Venice Variations
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Crafting architectural space: Le Corbusier’s Venice Hospital and the three paradigms

Introduction

Exploring Venice’s urban networks and ceremonial spaces together with Calvino’s authored work of fiction, I have described a range of versions of Venice inspired by the city. I looked at how it was gradually formed as the lived space of everyday practice by the physical linking and interconnecting of separated islands. Parallel to this physical manifestation of growth, there was the development of Venice as the imagined city, by artists, writers, cartographers and the Venetians themselves, who described it as an exemplary place in its own right. Architects in the sixteenth century saw it as the humanistic city, projecting the myth of Imperial Rome onto its spatial configuration. Calvino, a twentieth-century writer, saw Venice as the prototypical city, stimulating the imagination with its own particular form of utopia.¹ To this repertory of Venice’s variations, I will add one more project: Le Corbusier’s Venice Hospital (1964), which has also left a significant impression upon the architectural imagination (Figure 4.1). The Hospital is a unique project in Le Corbusier’s oeuvre. Unlike his other architectural works, which were designed as simple volumes, it has an open-ended logic based on cell aggregation. In contrast to his urban visions, replacing dense urban areas with freestanding buildings in a park, it was designed to be embedded in Venice’s age-old fabric. Yet, with an architectural language consisting of courtyards, classical proportions and the Modulor,² the Hospital project embodies key moments that informed the architectural practices of modernity, from the Renaissance to Le Corbusier’s own body of work. This chapter has a two-fold purpose: first, to explore
the influence Venice had on the Swiss architect and the design of the Hospital; and second, to trace a larger panorama of architectural ideas in the work of Palladio, Le Corbusier and some present-day architects, extending in this way the relevance of Venice into contemporary architecture.
Le Corbusier described Venice as a cardiac system, a testimony to functional precision, intersecting but also separating the waterways from the pedestrian routes. He had a long-term fascination with organic architecture for its capacity to be appreciated on foot: ‘it is by walking, by moving, that one sees the order of the architecture developing. It is a principle contrary to that of baroque architecture, which is conceived on paper, around a fixed theoretical point’. When he accepted an invitation from Venice to design a new hospital in 1964, he had already generated some of the key tenets of Modernism, in various works from small houses to large urban projects, and experimented with the concept of the architectural promenade. As opposed to the clean-slate approach used in his early work, the Hospital was inspired by the calli (streets) and campielli (squares) of Venice. In the design of the project, these elements were translated into a series of pinwheel squares with radially arranged corridors, and were assembled into a matrix. The building was to be located in the run-down area of San Giobbe in the north-western part of Cannaregio. It was intended to be spatially integrated with the city, serviced by both roads and pedestrian access. The purpose was to create an easily accessible system that could expand horizontally according to future changes in medical care and technological innovations. Systematically engaging constraints imposed by different kinds of demands, Le Corbusier articulated a response to one of the most complicated programmes and sensitive contexts of our time.

A site location map published in his Oeuvre Complète clearly demonstrates this point. The map shows the Hospital behind the train station of Santa Lucia, also identifying a number of other buildings in Venice (Figure 0.4). By choosing certain structures and omitting others, as illustrated through this map, Le Corbusier connected the Hospital at the ‘backdoor’ of Venice with Palladio’s San Giorgio Maggiore at the celebrated front of the city. The link between the two places is through the Grand Canal, which he dotted by marking out patrician palazzi, the Rialto market, the Merceria, the Piazza San Marco and the Piazzetta. The Swiss architect had always aspired to design a public building in Venice comparable in scale and impact to Palladio’s convent and church on the island of San Giorgio, the grand Piazza and the Ospedale Civile, an early Renaissance work by Mauro Codussi. In his Four Books of Architecture, Palladio had described the convent as a monastery intended for the recreation of the ‘houses of the ancients’, a reference to classical antiquity. The ‘march’ from the ‘service yard’ of Venice to San Giorgio Maggiore in this map expresses Le Corbusier’s heroic
entrance into Venice, claiming his part in the legacy that had begun with Roman architecture.

However, the link with Palladio’s San Giorgio is not simply because Le Corbusier wanted to measure himself against the great classical architect. It is also because he was aware of the disciplinary roots of architecture. It is in Venice that the first translation of Vitruvius and Palladio’s *Four Books of Architecture* (1570) were published. More importantly, it is in Venice and the Veneto that Palladio had practised. Le Corbusier positions the Hospital not simply in the urban context, but also within the disciplinary tradition of structured architectural knowledge. With this map, he offers a synoptic notation of the history of architecture through three key canonical moments: Venice’s evolutionary urban form; Classicism represented by San Giorgio, the Piazza and Codussi’s Ospedale Civile; and finally, Modernism through his own project.

These three moments translate to the Organic, the Classical and the Modern paradigms in cities and architectural practice, respectively. The Organic recognises the gradual evolution of cities like Venice as accumulations of buildings and spaces developing an emergent spatial logic over time (yet not entirely without control). The Classical, with its high point in the Renaissance, is based on designs and systems of thought rooted in classical antiquity and is very much the antithesis of the Organic. Finally, the Modern, originating in the early twentieth century, is based on a break with historical forms, heralding a new model for thinking about cities and buildings. The synthesis of these paradigms in Le Corbusier’s map brings together the concept of the *tabula rasa* advanced by Modern architecture – of working afresh and innovating each time – with the idea that cities and buildings evolve over time, and with the transcendental values of Classicism across time. More specifically, as a synecdoche of the three periods, the map is a record of the trajectory of architecture, each type of structure expressing a paradigm that deviates at critical moments from a previously established model.

Had Le Corbusier’s project been built, it would have given Venice a building that, while mindful of constraints imposed by the context, would be as radical in its form as his celebrated early Modern designs. Like his avant-garde villas, it would have been rendered in white. It would have been supported on pillars reminiscent of previous designs, which rested on pilotis. A large number of these supports would have foundations in the water, analogous to the free-flowing parkland in his urban projects. It was envisioned that people would enter the building from underneath, as happens in Le Corbusier’s Villa Savoie and the Tokyo Museum, which were designed without a main façade (*Figure 4.2*). The
third floor of the Hospital was organised through the pinwheel pattern of movement, which had provided a standard for systematic variations on a theme in many of Le Corbusier’s designs. Through the Hospital project, Le Corbusier would have demonstrated that building and innovating in Venice meant working with the medieval fabric, geometrical and spatial ideas from classical heritage, his own established language, and at the same time transcending all of these factors, including Venice as the immediate and present context.

Le Corbusier’s dialogue with these paradigms shows that the Hospital is uniquely placed, contributing to the subject of the relationship between buildings and cities as collective products of society and as conscious designs by individual minds. It is a key project, raising issues about Venice and beyond Venice. By being responsive to many influences and design traditions, it advances the question of the multiplicity of the architectural imagination and the effect of cumulative comparative knowledge in architecture. The fact that the architect of the Hospital owed as much to Venice as to Palladio, as much to his own compositional devices as to classical architecture and the Organic tradition, raises the need to explore this building within the immediate context of Venice as well as the larger development of design ideas in their own right. Is Le Corbusier’s design of the Hospital based on some superficial resemblance
to the *calle* and *campiello*, or is it deeply rooted in the invisible structure of the city? How does it relate to the larger context of design practices of modernity that shaped cities and architecture? These questions structure the chapter in two parts: one concerned with the Hospital in the immediate context of Venice, the other with the broader context of architecture as spatial practice.

**Part 1: The Venice Hospital**

*A shapeless hospital*

In 1964, Guillermo Jullian de la Fuente, a young Chilean architect who was working for Le Corbusier, led the team that travelled to Venice for field research and for a presentation of the Venice Hospital project to the Venetian authorities. Earlier in 1962, Jullian had selected from a botanical treatise a picture that showed a cell splitting into four new nuclei and drew it over the plan of the Olivetti factory workshop. Superimposed over the industrial building, the organic form was the nucleus of the idea to make a building expandable, liberating it from rigid boundaries. A year later, on his trip to Venice, Le Corbusier declared to Giuseppe Mazzariol that designing a hospital in Venice would be subject to height limitations, and that it would be paradoxically necessary ‘to build without building’. Le Corbusier presented the project on pilotis, like the Ducal Palace, and developed what many critics consider to be an example of a ‘Mat-building’, that is, a building without walls, overcoming the boundary between itself and the city. The Venetian authorities enthused over the horizontal arrangement of the volumes that left the silhouette of the city unchanged and generated the possibility for an extendable hospital.

In 1974, in her article ‘How to Recognize and Read Mat-building: Mainstream Architecture as It Has Developed Towards the Mat-building’, Alison Smithson defined this new typology as the epitome of the ‘anonymous collective; where the functions come to enrich the fabric, and the individual gains new freedoms of action through a new and shuffled order, based on interconnection, close-knit patterns of association, and possibilities for growth diminution and change’. Smithson used examples from vernacular and modern architecture to illustrate Mat-building, including Le Corbusier’s and Jullian’s Hospital in Venice. In the *Rapport Technique* – the technical document of the project – Le Corbusier associated the origin of the design idea with the urban form of the city, identifying the paths within the building that link the four care units as ‘*calli*’, and the central spaces of communication between these
units as ‘campielli’. Planned on the site of an abandoned slaughterhouse in San Giobbe, the hospital was intended mainly for the acutely and terminally ill. Poignantly, the hospital project was underway at the time of Le Corbusier’s sudden death while swimming at Cap-Martin on 27 August 1965. The team continued working under Jullian’s direction on a design that took more than nine years to develop and was never built. Le Corbusier and his team had designed a shapeless building without a single and clear overall form. For the following decades, it would attract renewed attention each time architects and critics became interested in methods of form aggregation, a design approach based on bottom-up processes of generation.\(^\text{13}\)

The Rapport Technique

Le Corbusier organised the Hospital so as to emphasise its horizontal extension and layered it vertically, with the patients’ area located on the top floor. This floor consists of a series of squares and pathways, arranged in a pinwheel pattern around a central space. The patient rooms form a matrix of building units with a square and a lift placed at each intersection (Figure 4.3). Each of the building units accommodates a different treatment, from gynaecology and paediatrics at the front to the neurological unit at the rear left of the complex. The patient rooms open to the outside only at the top, through a cave-like section, drawing light to the interior but blocking views to the outside. A service mezzanine floor facilitates sterilisation processes through special conduits of circulation, while a series of ramps enable communication between the top floor and the departments of surgery, radiotherapy, pharmacy and the doctors’ offices on the first level (Figure 4.4). In addition to these facilities, the first floor housed emergencies, diagnostics, a free clinic, a maternity ward, laboratories, a theatre and a morgue. The ground floor accommodated the entrances, administrative offices and services. There were two means of access: by water and road (Figure 4.4). A chapel situated directly on the water on the north-west side of the hospital would act as a landmark reminiscent of the island cemetery of San Michele.

According to the Rapport Technique, the point of departure of the design is the cellule, or the room of the patient:

This element gives rise to the ‘care unit’ [Unité de soins] of twenty-eight patients, which functions autonomously. This unit is organised around a central space of communication (Campiello) and four paths (Calle), which are intended for both inhabitation and circulation by
patients in convalescence. Four units of care form a ‘building unit’ [Unité de bâti]. Through the progressive juxtaposition of building units, this framework yields a horizontal hospital.\textsuperscript{14}

The entire third floor was conceived to provide ‘the same conditions of city life, upon entrance into the Calle, the Campiello and the hanging gardens’.\textsuperscript{15} This system was claimed to have the flexibility to accommodate growth, presumably along the sides facing the lagoon and
the Cannaregio Canal. It was also designed to adapt to future medical innovations and provide effective health care around the preventative capabilities of the hospital. By opening the ground floor directly onto the city, one allows for a city–hospital encounter and facilitates the visual transmission of medicine toward the outside.\textsuperscript{16} The technical document also stresses that it is above all man, rather than the patient, who is being considered. This is to say that the scale of construction had to be found at the level of humanity: the \textit{cellule}, and everything that it comprises, is the primary element upon which the entire conception of the hospital is
Signification

In the *Rapport Technique* the building is described as a successive agglutination of units derived from the patient cell, the minimum unit of the design. However, as Alan Colquhoun observes, the design is both ‘additive’ and ‘geometric’. The additive logic is formed by the aggregation of cells into care units. The geometric logic is organised through a system of squares and golden-section rectangles. The latter is made of a large square of $4 \times 4$ units, which is divided into an L shape and a smaller square, containing $3 \times 3$ units (*Figure 4.5*). The centre of the smaller square is the centre of the treatment department, also forming the main point of circulation for patients. It is open to the sky and directly linked through a cluster of voids with the ground floor. The $3 \times 3$ square is also shaped by the pinwheel pattern, consisting of a central core linked with four openings at the outer edges of the building through circulation corridors forming an off-set cruciform shape. By varying the closed and open elements in each care unit, the architects have provided a series of balconies, terraces or simply voids crossed by pathways.

Intertwining geometrical and spatial organisation with the city and the social programme, the *Rapport Technique* provides a description of the functional dimensions of the Hospital that is also a description of the compositional strategy and the ways it articulates meaning. By placing emphasis on the modular structure of the design, it conflates the idea of the evolutionary development of the city with the accumulative logic that produces the patient wards and the future expansion of the building. Le Corbusier placed the Modulor man on the hospital beds – which were raised on slabs – and made reference to Vittore Carpaccio’s painting of the body of St Ursula raised over a crowd of pilgrims (1943) (*Figure 4.6*). By defining the cell as the elementary unit, he expressed the patient as the universal man, and the Hospital as the realm of humanity. He thus dramatised the project as the interplay of the additive system of cells with the accumulative effect of human bodies raised in a cave-like interior over the water. The emphasis on the Modulor and the universal man provides a link with humanist architecture rooted in Italy. The significance attributed to the direct encounter between the patients and the city suggests an egalitarian attitude, in accordance with the historic perception of Venice as an ideal society. Finally, by linking the *Unité de soins* with the *campielli* and *calli*,

articulated. The *Unité de soins*, the *Campiello* and the *Calle* serve to create relationships between the patient and the city.
Le Corbusier guaranteed an unequivocal link between the Hospital and the floating city.

The Rapport Technique used the modularity of the design as the means to validate the functional efficiency of the Hospital and its expandable anti-institutional logic. At the same time, it established poetic affinities between the city, humanity and the building, universalising the project. If these are the means by which the project articulates signification, it is interesting to understand how it addresses significance, that is, the spatial relationship between the building and the city and the structural analogy between Venice’s urban networks and the network of

**Figure 4.5** Le Corbusier. Venice Hospital. Diagrams of morphogenesis and geometrical analysis of the building. Drawing by the author
pathways and squares in the building.\textsuperscript{21} Does the influence of Venice on the design extend beyond metaphoric association and the typologies of the \textit{calle} and \textit{campiello}?

The Hospital – the city–building encounter

We can represent each space in the Hospital with a line drawn tangentially to surfaces so as to capture the maximum linear extension of movement and sight. The resulting network (called the ‘axial map’ in space syntax terminology) is then analysed to measure closeness centrality (or integration), the measure previously used in the analysis of Venice, the Piazza and Calvino’s network of themes in \textit{Invisible Cities}.\textsuperscript{22} The analysis of the building as a whole shows that it is well integrated in terms of both its internal organisation and its relationship with the exterior (Figure 4.7). This is evident in the large number of integrated lines which stretch from side to side, penetrating deeply from the ground to the deepest parts at the top level inside the building. The properties responsible for this pattern of integration are the large-scale connections along the vertical and horizontal axes. On the basis of previous research on hospitals and other building types, it is possible to suggest that the architectural intentions to create a strong city–Hospital encounter were likely to be met by the design.\textsuperscript{23} On the basis of studies of large buildings resembling urban systems, one can also say that the Hospital would have the capacity to generate an emergent field of informal encounters between different categories of people.\textsuperscript{24}

These characteristics explain the functionality and social performance of the design. However, a description of architecture that focuses on

\textbf{Figure 4.6} Vittore Carpaccio. \textit{Martyrdom of the Pingrims and the Funeral of Saint Ursula}. Museo Nazionale Gallerie dell’Accademia di Venezia
Figure 4.7  Le Corbusier. Venice Hospital. Axial integration analysis of the entire building. Drawing by the author
functional factors alone cannot account for the imaginative engagement of Le Corbusier with the city or the configurational analogy between the Hospital and Venice. Central to this question is whether the relationship of the Hospital to the urban fabric can be captured through the Mat-building typology, since it emulates the aggregate logic of organic processes of generation. Smithson’s emphasis on Mat-buildings, Aldo van Eyck’s concept of the ‘organised casbah’ and Candilis-Josic-Woods’s principles of stems and webs might have had a direct influence on Le Corbusier and Guillermo Jullian de la Fuente. Yet, a number of critics have stressed that the Hospital was not just another instance of Mat-building. In contrast, the significance of the project was its ‘poetic integration’ into the essence of Venice. This essence was discovered ‘not in the drawing board, but through [Le Corbusier’s] eyes, his hands, and even his feet, that is, by observing and going throughout it for a long time’. As for Le Corbusier, he explained he had invented nothing; inspiration for the Hospital was contained in the logic of the terrain on which it was to be founded. It is thus essential to explore how the Hospital relates to the urban organisation of this terrain.

A hospital that is like Venice

[... ] because the eye, our only raw, fishlike internal organ, indeed swims here: it darts, flaps, oscillates, dives, rolls up. Its exposed jelly dwells with atavistic joy on reflected palazzi, spiky heels, gondolas, etc., recognising in the agency that brought them to the existential surfaces none other than itself.

Joseph Brodsky, Watermark: An Essay on Venice

Looking at the diagram of distribution of betweenness centrality (or choice), capturing the shortest paths between all pairs of origins and destinations, a configurational analogy is revealed between the streets and squares of Venice and the pathways and square areas in the building (Figures 1.3, 4.8). This analogy becomes stronger if we focus on the visibility structure of the third floor in the Hospital, separately from the permeability structure (or the structure of movement). In order to let natural light into the inner core of the design, the architects have used a series of patios and courtyards that are traversed by pathways and bridges. These elements enable a large number of visual links partly coinciding with and partly diverging from the elements of circulation. The analysis of the visibility structure shows that integration develops along a set of orthogonal lines that cover the pathways and a few long lines that stretch diagonally on the plan from side to side (Figure 4.8a–b). The square-shaped areas (the centres of the Unité de batisse) are the points where the structure of
visibility intersects with the structure of circulation. This is characteristically expressed by two geometrical systems: one follows the orthogonal geometry of the design; the other is rotated on a pivoting point found at the centre of a large rectangle that consists of $9 \times 9$ Unités de bâti. Like the dualistic system of water and land linking the urban squares of Venice, the square-shaped areas in the Hospital are connected by two network structures: one for visibility and the other for movement.

How is this characteristic configurationally possible? A closer look at the campi of Venice shows that they are adjacent as well as open to the
canals at least on one side. This property has existed since Venice’s early days, as can be seen in the map by de’ Barbari (Figure 4.9a–c). If we ‘flood’ the canals and all the squares with the same colour, we see that 65 per cent of the campi are not defensibly enclosed areas, but open on one side (Figure 4.9c). Similarly, 10 of the 15 square-shaped spaces in the Hospital are ‘dematerialised’, that is, not enclosed by physical boundaries on all four sides, but open to voids and gardens on at least two sides (Figure 4.10).
Figure 4.9  (a) Campo San Giovanni and Paolo. Photo by the author

Figure 4.9  (b) Campo San Giovanni and Paolo. Jacopo de’ Barbari, *Venetie MD*. Bird's eye view of Venice, c. 1500. Museo Correr, Venice. The squares of Venice are adjacent to and open to the canals on at least one side. This can be seen in the map of de’ Barbari and was a characteristic of squares from the city’s early days

The *campi* in Venice and the square areas in the Hospital facilitate links between two frames of reference: on the one hand, local-scale properties we come across on our paths in Venice, articulating spatial connections between the pedestrian and water networks; on the other
Churches    Canals/squares adjacent to water

Figure 4.9   (c) Squares and canals are represented by the same colour (green), showing that a large number of them are next to the water (shown in circles) or a rio terra, a former canal. Drawing by the author

...hand, large-scale properties describing the position of elements in the larger system. The former are immediately available to perception. In contrast, the latter cannot be observed through human recognition all at once. They can be grasped only through moving and living inside a city or a building over time. Venice, however, is different from other cities because its campi recurrently reveal, by opening to a canal and via bridges that connect them to neighbouring islands, their strategic position in the urban fabric. Conjoining local and global frameworks of reference, the squares of Venice and the square units in the Hospital are ‘crossroads’ where the invisible structure of the city and the building, respectively, meet their visible surface. The ability of Venice’s squares to expose the visible and the invisible makes their strategic role available to human intuition. The power of urban elements to do this in other cities is not as strong, since they rarely recur with the same consistency, as we move
It is this capacity of the *campi* to interface two networks that enabled Le Corbusier to grasp their function in the city and use them imaginatively in a new project.

Venice is a city of ‘lightness’, both in metaphorical terms, in that it appears to float on water, and in literal terms, as functional demands since centuries past have led to waterfront *campi* that are open on one side. At the same time, structural demands for reducing building loads have resulted in filigree façades and buildings of pierced thickness. Water reaches these inside them, or consist of recursively repeated typological combinations. It is this capacity of the *campi* to interface two networks that enabled Le Corbusier to grasp their function in the city and use them imaginatively in a new project.

**Figure 4.10** Le Corbusier. Venice Hospital. Dematerialised squares shown with circles. In a manner analogous to the squares in Venice which are adjacent to the water, the square-shaped areas in the Hospital are open to the exterior at least on one side. Drawing by the author.
squares and penetrates the ground floor of buildings, which can be accessed by boat as well as on foot (Figure 4.11). One might say that what strikes the architectural imagination in the most architectural of cities is the balance of forces that enable weight and lightness to float on water. These forces do not have a mere visual effect, but enfold the body as it follows an up-and-down course over bridges, canals, steps and hanging landings (Figure 4.12). Whether the city is experienced through floating on a canal, walking on a bridge or dry land, or entering the loggia of a building, it heightens the

Figure 4.11  Doors in Venice connecting houses with the transportation system of the canals. Photos by the author

Figure 4.12  Venice. The sequence of bridges is analogous to the sequence of pathways crossing the voids in the Venice Hospital. Photo by the author
perception of weightless gravity through intersecting routes that dematerialise its mass, half liquid, half solid. To this we must add the pleasures of multiple forking itineraries, the endless variety in which the route segments can be combined in sequences, floating, elevated or at ground level.

The Hospital was also conceived as an aquatic realm in which the light would bounce on water, slabs, walls and the ever-extending sequences of pilotis, and water would penetrate the chapel and the patios, dissolving materiality and the physical limits of space. The project dematerialises the patios and perforates the perimeter of the building at different levels. Reflections on the glass surfaces show that solid and transparent walls would merge so that it would be difficult to separate the enclosed spaces from the courtyards and the building from the city (Figure 4.13). What Le Corbusier captured in Venice through the campielli, the calli, the patios, the courtyards, the cat-walks and the hanging gardens were not simply
individual urban types, fragments isolated from the urban fabric, but also integral parts of the visible city and its invisible substance.

Part 2: Geometry and space from Palladio to Le Corbusier

The Organic, Classical and Modern paradigms

As an example of conscious imaginative engagement with Venice, the Hospital has wider significance for Le Corbusier’s work as well as in the history of ideas on architecture and urban planning. It contains in its form the interface of the city as a process of growth, which Venice exemplifies, with an architect’s conscious understanding of the city and its urban structure. It also reflects the intellectual climate of the post-war period, during which architects were becoming aware of the difficulties of modern architecture to deliver its early-twentieth-century promises for the future. Faced with the complexity of cities as social realities, architects, planners and urban designers in the sixties considered that modern urban visions were socially rigid. Christopher Alexander began demonstrating the mathematical logic of networks, while Constantinos Doxiadis outlined the interaction of human habitation with all scales of human settlement. Under the influence of Alexander and of Claude Lévi-Strauss, architects focused on ideas of evolutionary development in vernacular architecture, which in the case of Smithson found expression in Mat-buildings. Generated through strategies of formal aggregation, Mat-buildings simulate urban growth characterised by formal variation. Consequently, they reflect no pre-existing knowledge of overall form in a design or preconceived ideas of formal organisation.

Le Corbusier did not make explicit references to networked flexible cities, although it is possible that he was influenced by the visionary designs of the early sixties. More importantly, in the Hospital he went beyond the surface appearance of networks and Mats, translating the invisible substance of Venice into a new structure. Yet, as his location map indicates, the urban network of Venice was not the only influence in his design (Figure 0.4). Le Corbusier had always drawn inspiration from classical architecture and incorporated his explorations on mathematics and proportions in his buildings. I explained earlier that Palladio’s churches were part of a coordinated theatrical scenography in the San Marco Basin, responding to geometrical alignments and an ideal image of Venice as classical theatre. To this integrative vision of the city Le Corbusier juxtaposed the late modern vision of the anti-ideal city, combined with the Classical idea of proportions in architecture and natural systems.
The Hospital is a unique project in Le Corbusier’s work. None of his other buildings looks like it, yet the pinwheel theme he used on the third floor is frequently encountered in his other projects. This theme shows a preoccupation with two types of properties: first, classical centrality through the central square located at the intersection of two geometrical axes; and second, four offset pathways, splitting the classical axes of symmetry and movement into four elements and dislocating them away from the centre (Figure 4.5). The pinwheel arrangement is conceptually aligned with other dominant motifs in Le Corbusier’s projects, such as the regulating lines and the architectural promenade, a twisting circulation path along stairs, balconies and ramps extending from the ground to the top level of a building in a flowing sweep. The pinwheel scheme shows a conscious engagement with the combinability of geometric rules and those of moving and seeing. Le Corbusier saw in the Hospital an opportunity to respond to the defining context of Venice, a body of work of humanist architecture, which had left a mark in the ceremonial parts of the city, and his own architectural repertory developed over time.

In parallel with the emerging interest in the Organic paradigm, which conceptualised buildings as evolutionary designs in the fifties and sixties, renewed engagement with Palladio’s villas rose up through Rudolf Wittkower’s publication *Architectural Principles in the Age of Humanism*, James Ackerman’s *Palladio* and Colin Rowe’s *The Mathematics of the Ideal Villa*.34 Wittkower described Palladian villas as variations on a compositional logic, including universal laws of geometry and proportions. Rowe, on the other hand, through his audacious comparison of Palladio’s Villa Malcontenta with Le Corbusier’s Villa Stein, drew attention to the centripetal distribution of movement in Corbusier’s building as opposed to the centrifugal classical composition of Palladio. Rowe’s study developed readings of the two works that oscillated between the visual perceptions in the experience of the buildings and the conceptual organisation of their elevations, sections and plans. Pointing to the tensions between the visual and the mental, the ideal and the real in the work of the two architects, these historians revived interest in the classical principles of composition. More importantly, by emphasising Palladio’s and Le Corbusier’s critical understanding of architectural canons, they offered an approach to history over and above the limits of stylistic or historical periods, in support of comparative knowledge in architectural design. Rowe’s unorthodox comparison between a classical and a modern building made an implicit yet significant contribution. His analysis showed a regard for buildings as open compositional systems, actively interacting with a universal repertory of structures that preceded and defined it.
This proposition and Le Corbusier’s preoccupation with the Organic and Classical paradigms raise the need to explore the architectural imagination within a wider context. The question of how Venice inspires the imagination should expand to broader exploration, focusing on how the imagination can be compositionally defined. The intention is to place Venice and the Hospital within a repertory of design strategies underlying architectural thinking since early times. In what follows I explore the variable relationships of space and geometry through three canonical moments in architectural design. The first moment is when architecture emerges as a reformed discipline, coterminous with the invention of geometric notations. In these notations geometry served as the generator of design, guiding through symmetry and the axial organisation of plans, sections and elevations the distribution of rooms and the ways they were accessible from the outside. The second moment occurred with Modernism, disintegrating the classical correspondence between spatial organisation, movement and axial planning. Within this dismantling strategy, geometry played the role of the regulatory framework against free-flowing space, manifested in the work of Le Corbusier, Mies van der Rohe and other architects. The third moment brought an end to the geometric limitations imposed on design, a battle won by digital technology. Digital architecture dissolves the impact of geometric restrictions on the variability of form that, by and large, have conditioned design thinking for centuries. Nevertheless, the role of space and geometry in buildings and cities still remains largely unexplored. The following discussion extrapolates projects from their historical and physical context in order to understand them comparatively. Yet, it discusses them in chronological order, providing in this way a description of morphological relations which is evolutionary and synchronic. It is only within the combined sequential reading of history and the synchronic reading of morphology that innovative breaks in inherited norms are understood comparatively and as lineage.

Geometry, space and the invention of architectural notation

Alberti, Palladio and numerous architects saw Vitruvius as the source of rules for the correct arrangement and proportioning of plans, sections and elevations, on which architects and theorists over the centuries developed subtle variations. Outstanding contributions by Wittkower, Rowe and Peter Eisenman extended the intellectual heritage of classical composition, defined as the logical organisation of parts into a whole, into the twentieth century. Yet it is primarily Robin Evans who focused on geometry as the medium through which buildings are produced and
visualised, arguing that the architectural imagination resides in the gap between the building as three-dimensional world and its representation. Studying the role of geometry in architectural drawing and architectural thinking, Evans outlined the imposition of laws from orthographic projection to spatial organisation.

Geometry was always present in architecture, but the conscious employment of it goes back to the Renaissance, where through intensive studies of ancient architecture and influential patronage, architects such as Alberti, Serlio and Palladio established architecture as a discipline separate from the artisanal inherited traditions. The purpose was to elevate it to an intellectual activity, conversing with learned men, poets, philosophers and literati. Alberti advises architects to conceive the design in the mind and revise it many times before building. Once revisions are finished, nothing should be altered, for better or worse. Although Alberti produced the first architectural treatise of the Renaissance, it was not illustrated and was written in Latin. It was Serlio who pioneered the use of high-quality illustrations to supplement his text, which was written in Italian. Illustrations and the discovery of the press spread the influence of these books in the Western world. While previously architects had had to travel in order to study ancient ruins, books brought to them the treasures of antiquity in illustrated volumes. Pocket-sized books in particular, like Palladio’s guide book to the ancient sites of Rome, helped spread knowledge of classical architecture, paving the road for its revival.

More importantly, it was orthographic projection, the use of techniques to survey existing fragments and generate plans, sections and elevations that facilitated the establishment of classical architecture. Orthographic projection has been since then – at least, up to the digital revolution in the late twentieth century – a method of representation, of collecting data about buildings and a process of design. In his Hospital project Le Corbusier employed the same method of drawing that had been in use for five hundred years. In his letter to Pope Leo X, Raphael describes this method of surveying and designing through scaled drawings:

> you should draw always measuring everything with the scale, and use a line that equals the width of the base of the entire building. From the central point along this line, draw another straight line that makes on either side two right angles; this will be the centre line of the building. From the two extremities of the width line draw two parallel lines, perpendicular with the base line; these two lines should be as tall as the building is to be. Between these two lines, which make the height, you should then measure off the columns,
the pilasters, the windows and other ornaments drawn on the front part of the building. And do all this always drawing the lines from every single extremity point of the columns, pilasters, openings, or whatever else, such that these lines are parallel to the lines at the extremities.\textsuperscript{40}

He goes on to describe how the elevation (‘exterior wall’) and the section (‘interior wall’) are derived from the plan. Corresponding parts are joined with parallel lines, which are the conservers of true measure. These lines are considered to be representations of light paths with the source set at infinite distance: ‘the interior wall shows the inside of the building – half, that is, if cut down the middle […] In short, with these three orders or styles, it is possible to consider in minute detail all the parts of any building, inside and out’.\textsuperscript{41} This method of drawing was essential for the building to be constructed on true measures. But it was also the method that created space. As Evans explains,

architectural space would remain, one way or another, limited by and bonded to the pictures that normally gave access to it […] projection was an extra ingredient grasping more or less cautiously at the imaginary space behind the three drawings […] if the side you see is the mirror image of the side you do not see – if, that is, the building is symmetrical about the sectional plane – you see it all through one cut […] Vertical, bilateral symmetry is economical within the confines of the technique […] A centre line projected through the cavity easily converts into a processional axis. Then the axial route will show up on the principal elevation as a principal entrance, thereby converting the simple, binary equality of left and right sides (a–a) into a tripartite, therefore hierarchical, centralised symmetry (a–b–a) […] This is why in most classical architecture design and building are in a near perfect accord.\textsuperscript{42}

Andrea Palladio – identity between design and building

Another way of saying this is that the building as three-dimensional physical space was an identical scaled copy of the design. Architects practised a method that constructed an isometric correspondence between the design and the building. The invention of geometrical notations provided – as an analogue algorithm – instructions for producing a design and experiencing a building as three-dimensional physical space. This can be illustrated by looking at Palladio’s Villa Almerico
Capra, known as the Rotonda, in Vicenza (1566), one of the most ‘ideal’ of Palladio’s villas (Figure 4.0a, 4.14), which are often seen as exercises on the Roman ideal of the house in the countryside. Following the conversion of the Venetian elite from mercantile nobles to landowners in Venice’s mainland, the villas were a response to the practical demand for a new building type and a temporary defence against the decaying economy of the Serenissima. Palladio’s villas were generally adjoined by storage and gallery passages (the barchesse). In contrast, the Rotonda is a free-standing building on a hilltop outside Vicenza. Palladio included it in his *Four Books*, explaining that the site was

one of the most pleasing and delightful that one could find [...] on one side it is bathed by the Bacchiglione, a navigable river, and on
the other is surrounded by other pleasant hills which resemble a vast theatre [...] ; so because it enjoys the most beautiful vistas on every side, some of which are restricted, others more extensive, and yet others which end at the horizon, loggias have been built on all four sides.\(^{45}\)

The Rotonda features in the section about palaces in *The Four Books*. It resembles a temple-villa, closer to a suburban residence than a country house. Composed by two geometries, the perfect cube and the sphere, it offers views of the surrounding hills through four classical porticos which are geometrically aligned along the cardinal axes. The villa is traced to a number of ancient precedents that must have offered Palladio inspiration: the Pantheon, the mausoleum of Romulus and a drawing made by Palladio of the so-called Temple of Hercules at Tivoli, showing a porch with pediment repeated four times.\(^{46}\)

Using the measure of integration, which was used in the analysis of the Hospital, we see that the most integrated positions in the Rotonda are situated in the circular hall, attracting all pathways and views from every space to every other space in the building (Figure 4.15). All systems of spatial relations, such as physical elements, lines of movement and lines of sight, obey the same laws of invariance. All systems of conceptual relations governing similarity and difference between elements, and all registers of symmetry, correspond with each other so that when viewers move in the villa, the geometric order of the design conditions their vision, movement and appreciation of the relationships between the parts and the whole. The transformations of visual fields, expressed by the way in which the angles and radials of visual polygons change, are symmetrical along the axes of movement. At the same time, views are symmetrical from symmetrical positions (Figure 4.16). Aligning the geometrical axes with the processional lines, as Raphael advised, has the effect of controlling the variability of visual information, so that the whole building can be experienced as a stable image.

Group theory is the branch of mathematics that describes symmetry as the properties that remain invariant under a transformation. In terms of geometry, the Rotonda has six symmetry transformations: reflection on two axes and rotation on 90, 180, 270 and 360 degrees (this is an approximation, as it is worth noting that passageways at the front and back are slightly wider than those located at the two sides). The spatial networks of movement and visibility can be represented by a graph, by assigning a circle to each space and joining circles through lines connecting adjacent spaces (Figure 4.15). The four porticos of the Rotonda in the graph are
symmetrical to each other with respect to the central hall and the outside. This is because they are directly connected with the outside and are situated at a distance of two ‘steps’ in the graph away from the central hall. The four passageways are symmetrical to each other with respect to each entrance, and so on. The conceptual ordering of porticos, passageways,
rooms and doorways into similarity classes is governed by geometrical symmetry. In addition, geometric symmetry and graph symmetry have the same registers of invariance. This means that conceptual rules, rules of geometry and the topological rules of adjacency and connectivity determining moving and seeing converge, following the same structure. As the eye is drawn along the enfilade axes, the body follows the course of these same axes. Coordinating all potential pathways and views, the central hall enables an understanding of the correspondence between compositional, spatial and geometrical structure, substituting dynamic spatial exploration for static appreciation. Although the building can be experienced along

Figure 4.16  Palladio. Villa Rotonda. Visual polygons from the central hall and the space at the top left side. Drawing by the author
infinite paths, the architectural composition foregrounds only a few of the possible ways of perceiving.

It is important to note that each room in the Rotonda is different from the other rooms due to the decoration, statues and frescos adorning the walls and ceilings and the views of the countryside offered through the windows. The villa absorbs viewers into different mythological scenes as they walk from room to room, drawing attention to the sensual pleasures of moving and seeing. Crowned by a dome that is reminiscent of the Pantheon, the circular hall was planned with an \textit{oeil-de-boeuf}, which later was closed. Rainwater flew through the face of a perforated fawn, at the centre of the floor, to the lower level, where it was gathered in a container.\footnote{Axially linked with the spectacle of the surrounding hills and open to the sky, the hall would draw the landscape to the interior. Mindful of intellectual abstractions of space and geometry, the landscape and the weather, Palladio synthesised an abstract ideal with the changing evidence of the senses and the infinity of nature. He built this villa during the same period when he worked on the churches of San Giorgio Maggiore and the Redentore in Venice, the Valmarana and the Porto Barbaran palaces, the Capitano house at Vicenza and the little temple of Meser.\footnote{There is no evidence that he thought of the building as an abstract temple. There is a strong possibility, though, that he saw in it an opportunity to produce a \textit{belvedere}, exploiting the theatrical qualities of the site, and a monument to the humanist principles he had engaged with throughout his life.}} Palladio had a heightened understanding of the differences between an actual building and a design. Ackerman stresses his unique capacities to respond to practical functional problems and to specific sites using economical, elegant solutions.\footnote{Both projects were adjusted to the irregularity of the setting. Yet, in his book Palladio presented an idealised view of architecture in which all adjustments addressing the imperfections, misalignments and irregularities encountered in a physical site were eliminated. This marked difference between real and ideal was the outcome of the erudite climate of the period. Architects had to demonstrate to fellow architects and learned patrons that they practised architecture as liberal art and not as mechanical art, favouring design thinking over manual labour.}

For Alberti, the design, essentially an informational model, was the product of the author, conceived in the mind. The building, on the other hand, was an identical copy of this product. In artisanal practices,
Artisans and craftsmen ‘inherit’ ‘designs’ from existing building practices that survive the test of time by word of mouth. For Palladio, architecture resided in the tension, the gap or hinge, between the logical ordering of space and form, conditioned through drawings, and the empirical reality of the buildings themselves.

Notation became the medium of dissemination of architecture at large scale, gathering architectural orders, vocabularies and canons synoptically in one book or print and spreading them far away in space and time. Translating the three-dimensional world into a notation, geometry was until recently the tool through which relations of space and formal order were mapped onto simultaneous forms of knowledge. The mobility and transferability of notations meant that the visual and written language of geometry controlled the relationship between the built three-dimensional world we occupy with the body and the world of design. More importantly, it turned architectural drawings, including buildings and spaces, into ‘objects’ that were immutable, presentable, readable and combinable with one another. We saw in the discussion of the Bacino San Marco how age-old spatial relations rehearsed through movement and navigation were in the sixteenth century transcribed into a network of radial geometry, translating sequential to synchronic modes of understanding.

If the Renaissance artefact was designed as a microcosm of the universe, and the universe had mathematical origins, the architectural creation had to provide the union between mathematics and the world of the senses. Identity is a special property that defines a symmetry group in mathematics, where a thing can be superimposed upon its image through an isometric relationship of sameness. The classical system of notation established a relationship of identity – or sameness – between geometric notation and space, between the design and the building. This type of relationship caused the spatial to emerge from the flat surface. Once captured through geometry, the properties of space, beyond the reach of drawing and language, have since remained an active but silent partner.

Variably standard – geometric control and variable space

Palladio’s ideas travelled to the West in the seventeenth century, engendering English Palladianism through Inigo Jones, who met Scamozzi, Palladio’s student, in Italy. Jones’s projects were based on antique building types, such as palaces, villas and baths. In the eighteenth and nineteenth centuries emerging modern social institutions
required designs for new functional types. In his *Cours d’Architecture* Jean-Nicolas-Louis Durand (1760–1834) provided such types through a highly rationalised encyclopaedic survey, combining formal schemata that were literally empty of any specific content. This approach was rejected by the twentieth-century avant-garde architects under the influence of organic evolutionary typology, inspired by studies such as D’Arcy Thomson’s (1860–1948).

It is important to discuss a unique case of synthesis of classical ideal and empirical real (the Organic or Picturesque) before the arrival of Le Corbusier and modern architecture. Often considered as the first modern architect before the modern movement, John Soane built incrementally a house at 12–14 Lincoln’s Inn Fields that challenged the classical isometric invariance between design and building (*Figure 4.17*). The distribution of visual integration on the ground floor captures the grid-like geometry

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**Figure 4.17** Plan of Soane’s House, now Sir John Soane’s Museum. Drawing by the author
of Durand’s compositions, but the frontal axis of symmetry is fractured by the \textit{pasticcio}, and the sequence of rooms, which in classical buildings are arranged in perspectival recession, is distorted. The doorways are aligned neither with the geometrical axes of rooms, nor with the lines of sight. In addition, there are multiple oblique views through courtyards, windows, tinted glass and mirrors (Figure 4.18a–b). Finally, compared with the visual fields in the Rotonda, the visual fields in Soane’s house have greater variation in terms of shape, size, radial angles and direction, changing along with movement.\textsuperscript{54}

It was Le Corbusier who intensively engaged, more than any other architect, with the complex relationship between space and geometry in modern and classical buildings. The origin of his pinwheel scheme goes right back to the Villa La Roche (1925), built for a wealthy client to house his collection of paintings.\textsuperscript{55} This is also the project in which the architectural promenade was invented, guiding the visitor through changes of direction along ramps, stairs, balconies, vestibules, passages, suspended walkways and bridges. In contrast to the classical axial coordination, Le Corbusier used a twisting pattern of circulation covering heterogeneous elements. Rather than employing geometry to guide the body and the eye along the same course, he privileged human empirical movement.

Yet, the combination of a simple volume with a meandering path emerged in the project for the Villa Savoie (1928–31) as the first instance of what would later become for him a persistent method of designing (Figure 4.19). While working on Savoie, Le Corbusier was also collaborating with Paul Otlet on the Mundaneum (1929) (Figure 4.20). Otlet was a significant figure in the history of information society and the networked knowledge of the future. His intentions for the Mundaneum were for a place that provided access to the world’s knowledge. Otlet envisioned a ‘city of knowledge’ that would serve as a central repository for the world’s information. The World City was a utopian vision, bringing together, like a universal exhibition, all the leading institutions of the world: a World Museum, a World University, a World Library and Documentation Centre, Offices for the International Associations, Offices or Embassies for the Nations, an Olympic Centre, a residential area and a park. Le Corbusier’s design for the Mundaneum experimented with a giant circulation ramp forming a ziggurat shape. The two schemes, one domestic (Savoie), the other public (Mundaneum), were worked on in parallel, combining a simple solid with the twisting course of movement.

In his design for the Museum of Contemporary Art (1931) Le Corbusier shaped the whole building as an unfolding wall, defining
Figure 4.18  (a) Visual integration analysis of Sir John Soane’s Museum. Drawing by the author

Figure 4.18  (b) Sir John Soane’s Museum. Visual polygons representing views of accessible spaces, drawn from selected view-points (white circles). Drawing by the author
continuous movement (Figure 4.21a–d). Lacking a façade, the museum is entered through an underground passage, absorbing the exterior into the interior. A few cuts made in its surface allow visitors to move outside the designated journey, circulating in different ways. Le Corbusier explained that the human eye requires rotation and change of scene, showing his concern that architectural space should stimulate the viewer’s experience. In 1936 he used the pinwheel pattern again in the Centre for Contemporary Aesthetics. In 1939 he employed this design theme in the French Pavilion in San Francisco and in the exposition in Liège. The same year marked the Museum of Unlimited Growth in Algeria, in which the future spiralling growth of its space is indicated on the ground around the simple box-like form of the building. In this project, the rotating
pattern of movement is combined with a central void and four spaces, each located on a different side of the volume, defining the pinwheel schema of composition (Figure 4.21a–d). Le Corbusier used this schema in 23 designs of different sizes and different programmes, from museums and exhibition spaces to villas, including the monastery of La Tourette. The persistence of this schema throughout his career and its development from a simple pattern of spiral movement to a prevailing structure suggests that it became a systematic structure or metalanguage. What was its significance, and why did it so preoccupy him?

We can find answers to these questions by analysing two of the projects constructed as variations of the endless museum and the pinwheel pattern: the Tokyo Museum (1959) and the Museum of the Cultural Centre in Ahmedabad (1951) (Figures 4.0b, 4.22, 4.23, 4.24, 4.25). Le Corbusier stated that in the Tokyo Museum ‘every time a visitor, in the course of his wanderings, finds himself under the lowered ceiling [marked in the figure with the shaded areas], he will see, on one side, an exit to the garden, and on the opposite side, the way to the central hall’.
Figure 4.21  (a) Le Corbusier. Museum of Contemporary Art (1931). © FLC/ADAGP, Paris and DACS, London 2017

Figure 4.21  (b) Le Corbusier. Centre for Contemporary Aesthetics (1936). © FLC/ADAGP, Paris and DACS, London 2017
Figure 4.21  (c) Le Corbusier. French Pavilion in San Francisco (1939). © FLC/ADAGP, Paris and DACS, London 2017

Figure 4.21  (d) Le Corbusier. Museum of Unlimited Growth (1936). © FLC/ADAGP, Paris and DACS, London 2017
Figure 4.22  (a) Le Corbusier. Tokyo Museum (1959). Ground floor. Drawing by Athina Lazaridou

Figure 4.22  (b) Le Corbusier. Museum of the Cultural Centre in Ahmedabad (1951). © FLC/ADAGP, Paris and DACS, London 2017
The views he refers to are those connecting the central space with the exterior. As with the Rotonda, there are four axial connections linking the central space with a large window or entry point (Figures 4.23). In contrast, these axial links travel along the perimeter of the central hall rather than traversing its centre. Looking at the graph of the main spaces, we see that graph symmetry operates only with respect to space 1 – at the end of the ramp – which is off the main axis. In the classical model, there are usually a higher number of elements bound in symmetrical relations. As a result, the distribution of integration in the Tokyo Museum follows a different logic from the one invested in its geometric ordering.

In addition, relationships between the central space and the peripheral galleries break the classical correspondence between seeing and moving. Analysing the building in terms of permeability and visibility structure, we see the clear impact of inserting an object at the centre of a layout and pushing integration values to the corners of the space. More importantly, the central hall has the lowest values of integration, as opposed to the central hall in the Rotonda, which manifests the opposite property at the highest end of the integration spectrum (Figure 4.23). Particularly, the distribution of integration in terms of visibility emphasises the top- and bottom-left corners, in clear contrast with the processional axial element, which is off the main axis. A look at the Cultural Centre at Ahmedabad shows similar tensions. There is two-fold geometric symmetry on the horizontal and vertical axes; rotational symmetry in terms of permeability; and rotational symmetry and two-fold symmetry on the diagonal axes in terms of the visibility structure (Figure 4.25).

Looking at the Rotonda it is possible to intuit from the abstraction of the plan the distribution of integration, translating in our mind the
Figure 4.24  Le Corbusier. Tokyo Museum. (Top) Permeability graph and axial visual links. The four zones in different colours mark the pinwheel scheme. (Bottom left) Visual integration analysis (though central void and stairs). (Bottom right) Visual integration analysis (without central void and stairs). Drawings by the author

Figure 4.25  Le Corbusier. Cultural Centre at Ahmedabad. (Left) Visual integration analysis (though central void). (Right) Visual integration analysis (without central void). Drawings by the author
abstraction of the plan to empirical space. The correspondence between geometric order and the system of spatial interconnections, inherent in Raphael’s method of design and notation, raises the structure of space to the level of perception and makes it understood in an instant. The effect is that the essential distance between the design and building in Palladio is removed, whereas in Le Corbusier’s architecture it is accentuated. Palladio and Le Corbusier layered building and drawing (and writing), opening their work to tensions residing in between these modes of thinking and existence, with no mode taking precedence over another.

Developed over 30 years of architectural activity, the pinwheel plan became a standard formal type, producing different variations on a theme, based on invariance between conceptual ordering, visual perception and embodied experience. There are three main mechanisms in Le Corbusier’s approach: first, four-fold symmetry of the outer volume and the central space, the latter occupying the centre of the plan (sometimes slightly off axis); second, rotational symmetry governing the axial relationship between the central space-void and the adjoining galleries, exterior openings and pathways; third, selective screening of the central space-void from the galleries, dissociating the structure of seeing from that of moving. Le Corbusier dismissed the Beaux-Arts language of architecture, which is based on axial planning and symmetrical arrangements. Yet, he had a clear understanding of the classical strategy of correspondence between what is sensed by the body and what is accessed by the mind. He used axial principles to organise plans through variable rules, meaning that what is invariant in one set of rules differs from what is invariant in another. The spectator engendered by his architecture follows one course of movement while exploring vistas developing along a different direction. However, Le Corbusier’s work cannot be fully understood by reference only to the building, the spectator’s experience, or the invariant pattern of symmetries. Only by absorbing the tension between design and building, including their dialectic relationship with classical composition, does his architecture take on its full significance.

Modern practices

The strategy of breaking the isometric invariance between geometric order and spatial organisation was widely adopted by modern architects. In many modern buildings geometry simply works as a supporting armature rather than as the generator of the design. However, Le Corbusier and Mies van der Rohe were among the few architects attempting to establish through this persistent type of invariance a systematic
language, critically positioned in relation to the Classical paradigm, responsive to the Modern paradigm and aware of the Organic paradigm.

During the same period that Le Corbusier was experimenting with his pinwheel schema of composition in architecture, Mies van der Rohe was opposing reductive functionalism through the idea of transcendental technology. Influenced by the Jesuit philosopher Romano Guarini, he used advanced construction technology to transcend functional material contingency, dematerialising light, glass and gleaming metal, a condition in architecture that Mies characterised as ‘almost nothing’. In Mies’s Barcelona Pavilion there is almost inverse symmetrical distribution of integrated and segregated positions (Figure 4.26). More importantly, Mies aligned the end points of partitions by oblique lines of sight, obliterating the distance between the geometrical coordination of elements and optical experience (Figure 4.27). The classical correspondence between building and design is still at work but through an oblique geometry, transferring importance from the geometry of space to visual interconnections among spaces.

Photographs of the Pavilion indicate that the geometrical-optical alignments were intentional. Mies found a block of onyx accidentally, and used its size to determine the height of the building. Carefully calculating space, materials and dimensions, he must have worked with plan, section and interior perspectives to control the impact of reflections on the onyx wall, the inner dividing surface. The effect of this coordination is the illusion that the surface of the onyx wall is penetrated by vision (Figure 4.28). Similar effects were used by Mies in other projects,

Figure 4.26  Mies van der Rohe. Barcelona Pavilion (1929). Visual integration analysis. Drawing by the author
Mies also made adjustments to the paving slabs of the Pavilion, working in a manner close to that of artisanal builders, that is, from the construction of the building to the design. In artisanal production, the design is a model that, once repeated often enough, becomes abstracted and transmitted to future generations. Unlike Alberti, who advised...
architects that the design is a conceptual model and the building its faithful copy, Mies designed the Pavilion taking into consideration the materials and process of construction. The design thus became a ‘copy’ of the building – not the other way around.

In the same way that Palladio influenced Le Corbusier and Mies, these modern architects affected contemporary architectural practice. An example of a return to classical traditions is the work of Mario Botta, using isometric invariance between space and geometry within the bounds of a Platonic solid, a clear distinction between front and back, and the principles of tripartite composition (Figure 4.29a–d). A contemporary case is Herzog and de Meuron’s De Young Museum in San Francisco (Figure 4.30). The architects have used the corporeal geometry of the building to inform the incorporeal structure of moving and seeing. The museum seems to gather all the elements of a Beaux-Arts building – an open courtyard, a tower, a grand staircase, a portico – reassembling them in a new fashion. But the most striking reference to the Beaux-Arts method of design is made evident by the analysis. The pattern of integration picks up the lines defining the geometry of the building, replacing
orthogonal geometry with oblique visual lines. Contemporary architecture thus is still choreographed by movement of the body and the eye.

Non-standard variation

Tracing morphological paradigms since early modernity, I have explored how geometrical notation influenced architecture. Traditional drawing was an additive process. The consistency and associative relations between plan, section and elevation, between one element and another, between geometry and space were managed by the designer. Raphael’s
method of orthographic projection guaranteed exactly that. Geometry was not simply the scaffolding for designing buildings and holding them up, but also provided the conceptual and intellectual network of associations needed to establish internal coherence. By foregrounding a world of conceptually intelligible structures, geometric notation in classical architecture established an identity relationship between building and design, fastening temporally evolving spatial perceptions into a recognisable stable image.

**Figure 4.30** Herzog and de Meuron. De Young Museum (2005). (Top left) Visual Integration analysis of ground floor. (Middle left) Visual Integration analysis of first floor. (Top right) Axial integration analysis of first floor. (Bottom left, right) Sections. Laurence King Publishers, © FLC/ADAGP, DACS, London 2017
By organising physical and conceptual relationships, geometry made symbolic messages more pronounced. It eventually articulated communication between built space and the symbolic realm of representations evident in both buildings and urban structures. The meaning of architectural space thus relied not only on what could be materially seen but also what should be symbolically evoked, the ‘artist working as second Nature, so that an artefact is designed as a micro-cosm of the universe’. A clear example was seen in Venice, in the scenographic order of the Venetian lagoon, which expressed a political and cosmological order at the service of the Venetian Republic. Being visible as well as abstract, geometry helped translate conceptual relations from one realm to the other, from abstract to physical, tangible to intangible, and from cities to architectural structures.

The power of geometry to bind design and building came to an end in the twentieth century. The technological invention of the structural grid lifted the constraints imposed by load-bearing partitions. Freed from geometrical limitations on the distribution of space and building loads, modern architecture established variability of moving and seeing, as manifested in the work of Le Corbusier. Yet, geometry and geometric notation remained the tools through which the associative relationships among various parts of the building were controlled and visualised. The invention of CAD software simply meant that this additive logic was continued in the digital realm. Even though geometry and space in modern architecture were decoupled, there were no changes in terms of notational tools (plans, elevations and sections) or the strict repertory of orthogonal geometrical forms until the rise of digital technology.

Over the last decades, digital architecture has led to interactive algorithmic models based on associative logic, responding to variations in the input by manipulating the entire system.

Indeed, 3D printing, 3D scanning and reverse modeling have already made it possible to envisage a continuous design and production process where one or more designers may intervene, seamlessly, on a variety of two-dimensional visualisations and three-dimensional representations (or printouts) of the same object, and where all interventions or revisions can be incorporated into the same master file of the project.

Further, Deleuze and Cache’s description of the ‘objectile’ (originally the notation of a parametric function) defines design not as an object but as an algorithm, a parametric function which may determine
an infinite variety of objects, all different yet all similar, as the underlying function is similar to all.\(^67\)

The concept of the objectile is similar to Hillier and Hanson’s idea of the genotype in the beady ring, an underlying structure of open spaces connected together like ‘beads on a ring’, producing endless phenotypical variations of the same model.\(^68\) The objectile can be collaboratively manipulated to produce a series of non-identical elements. As Carpo explains, together with the demise of geometrical notation there is no longer the Albertian author of identical copies.\(^69\)

The invention of the digital not only enabled design to operate directly on three-dimensional coordinates, but also provided a vast repertory of forms freed from the constraints imposed by buildable geometry. More importantly, it allowed the designing and building of ‘digitally variable objects’, whose geometric descriptions can vary within the same output, or in different outputs of a form.\(^70\) However, although orthogonal geometric notations and the limitations they impose on formal variability have gone (not entirely of course), the essential link of geometry to space has not gone. Aided by computational tools, designers use geometry to generate complex variable forms and visualise what is experienced by seeing and moving in three dimensions. Even when a building is not intended to be aesthetically revealed by moving or to be geometrically consistent, it still embodies interrelations of geometry and movement. The spatial networks of cities also have geometrical relationships related to angle of incidence and alignments embedded in the urban grid and influencing their configuration and function. Whether conspicuous or hidden, regular or irregular, intentionally generating a building and urban plan or simply supporting their construction, geometry and movement arise from and translate back into the development of cities and architecture. Design software can produce different formal outputs through inputs that affect the geometry of objects, but the impact of the algorithm and geometry on space outputs is still in the blind spot, still in the shadows of these data and node diagrams of digital production.

Generic relations and the architectural imagination

So far, this chapter has introduced Palladio and Le Corbusier and the respective parts played in their work by geometry and topology. It now returns to the broader question of how these recombinant properties relate to the architectural imagination, or whether the imagination can be compositionally defined. Palladio’s and Le Corbusier’s work offers clues to answering these questions. Aware of the interplay between geometrical
control and variable space brought about by the pinwheel scheme, Le Corbusier employed it in various public and private commissions, for different sites, programmes and cultural contexts. In *Une Maison – Un Palais*, published in 1928, he extended his ideas from the private house to the public building and to the city. For Beatrice Colomina, the use of the spiraling theme in villas and cultural projects indicates that domesticity may have been ‘the real source of modernity in museums’. A bourgeois house was not far away from being a treasury for a private collection. In museums and housing schemes, the houses became prototypes for a universal way of living, and the museum a prototype for the city. In effect, Le Corbusier’s pinwheel plan and his translation of Venice’s spatial structure into the design of the Hospital show investment over and above the functional performance of a house, a museum, a hospital or even an entire city. The persistence of the pinwheel layout beyond the specificity of site and programme in his work explains it as a generic framework for experimentation on the interplay between conceptual unity and perceptual variation. A museum of everything is in the end a museum of almost nothing, showing the modern architect’s concern for abstract configurationality and universality.

If the preoccupation of modernity has been with generic properties, functions and terms, it is not a huge leap to suggest that the roots of modernity extend back into the classical villas of Palladio. While it is true that his villas satisfied particular social, economic and functional concerns, they reflect neither hierarchical social relations nor distinctions between servant and served spaces. Decorated by statues and murals and hosting theatrical plays and concerts, the interconnected rooms of the Renaissance villas diffused boundaries between the house as space for private living and the house as art gallery, performance space or theatre. Influenced by Alberti, Palladio also claimed that a building is like a city. His villas and churches were based on his studies of Roman baths, which suggested to him indoor miniaturised cities, theatrically framing space from the scale of the apse to the scale of the house and the landscape. Is the trans-nationality of these projects, the expansion from the room to the villa and museum, from the hospital to the city as a whole, and the fluid interpretation of functionally dissimilar programmes peculiar to Palladio, Le Corbusier and Mies, or does it suggest a framework for the imagination specific to the architecture discipline as a whole?

In a building that is like a house, a museum or a city, functional demands imposed by the site and social programme are just one filter among others. Without circumventing practical requirements, these architects had a conscious concern for crafting space and using geometric notation to establish coherence against different constraints and
requirements. By interfacing generic relationships related to the empirical reality of moving and seeing as we encounter it in buildings and cities and the conscious crafting of architectural space, they operated over and above distinctions between functional types, architecture and urban contexts. The spatial networks of moving and seeing are shared between cities as multi-authored products of society and architecture as self-conscious product of design. However, these properties in architecture are consciously placed in relation to one another within a conceptual framework, using geometry to establish internal coherence. If cities (and, to a large extent, buildings) arise as collective products of micro-economic activity and reproducibility of culture, architecture is the result of conscious intentionality that recognises patterns common to all, permutes and transfers them to new structures through creative invention.

Architects may use different geometries and technologies of generation, but space, geometry and their relationship are generic properties of buildings and cities, defining the tools of architectural imagination. Yet, in contrast to proportions and geometry which were widely available through treatises and academic studies, the spatial properties of visibility and movement remained less pronounced. Unlike classical principles, which have been systematically articulated and visualised, embodied spatial relations of moving and seeing in architectural discourse have not been made thoroughly obvious; their logic has not been properly described.

In discussing ritual practices in Renaissance Venice, I explained that the activities of moving, seeing and interacting are intuitively performed rather than consciously recorded and transcribed. Spatial relationships and their capacity to stimulate the imagination lack a system through which they can become transmissible, not simply in a visual way, as geometry becomes evident through architectural drawing, but also operationally, mastering and aligning the representation of space with the distilled cognitive outcome of moving and seeing inside it.

Describing space as a configurational relational field, the analytic theory of Hillier and Hanson has in the last four decades studied space in buildings and cities in relation to human activity and function. This theory explains that geometry gets into the topology of the urban network, affecting through the intersections of street lines and the angles of their incidence their spatial structure. However, in spite of its extensive application in real projects, the social theory of configuration treats architecture and cities as entities that are already formed. It tends to regard them as ‘found’ environments, with little attention being paid to the conceptual processes which brought them about. In other words, it does not take into account how architecture is thought
of and produced from without. If space has been a silent partner in architectural discourse, geometry has been a silent conductor in the theory of spatial configuration. The reason for this deficit is often explained by the fact that the relationship between design and use passes not through geometry or form but through the realm of space.\textsuperscript{76} However, with a clear focus on how configurational ideas travel from cities to designs and vice versa, as revealed by this analysis, the picture is more complex than splitting architecture into analysis and design, aesthetic and social practice. It should be possible to explore buildings and cities as both the non-authored products of society and the authored products of design.

The examples discussed in this book help reveal a genealogy of ideas around which the concerns of architects converge and the architecture discipline is defined. Architecture concerns critical commitment to comparative architectural knowledge on the part of an empirical and historical architect, that is, a person endowed with historical consciousness (and an unconscious). Historical consciousness means understanding how architectural ideas and forms change with time, and that the fact that Palladio built before Le Corbusier, and Le Corbusier operated before Rem Koolhaas, is as significant as the exploration of their buildings. Comparative morphological knowledge and historical consciousness establish an architect’s place in history in relation to the available knowledge of ideas and tools that shape the discipline up to one’s present, together with the possibilities and limitations for the future one’s historical position enables and withholds.

If architecture and innovation proceed from the intersection of possibility with constraint, the intersection of morphological knowledge and historical sequence brings us back to the question of the imagination. The architectural imagination transgresses functional restrictions, social programmes, and ontological and historical categories by transferring generic properties across different domains in ways which enable one to make innovations, and overcome constraints. The principles of space and geometry are not simply generic tools, but also the critical faculties in architects’ work. Abstract comparative knowledge and historical consciousness can raise space and geometry from silent instruments to the level of abstract comparative thought, towards a unitary theory of generation and explanation in architecture and the architectural imagination. Developing intelligence on the ideas of space and geometry, including their history and theory, can transform contemporary architecture of non-standard variation from intuitive practice to principled understanding.
Figure 5.0  Venice. Drawing by Athina Lazaridou