible (L1) goes only to level 2 (refer to figures 5.3.5 and 5.3.31). Figure 5.3.31 shows that there is ample room for this lift to be simply extended vertically to level 4 at least. In figure 5.3.28 the isovist field indicates good exposure to the stair (S1) straight ahead, and to the left into the shop, but the level 2 itself is too high to be viewed directly.

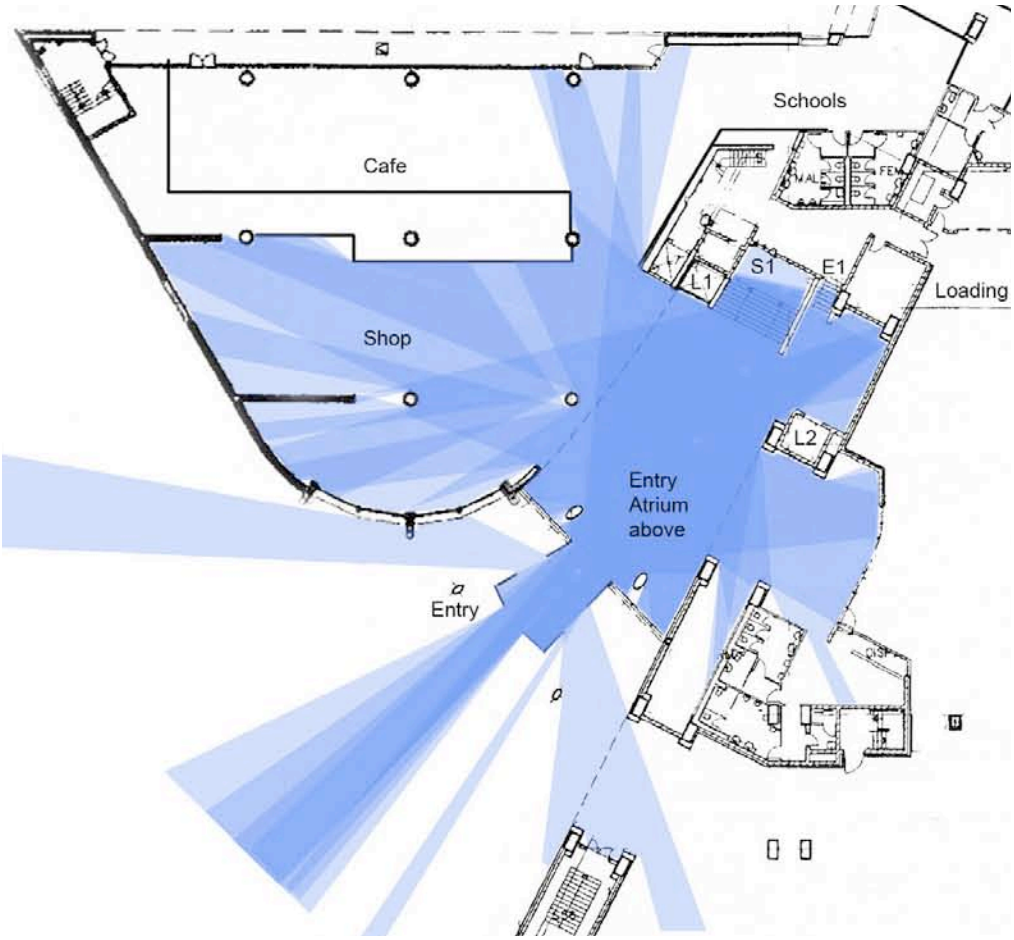

Figure 5.3.28 – Level 1 enlarged isovist field. Route of isovists goes from front door direct to main stairs up to level 2. For full plan, and other floors, refer to figure 5.3.27 *Source: author*

• The sole lift (L2) that rises right through to level 4 is completely (presumably on purpose) hidden behind the faultline wall (refer to figures 5.3.4 and 5.3.29). As can be seen in figure 5.3.28, lift L2 is to the right of the main stairs and is not visible until you are already climbing the main stair (S1), or approaching the escalator (E1). I did not notice this lift until many years after my first visit, when I started to investigate the circulation of this building. The positioning of this lift in plan ensures a feeling of exclusivity: it is not for everyone and seems to be reserved for the elderly.

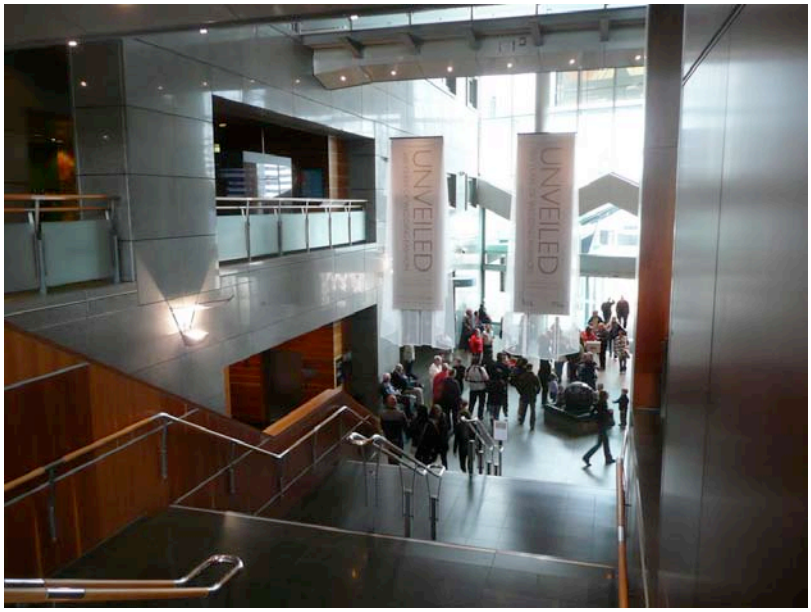

Figure 5.3.29 Te Papa 'faultline' wall, viewing from level 2 down to level 1. Note that 'faultline' wall obscures lift secreted within. *Source: author (2012).*

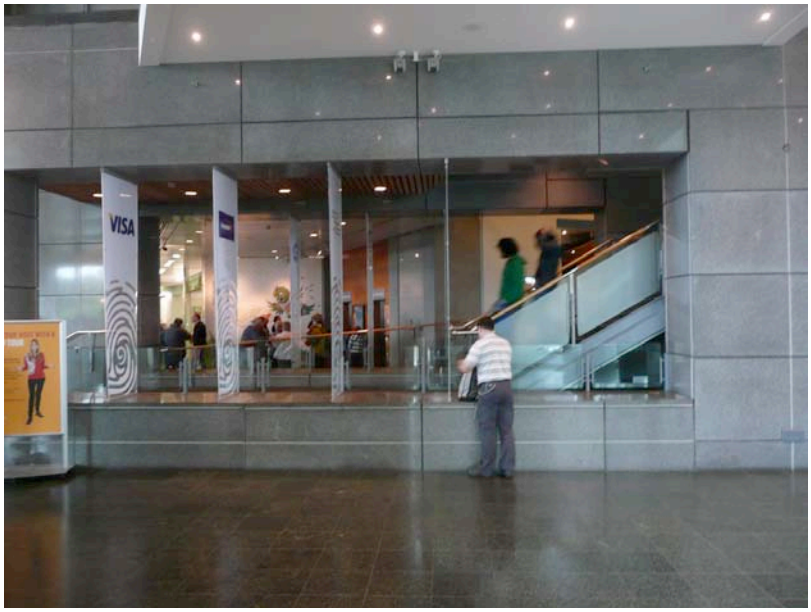

Figure 5.3.30 Te Papa 'faultline' wall, viewed at level 2. Solidity and placement of wall may obscure user's understanding of circulation spaces within building. *Source: author (2012).*

• The main stair (figure 5.3.5 and 5.3.29) and the sole escalator E1 are clearly visible at the entry, but this takes visitors only to level 2. Physical connectivity between levels 1 and 2 is strong, but visual connectivity is limited to linkage between 'top of the steps' and the 'bottom of the steps'. Connectivity does not link at this point into the rest of the museum.

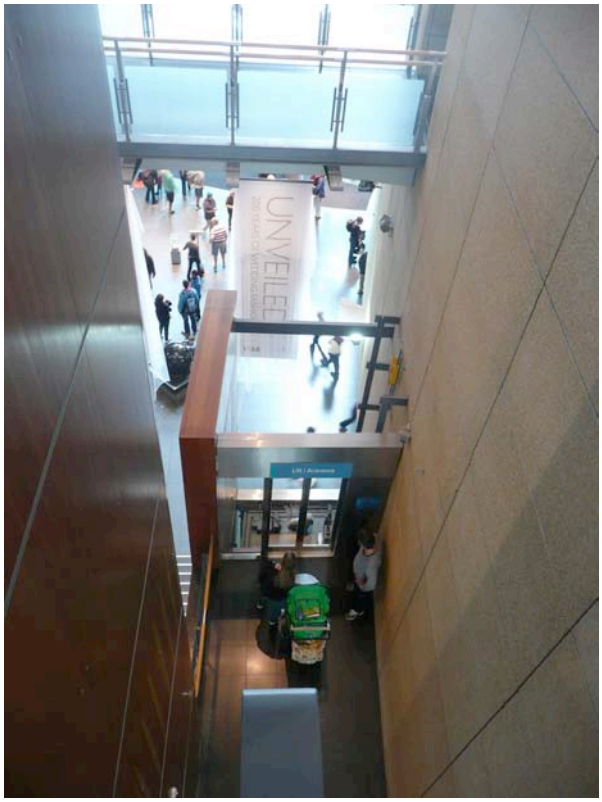

Figure 5.3.31 Te Papa level 2 lift, viewed from level 3, and walled off visually from main stairs. Although there is room for the lift to ascend higher, this lift travels between levels 1 & 2 only.
Source: author (2012).

• The stair from level 2 up to floors above (refer figure 5.3.24) is not readily apparent: by turning 180 degrees from entry, views of the stairs to upper floors and lift bank (from level 2 to 5) are available, as indicated in figure 5.3.32. Despite views shafting into selected areas of the natural history exhibition, there is little penetration of views (visual connectivity) into other surrounding spaces except for a long corridor-view up the path to the marae. The very popular interactive 'rides' are completely hidden behind screens at level 2, via an entry with very low light levels.

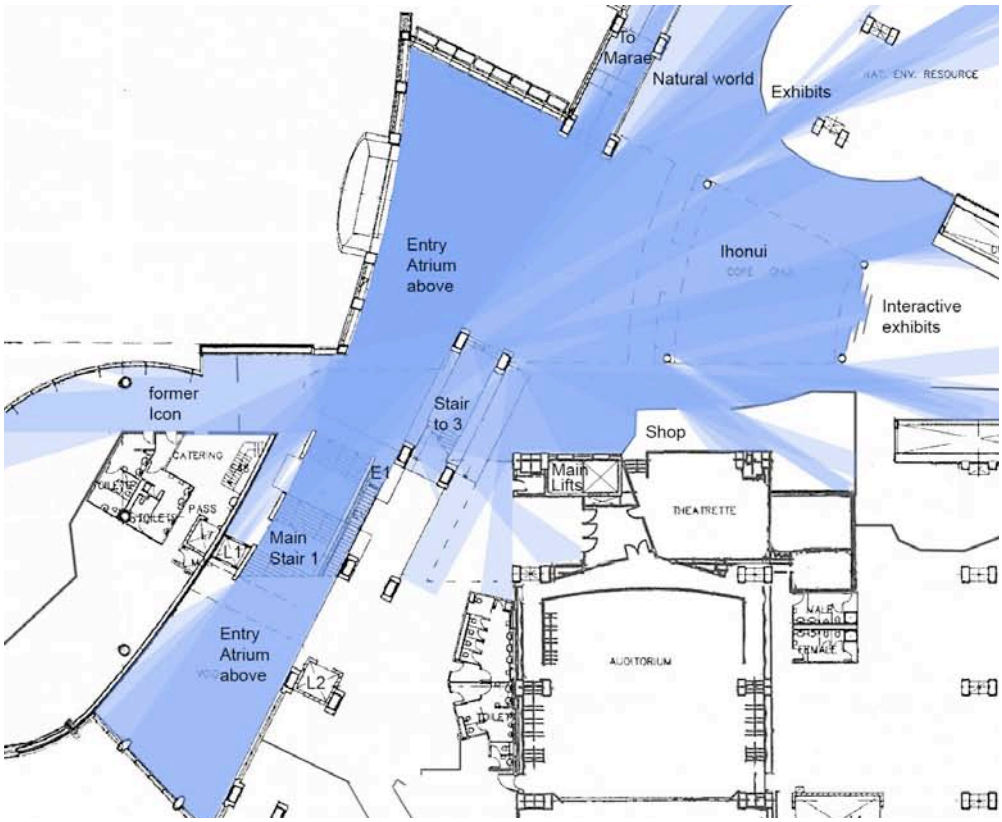

Figure 5.3.32 – Level 2 enlarged isovist field. Route of isovists goes from top of stairs direct to main space and reception desk area. For full plan, refer to figure 5.3.27 *Source: author*

• The isovist field at level 3 (figure 5.3.33) reveals quite good visual connectivity to a number of spaces, including the entry atrium and the ihonui, but there are few exhibits at level 3. Those exhibits that are there are largely blocked off from view – ie visual connectivity is thwarted. Level 3 is used mainly for seminars and has become increasingly separated from the rest of the exhibition spaces within Te Papa by recent additional barriers erected to block off views into the ihonui and along the main pedestrian route by the lifts.

• The cross-atrium aerial bridges are prominent and highly visible at entry, high above, (refer figures 5.3.5 and 5.3.12, as well as the cover page to this case study), but how to get there is not entirely clear. Both sky bridges are effectively unused for regular public access anyway, as the sky bridge to level 3 connects only to the special events room (TelstraClear lounge), and the sky bridge to level 4 leads to a staff-only area. Routes to both sky bridges are largely obscured by the faultline wall.

Figure 5.3.33 – Level 3 enlarged isovist field. Route of isovists goes from top of stairs along to exhibition space at right. For full plan, refer to figure 5.3.27 *Source: author*

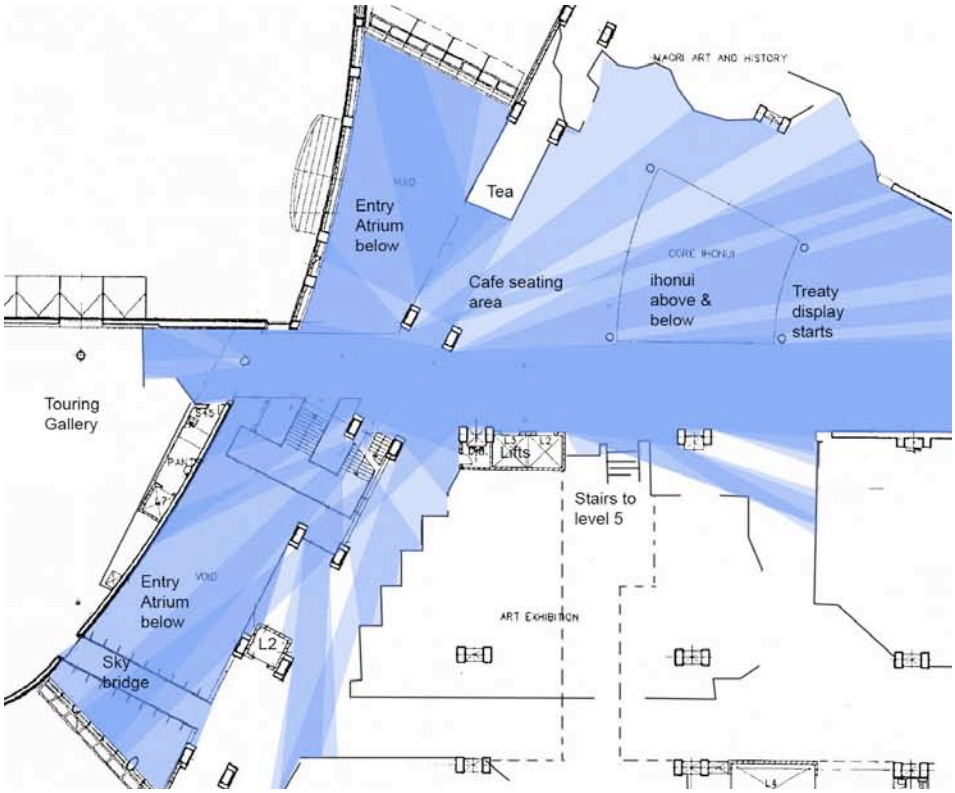

Figure 5.3.34 – Level 4 enlarged isovist field. For full plan, refer to figure 5.3.27 *Source: author*

• The Marae is on level 4, which is accessible directly by combination of ramp and stair from level 2, or by threading through exhibition spaces at level 4. The isovist field for this level 4 (figure 5.3.34) indicates that the marae is completely visually and physically unconnected to the main atrium, as well as unconnected to the ihonui / art void. As the marae is meant to be the 'heart' of the building, it is clearly a 'heart' unconnected by circulation flows. Metaphorically and literally, we can say that the heart is dead. This very point, of the separateness of the marae at Te Papa and its symbolic role as the heart, is allied strongly to its place as a focus for issues regarding the Treaty of Waitangi, and the bicultural basis of which New Zealand is built on.[20] Michael Goldsmith argues that "Te Papa is an extremely (perhaps frighteningly) coherent presentation of an inherently volatile and problematic subject : New Zealand's bicultural nationhood." Goldsmith goes on to question:

> where exactly is the sacred centre? Is it the Museum's own *marae* complex… Or is it the much older meeting-house (*wharenui*) inside…? Or do these spaces jointly constitute the sacred centre within a wider Maori area that encompasses them both?[21]

It is notable that even as Goldsmith notes the lack of an identifiable true heart, and identifies the "regretted" bicultural "double standard in terms of displaying culture at Te Papa", he still does not identify any of the atrium spaces as possible locations for the 'heart' of the building. Goldsmith clearly identifies Maori whare whakairo (both old and new) as candidates for a role as spiritual centre, or heart; but does not rate the atrium spaces in the same manner.

• The Art Gallery is on level 5 (figure 5.3.38), which is accessible only by the main lift from level 2, or by a side stair at level 4 (figure 5.3.35) leading to an aerial walkway over the level 4 exhibits. It has the appearance of a hasty afterthought – as indeed it was - added in a major retrofit to the museum in 2004, to expand the National Art Gallery and link it back to the hub of circulation at level 4. The isovist field for this level 4 (figure 5.3.34) indicates that the level identifies bottom of the stairs up to level 5. There are two other sets of stairs up to level 5, which are not identified by the isovist field at all, and hence are rarely used by members of the public. This contrasts with the isovist field at level 5 (figure 5.3.38) which shows a strong over-looking ability from the walkway at level 5, but little real connectivity to the people or the exhibits at level 4 (figure 5.3.36).

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[20] Williams, "A breach on the beach: Te Papa and the fraying of biculturalism," 84; and Goldsmith, "<<Our Place>> in New Zealand culture: How the Museum of New Zealand Constructs Biculturalism."

[21] Goldsmith, "<<Our Place>> in New Zealand culture: How the Museum of New Zealand Constructs Biculturalism," 10.

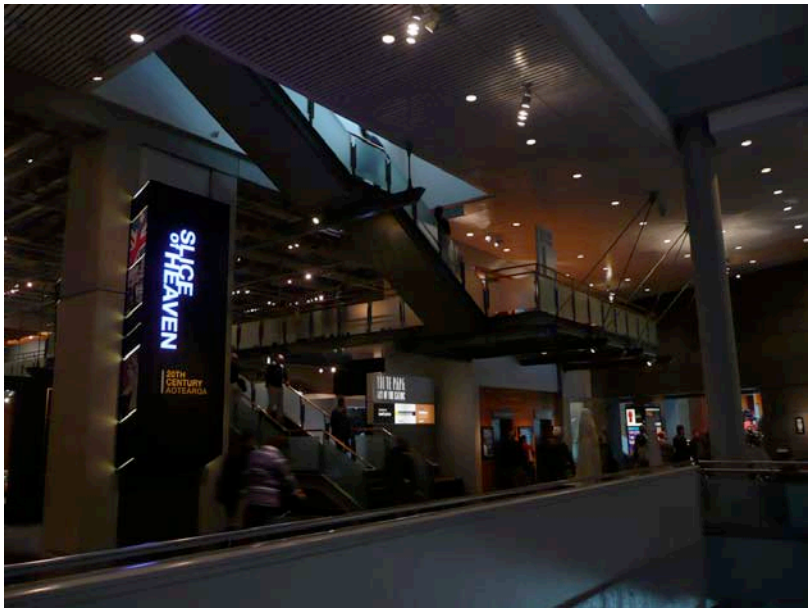

Figure 5.3.35 Te Papa stairs, level 4-5-6, as viewed from main 'art void' space at level 4. Stairs and aerial walkway to level 5 are on left; stairs up to level 6 are visible ascending at top. No use is made of the atrium space as a circulatory, social, or orientation device. *Source: author (2012).*

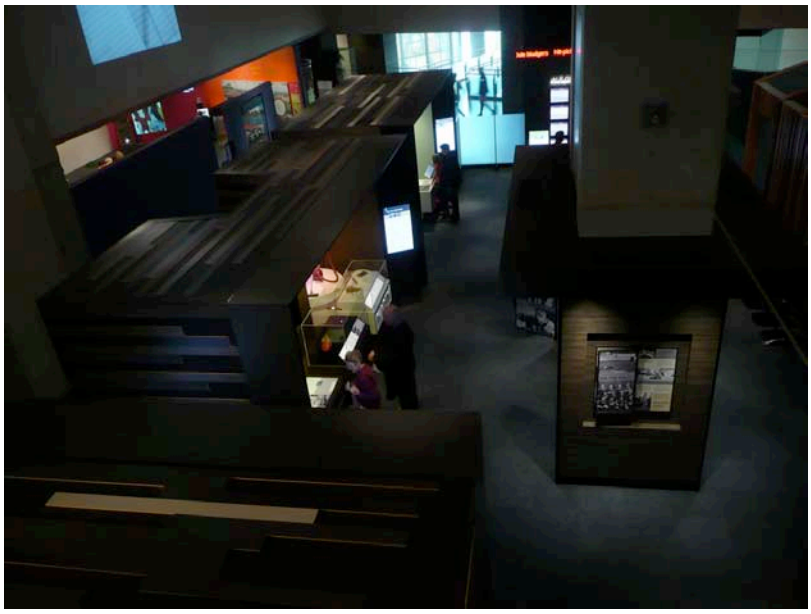

Figure 5.3.36 Te Papa level 4 exhibition space, viewing down from level 5 aerial walkway. With only roofs of exhibits visible, this is not conducive to connectivity. *Source: author (2012).*

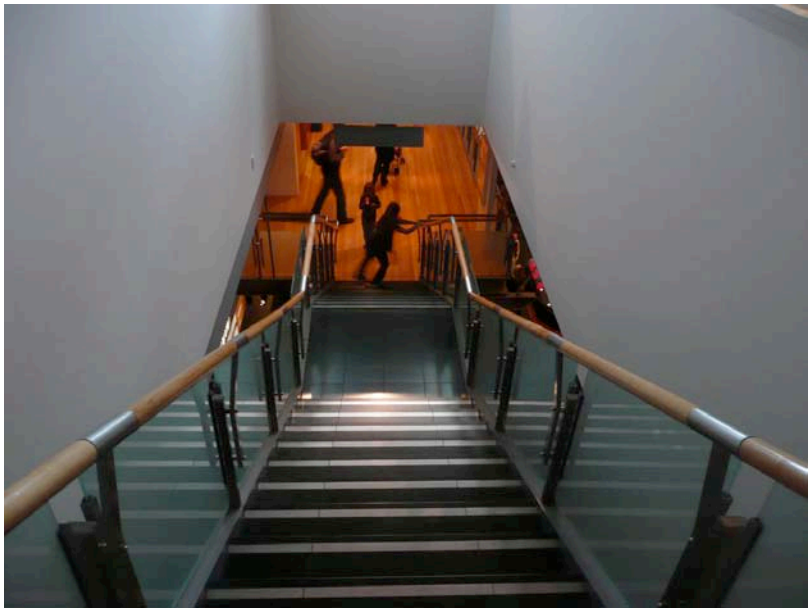

Figure 5.3.37 Te Papa level 6 stairs, viewing down to level 5. Stairs were added when level 5 art gallery was added / altered. Prior to that, access to this level was by lift only. Visual and physical connections between level 5 and level 6 are very poor. *Source: author (2012).*

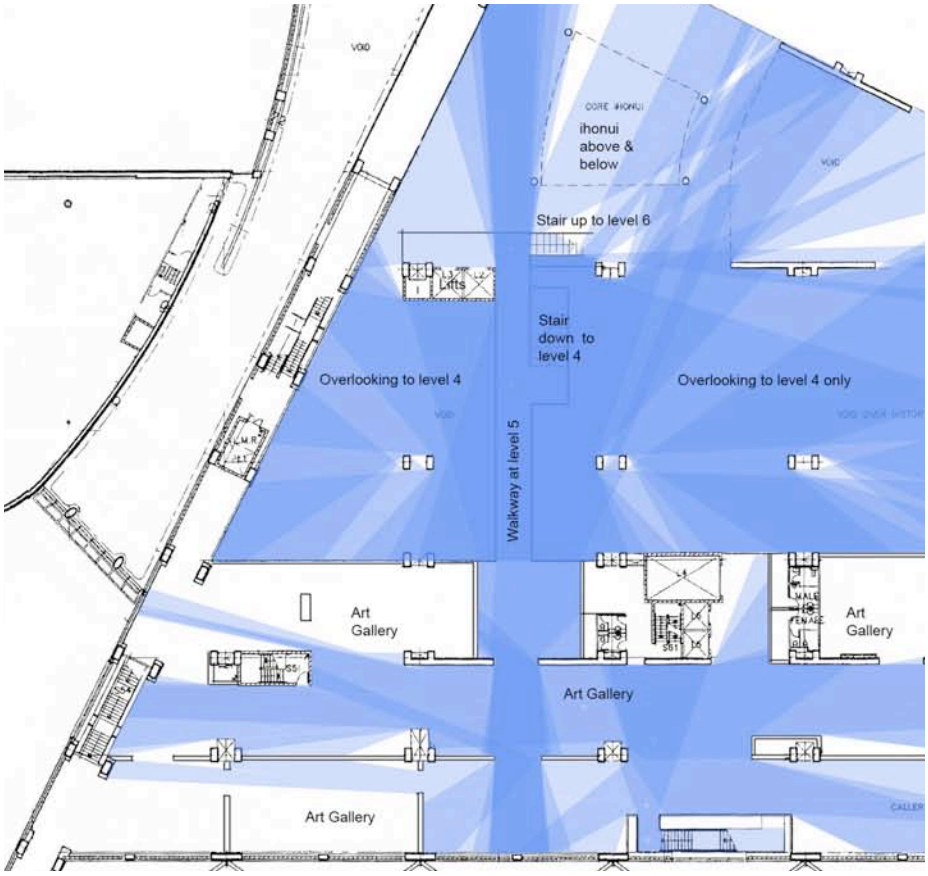

Figure 5.3.38 – Level 5 enlarged isovist field. In dark blue area at centre, little real connectivity occurs – just overlooking to roofs below. For full plan, refer to figure 5.3.27 *Source: author*

• The visible connection to level 6 is weak, as it has pedestrian connection only by lift or up a small, poorly-marked side stair from level 5 (refer figure 5.3.35 and 5.3.37). Levels 5 and 6 are probably therefore largely undiscovered by most visitors to Te Papa. Isovist field shown in figure 5.3.27 shows the self-contained, insular nature of level 6, with no visual connectivity to the rest of the museum, except down through the ihonui and down to the treaty court. As this level 6 space connects to the outside 'sculpture court', which could house some of New Zealand's excellent sculpture, the lack of connectivity to the level 6 spaces is highly unfortunate. In 2011 the level 6 sculpture court was discontinued. An external organization is showcasing new sculpture in four plinths outside the front of the building, at ground floor. Te Papa is now without a sculpture gallery of any form.

5.3.12 Isovist section analysis

Tied in with the creation of isovist fields in plan, isovist fields have also been created to test 3-dimensional space in section. The initial isovist from the ground floor entry in a long section through the entry atrium (figure 5.3.39), shows that the viewshaft from this point includes the underside of the stairs and sky bridges above, and views out to the far window at the other end of the atrium. The full isovist field through the entry atrium (figure 5.3.40) reveals that the underside of these stairs gets very good exposure, but entry points to the regular and special exhibitions do not show up. This indicates that visual and physical connectivity to upper floors is poor.

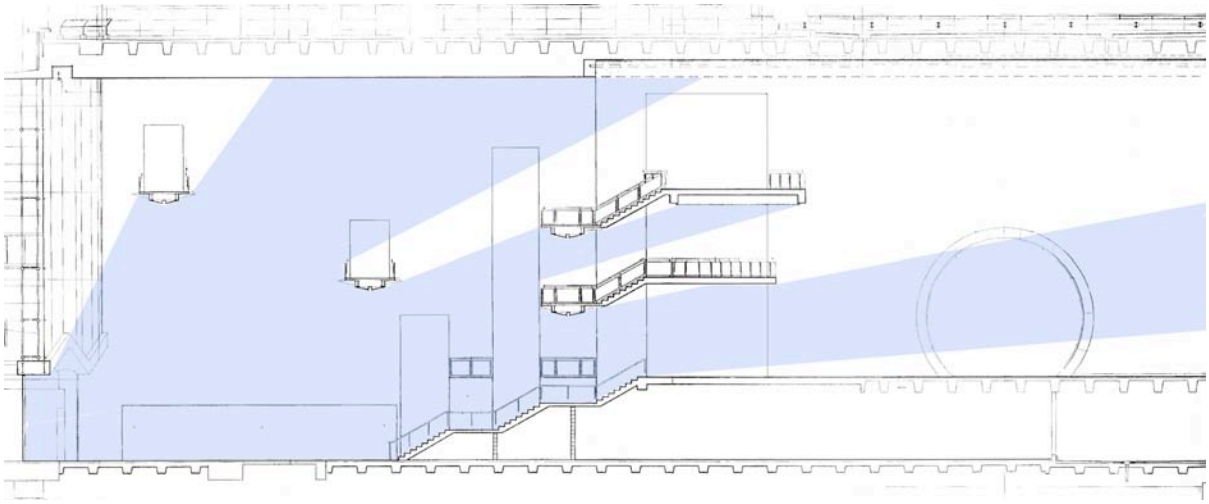

Figure 5.3.39 – Isovist in long section, through entry atrium. From entry *Source: author.*

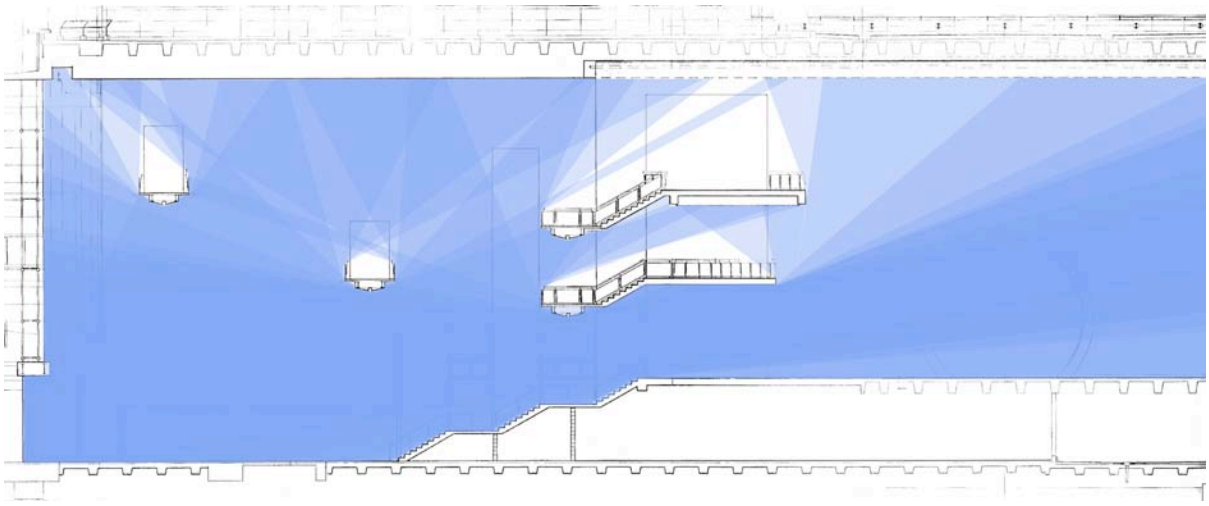

Figure 5.3.40 – Isovist fields in section, isovist field through entry stair atrium. *Source: author.*

In contrast to the long section isovist, another isovist field was created for the cross section through the ihonui (figure 5.3.41). The resulting field, taken on a vertical path up through the stairs from level 2 to level 4, indicates that the visibility of levels 4 and 5 is poor, and that the exposure of the ihonui is negligible. Connectivity within the entry atrium is mainly retained within the antry atrium. Apart from long views down to the Treaty Court area (visible from level 4 only), there is very little connectivity between the stairs in the entry atrium and the exhibition spaces themselves.

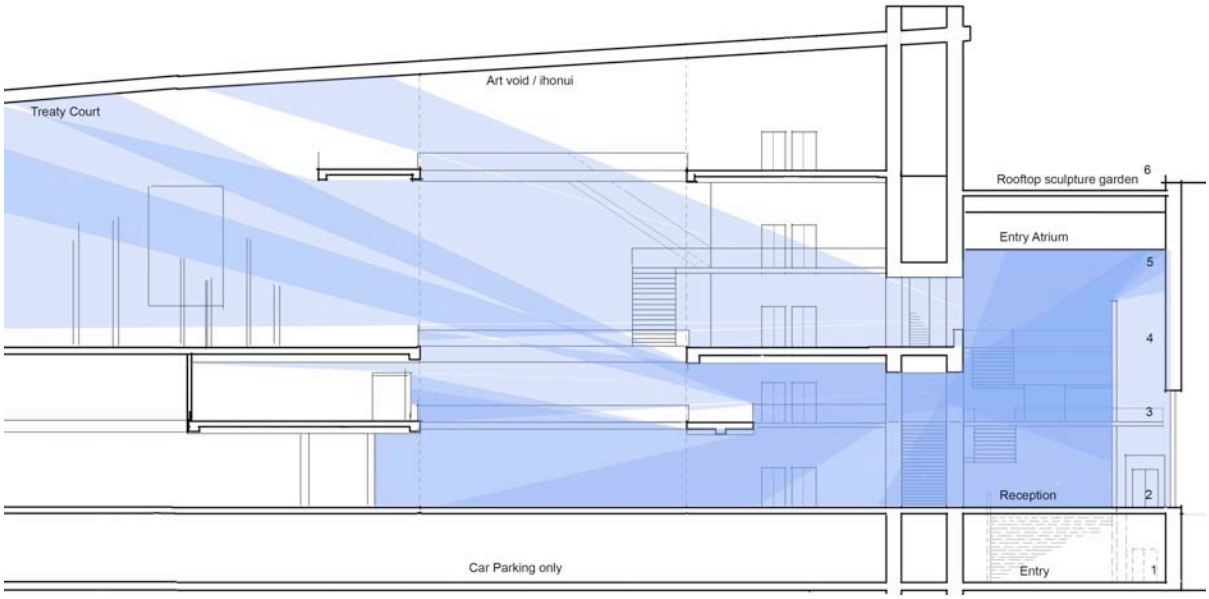

Figure 5.3.41 – Isovist fields in Cross section, through entry atrium space and art void, through to Treaty Court. *Source: author.*

5.3.13 Conclusions

It is apparent from the extensive analysis undertaken, that issues regarding circulation are probably at the core of Te Papa's confusion, as noted in 5.3.9. Circulation throughout the building is not possible through the one atrium that does contain circulation, while the ihonui connects all the floors (except the carpark), it contains no circulation at all. Many key stair connections are hidden from view from the general public. The analysis shows that the stairs are badly connected and poorly visible. While the stairs from level 3 to level 4 are comfortably positioned in the void high above the entry, offering excellent views up and down the entry atrium, the connecting stairs from level 2-3 are somewhat hidden behind the stone-grey 'faultline' wall, and do not feature strongly at level 2 (figure 5.3.32).

The lack of physical (figure 5.3.17) and visual (figure 5.3.34) connectivity to the marae has been strongly proposed as a primary reason for the marae's lack of coherence in the museum fabric. Bicultural issues aside, the marae is not spatially well connected.

The smaller floors at levels 3, 5 and 6, need public exposure even more than levels 2 or 4, but have little physical connection to the rest of the building – and in some cases almost no visual connectivity either (figure 5.3.38). Level 6's sculpture gallery has been closed as a result. Similarly, the lack of connectivity to levels 5 and 6 is strongly identified by all the analyses shown here (J-graphs, Depthmap, Moretti inversions, and isovist fields).

Lastly, the isovist fields of Te Papa show just how disparate and disjointed the spatial circulation systems within Te Papa really are (figure 5.3.27). The section isovists (figures 5.3.40 and 5.3.41) clearly show that while the entry atrium has excellent views up and down its length, the isovist field into the ihonui and treaty court is only barely visually apparent from the main stairs. This undoubtedly has an effect on the encounters within the museum: the main lift bank gets used as a re-orienting device, while the stairs are not used so much for exploration as they are for escape. The relative lack of exhibits at level 3 only reinforces the vertical intermingling between levels 2 and 4. Put bluntly: the stair's lack of apparent relevant destination will only lessen their appeal to many. Exploration of New Zealand's national identity, if that is what is intended here, is unfulfilled.

The "ideas of encounter and dialogue embodied in the competition concept" that Bossley discusses as a precursor to the later concept of "cleavage" of the building (figure 5.3.2), have perhaps overtaken the more

practical aspects of prioritizing visitor's experiences as they walk around the museum.[22] The "reintroduction of the idea of geological power / Ruamoko expressed as a mighty wall slicing diagonally through the building" that Bossley notes as the resulting cleavage, undoubtedly takes visual precedence over the space within, and overpowers the more basic role of the design as a museum.

While Bossley's intent is that this wall aids circulation and orientation, the results of the spatial analysis seem to indicate that instead, in many ways, it obscures the circulation and confuses the orientation of the visitor. Both Williams[23] and Goldsmith identified early on, respectively in museological and anthropological terms, that the bicultural aspects of the building had the ability to both bring two peoples together, as well as drive them apart:

> Thus, even according to its supporters, Te Papa Tongarewa cannot avoid the accusation that it is frivolous, mobile, temporary, and incoherent.[24]

The spatial analyses demonstrated here clearly identify that the circulation system within the atria of Te Papa has some serious issues to resolve, as du Fresne identified in January 2010,[25] and which the Te Papa management may have at last planned to take on board.[26] Computer analysis such as has been undertaken here, had it been undertaken in the design stage of Te Papa for the analysis of connectivity, may have exposed these self-evident circulation weaknesses. As a result, Te Papa may have been designed differently, and thus avoided at least some of the criticism (refer to Appendices for more critical commentary) that it has come in for.

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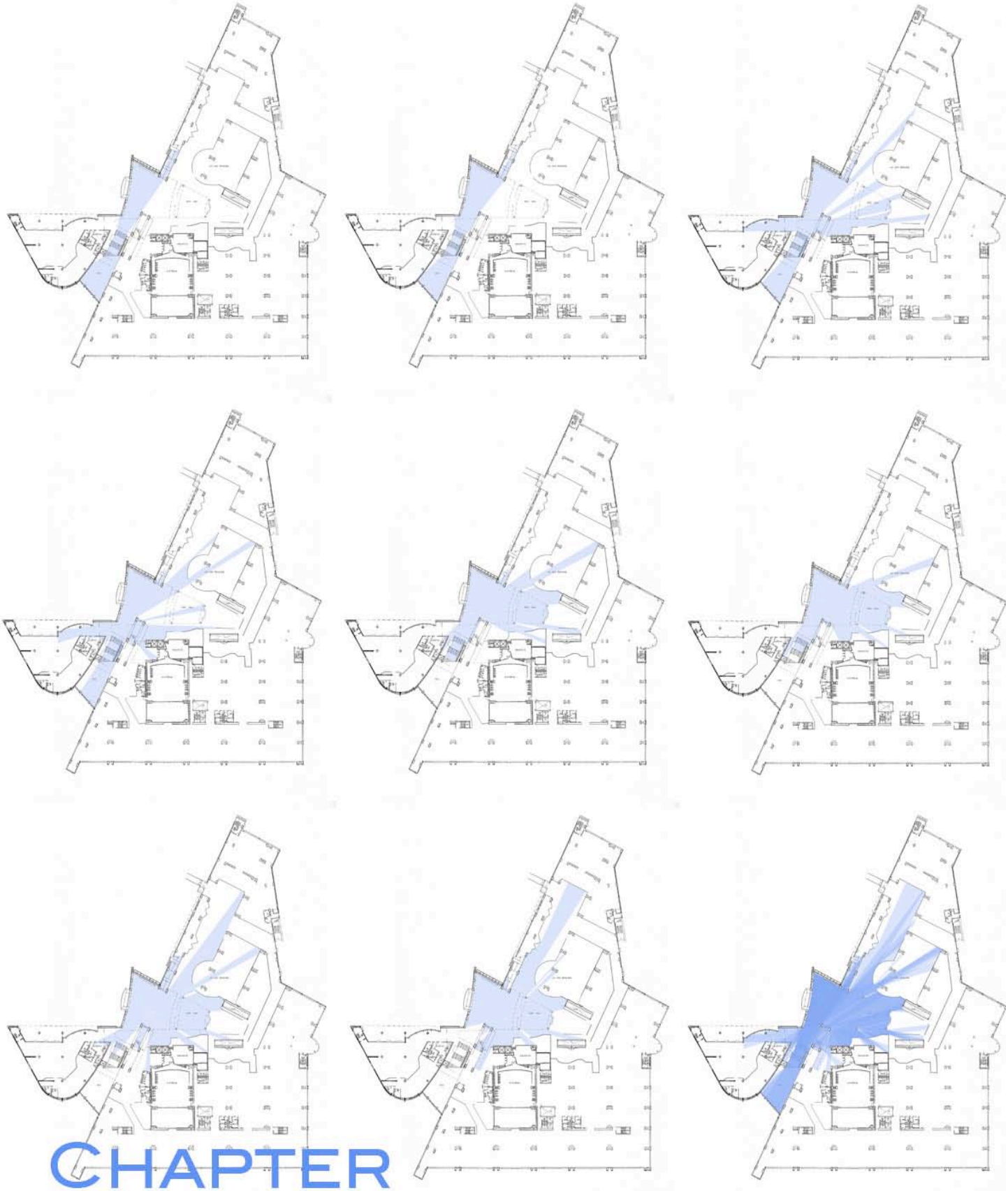
[22] Bossley, "Redirect, redevelop," 23.
[23] Williams, "A Breach on the beach," 81.
[24] Goldsmith, "<<Our Place>> in New Zealand Culture, 5.
[25] Du Fresne, "Te Papa founders on the rocks."
[26] Museum of New Zealand Te Papa Tongarewa, *Briefing to the Incoming Minister*. Recommendation 10 notes: "A key outcome of our strategic planning process will be the development of a master plan. Master planning at Te Papa will review the total spatial usage and needs of Te Papa's Cable and Tory Street sites…" 4.



Chapter Six:

Discussion

Chapter 6: Discussion of Case Studies

6.1 Introduction

At the start of this research, the Research Question was put:

How can multi-level atrium spaces be analysed for connectivity?

Earlier chapters examined spatial theories and proposed some possible methods of analysis that may be used to examine 3-D spaces such as multi-level atria. Atrium designs and atria features were examined in depth, and a number of possible analysis methods were selected. The previous chapter undertook analysis of three selected case studies, utilizing selected methods to identify connectivity.

This chapter looks at the results of the case study analyses, and discusses the findings arising. Rather than the examining by case studies, as used in the last chapter (refer figure 5.1), it examines the results on a method-by-method basis, as noted in the following structure diagram (figure 6.1).

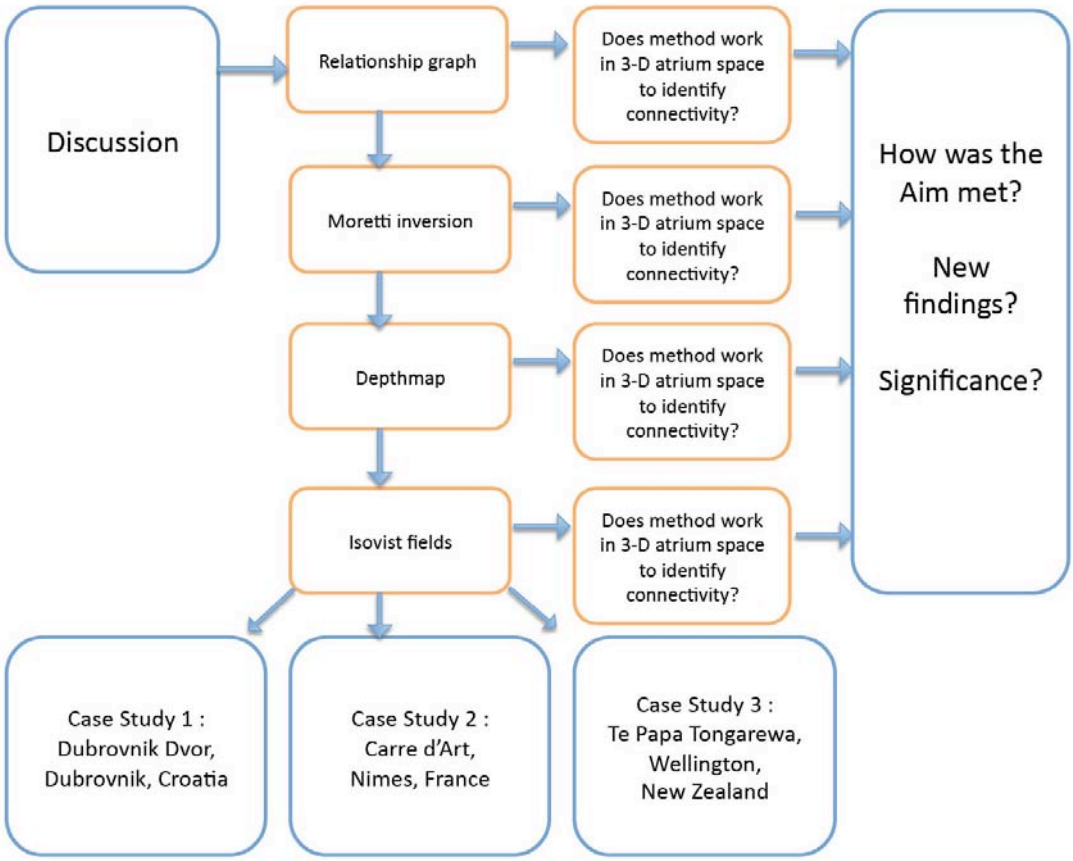


Figure 6.1 Chapter 6 structure diagram

6.2 Relationship mapping / justified permeability graphs

Room mapping ('gamma mapping') and justified permeability graphs (or, J-graphs) are traditional forms of syntax mapping, although they are used here only at a fairly basic level and not analysed computationally. Undertaking this analysis method resulted in complex J-graphs, that, while it is a method admirably suited to the simplicities of traditional room design (such as in Hanson's viewing of traditional suburban homes), suggest that it is less successful in complex spaces like atria. While the mapping and justified plans in the Dvor case study were relatively straightforward, given that the building is the most 'traditional' in terms of its rooms (fully enclosed space), the more open plan layouts of the Carré d'Art and Te Papa meant that there was no clear rule about exactly which space was connected to another space. But even in the Dvor there were queries. Where did one boundary end and another space begin? Is the colonnade part of the same space as the courtyard, or a different space? Decisions were made regarding positions of spatial boundaries. The Dvor case study was specifically selected because its boundary conditions were undefined. This added an important variable to the research, requiring some subjective decisions on how 'boundaries' undefined architecturally, might actually be 'experienced' spatially.

How was the Aim met?

While the standard syntactic method is to link room dots with solid lines, equaling both visual and physical connectivity, I have initiated use of a dotted line to indicate atrium links and lines of sight that are visual only, indicating that physical links were not possible. The use of zig-zag symbols to denote vertical circulation is also an innovative simplifying device for mapping connectivity.

Does the analysis of the connectivity within this multi-level space by space syntax actually show us anything? Does it show whether connectivity is important, or how it works, or if it is in the right place, or are there differences between visual and physical connectivity? Certainly, the J-graphs show (refer figure 6.2) that public access to most of the rooms of the Dvor is straightforwardly accessible from the central courtyard. The Dvor is well integrated: spaces are 'shallow'. Rooms that are spatially hierarchically removed are those for the sleeping quarters of the Rector, which is reasonable – there is an understandable need for privacy for this purpose. Other than that, there is little spatial hierarchy visible, even in the case of the former dungeon rooms.

Mapping the depth of rooms within the Carré indicates that the room spaces here are also very strongly integrated, and there is very little hierarchy within this building. This means that the feeling of openness and community participation in this building is likely to be high. Social interaction from the centralized vertical connectivity will be strong. The high level of glazing ensures that everything is on show within this building –

that there are no secrets. Of course, there are some areas of the building that have restrictions, such as escape stairs, staff facilities, boiler rooms etc, and further floors of storage below level A; nevertheless these rooms are still readily accessible and are not deeply hidden away in syntactic terms. This building is exemplary in its open attitude towards public accessibility.

Te Papa's J-graph analysis (figure 6.2) reveals the depth of sub-group branching on this building. Many smaller areas act as hubs, where numerous other spaces branch off. Few of those relate to the atrium spaces. While this sub-group branching is understandable for a large building like Te Papa, it also shows that the atrium spaces are not being used as circulation points, especially on the upper floors. The J-graph in particular reinforces what is already apparent – that levels 5 and 6 are poorly connected to the rest of the museum, and that spatially these levels are quite remote. This tells us that J-graph analysis is clearly identifying the complex network of connections that exist in the building, and also highlights the known issues with the level 5 art gallery.

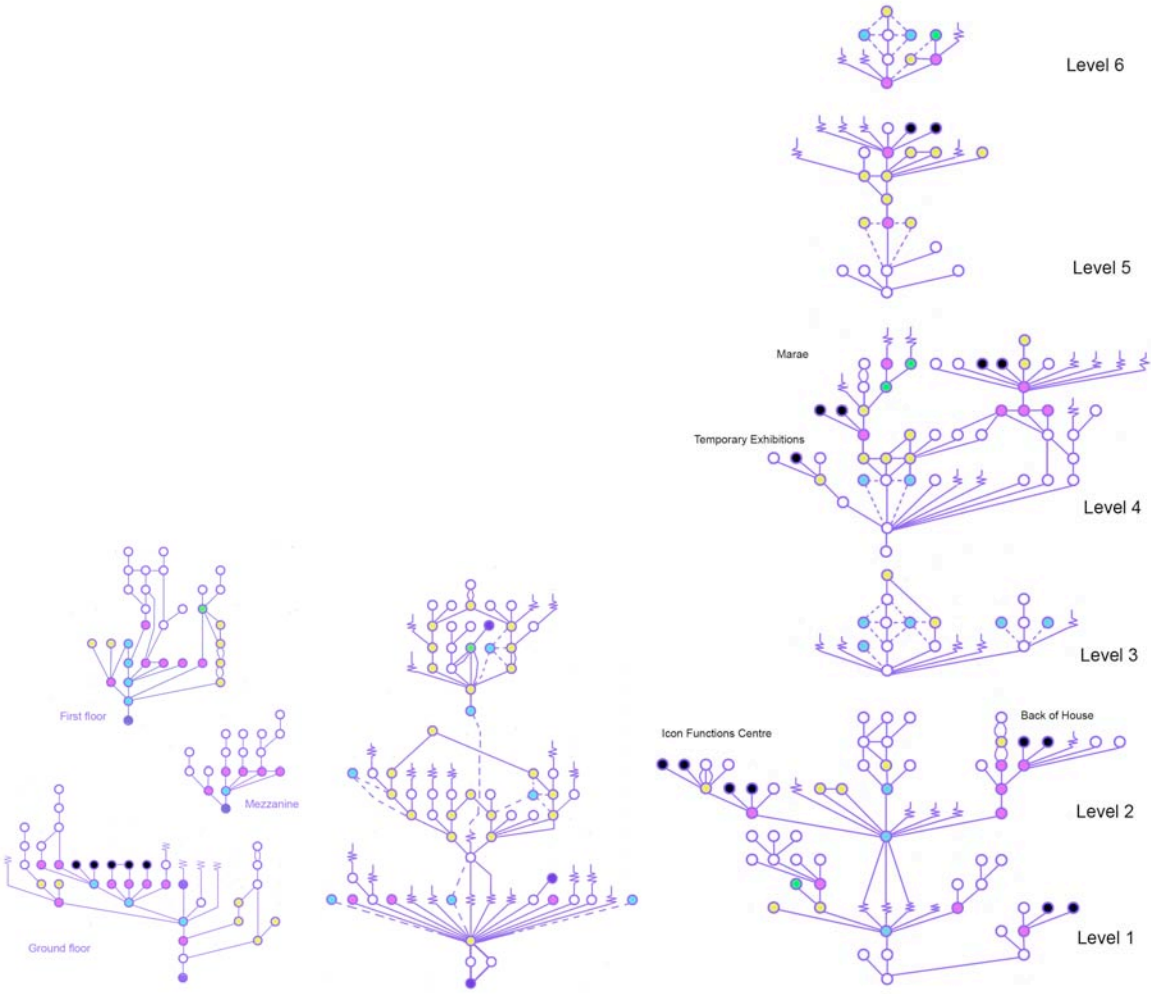


Figure 6.2 J-graphs of Dvor (left), Carré d'Art (middle) and Te Papa (right).

New findings?

The results of mapping these modern spaces into relationships graphs and justified gamma plans are not necessarily able to be replicated. As a rigorous scientific method of enquiry therefore, it cannot be recommended, especially for modern, open plan buildings. The findings are, primarily, that these methods cannot be said to work reliably in open-plan buildings without substantial refinement of the method to take this spatial configuration into account. Although it is possible that further work in this area could contribute towards an improved set of conventions as to how this may be done, the difficulty of objectively ascribing boundary conditions will always restrict the accuracy of this method.

Significance?

These J-graphs shown in figure 6.2 identify connectivity, which I have emphasized in two ways – the zigzag symbol recognizing vertical (physical) circulation connectivity, and the use of dotted lines denoting visual connectivity. Although this increases the complexity of the diagram it also reflects the situation more accurately. This is an area in which further work could be undertaken. Drawings were produced for this study as separate floors, and yet one of the key points of an atrium is that the space visually links all of these individual floors. The gamma analysis and J-graphs produced would be so much more complicated if the significance of the atrium space was fully recognized and a more fully interactive mapping was introduced. This thesis argues, however, that greater clarity is achieved through simplification of the diagrams. Different floors are therefore not joined up into one larger diagram, which would have significantly diminished clarity and made their results less readily interpretable.

The key significance of this work is that modern, open plan spaces, including atrium spaces, are not reliably mappable using J-graphs. It does, however, force recognition of the physical connectivity within each building type, as well as being useful at recognizing the nature of hierarchical spaces within the buildings observed. Even though Hillier and Hanson have extensively computerized the methods that follow on from the stages noted here, computationally and numerically assigning values to spaces and connections, this research indicates that better base information is needed prior to taking that next stage. Without better, more consistent base information there are too many variables, and as such, it cannot be recommended.

In relation to the objectives for identifying connectivity developed in section 4.12, how well did this research method fare?

Relationship mapping / justified permeability graphs

•Does the method identify visual connectivity – ie can it portray limits of sight?

No – very subjective recognition only

•Does the method identify physical connectivity – ie can it be made to recognize staircases etc?

Yes – Shown graphically

•Does the method actively identify these connective routes, or does it involve human agent intuition?

Relies on human intuition – not a rigorous process

•Does the method produce feedback visually in some intuitive manner?

J-Graphs produce good basic diagrams that are explainable with basic training, but overall, the method is not very intuitive.

6.3 Moretti-style spatial inversions

The Moretti method of casting spatial inverts was initially perceived to be a potentially useful line of research for this project: a simple, readily understandable method of depicting space. The end result, however, was inconclusive. Although disappointing, this was not entirely unexpected. The full Moretti-style spatial inversion requires a fully 3-D casting / creation of a physical model. Attempts to show analyzing of commissioned 3-D CAD models (figure 6.3) only proved that the depiction in 2-D of a 3-D object omits considerable amounts of information. While on screen the virtual model could be manipulated and viewed interactively, as a simulacrum of a real 3-D object it was unproductive. It lost all authority for 'feeling 3-D' on its conversion to 2-D media such as for the images for this paper-based thesis.

How was the Aim met?

Connectivity was not identified with confidence using the computer simulation of Moretti's method in this study. As a method of molding space however, it works well, although the identification of physical means of connection such as stairs or lifts is fraught with difficulty. Items like stairs that penetrate through the atrium space, when inverted in the Moretti-model, become just confusing little crevices that neither elucidate nor explain the circulation. Boundaries of the space produced are also highly subjective, especially when dealing with modern, open plan buildings where definitive edges to room spaces are uncommon. As a result therefore, so far the Moretti investigation has neither met its aims, nor provided any significant new findings.

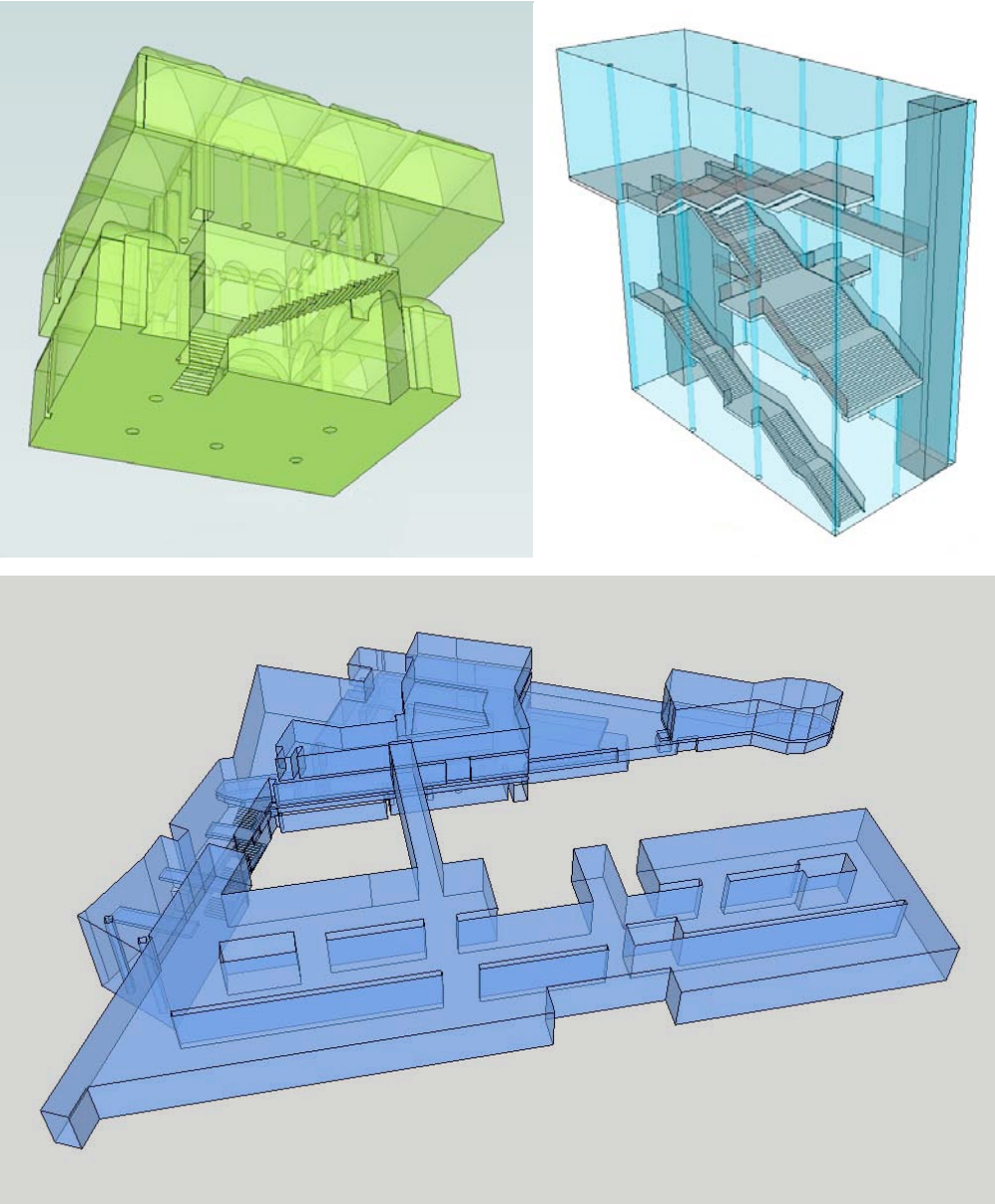


Figure 6.3 Spatial invert models of Dvor (top left), Carré d'Art (top right) and Te Papa (bottom). In terms of describing connectivity, these Sketchup CAD models are of limited use without the full 3-D physical model to back it up. Dvor model has been rotated to show stairs up. *Source: Eli Nuttall.*

The undefined architectural definition of the extent of the spatial boundary shown in figures 5.2.9 and 5.2.10 required some subjective decisions as to where 'the atrium' actually starts or finishes. This reduces the significance for making a case either for or against the identification of connectivity. If anything, the Moretti spatial inversion would seem to argue for more stairs inside the Dvor, although this would be unnecessary as the Dvor's main courtyard stair is already highly visible.

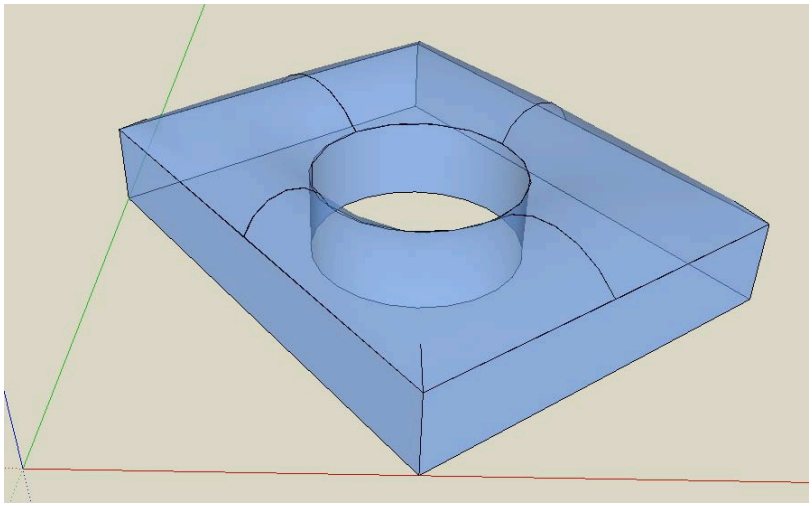


Figure 6.4 Spatial invert model of British Museum Grand Court project, although not detailed, the model of the space within the Great Court shows the spatial simplicity that can be achieved in a major Museum project. Refer to figure 2.12 for a photograph of the finished space. *Source: Eli Nuttall.*

The Moretti technique does however clearly show the lack of connectivity within Te Papa which appears to be at the heart of the problems with that particular case study – not just with the connectivity between the main atrium spaces, but with the marae and the National Art Gallery as well. A simple model of the British Museum's new atrium (figure 6.4), as a comparison against the Te Papa atria, shows how conceptually simple an organizing space can be.

New findings?

The Dvor model provides the most certainty. With the atrium space filled out to the full depth of the surrounding colonnades, the modeling of the ceiling vaults gives a strong visual appearance to the CAD model, but little is visible in terms of the connecting stairs. Figure 6.3 presents the model rotated to show the main stairs from the underside.

In the Carré, the model of the spatial invert made some sense when it was tightly constrained to the immediate area surrounding the stair, but less sense when it was expanded to its full extreme. The spatial invert model of the full space is intuitive only in terms of its vast size – the shape is not helpful, and nor does it assist in establishing any form of connectivity. Even though it is inaccurate therefore, the tighter, smaller model appears more useful in describing the central atrium space, than the full true extent shown previously in figures 5.2.10 and 5.2.11.

The 3-D spatial invert model of Te Papa's spatial voids presents a better description of the spaces than one perceives when physically located within the building. What is apparent is the extent of the public space – it is

difficult to visually define 'atria space' apart from other, general, exhibition space. The spatial invert makes it clear how disjointed the Te Papa atria are, linking together only peripherally, and prioritising the exhibition spaces at the expense of the atria as hubs for circulation.

Significance?

Moretti's methods of spatial inversion, when considered alone, do not suggest a viable method of assessment. This is however noted as a path of interest to be explored further in later research, with actual 3-D physical models rather than 2-D virtual depictions produced on screen. There is scope to use this method properly in the future, but only if taken to the logical extreme of full 3-D physical scale modeling of the building atria, so that they can be picked up and held in the hand.

In relation to the objectives for identifying connectivity developed in section 4.12, how did this research method fare?

Moretti-style spatial inversions

•Does the method identify visual connectivity – ie can it portray limits of sight?
No - not intuitively

•Does the method identify physical connectivity – ie can it be made to recognize staircases etc?
Yes - but the methodology is awkward

•Does the method actively identify these connective routes, or does it involve human agent intuition?
No - neither really.

•Does the method produce feedback visually in some intuitive manner?
No – Boundaries need to be set better to retain edge.

6.4 Depthmap Visibility Graph Analysis

Each floor of each case study was analysed with Depthmap. Similarities between the case studies are identified, and differences are discussed.

Figure 6.5 Depthmap plan of Dvor ground floor, most of floor appears unconnected, including stairs. *Source: author.*

How was the Aim met?

Despite the fact that the software actively calculates every square of a plan for its numerical version of connectivity, in terms of plan connections it had little success in identifying any vertical physical or visual connectivity within the atria trialed here. Practice and experience at tweaking parameters could improve performance, however, the output results are already clear. The method of calculation used within the Depthmap model clearly identifies connections in the one, single, flat plan of space shown in each resulting Depthmap plan, and has no inherent ability to take into account any extra height or recognizing other special characteristics of the space that may be present.

During site visits, it was evident that visitors were invariably drawn directly to the vertical atrium courtyard space, and it can be assumed that these take in basic atrium issues such as fresh air, daylight, and spatial exploration, visually linking upwards toward the sun. It is here at the centre of the atrium courtyard that visual connectivity is at a peak. By comparison, Depthmap has highlighted an area on the ground floor mapping (figure 6.5) where two long viewshafts intersect (reflecting the axial line origins of the program). Clearly modifications would need to be made to Depthmap to enable it to mathematically understand the significance of the staircases and for it to recognize the strong psychological impression that open courtyard space has on a visitor. It is however entirely conceivable that Depthmap software could be altered and adapted by its creators to computationally reflect the perceived importance of these issues.

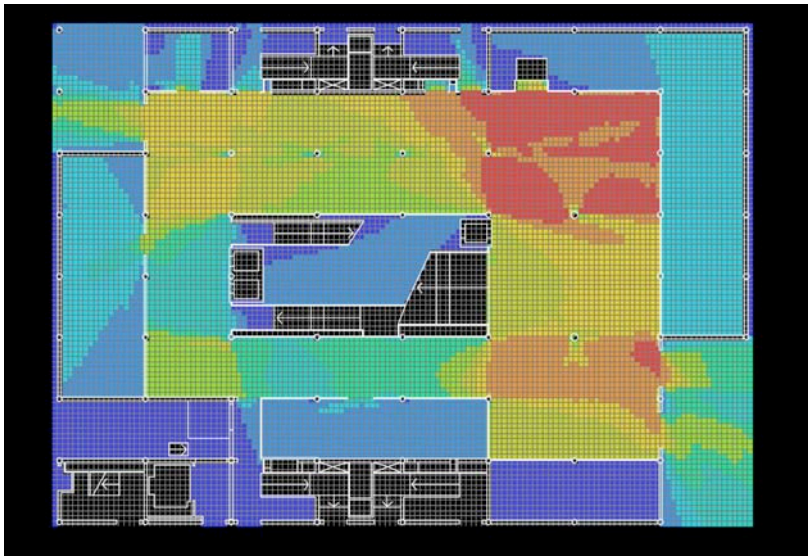


Figure 6.6 Depthmap plan of Carré d'Arte ground floor (level D), highlighting strong connectivity in top right corner. *Source: author.*

The Depthmap results for the Carré appear almost believable at first glance (figure 6.6 and also 5.2.12). The software appears to be recognizing the hotspots of connectivity within the plan at level D, pictured here. Highlighted areas include the entry doors and the area adjacent to the café lift. Unfortunately it becomes obvious that recognition has not been given to the stairs (which the software would read only as a series of obstructions), nor to the central atrium. Without modification to recognize the special aspects of these spaces as described above, the results become less significant in this atrium space.

In Te Papa, the Depthmap plan appears to be most useful at level 2 (figure 6.7) as it is a single level analysis. The highlighted 'hot spots' of connectivity at level 2 appears to coincide almost directly with the base of the ihonui rising up above the floor at this point. This indicates that connectivity at this point is high, and thus is indeed a good place to construct an atrium. If the staircase circulation ascended through this void, it becomes apparent that Te Papa would likely be a far better connected building than it is now.

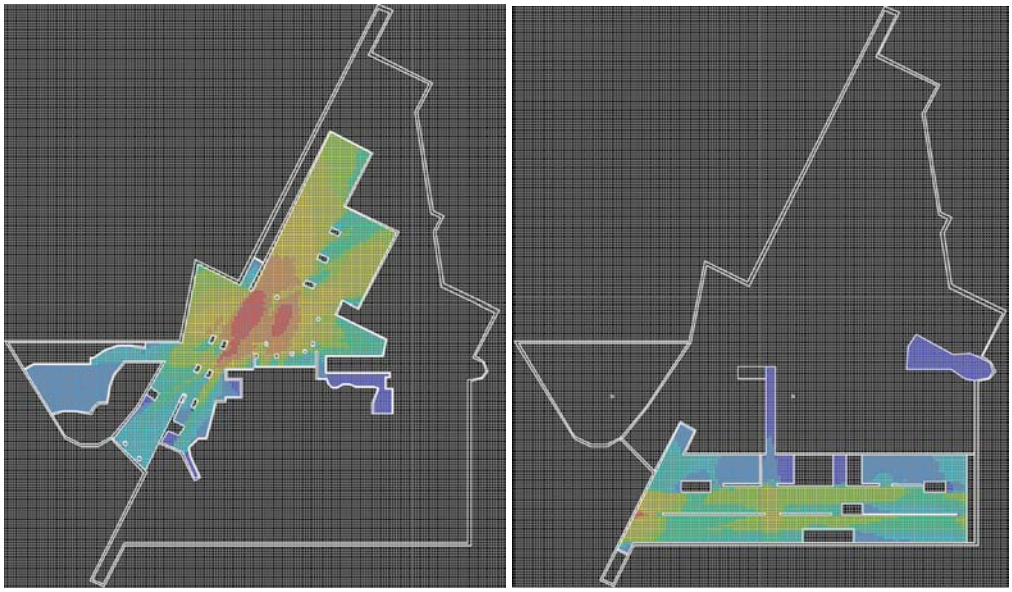


Figure 6.7 Depthmap plans of Te Papa, level 2 on left, level 5 on right. *Source: author.*

The contrast of level 2 with level 5 (also shown in figure 6.7) shows the dearth of real connectivity within the National Art Gallery at level 5. The software clearly shows that as a single level analysis, level 5 of Te Papa is ruefully unconnected.

New findings?

After using the Depthmap software on this project however, its relevance and suitability for work on 3-D spaces remains unconvincing. Researchers from the space syntax community (via the email list-server at the Bartlett School of Architecture) provided many helpful suggestions as to how it could be tweaked and encouraged to give more suitable outputs, including referring me to a number of papers where some acknowledgement had been given to 3-D spaces.[1] Most of these involve some simple linking of one space to another to recognize the availability of vertical circulation like staircases, but none of them had coped with a fully 3-D interactive space such as a complex multi-level atrium. Results for the Depthmap analysis produced for the case studies seemed promising initially, but it is clear that while Depthmap performs well as a 2-D feedback tool, it has not successfully interpreted the 3-D aspects of the spaces being simulated here.

Significance?

At the suggestion of some of the space syntax researchers on the UCL list server, Depthmap was also trialed on a section through each building (figure 6.8). On a normal cross-section through a standard office floor, Depthmap would produce unremarkable diagnoses: there is little differentiation on spatial integration within a

single regular rectangular space. Cross-sections through the case study atria, while holding out possibilities of new insights, regretfully resulted in similar unreliable diagnoses.

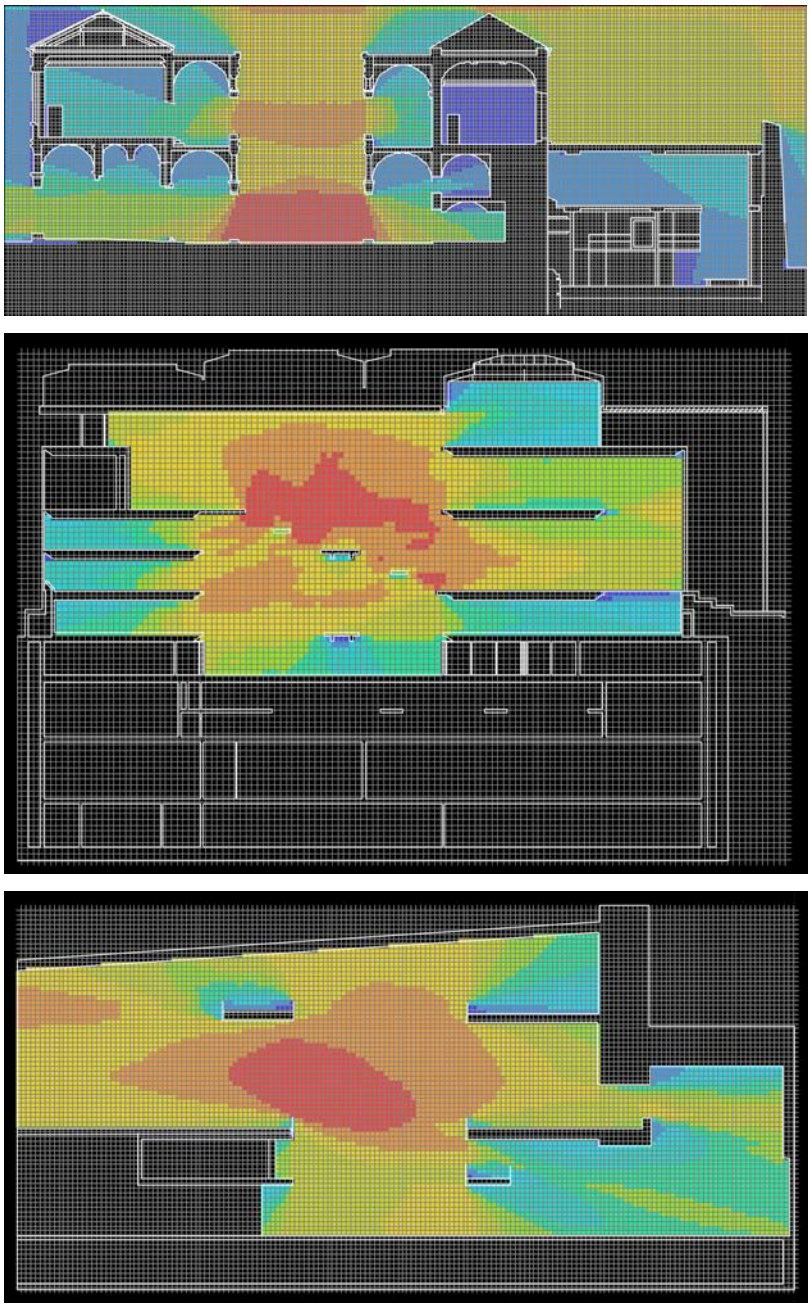


Figure 6.8 Depthmap sections of Case Studies, top: Dubrovnik Dvor; middle: Carre d'Art; bottom: Te Papa. In all of these sections, the atrium has been identified as the location of maximum connectivity. *Source: author.*

A key part of this is the removal of any background lines that may be in the section, as the software interprets this as a solid wall, rather than casual background information. Areas with the longest sightlines are highlighted

[1] Research included: Sailor, *The Space-Organisation Relationship*; Koch, *Architectural Fashion Magazines*; Dalton and Dalton, *Solutions for visibility, accessibility and signage*; Lee, *Spatial Properties and Meanings of Atria in Built Environment*; Doxa, *Morphologies of Co-Presence in Interior Public Space*; Paliou, *Visibility analysis in fully 3D spaces*; and Psarra, *Architecture and Narrative.*

as the most active, leading to unusual results, such as the sky being highlighted as the most active. Clearly, in terms of the relevance of this, the software was highlighting elements that were not crucial.

Calculations are undoubtedly complex in ascertaining values for each square on the grid. Calculating values in a 3-D grid of squares is many times more complicated than ascertaining the same thing in a 2-D-only plan. However, modern computers have improved significantly since the introduction of the Depthmap program, and the speed at which the program runs is far faster now than it was when first introduced in 2001.

Virtual alternatives

The recommendations from this research project are that Depthmap could become more successful if it were rewritten, and that new 3-D versions are needed that are explicitly designed to run within a fully 3-D virtual building model. New methods of virtual simulation are advancing greatly in the world of computer software, including allied fields such as fire egress analysis. New advances in 3-D modeling software such as Grasshopper for Rhino are taking an active part in the modeling of 3-D isovists, even though they are not doing it for reasons of space syntax analysis.[2] In particular, software developments in the field of gaming theory are likely to have an impact on virtual simulation of building models in a cross-over between media design and building design.

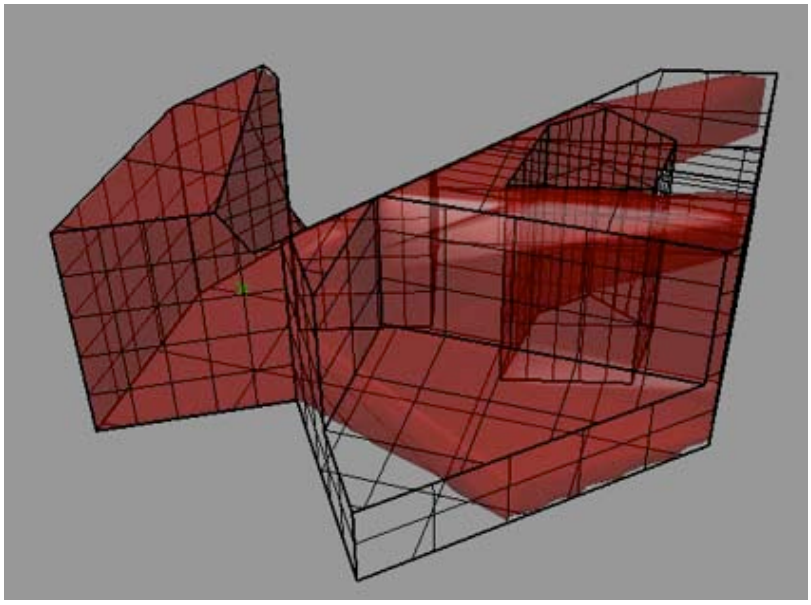


Figure 6.9 Parametric model of live 3-D isovist, creation within virtual building outline. *Source: Andrew Heumann, http://parametricmodel.com/3DIsovist/32.html*

[2] http://www.grasshopper3d.com/forum/topics/request-index-value-for-isovist-hit

Heumann has posted images and video online of a space being analysed by a moving point isovist within a rigid virtual boundary (refer figure 6.9). All that is needed now is for software to record and analyse the results from output such as this, and space syntax could take a big leap into a more completely 3-D future.

In relation to the objectives for identifying connectivity developed in section 4.12, how did this research method fare?

Depthmap Visibility Graph Analysis

•Does the method identify visual connectivity – ie can it portray limits of sight?

Yes – brilliantly, although not to other floors

•Does the method identify physical connectivity – ie can it be made to recognize staircases etc?

Yes – but again, very poor links to other floors

•Does the method actively identify these connective routes, or does it involve human agent intuition?

No – neither, as it does not work in 3-D

•Does the method produce feedback visually in some intuitive manner?

Yes – highly intuitive visual feedback in forms of coloured arrays.

6.5 Isovist fields

This final form of space syntax analysis has turned out to be the most useful tool for identifying means of connectivity. While the isovist fields themselves are a record of visibility over time (ie the walk from the entry doorway to the stair), they have also proved capable of highlighting the relative visibility of all methods of physical connectivity within the scope of that walk.

I believe however that it is more than this. The crucial factor at play here is the input of the 'intelligent operator', in that the analysis is not just left to a software program, but that the plans produced are analysed and interpreted in their results by a sentient human being. It is via this input that the significance of the highlighted areas is recognized. Other methods of having the human agent involved could be via time lapse photography or otherwise mapping user movements and behaviour. The importance of human agency in the form of the intelligent operator is clearly of key importance.

Figure 6.10 Dvor main stair, viewed at Ground floor level. Stair is highly prominent throughout most of ground floor atrium space. Back of house stairs are directly behind the wall shown. *Source: author.*

The isovist fields in the Dvor clearly highlight the strong visibility of the main central stair coincident within the atrium space. The same isovist fields also conveniently hides from view the 'back of house / servant stair' that equally rises from ground to first floor. An intelligent viewing of the isovist map produced shows instantly how important the atrium space is to the use of the building. The high visual prominence of the major stairs readily demonstrates that connectivity is easily identified. The coincident use of the isovist in section reinforces the same perception.

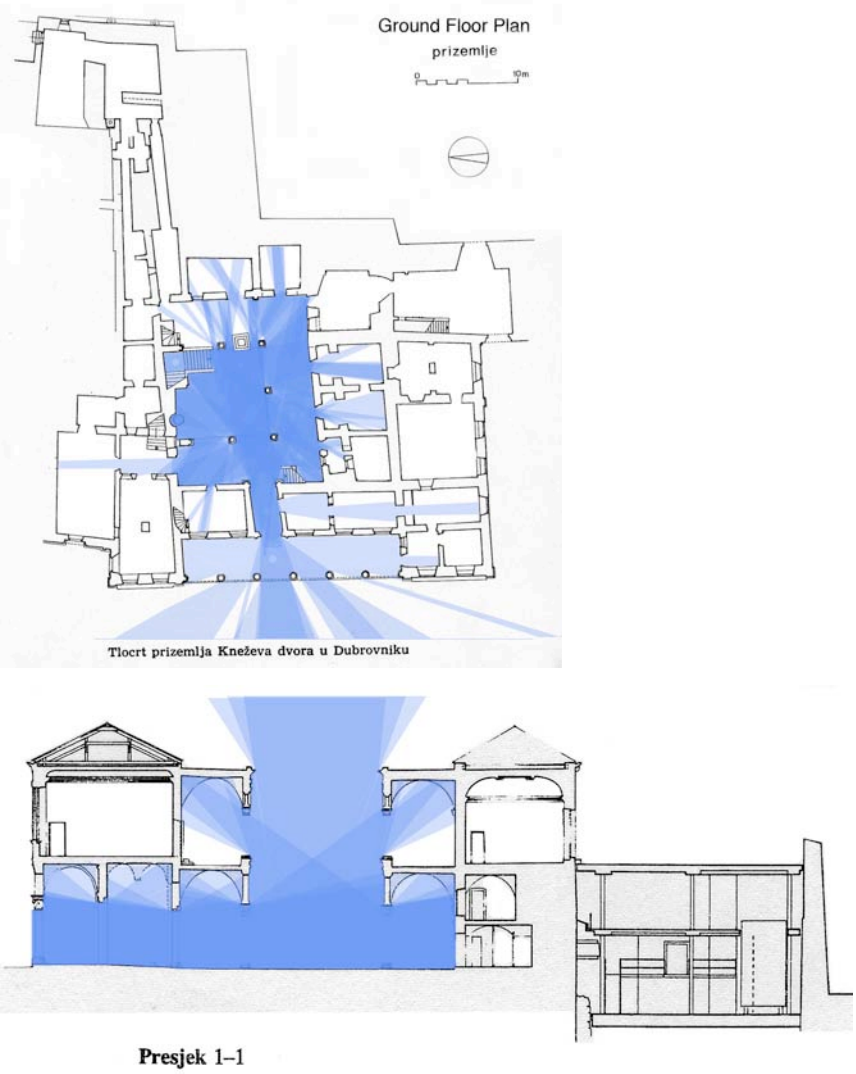


Figure 6.10 Plan and Section of Dvor, isovist field at Ground floor shows that main stair is highly visible within atrium.
Source: author.

In the central atrium courtyard at the Dvor, there is a large open void enabling expansive views over and across the atrium, in which the stair moves through. By contrast, at the Carré d'Arte there is substantially less atrium space around the actual physical staircase elements: in plan there appears to be very little space. However, because of the modern design of the Carré, the thickness of the stair is kept to a minimum, enabling views across and both above and underneath the glazed stairs. This is an awkward thing to depict on an isovist plan – and yet is so easy to understand in a photograph of the space concerned (refer to figure 6.11).

Figure 6.11 Carre d'Arte stairs, viewing across atrium. Glazing to stair treads, glazed balustrade, open nature of stair flights, all help maximize views in and across atrium. *Source: Villela.*

How was the Aim met?

The aim of the study was clearly met here using the hand drawn photoshopped isovist maps. Areas of connectivity, such as the stairs in each case study, are readily identified by an 'intelligent operator'.

The isovist field of the Carré d'Art clearly shows that the visibility of nearly all forms of vertical circulation are immediately apparent within the mediatheque, proving that this building has excellent transparency in all senses of the word. The isovist analysis reveals the high visibility that circulation has within the building, right from the front entry. As a visitor enters the rotating doorway, not only is the main stair up immediately visible, but also visible are the lifts at both the side and the rear, the top of the stair up from below, and two other sets of stairs as well.

While the glazed walls obviously add to the transparency of this building, in this study the glass walls are treated as solid and so do not add to the all-pervasive nature of the isovist field. In effect therefore, the Carré would be even more transparent in its effects, if glazed walls were treated as completely invisible.

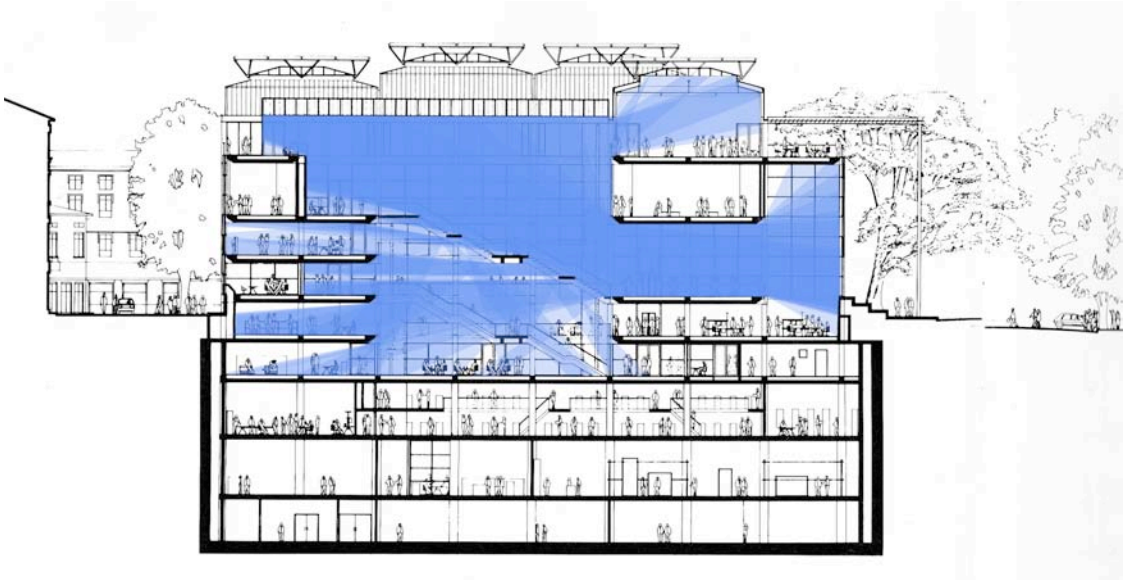


Figure 6.12 Plan and Section isovist field of Carré d'Arte, plan taken at level D: Ground floor. *Source: author.*

New findings?

Although the two longitudinal sections of the Carré and Te Papa look similar, the key difference is that in the Carré views encompass not just the stairs themselves, but also visual connections with the exhibitions spaces themselves. In Te Papa by comparison, views of the stairs are strong in the long section, but fail to connect well in the cross section.

Figure 6.13 Plan and Section of Te Papa, isovist field analysis at Level 2. *Source: author.*

Significance?

Perhaps what is notable here is not the visible, but perhaps instead the emphasis should be on what is not visible. In the Dvor, back of house stairs are not visible to general view, but the grand public stair is. In the Carré, although fire escape stairs are hidden away, nearly all other stairways are highly visible. All circulation is via the atrium. In Te Papa, by contrast, viewings of all the means of circulation is not possible from any one location. There appears, to this researcher, to be an issue regarding feedback via visual clues that the visitors need to navigate their way around, and the disjointed circulation choices offered by the planning structure of Te Papa. As a result of this mismatch, visitors get lost – or may not find what they are looking for.

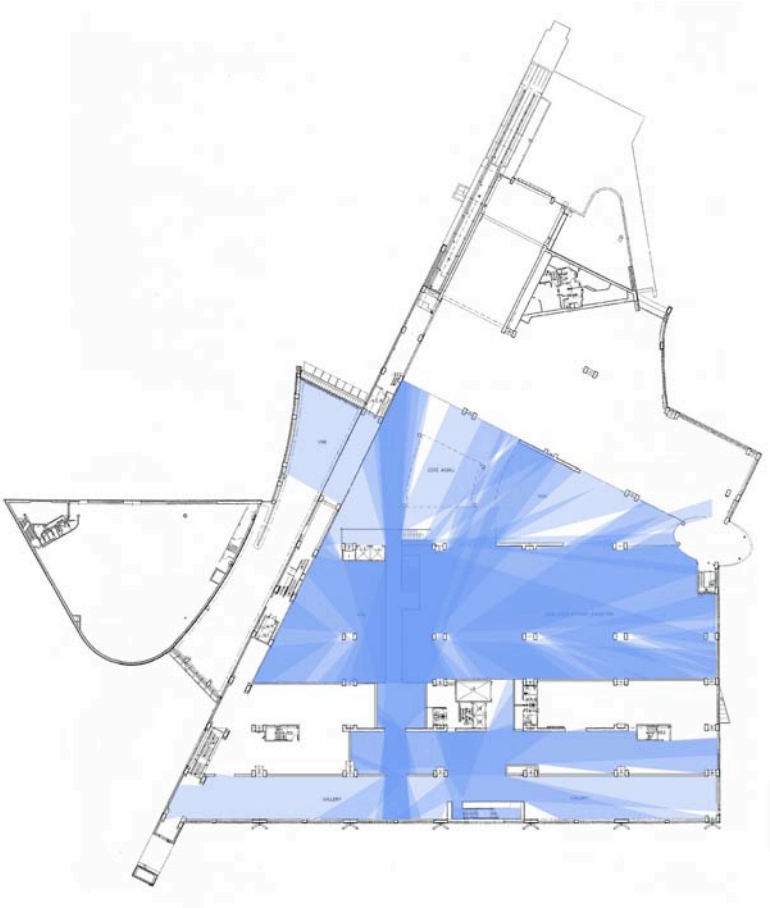


Figure 6.14 Plan and Section of Te Papa, isovist field analysis at Level 5. *Source: author.*

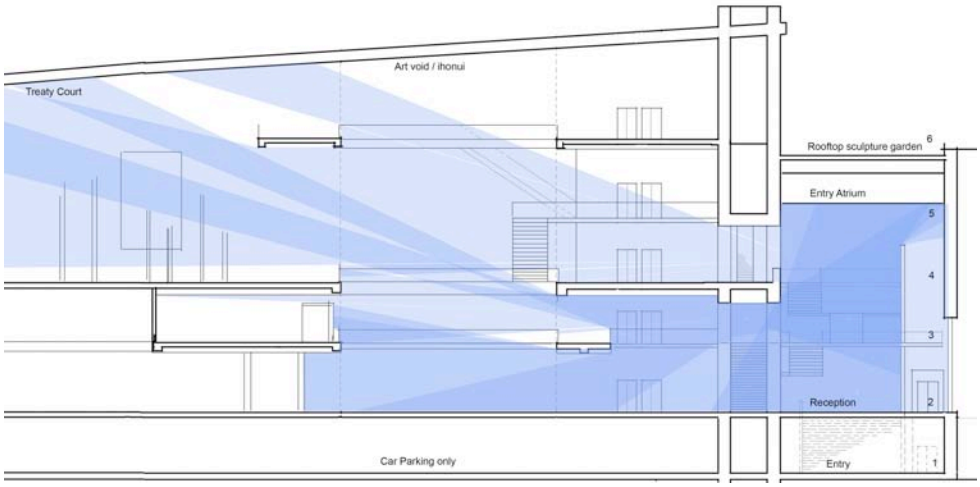


Figure 6.13 Plan and Section of Te Papa, isovist field analysis at Level 2. *Source: author.*

In relation to the objectives for identifying connectivity developed in section 4.12, how did this research method fare?

Isovist fields

•Does the method identify visual connectivity – ie can it portray limits of sight?

Yes – in 3-D also, via section

•Does the method identify physical connectivity – ie can it be made to recognize staircases etc?

Yes – but intuition required

•Does the method actively identify these connective routes, or does it involve human agent intuition?

Both – a route for human discovery needs to be made, which is a subjective decision

•Does the method produce feedback visually in some intuitive manner?

Yes – it is a reasonably intuitive process

6.6 Conclusion

This chapter has primarily re-examined results coming out of the the three case studies, and discussed the findings in relation to the four means of analysis selected. A summary of the key points arising from this discussion is presented here in table 6.1.

Each of these different atrium buildings has a differing form of atrium, with varying implementation of atrium features. Some have strengths, while others have weaknesses. If no viable means was available regarding assessing the connectivity within each building in the design phase, then the building design has risks.

If the design of these buildings had included some kind of study method, there would have been greater opportunities to enhance the connectivity.

This chapter sums up the relative advantages of each system tested within this thesis, and these findings can be used to mitigate such design risks in future multi-level public building designs in New Zealand.

Table 6.1 Success of identifying connectivity within atria

Analysis method	Degree of Success			Recommendations
	Case Study 1 **Dvor**	Case Study 2 **Carré d'Art**	Case Study 3 **Te Papa**	
Relationships / J-graphs	Good success rate	Partial success	Partial success	Needs to take vertical circulation and visual connections into account. Works best with enclosed rooms, not open plan space. Relies strongly on human interpretation, plus subjective placement of 'spaces' on different floors
Moretti-style virtual spatial inversions	None – but possible	None – but possible	None – but possible	Needs to be trialed with fully 3-D crafted object as final output. No intuitive solutions with this method.
Depthmap software and visibility graph analysis	None – misaligned	None – misaligned	None – misaligned	New software needed, or substantial revisions to existing software, to take the 3rd dimension into account. Excellent method for 2-D, but still missing out on 3-D.
Isovist fields	Yes	Yes	Yes	Automate recognition process of circulation elements; devise method of working simultaneously in section.

In the next and final chapter, this thesis comes to a conclusion.

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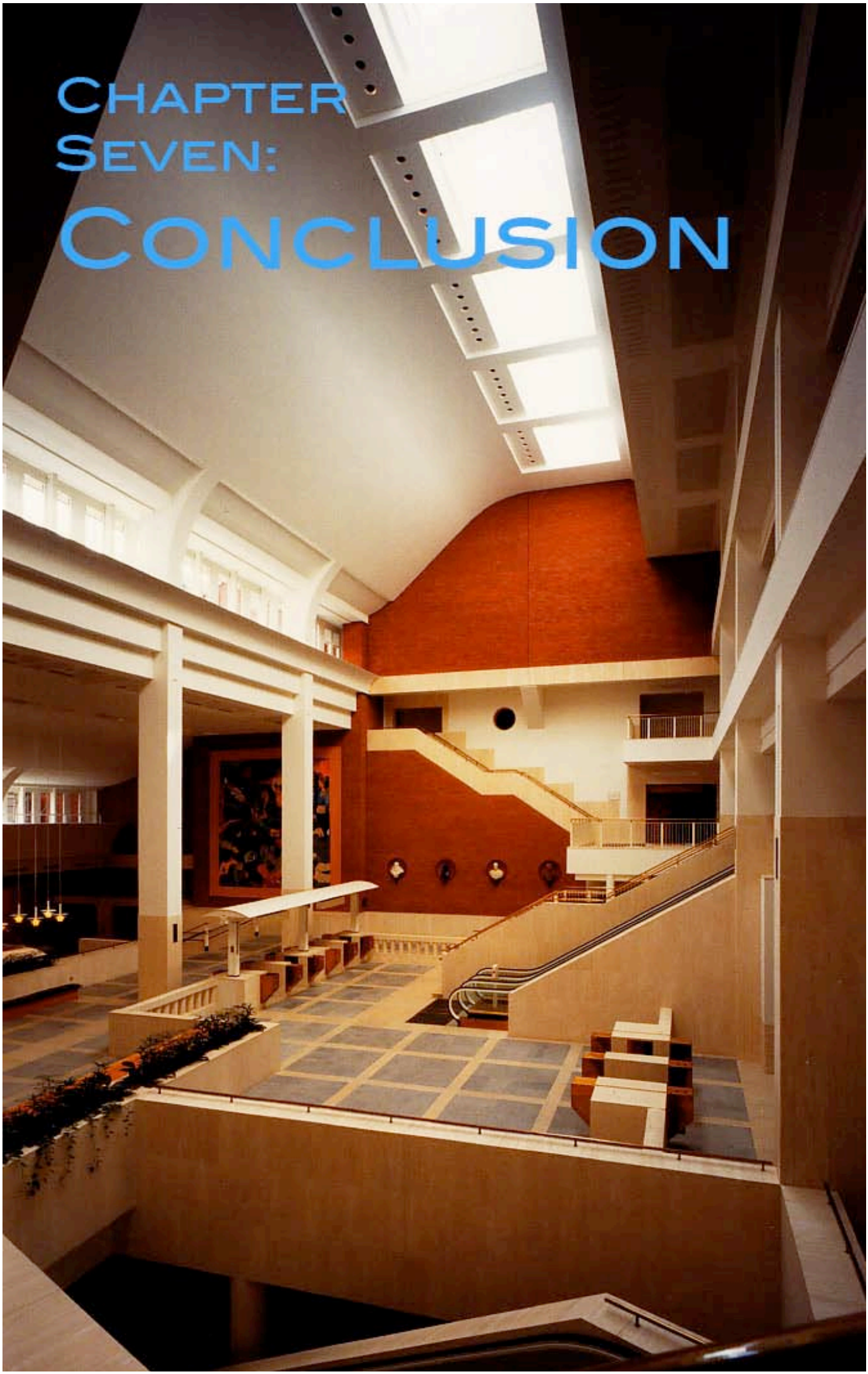
Chapter Seven: Conclusion



Chapter 7: Conclusion

7.1 Introduction

In previous chapters in this work, the focus has been on atria and connectivity within atria. Three case studies have been analysed using space syntax and other methodologies. The results have been discussed for their appropriateness in answering the primary research question. This chapter examines whether the aims of the study have been met and summarises what significant factors have been noted along the way.

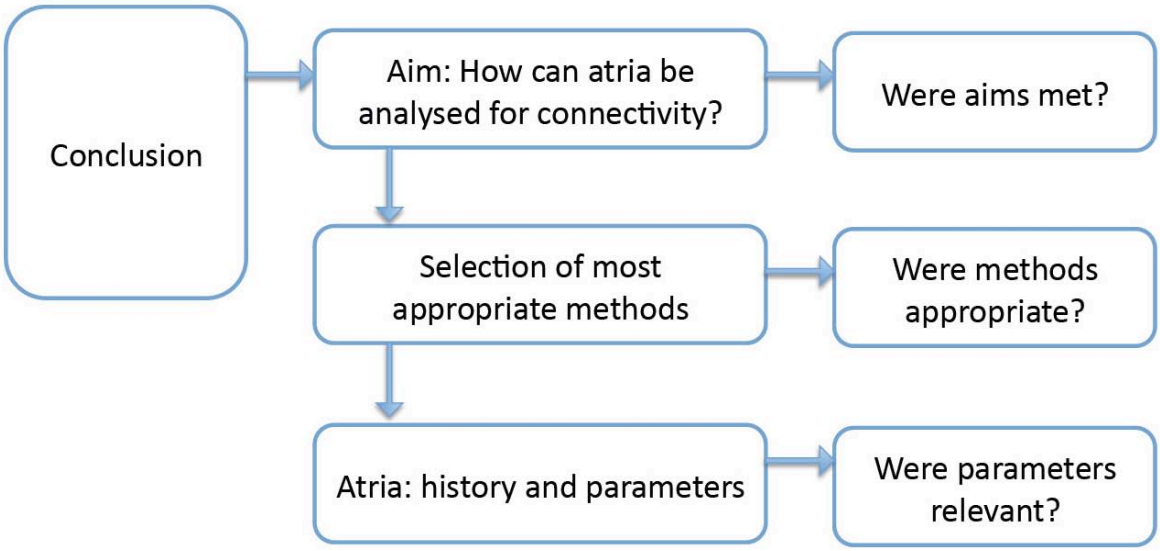


Figure 7.1 Chapter 7 structure diagram

7.2 Aims and objectives

During this study of atria spaces the thesis has investigated what makes them work – what are the different types of atria, what are the features associated with atria, and how do the connections work within atria? Most of all, I have addressed the research question of: How can multi-level atrium spaces be analysed for connectivity? This has necessitated an investigation into the paths, connections, and empty void space of the atrium. A series of key objectives were also set:

Objective 1 – Analyse atrium features generally and identify key attributes that contribute to enhanced social connectivity in atrium buildings

Objective 2 – Examine traditional 2-D spatial theory with regard to connectivity and sociability

Objective 3 – Establish 3-D digital analysis methods that can be applied to more accurately assess atria connectivity

Objective 4 – Test relevant 3-D digital spatial analysis methods not normally applied to atria connectivity, with regard to their ability to provide more accurate assessment of connectivity

7.3 Aims – were the Aims met?

Thesis results have indicated that progress towards full 3-D spatial analysis has been made, both by myself and others. Successes include the trialling of isovist fields as a means for exploring both 2-D and 3-D spaces, subject to the intervention of an intelligent human agent. Weaknesses include the lack of good feedback from the 2-D versions of the 3-D Moretti-style modeling; and the lack of objective outcomes involving Depthmap within 2-D atrium sections. The thesis was focused on particular objectives, Other, later research may want to investigate these other points further, especially using new forms of 3-D modelling tools to identify and clarify methods of connectivity in atria.

7.4 Methods selected

This research evidences that methods of space syntax can be used to identify connectivity. The thesis strongly suggests that connectivity in 3-D spaces can be identified by factoring in recognition of vertical circulation and spatial volume. The scientific methods currently used can be and should be upgraded or replaced for more accurate depiction of the 3-D environment.

The next question, closely related to the first, is: 'Has this research identified a method which can accurately and reliably analyse connectivity in an atrium, every time?' While the research has not identified a method which can solve all the issues on its own, the research has determined what needs to be done to achieve this. The key would be to identify connectivity in 3-D spaces by factoring in recognition of vertical circulation and spatial volume.

The scientific methods currently used to analyse 2-D spaces do not at present directly analyse 3-D space, but the current procedures can be extrapolated into the third dimension. Of the various methods used, the use of isovist fields appears to have worked most successfully, but still has further to go in terms of the practicality of its application.

While an isovist field does not give a true 3-D representation equivalent to actually being in the space itself, continued improvement in the computing power available for analysis means it is highly likely that 3-D simulations will be developed in the future. Computer programs continue to be developed by UCL's Space Syntax, MIT's Senseable City Laboratory etc, and software is likely to continually evolve, offering spatial simulation tools to the wider architectural community.

Appropriateness of selected methods

This thesis investigation has evidenced that the hand-crafted nature of Moretti's spatial inversions were not very successful; the application of very basic gamma mapping and J-graphs are overly complex for use within an atrium; and the computer software Depthmap is in need of significant upgrading to cope with the needs of a fully interactive 3-D space such as a multi-level atrium.

However, some of the methods trialled were very successful. The hand-drawn nature of the isovist fields had a great deal of success. The use of computing methods in this analysis is likely to be significant. Even since beginning this research, further potentially useful advances in computer analysis have emerged. There is still room for much more work in this field in the future.

7.5 Atria – parameters

Focused on identifying connectivity, the parameters affecting the outcomes of atrium design afford unlimited possibilities for variations. With so many parameters to be assessed, the outcomes are numerous and varied. The particular focus of this research investigation has been on elements of circulation and connectivity.

Relevance of atria parameters

In recent years, young adventurous architectural companies such as Denmark's 3XN and Australia's BVN have specialised in the construction of buildings with significant spatial contortions. Factors I identified as important, such as vertical circulation through the space, perforated boundaries and their ensuing active edges, intersecting boundaries, forced 'bump' encounters to increase sociability, as well as basic matters like fresh air, daylight, and security have all been combined in a number of each of their projects. These factors have been played out not just in public atria as discussed in this thesis, but also in other building types as well – the private office buildings such as BVN's Sovereign House, the educational facilities such as 3XN's schools and polytechnics in Scandinavia, as well as the complex spatial convolutions of architectural practices such as London's Zaha Hadid studio, and her *piece de resistance*, Maxxi, in Rome. These new buildings, which evidence a great deal of success in relation to issues of connectivity, took risks. New methodologies for early assessment

in the design phase, such as those explored in this thesis, will help ameliorate such risks and lead to greater opportunities for success.

The selection of parameters, on reflection, is a good cross-section of the possible factors that affect the design of atria.

7.6 Objectives

The set of four objectives listed in 7.2 were set early on, and have provided a framework for research.

Meeting study objectives

1 - Key atrium features were analysed and key attributes that contribute to enhanced social connectivity in atrium buildings were noted.

2 - Spatial theories were examined, in particular with regard to connectivity and sociability.

3 – Digital 3-D analysis methods were established, that could more accurately assess atria connectivity.

4 - Spatial analysis was tested with these relevant 3-D digital spatial analysis methods, in relation to their ability to provide more accurate assessment of connectivity.

7.7 Recommendations

The chapter on the features of atria and the factors that contribute to a successful, lively atrium proposed some broadly significant items that influence the design and daily use of an atrium. Amongst these was a recognition of the strong design impact that visual and physical connectivity can have on atrium design. This focused the attention on vertical circulation within an atrium as a key point to study: most successful public buildings with multi-level atria use their atria as a means of spatial orientation within the building. Clarity and legibility of the circulation space within that space is therefore not just important, but key to the successful negotiating of the entire building. This has become evident, not just through the case studies presented here, but also in my wider travels through other significant atrium buildings illustrated in this thesis.

Further work on this research area is recommended to take place on adapting computer simulation models to integrate factors such as atrium height, and recognition of circulation methods. This may be through alterations to programs like Depthmap, or may be better utilised by adapting more recent software such as Grasshopper and adapting that to produce values for a 3-D grid matrix within. It is anticipated that increasing sophistication in 3-D modelling software in associated industries such as gaming, as well as ongoing advances in fire egress

modeling (with the use of simulated 'intelligent' agents) may also have input into the increasing sophistication with which interior spaces such as multi-level atrium spaces may be analysed for connectivity. At present these are not used within space syntax as tools, but this research indicates that, with adaptation, they could play a useful part in future developments in the space syntax field.

The methods of analysis trialled within this thesis have strongly reinforced that physical connectivity is reinforced by visual connectivity. The three case studies indicate that the ability to have both physical and visual connectivity happen within the one atrium space improves the legibility and understanding of the space. While none of these analysis methods are likely to have been used at the design stage of any of the case studies, their use – particularly in the case of Te Papa – could have identified some serious design issues at an early stage. This thesis has argued that future advances in this field could assist in identifying, resolving, and eliminating design mistakes before they are constructed. This research is a vital first step along that path.

Guy Marriage
2012.

Appendix One

History of Dubrovnik Dvor

Although often allied to the more powerful Venetian empire, the city-state of Ragusa retained its independence from both the east (Turks and Serbs) and the west (Venice and Rome), while often acting as an intermediary between Roman Catholic, Serbian Orthodox, and Bosnian / Turkish / Muslim interests. Ragusa managed to remain independent "by skilful diplomacy with the stronger nations of the sea. Ocean-borne commerce was the mainstay of Ragusa's prosperous economy..."[1]

The rule of Government was remarkably stable: the Rector (a rotating position elected monthly from the noble merchant families) governed, while favorable Senators and "Noble persons about 200, out of whom they fill their Councils and Magistracies"[2] undertook remaining roles. The Rectors retained complete political control for over 800 years until the downfall of the Republic of Ragusa in 1806.[3]

A notable feature of the Ragusan culture was the express forbidding of personal monuments: there are no statues to former heroes or proud rectors, no portraits of the ruling elite. Indeed, it was only in the late sixteenth century that the erection of a bust of "Miho Pracat, a rich merchant who had left all his properties to the state…" was approved.[4] This one bust, the only civic statue in the whole city, lies at the heart of the Dvor. Civic, public duty was exhalted before all else – this point is made obvious in the building of the Dvor.[5]

The Dvor as it stands today was neither conceived of nor built as one complete design. Starting its existence as a Roman palace or fort, used as a jail around 800 years ago, later becoming a fortress, later still becoming the Rector's Palace and thus a centre of civic administration, the Dvor as it exists today is a combination of Venetian Gothic and Renaissance elements by a number of architects: the earliest, Gothic era architects, are unknown. The secular Dvor belonged to no one individual or even family – and therefore the Dvor may be regarded as a very public building – almost unique in its time.

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[1] Nach, *Yugoslavia in pictures*, 12.
[2] Anon, *A True Relation of the Terrible Earthquake Which happened at Ragusa,* 2.
[3] Krekic, *Dubrovnik in the 14th and 15th Centuries*, 32.
[4] Krekic, *Dubrovnik in the 14th and 15th Centuries*, 135.
[5] The door to the Great Council's rooms contained the inscription *Obliti Privatorum – Publica Curata,* which translates as "Forget private affairs, look after the public causes".

The original fortress relied on towers at the corners, which had become redundant as the city walls were themselves built up.[6] Ground floor parts of the Dvor were used as arsenal, armament storage, dungeon and place for torture. On the upper floor the Dvor served as private accommodation for the Rector.

From outside, the Rector's Palace presents a "facade of quiet beauty: six arches and five pillars, the capital of each one curiously carved" (figure 5.1.3).[7] Between the arches to the facade is a sheltered loggia. Between 1349 and 1442 the Naples architect Onofrio de la Cava remodeled the straightforward stone fortress into a rather more enlightened venue as the seat of government:

> …maintaining from the previous building only the ground floor, and gallery (avlia) or loggia with columns and arches, and a courtyard with a small stair on the right. This new palace maintained two towers flanking it for protection, and had the function of duke's residence, state assembly, arsenal, and dungeon.[8]

A gunpowder explosion damaged the building in 1463, and the Dvor was ordered to be rebuilt again. The new Florentine architect Michelozzo di Bartolommeo,[9] working with Jaraj Dalmatinac from Zadar, adopted the emerging Renaissance style in preference to the older Croatian Gothic style. While the upper floors remained intact, areas of the ground floor were remodeled.[10] According to Cvetkovic, the "Senate of Dubrovnik requested Michelozzo to keep in Dubrovnik Dvor all forms of Onofri's plan and all featured of Dalmatian-Dubrovnik's style… …Renaissance style was not favoured by the Dubronik government."[11]

In 1667 a large earthquake also demolished most of the houses in the city, and badly damaged the Dvor once more. It was repaired by an engineer, Cerutti, leaving a building which is a mix of several different styles overlaid on a far more ancient plan: although substantially unchanged since 1464. Carter notes that although born from many hands, the "front facade bears a strong familial resemblances to the Doge's Palace in Venice"[12] and

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[6] Cvetkovic, *Dubrovacki Dvor,* 18. (English translation by Emina Petrovic), "Initially Dubrovacki Dvor and Duzdeva Palata had two towers flanking them, with fortified bastions, toothed fortification walls, moveable bridges and surrounding channels" (Duzdeva Palata may refer to the Doges Palace in Venice, which was of a similar design).
[7] Dilke, *The Road to Dalmatia,* 181.
[8] Cvetkovic, *Dubrovacki Dvor,* 19. Translated by E Petrovic.
[9] *The Penguin Dictionary of Architecture*, 192. Pevsner notes that Michelozzo di Bartolommeo (1396-1472), a sculptor and architect of extreme elegance and refinement, nevertheless lacked the genius of his great contemporaries Donatello and Brunelleschi.
[10] Grujic, *'Cultural Heritage of Croatia etc*, 130. The reconstruction of the atrium was the work of a group of builders from Florence and a great number of native builders and stonemasons who seem to have carved some Renaissance capitals of the atrium and the Gothic biforas on the first floor.
[11] Cvetkovic, *Dubrovacki Dvor,* 23. Translated by E Petrovic.
[12] Carter, *Classic City State,* p. 456.

along with that Venetian example, it is one of the few examples of secular Gothic buildings of the medieval period.[13]

To the right and left of the main entrance are rows of carved marble benches running along the back of the wall in the loggia, where the Rector and the Ground Council apparently met informally, effectively under the arches (refer figure 5.1.5). A more formal Great Council hall nearby was demolished in 1863, after the end of the Ragusan independence. The Senate met inside, at the rear, overlooking the sea. The Small Council hall took residence on the mezzanine inside: the ground floor contained the legal office, the law court, and the jail. The upper floor contained function rooms such as the chapel, the rector's bedroom, the study, and the state receiving rooms.

[13] The closest comparison in function may also be the office of the Doge in Venice, although the Doge in Venice had not just a civic, but also an ecclesiastical role. The Doge ruled for life: the Rector ruled only for a month at a time.

Appendix Two

Criticism of Te Papa

According to Theodore Dalrymple, Te Papa is "the institutional exemplar of the lowest common demoninator turned into official cultural policy, and stands as a terrible warning to the rest of the world."[14] Hamish Keith has stated that "The problems and shortcomings that have plagued the national museum since its opening are still there and will not be resolved by pretending that they are not."[15] It has been described as having "all the charm of a paint factory" by Gordon Campbell.[16] Clearly, Te Papa is a highly contentious project.

Cultural commentators have not held back: Hamish Keith noted that "it was clear there would be a battle between the building and the museum, and the building won" and further noted that the "the coverage of Te Papa's opening decade was as shallow as the museum itself."[17] Architectural commentators have largely held back from commenting, at least in public.[18] Public criticism from the mainstream press has been mixed since then.[19] Art critics have been vocal on its lack of adequate display room for the nation's art collection.[20]

The few public critics of the architecture have largely been members of academia.[21] Michael Linzey is one of the few architectural commentators to attempt to rationally and dispassionately dissect the design decisions within the building. Linzey notes that at the time of publication, there were only two other articles on Te Papa in the "international scholarly literature, both addressing museological, rather than architectural issues."[22] Christine McCarthy acknowledged the tensions within Te Papa, comparing it with the Auckland and Otago Museums, noted that "the boundary line between exhibit and the outside" has the "innermost edge… now programmatically and clearly displaced internally, located within (rather than at), the built boundary of the museum."[23] Russell Walden has been the most public architectural critic, describing it as confused and ugly on TVNZ Backchat arts program, and in recent commentary in the New Zealand national architecture magazine, describes it not only as "muddle-headed in thought and deed" but also that "what ended up down on the wharf is little short of a national

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[14] Theodore Dalrymple, "An amusement arcade masquerading as a museum", *New Statesman*, 1999.
[15] Keith, "Te solution", 37.
[16] Gordon Campbell, "Our place in the world", *Listener*, 1998.
[17] Keith, "Te Solution", p37
[18] The NZIA's professional code of conduct restricts commentary on one architect's work by another member: in New Zealand at least, architects rarely comment publicly.
[19] Linzey, *On The Name*, notes that "When the museum first opened, Steve Bohling, then Editor of *Architecture New Zealand*, anticipated a floodgate of criticism. By and large this has not happened, at least not through the conduit of New Zealand's architectural press."
[20] The art gallery was subsequently extended in 2004 – but criticism of the gallery spaces has not ceased. See also Keith, "Te Solution".
[21] Former professor at Victoria University's School of Architecture, Russell Walden, is well-known for a dislike of Te Papa, of which he feels it is, at best, a lost chance (and at full strength, fairly unprintable). Walden's outbursts have typically been about the external appearance (he has appeared on TVNZ arts program BackChat on more than one occasion relating his dislikes).
[22] Linzey, *On the Name -Te Papa*, 471.
[23] McCarthy, "Boundary Arbitrations…" 75.

embarrassment."[24] This is a common complaint. For instance, Karl du Fresne claims that "…the architects missed an opportunity to make a dramatic statement - something to rival the Sydney Opera House - on its prime waterfront site."[25] In a similar vein, Campbell states his view that the building is "a pastiche, with some fairly mouldering ingredients", and the "the building doesn't sing. It feels anonymous and sullen."[26]

Du Fresne points out the inherent difficulties with the faultline wall approach:

> You could excuse that failure if the building worked internally, but it doesn't. It's a haphazard, chaotic jumble, so poorly signposted and lacking in cohesion that every time I leave, I have an unsettling feeling that there must be things that I have missed.[27]

The architects may feel that du Fresne has missed the entire series of metaphors that the building has been based on: that the building is meant to express the plate tectonics ripping the country apart, the bicultural divide between Maori and Pakeha evident in settlement patterns (and much else besides), and the Treaty of Waitangi between the Crown and Maori meant to be bringing us closer together. Te Papa entreats us to explore, but does not explicitly state the obvious rends in our political fabric: these warning shots may become obvious for the repeating, New Zealand visitor, but are undoubtedly aimed over the head of the casual overseas visitor. What is obvious to the architect and exhibition designer evidently just comes off as a "haphazard, chaotic jumble… lacking in cohesion…" to the casual visitor. What the building could do with, therefore, is some fundamental ordering of its public space.

This circulation is rightly noted by some as confusing; du Fresne states:

> A good museum leads visitors on a voyage of discovery. Te Papa leaves them to stumble about and hope that with time and luck they'll find their way around the interesting bits. Not good enough.[28]

Art critics have publicly called for a new Art Gallery to be built instead of continuing with the spaces at Te Papa. A competition was run (by a City Council owned subsidiary) for a new Art building, and a winner announced,

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[24] Walden, "Russell Walden looks back on a life of engagement," Architecture New Zealand, January 2013 (forthcoming).
[25] du Fresne, "Te Papa's voyage of discovery founders on the rocks of poor design." B5.
[26] Campbell, "Our place in the world", 27.
[27] du Fresne, "Te Papa's voyage of discovery founders on the rocks of poor design", B5.
[28] du Fresne, "Te Papa's voyage of discovery founders on the rocks of poor design", B5.

even if the budget was not there to carry out the proposal.[29] Even Te Papa chief executive Mike Houlihan has stated that the museum's art spaces are "not ideal" and that this should be addressed in its long-term planning:

> You've got art at the top of the building. You have to take two lifts to get to it and that's not easy. If you were taking a slightly cynical view, you would say art is being sent back to the attic.[30]

In this building, which should have been the peak of achievement within New Zealand architectural circles, a slavish adherence to an overly metaphoric design decision has left the building bereft of a logical system when it comes to circulation. Te Papa's designers wanted people to explore, but that need not mean that the visitors have to get lost. Karl du Fresne notes:

> Assuming the Government ever gets around to announcing an appointment, I have some advice for whoever succeeds the late Seddon Bennington as chief executive of Te Papa - blow it up and start again.[31]

[29] Competition was won by UN Studio, with a highly futuristic design. It remains unbuilt.
[30] Newton, "Te Papa chiefs call for $100m home for nations's art."
[31] du Fresne, "Te Papa's voyage of discovery founders on the rocks of poor design", Dominion Post.

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Figure 5.1.21 Moretti-style spatial inversion SketchUp model of atrium, *Source: Eli Nuttall.*

Figure 5.1.22 Depthmap VGA of Dvor - Ground floor plan. While some inaccuracies may be attributed to the non-rectilinear nature of the walls, of more concern is the non-recognition of staircases as prime areas of circulation. Note that the stairs in this image are dark blue, indicating low connectivity. *Source: author.*

Figure 5.1.23 Depthmap VGA of Dvor - Mezzanine floor plan. Note how, on the left, the simulation has been run with the atrium omitted ie where physical connections only are possible. On the right, the atrium was included, to depict where visual connections are possible. However, in neither case was significance / recognition given to the staircases. The random generated line through the centre does not appear to be having a significant effect. *Source: author.*

Figure 5.1.24 Depthmap VGA of Dvor - First floor plan. On the left, the simulation has been run with the atrium omitted ie where Physical connections only are possible. On the right, the atrium was included, to depict where Visual connections are possible. In this case, the similar random generated line is having an effect, but it does not appear to be that significant. *Source: author.*

Figure 5.1.25 Depthmap VGA of Dvor - cross section. The result does reflect the intersection of the horizontal and the vertical elements within the atrium, highlighting the intensity of spatial experience at the base of the atrium. *Source: author. Section provided courtesy of Nikola Radic, Zagreb, and Ivan Tensek, Institute of Art History, Zagreb.*

Figure 5.1.26 – Isovist field of Ground floor plan. Source: author.

Figure 5.1.27 – Isovist field of First floor plan. *Source: author.*

Figure 5.1.28 – Isovist fields from entry, taken from section. *Source: author.*

Figure 5.1.29 – Isovist fields through atrium, taken from section. *Source: author.*

Figure 5.2.1 **Aerial photo of Maison Carrée and Carré d'Art.**
Source: Nigel Young, Foster and Partners

Figure 5.2.2 Public Square outside Carré d'Art.
Source: Nigel Young, Foster and Partners

Figure 5.2.3 Cross section through Carré d'Art. This section shows the overall relation of the building to the urban environment, including the Roman temple. An enlarged version of the section appears in 5.1.13 *Source: Foster and Partners*

Figure 5.2.4 Carré d'Art, central atrium and staircases Strong sunlight can be seen falling onto the frosted glass stairs, which filters the light down to the lower floors.
Source: Nigel Young, Foster and Partners

Figure 5.2.5 Carré d'Art, central atrium and staircases. Staircases seen from below indicate that daylight filters strongly through, while obstructions (people) do not cause a significant blockage.
Source: Addison Godel, flickr.com/photos/doctorcasino/2729070624/

Figure 5.2.6 Carré d'Art, central staircase diagram by Norman Foster.
Source: Norman Foster, Foster and Partners

Figure 5.2.7 Upper floors – gamma analysis, *Source: author*

Figure 5.2.8 Lower floors gamma analysis, *Source: author*

Figure 5.2.9 Upper floors - justified permeability graph, *Source: author*

Figure 5.2.10 Moretti-style spatial inversion SketchUp model of Carré d'Art atrium core. A spatial imprint of the stairs are visible through the 'jelly', indicating the paths of visible connectivity.
Source: Eli Nuttall (2012).

Figure 5.2.11 Moretti-style spatial inversion SketchUp model of Carré d'Art atrium full extent. The atrium is much less confined – space 'flows out' from the core. *Source: Eli Nuttall (2012).*

Figure 5.2.12 Depthmap VGA: Carré d'Art floor plans. Note that in plan D (ground floor) the simulation has indentified the top right corner of the plan as being the most integrated, near the lift to the roof top café. *Source: author.*

Figure 5.2.13 Depthmap VGA: Carré d'Art section through Atrium stair. The software has identified the top of the staircase as highly connective. *Source: author.*

Figure 5.2.14 Depthmap VGA: Carré d'Art section through Atrium stair. In this version, the actual stair treads have been removed, simulating the situation of the atrium with just the key landings retained. *Source: author.*

Figure 5.2.15 Upper floors: isovist fields, *Source: author*

Figure 5.2.16 – Isovist from Entry, section through central stairway. Ground floor entry (level D) is from external stairs at right, on a glazed bridge over a basement level - from this point sky can just been seen through the walls at the top of the main stair (top left of section). *Source: author.*

Figure 5.1.17 – Isovist field from entry to atrium, section taken through central stairway. Isovist field as section expresses the saturation of views available to the occupant, as they ascend from ground floor up the main stairs. Although stairs and landings are glass, they have been treated for the most part as if solid. Transparency of this void is likely, if anything, to be even more transparent than is shown here. Views would not stop, as shown here, at internal glazed walls, but would extend out even further into the surrounding built environment. *Source: author.*

Figure 5.2.18 Carré d'Art, rooftop café overlooking square. Visual, audible, and probably even olfactory connectivity is established between the café clientele and the city dwellers in the square below. Physical connectivity is kept close by, in the atrium just behind the café.
Source: Nigel Young, Foster and Partners

Figure 5.3.1 Te Papa - primary city view, featuring the grey paneled 'faultline wall'.
Source: author (2010).

Figure 5.3.2 Bossley/Jasmax design rationale. Concepts noted here include the 'symbolic faultline' wall, a 'wedge space' intended "to cleave", and maori / pakeha settlement grid patterns. All are still present in the finished building. *Source: Architecture New Zealand, Feb 1998.*

Figure 5.3.3 Map of Te Papa, official guidebook. Note that the atria within Te Papa are not highlighted as part of the system for understanding the building. The usefulness of this diagram as a guide for visitors is doubtful. *Source: Te Papa - Your Essential Guide.*

Figure 5.3.4 The mytho-poetic 'Faultline' wall, pierced with openings. It is more prominent from outside. Connecting sky bridges span across the atrium's void. The second ground floor lift can just be made out nestled within the wall. *Source: author (2012).*

Figure 5.3.5 Entry atrium, lit primarily by south-facing windows above entrance. Advertising banners obscure the connecting staircases above. Lift from level 1 to 2 is at left. *Source: author (2012).*

Figure 5.3.6 – Long section through Te Papa, taken through art void / ihonui (centre), with auditorium visible at left, and whale skeleton hanging in display space centre right. Entry is behind wall on far left. Harbour is to far right. The official marae is in room at far right / top. *Source: Jasmax.*

Figure 5.3.7 Te Papa Explorer, guidebook front cover. Te Papa appear to actively promote that their space is a labyrinth of discovery. *Source: Te Papa Press (undated).*

Figure 5.3.8 Oculus, viewing back over city, heavily shaded. The building takes the opposite viewpoint to light that Foster's media gallery at Nimes. Here, direct sunlight is banned, and daylight is actively avoided. *Source: author (2012).*

Figure 5.3.9 Art void / ihonui, looking into the 'heart' of Te Papa. *Ihonui* refers not to the art work, but to the space it is in. Note lack of activation of edges due to exhibition layouts, particularly at level 3, where blank walls and even a container have been situated. Black circle on the floor (and ceiling above) is *Te Kore* (the Void), 2006. Bill Culbert, Ralph Hotere. *Source: author (2012).*

Figure 5.3.10 Art void / ihonui, looking down into void, featuring artwork by Ralph Hotere (mirrored by a similar circle on the ceiling 4 floors above). *Source: author (2012).*

Figure 5.3.11 Treaty void, looking down into void; two versions of the Treaty facing each other across unlit atrium space, enlarged fragmentary remains at end. This is only a replica – the real treaty is kept in the National Archives. *Source: author (2012).*

Figure 5.3.12 Unused sky bridge, level 5, looking across entry atrium, at blank wall and locked door. Skybridge is unused by public, and so as design feature, is inactive. *Source: author (2012).*

Figure 5.3.13 Stairs within entry atrium, landing at level 3 features two alternative directions to go up, poised in mid-air above the atrium. Which route should a visitor take? *Source: author (2012).*

Figure 5.3.14 Stairs within entry atrium. The circulation is confused: despite lifts nearby, this visitor attempts to take a push-chair down stairs in the atrium. His child looks worried. *Source: author (2012).*

Figure 5.3.15 Stairs within entry atrium, sketch (better sketch still to come). *Source: author.*

Figure 5.3.16 Te Papa Moretti style spatial inversion model, showing three key atria and art gallery off-shoot at level 5 in foreground. *Source: Eli Nuttall.*

Figure 5.3.17 – Level 6 floor plan gamma analysis with J-graph. *Source: author.*

Figure 5.3.18 – Level 5 floor plan gamma analysis with J-graph. *Source: author.*

Figure 5.3.19 – Level 4 floor plan gamma analysis with J-graph. *Source: author.*

Figure 5.3.20 – Level 3 floor plan gamma analysis with J-graph. *Source: author.*

Figure 5.3.21 – Level 2 floor plan gamma analysis and J-graph. *Source: author.*

Figure 5.3.22 – Level 1 floor plan gamma analysis and J-graph. *Source: author.*

Figure 5.3.23 Levels 1-6 justified permeability graph. *Source: author*

Figure 5.3.24 Depthmap VGA of Te Papa. The six levels of Te Papa were analysed using UCL's Depthmap software. Results discussed in the text at 5.3.8. *Source: author.*

Figure 5.3.25 – Levels 1- 6 isovist field long section. Depthmap has identified that the stairs crossing over present a visual obstacle, but has failed to interpret this as the key connectivity zone for the entry atrium. Instead it has identified an area near the door (bottom left) and at the top of the wall (top right). This is unhelpful. *Source: author*

Figure 5.3.26 – Levels 1- 6 isovist field cross section. In this image, Depthmap has highlighted the connections at the centre of the ihonui at level 4. *Source: author*

Figure 5.3.27 – Levels 1- 6 isovist field plans. Discussion follows in text. *Source: author*

Figure 5.3.28 – Level 1 enlarged isovist field. Route of isovists goes from front door direct to main stairs up to level 2. For full plan, and other floors, refer to figure 5.3.27 *Source: author*

Figure 5.3.29 Te Papa 'faultline' wall, viewing from level 2 down to level 1. Note that 'faultline' wall obscures lift secreted within. *Source: author (2012).*

Figure 5.3.30 Te Papa 'faultline' wall, viewed at level 2. Solidity and placement of wall may obscure user's understanding of circulation spaces within building. *Source: author (2012).*

Figure 5.3.31 Te Papa level 2 lift, viewed from level 3, and walled off visually from main stairs. Although there is room for the lift to ascend higher, this lift travels between levels 1 & 2 only.
Source: author (2012).

Figure 5.3.32 – Level 2 enlarged isovist field. Route of isovists goes from top of stairs direct to main space and reception desk area. For full plan, refer to figure 5.3.27 *Source: author*

Figure 5.3.33 – Level 3 enlarged isovist field. Route of isovists goes from top of stairs along to exhibition space at right. For full plan, refer to figure 5.3.27 *Source: author*

Figure 5.3.34 – Level 4 enlarged isovist field. For full plan, refer to figure 5.3.27 *Source: author*

Figure 5.3.35 Te Papa stairs, level 4-5-6, as viewed from main 'art void' space at level 4. Stairs and aerial walkway to level 5 are on left; stairs up to level 6 are visible ascending at top. No use made of the atrium space as a circulatory, social, or orientation device. *Source: author (2012).*

Figure 5.3.36 Te Papa level 4 exhibition space, viewing down from level 5 aerial walkway. With only roofs of exhibits shown, this is not conducive to connectivity. *Source: author (2012).*

Figure 5.3.37 Te Papa level 6 stairs, viewing down to level 5. Stairs were added when level 5 art gallery was added / altered. Prior to that, access to this level was by lift only. Visual and physical connections between level 5 and level 6 are very poor. *Source: author (2012).*

Figure 5.3.38 – Level 5 enlarged isovist field. In dark blue area at centre, little real connectivity occurs – just overlooking to roofs below. For full plan, refer to figure 5.3.27 *Source: author*

Figure 5.3.39 – Isovist in long section, through entry atrium. From entry *Source: author.*

Figure 5.3.40 – Isovist fields in section, isovist field through entry stair atrium. *Source: author.*

Figure 5.3.41 – Isovist fields in Cross section, through entry atrium space and art void, through to Treaty Court. *Source: author.*

Figure 6.1 Chapter 6 structure diagram

Figure 6.2 J-graphs of Dvor (left), Carré d'Art (middle) and Te Papa (right).

Figure 6.3 Spatial invert models of Dvor (top left), Carré d'Art (top right) and Te Papa (bottom). In terms of describing connectivity, these Sketchup CAD models are of limited use without the full 3-D physical model to back it up. Dvor model has been rotated to show stairs up. *Source: Eli Nuttall.*

Figure 6.4 Spatial invert model of British Museum Grand Court project, although not detailed, the model of the space within the Great Court shows the spatial simplicity that can be achieved in a major Museum project. *Source: Eli Nuttall.*

Figure 6.5 Depthmap plan of Dvor ground floor, most of floor appears unconnected, including stairs. *Source: author.*

Figure 6.6 Depthmap plan of Carré d'Arte ground floor (level D), highlighting strong connectivity in top right corner. *Source: author.*

Figure 6.7 Depthmap plans of Te Papa, level 2 on left, level 5 on right. *Source: author.*

Figure 6.9 Parametric model of live 3-D isovist, creation within virtual building outline. *Source: Andrew Heumann, http://parametricmodel.com/3Dlsovist/32.html*

Figure 6.8 Depthmap sections of Case Studies, top: Dubrovnik Dvor; middle: Carre d'Art; bottom: Te Papa. In all of these sections, the atrium has been identified as the location of maximum connectivity. *Source: author.*

Figure 6.9 Parametric model of live 3-D isovist, creation within virtual building outline. *Source: Andrew Heumann, http://parametricmodel.com/3Dlsovist/32.html*

Figure 6.10 Dvor main stair, viewed at Ground floor level. Stair is highly prominent throughout most of ground floor atrium space. Back of house stairs are directly behind the wall shown. *Source: author.*

Figure 6.10 Plan and Section of Dvor, isovist field at Ground floor shows that main stair is highly visible within atrium. *Source: author.*

Figure 6.11 Carre d'Arte stairs, viewing across atrium. Glazing to stair treads, glazed balustrade, open nature of stair flights, all help maximize views in and across atrium. *Source: Villela.*

Figure 6.12 Plan and Section isovist field of Carré d'Arte, plan taken at level D: Ground floor. *Source: author.*

Figure 6.13 Plan and Section of Te Papa, isovist field analysis at Level 2. *Source: author.*

Figure 6.13 Plan and Section of Te Papa, isovist field analysis at Level 2. *Source: author.*

Figure 7.1 Chapter 7 structure diagram

Tables

Table 2.1 Atria – Commercial vs Public In his book The New Atrium, Bednar groups atria into only two categories – Public and Commercial – while his other work goes into more detail as shown in this table. *Source: adapted from Bednar, Interior Pedestrian Places.*

Table 2.2 Atrium types. *Source: adapted from Shum.*

Table 2.3 Atrium types and examples *Source: Marriage, following Shum (1990). Shum's categories are noted in italics.*

Table 3.1 Spatial Theories and Theorists, chronologically

Table 6.1 Success of identifying connectivity within atria

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