Chapter 14
Teaching Urban Morphology in a Sustainable Perspective

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Abstract If, on the one hand, sustainable architecture has been viewed very largely through the lenses of technology and energy performance, remaining at the margins of architectural culture, on the other, urban morphology has acquired, for several years now, a globally recognized role among the disciplines that deal with urban analysis. This role has then grown further, thanks to the irruption of sustainable topics nominating urban morphology as a disciplinary ‘plug-in’ between architecture, urban design and landscape. Urban morphology can thus be a valuable tool connecting the technological aspects typical of sustainable strategies to the various cultural, social, civic and formal aspects of urban design and architecture. That is why teaching urban morphology in a sustainable perspective is of the upmost importance. An educational methodology, morphologically-based, allows students and practitioners to develop a design and sustainable culture within the body of the architectural discipline giving them the needed awareness to face with the wide and complex topic of sustainability.

Keywords Urban morphology · Sustainability · Urban design · Architecture · Methodology

14.1 Introduction

For several years, urban morphology has acquired a globally recognized role among disciplines involved in urban analysis, by developing and improving important and effective tools for reading cities and territories. Their application to urban design and landscape, viewed as complex organisms, where all the other ‘dimensions’ of human life are included and become meaningful, has however remained at the margin of such disciplines, and only now, with the emergence of sustainability issues, has become a proper field of research. An ‘open’ field, in which urban morphology acts as a liaison
between the disciplines of architecture, urban design, landscape and sustainability. Urban design, in particular, has been playing a central role in the process of transformation and redevelopment of territories for years, establishing itself as an indispensable connection between architectural planning and design. The resulting project is the city par excellence, a learned synthesis of the skills and qualities of architects, urbanists, historians and geographers; the potential ground for experimenting a different way of understanding and designing cities and architecture. This is why the need to provide a scientific basis for this discipline has kept pace with its increasing importance in urban transformations. The city, in fact, is a complex and dynamic organism, and does not lend itself to mono-disciplinary and mono-scalar approaches. This is, perhaps, the main characteristic of the methodology we are proposing and what marks its difference from others. The scientific approach is genuinely used to identify the ‘structural’ rationale, which has conveyed urban transformations for centuries and dynamically defined their identity. A structure devoid of formal constraints, focusing on the logic of formation and transformation of the city rather than on its ‘historiography’, truly concerned with the ‘structural’ substance of urban fabrics, which corresponds to the social, economic and civic fabrics. But urban morphology involves all the physical scales, from architecture to territory, and this is perhaps where its greatest interest lies: the ability to detect an open system of structural signs in order to dynamically read all the characterizing scales of an urban organism. On this rationale, appropriately mapped out, it is, therefore, possible to base the design of the city. But, on closer inspection, since we are in the presence of a rationale based on behaviour, related to the way in which citizens live and transform their city, the very structural elements derived from scientific analysis can be translated into primary operational tools on which to base the actual design phase (Maretto 2015). A design phase, therefore, scientifically-based, and as such open to all the potential offered by the creative process.

Moreover, a morphological structure is necessarily a multidisciplinary structure. After all, the city is multi-scalar and multidisciplinary; therefore, urban morphology, as a direct expression of its fabrics, should be as well. Because of its ‘basic’ scientific nature, in fact, morphology is open to integrating the many disciplines that deal, in various ways, with urban phenomena; indeed, it is the benchmark for their indispensable physical structure. This is why we consider urban morphology to be of great interest in all matters related to issues of sustainability (Marat-Mendes 2013), in general, and sustainable urban design, in particular.

14.2 Methodology

14.2.1 Urban Morphology and Sustainability

To date, sustainable architecture has been viewed exclusively through the lenses of technology and energy performance, remaining at the margins of architectural culture. Yet, since for a substantial portion of Earth’s population, the technologies of
raw earth, wood and stone still represent not only the present, but also most probably the future, it is unrealistic to speak of sophisticated high-tech systems for environmental control. Such systems in certain areas of the globe are economically prohibitive and culturally unacceptable, therefore, useless. On the contrary, time-honored building traditions were (and are) strongly linked to climate and local materials. They were fully ‘sustainable’ because sustainability was the only possible way to survive. These building cultures, these architectures, were first of all able to satisfy the social and cultural demands arising from a particular civilization. They were the ‘concrete’ manifestation of those societies, their translation into building and their phenomenal ‘evidence’ on the territory. Societies linked to their land, to climate and local materials, yet also open to comparison and innovation, because innovation leads to progress, and progress often meant survival. This leads us to consider an important aspect of sustainability: authenticity. Authentic, in fact, literally means done by ‘one who does things himself’, therefore, made according to conscious procedures and logic. A structure is therefore ‘authentic’ when it is ‘recognized’ by the society that introduced it, when the culture of that society is able to understand it and make it its own and when the technology of that culture is able to reproduce it and, if necessary, develop it (Maretto 2012). Why urban morphology, then? Because a morphological analysis of urban fabrics allows us to understand the logic of its transformations, of its ‘structural’ substance, in other words, it allows us to plan, with ‘authentic’ awareness, an intervention within its modification process. Urban morphology can thus be a valuable tool connecting the technological aspects, typical of sustainable strategies with the various cultural, social, civic and formal aspects of urban design and architecture, according to a comprehensive and complex idea of sustainability, a different use of resources, a different pattern of settlement on the territory (Maretto 2014). However, the information revolution is already radically transforming the very foundations of the ‘fossil city’, exponentially increasing the opportunities for exchange in the new global society. On the one hand, the daily movement range has been progressively reduced, on the other hand, a ‘virtual’ macro-urbanism will intersect with an ‘actual’ micro-urbanism, physical and concrete, determining the form of the new urban environment. Within the binomial of macro and micro-urbanism, urban morphology identifies an interesting socio-building scale that can serve as the basic strategy for sustainable city planning in the twenty-first century. A strategy that involves, on the one hand, a scalar sequence of physical forms related to aggregation and spatial organization (from houses all the way up to districts) and on the other hand, a complementary sequence of forms related to association and civil organization (from families to urban communities). Sequences that find in the concept of ‘social neighbourhood building’, the lowest common denominator of sustainability: the sustainable unit, on which urban strategies of environmental control on a larger scale can be based. Urban morphology thus becomes the necessary plug-in for registering all the different ‘networks’ that characterize the contemporary city—from Information Technology and ‘smart’ devices to energy and environmental systems—in order to translate them into building practices for the physical city, that is, to translate them into ‘fabrics’ on which planning of sustainable cities will be based.
The validation protocol adopted for our methodology has thus provided a reading of the state of facts through some fundamental climatic conditions such as temperature, humidity, rainfall, wind and solar radiation (Pizarro 2009). These were added to the following: findings on the site form and the shape and porosity factors of the blocks, light analysis in relation to the altimetry profile of the involved sections and their albedo values, tracing of the solar axonometries on particular days considered ‘threshold period’, from dawn to sunset, from which to obtain the map of shading of the whole solar year.

The phases of the analysis protocol can be summarized as follows: (i) analysis of urban form; (ii) analysis of luminous contributions and distribution of albedo values through the use of solar axonometries and three-dimensional diagrams of the block; (iii) climate and microclimate analysis of the area (medium temperature and wind profiles) and (iv) analysis of irradiation profiles and solar axonometries. More precisely, we can talk about microclimate analysis that can be carried out through the effective survey of each void regarding the following: (i) analysis of thermal comfort; (ii) analysis of radiant components; (iii) wind component analysis and (iv) visual comfort analysis.

In order to carry out this kind of investigation, specific climatic software has been used to obtain data such as: average temperatures, relative humidity, precipitation percentage, mean values and peak values on irradiation. These data led to the elaboration of solar mapping and shading paths and other thematic maps to determine which areas were most affected by direct sunlight, such as those affected by more shadow hours during the summer and winter seasons (Gaitani et al. 2007).

Similarly, the wind component analysis was performed by comparing the following parameters: (i) dimension of outdoor space; (ii) wind speed at 2 m high; (iii) height of adjacent buildings; and (iv) direction of the wind, amplitude and location of the open faces of urban fabric—urban canyon (Gherri 2015).

### 14.2.2 Polarities, Routes and Fabrics

All urban organisms can be viewed fundamentally as anthropic settlements on the territory. Yet, settlements, starting with the choice of location, require some experience of the environment they become part of envisaging a rudimentary system of land division, a network of land ownership and so on. This structure, even in the rural settlements of the most primitive sedentary civilizations, is always an expression of a similar, albeit elementary, social structure, characterized by all those polarities and hierarchies of communal spaces that identify a community. These spaces will gradually multiply, differentiate, be arranged by a hierarchy as society expands, becomes richer and develops a complex civic structure, accurately mirrored in its system of polarizations, routes and fabrics.

Since the emergence of the first permanent primitive settlements, three key concepts can characterize all human settlements up to the twentieth century: the concept of polarity, the concept of route and the concept of fabric. ‘A city is a system in which
all life, including daily life, reveals a tendency to polarize, to unfold in terms of social aggregates, which are either public or private. The more strongly the polarization is exerted and the closer the interchange between the public and private spheres, the more urban the life of an urban aggregate is from the sociological viewpoint (Bahrdt 1966). It is no coincidence that, through history, a vast urban iconography presents the city as an object well enclosed by walls, enhanced by towers and domes on the inside and distinctly opposed to the ‘outside’. Such view generally tended to discern the essence of the location, fixing its special features in a ‘characteristic image’, where those towers, walls, steeples, domes, minarets, and so on, stand out from urban polarities as recognizable and identifiable elements within the social and architectural city’s fabric. Their task is to coordinate the urban fabric; their role is to identify the different urban communities in order to grant all citizens a sense of belonging to one civic individuality. Hence, polarities can have a centralizing or a delimiting role within an urban body. In particular, the most representative buildings, from a social and civic point of view, were generally located in the heart of the city or of specific neighbourhoods (the cathedral church, the parish, the Lord’s palace). Conversely, buildings of a specialized nature (city walls, lazarettos, monasteries, barracks, etc.), due to their greater dimensions and functions were usually placed at the edge of town, occupying the urban fringe belts. But, if in small-sized towns the relation between fabric and collective themes is clearly perceivable, since such themes have a substantial visibility and presence, in cities of larger size, on the contrary, the perception of the relation is more difficult. The organic value of the city will thus be entrusted to local themes embodied in its fabric (parish churches, ‘town halls’, etc.), whose task will be to reveal their connection to the wider urban system. Moreover, in situations of high polycentricism, where various urban communities coexist in the same district, even the simple non-residential (usually commercial) specialization of a square or a street can take on a local polar value.

Hence, two key elements emerge when studying the concept of urban polarity. The first is the dynamic relation that is established between polarities. It is thanks to this relation that urban structures can actually survive and change. The second is the relation that is developed between polarities and urban fabric. The relation is reciprocal: the fabric indicates the various potentials for polarization; however, it is only through the physical construction of polarities that this potential can be materialized and that the fabric can be realized. We can, therefore, see how the urban phenomena can be read according to a complex dialectic of systems which vary in their degree of collaboration, each with its own hierarchy of relations between centre and periphery, polarity and anti-polarity—dialectical systems concerning urban areas that are relatively self-sufficient, but that remain complementary to the wider urban organism.

The more a context is ‘anthropized’, the more the rationale of route formation is accurate and concise. In general, a distinction can be made between planned systems and spontaneous systems. We will focus on the latter, where few ‘basic’ route typologies generally found in all spontaneous building fabrics, from medieval towns to contemporary informal cities, can be noticed (Caniggia and Maffei 1979). Hence, given any two nodal points (urban or territorial points), the route linking
them in the most direct possible way will be termed a matrix route. The route is deeply connected to and influenced by the form of the fabric it fits into, be it natural or urban. It often takes on a distinct curvilinear outline, to achieve the required mediation between the geomorphological conditions of the context and the rectilinear continuity of a path.

But in order to develop urban sociality, it is indeed necessary, as already stated, to have collective areas, where the *civitas* can gather and share a common identity ‘recognition’: building will be centred around such nodal points. Yet, when the linear distance from these nodal points becomes considerably greater than the depth of the areas located behind the pertinent strip, then building routes will appear likely to form a fabric. Once again, however, the construction of a route does not continue indefinitely. Beyond a certain distance, the tendency will be to form a system of connecting routes (between building routes). Going further, a progressive hierarchy of roads will then follow in order to answer to the different levels of sociality characterizing the city. Finally, a city is an organism made of ‘fabrics’: social, economic, cultural and environmental fabrics on which the very functioning of any urban structure depends. The more such fabrics are interrelated and efficient, the more the organism will be dynamic, versatile and capable of meeting the demands of its citizens. The modes of interaction between fabrics express how citizens inhabit their city, how citizens transform the city through their daily actions. Understanding such logic or, better still, understanding the logical basis of such relations and discerning their role in the definition of urban fabrics can be considerably interesting and useful.

### 14.2.3 Hierarchies

A concept runs through the issues discussed so far and strongly influences them: the concept of hierarchy. Hierarchy means assigning priorities. It might be long or short-lived, but it is never static; on the contrary, it is essentially dynamic in nature. Day-to-day and long-term priorities, priorities that are planned and spontaneous, private and collective, they all contribute to the definition of an ever-changing system of hierarchies. Hierarchies, therefore, are the ‘geo-reference points’ on the map of our ‘dwelling’, they provide us with a scale of values, both individual and collective, on which to base the critical reading of a city.

In urban morphology, routes are what condition and determine, more than any other factor, the assignment of hierarchies. Routes are the main vehicles of city life and the fundamental instrument for reading and transforming the territory. This is particularly true in the case of polarities. Not all of them have the same relevance within an urban organism. The role of priorities depends on their location within the fabric but also (and especially) on the quantity and quality of the routes converging at that point. Two ‘internal’ polarities may have a strong hierarchal relation, and from such ‘hierarchization’ a number of developments might follow: the persistence
of one polarity at the expense of another, the transformation of one polarity depending on another, the layout of new road axes, the disruption of entire building fabrics, and so on.

The same applies for the various open spaces (public and semi-public) that characterize a city. In this case as well, the quantity and quality of routes converging in a given location determine the degree of ‘nodality’ of a public space, establishing a dynamic hierarchical system that is parallel to the formation process of an urban organism. It is exclusively because of their varying degree of nodality that these open spaces are perceived as ‘full’ civic spaces and not as ‘empty’ spaces to be occupied. This is confirmed when we look at fabrics as a whole. The process of spontaneous formation of urban fabrics takes place according to a nodality/anti-nodality dialectic, where this state of nodality will be followed by a greater fabric specialization, which will regularly decrease as the distance from the nodality increases finally reaching the opposite condition of ‘anti-nodality’. In other words, the degree of specialization acquired by a building over time depends on the level of hierarchy of the route it belongs to. Routes, therefore, are what determine the various levels of nodality within a fabric and the ‘weight’ of urban polarities. But what determines the hierarchy of routes? We might answer: the hierarchization of the society that built them in a constant and continuous interaction. It is actually true that what gives routes ‘priority’ is the quality and quantity of the polarities they connect, but also the different specialization level of the buildings that define them: a route joining two major polarities (urban or territorial polarities) will typically be occupied by highly specialized buildings, even to the complete exclusion of private residences. Building routes originating from that route are most likely to exhibit a good mix of both specialized and residential functions, while the degree of specialization will decrease gradually arriving at a predominance of residences as the route assumes a more anti-nodal quality. The same applies, at least partially, to the height of buildings, which increases when closer to the nodality; it should not be forgotten, however, that the terms ‘centre’ and ‘periphery’, ‘nodality’ and ‘anti-nodality’ are not geometric: it is, therefore, possible to find nodes and anti-nodes in the very centre of a city while, conversely, tall buildings can be found along main routes and, just a few meters away; buildings with only a few stories can be erected on connecting roads or in congested pertinent strips. Thus, polarities, routes and fabrics, when viewed within the unstable dynamics of their hierarchal relations, are key concepts. For centuries, the transformation of cities has been based on them and urban morphology relies on them to read the different urban phenomena. They also are, as a consequence, the thematic framework for a methodology aimed at planning the smart, sustainable, liveable city of the twenty-first century.

14.2.4 The Neighbourhood-Building Unit

There is a system of built structures whose essential task is to mediate the transition between the citizen’s (or the family’s) individual, sociological dimension and the
city’s public dimension. The more complex the public dimension is, the more important is the role played by these structures in the functioning of an urban organism. Such structures, at the same time physical and social, can be defined as ‘social-building neighbourhoods’. The neighbourhood, although representing the indispensable link between families (small-scale) and communities (large-scale), is generally non-institutionalized and only recognizable in a building context.

Perhaps the most significant historical example is that of Venice, where between the fourteenth and the eighteenth century, the Republic or other public institutions built a number of social housing units, generally centred around neighbourhood spaces: the courts. Another significant example, promoted by private enterprise, is constituted by the London squares and mews with their common areas well enclosed by the walls of houses (often serial and therefore, unitary in their ‘collective’ image) and polarized at the centre by a collective service: the garden. Actually, mews were traditionally linked to squares and terraced houses but when, in the 1970s, they lost their preexisting specialized role and turned into residential they became perfect, if small, neighbourhood units, complete with entrance gates and a central collective space: a sort of ‘neighbourhood within the neighbourhood’, confirming the great popularity that this type of structure enjoys in contemporary London.

The neighbourhood is, in fact, responsible for creating a collective dimension of space that acts as a fundamental area of mediation between urban public spaces and private pertinent spaces: a semi-public space of great relevance for urban identity, functionality and sustainability. Especially in polycentric cities, the transition from the individual (a person or a family) to the civitas is far from obvious and often requires an intermediate stage for collective identification, which is exactly what the neighbourhood is. It is, so to speak, an everyday belonging need that is not always sufficiently satisfied by the district; activities and functions that cannot be carried out easily at home, and even less so in the street, are, therefore, entrusted to the collective neighbourhood space. A space to carry out all those co-housing activities that have now become indispensable in a contemporary metropolis: nurseries, workspaces, laundries, sport facilities and more. Social-building neighbourhoods represent, moreover, the sustainable urban unit of contemporary cities. Their nature, both collective and unitary, allows for the implementation of a first strategic level of sustainability, which downscaled to individual buildings would not be very effective. Rainwater and grey water collection, centralized heating systems with clean energy production, neighbourhood-based and meticulous collection of waste, are just some of the needs the construction of a neighbourhood unit can meet. The value of social-building neighbourhood, therefore, lies in its intermediate position, both from a social and urban point of view, between citizens and civitas, public and private spheres and communal and individual rights, between the utmost open and permeable urban space and the utmost closed space, focused on its pertinent features. Social-building neighbourhood is, we could say, capable of bringing together the plurality of elements typical of urban fabrics and the demand for unity typical of living spaces: a sort of ‘unity in plurality’ that we believe can play an interesting role in planning the sustainable city of the twenty-first century.
14.2.5 The Morphological Map and the Nodality Survey

All the issues addressed so far, serve for devising an analytical tool we shall call a ‘Morphological Map’: a map offering complementary ‘levels’ of reading, each to be analysed individually or collectively, based on a relation of reciprocity. Each reading is the manifestation of a particular aspect of an urban context’s morphological structure and it is open to a large number of sublevels, in order to better define its qualities according to the needs. But, on closer inspection, it should be noted that a structural knowledge of an urban environment allows to ‘structurally’ plan its transformation. In other words, the same elements are used to analyse a given urban context can become valuable design tools. It will hence be possible to draw up a context (Figs. 14.1 and 14.2) and a design Morphological Map to act as the basis for urban design. The advantages of such a system are evident. On the one hand, it makes planning by stages possible, allowing at any time the transition from smaller to larger scales (and vice versa). On the other hand, it makes it possible to correct and edit the project without having to start all over again every time. Moreover, it is always possible, when focusing on a specific layer, to scale down what is being worked on without ever losing sight of the overall picture. In other words, if for instance, we are working on a single block we will always know what type of block it is, what type of routes it rests on and what this involves in terms of urban fabric whether the condition is one of nodality or of anti-nodality and so on, a sort of ‘compass’ for morphologically informed choices, no matter how specific and particular the intervention may be.

An important tool of the Morphological Map is the Nodality Survey (Figs. 14.3 and 14.4). The analysis of the different levels of nodality within an urban fabric is,
**Fig. 14.2** Sant Adrià de Besos, Barcelona—Project 2—context morphological map

**Fig. 14.3** The nodality survey
Fig. 14.4 Trondheim. Urban regeneration of Kjopmannsgata street: the nodality survey
as previously observed, the main instrument through which to attribute the morphological hierarchies. The whole sequence of factors previously treated (paths, polarities and tissue) depends, we could say, on their own level of morphological nodality. To analyse these levels accurately is not easy. The strong dynamism that characterizes them, their being a direct expression of the way in which men experience the city makes it a theme rather fluid. But this is also the strength and usefulness of the Nodality Survey in its ability to return, from time to time, an effective and dynamic socio-urban framework, able to understand the main morphological levels of hierarchy and to adapt itself (in real-time) to its temporal changes. For this purpose, two values of nodality have been identified, a quantitative one (scientifically measurable) and a qualitative one (subject to partial interpretation). The first is the grade of nodality and the second is the level of nodality. The grade of nodality depends on the number of paths that converges into a given point of the fabric. Its minimum value (Grade 2) is obtained by the convergence of only two paths in a point and so on until Grade 4. From the latter, in fact, it is assumed the occurrence of a dilatation of the public space (square, courtyard, etc.) to accommodate a higher number of routes. Alternatively, or in the presence of a particularly high number of convergent paths along the same road, we can hypothesize to be in the presence of a ‘linear nodality’.

The level of nodality is otherwise a typical qualitative matter and depends on the type of converging paths into a single location. These levels are calculated starting from a minimum (Level 1) up to a maximum (Level 10) of specialization of the paths, where Level 1 is given by the intersection of a local with a fabric route and Level 10 is the result of the convergence of two matrix routes. This distinction allows to calculate not only the level of nodality of a given urban context but also its dimensional scaling. So levels up to the third are related to a more local dimension of urban living, while those from the fourth to the eighth belong more to the scale of the neighbourhood and those from nine to ten are obvious urban nodality. A Node is thus given by the sum of Grades + Levels (G + L), where, however, levels are always hierarchically more important than the formers. On an equal Grade, in fact, two nodes can differ in the type of level, the one having the higher level will also have a greater value of nodality.

\[
\text{Node} = L + G \quad L > G \quad \text{ex: } L3 + G2 = 5 = N \\
L2 + G3 = 5 = N
\]

If then a node has a value greater than or equal to ten, we are probably in the presence of one polarity. A polarity that will be at the city scale (urban) or at the neighbourhood scale (fabric) depending on the value attributed to its level of nodality (fabric: L4–L8, urban: L9–L10). The subject does not change if we are in the presence of nodes of degree >2. In all these cases, in fact, the level to be taken into consideration for the calculation is always the upper one.
Finally, one last important aspect has to be considered. If a node was in a condition for which the grade (G) is greater than the level (L), there are two possible alternatives: we are in the presence of a manifest error of analysis, namely an initial error in the attribution of the type of routes existing in that given place (for instance, a building instead of fabric route) or we are facing the possibility of a clear upgrade of the node: a node whose changed urban conditions encourage an increase in size, function and of specialization of paths converging into it. The calculation for this chance is possible thanks to the introduction of a correction coefficient (α) given by the subtraction of G–L, whose value is added to that of level (L) in order to equate it to that of Grade (G). What is obtained is a new nodality value incremented of that minimum value of L congruent with the form of the context. In other words, the coefficient α indicates the minimum level of modifiability of a place in respect of its morphological congruence.

\[
\text{ex} : \quad N = L_4 + G_6 = 10 \quad \text{(polarity)}
\]

\[
\alpha = 6 - 4 = 2 \quad [L_4 > L_6]
\]

\[
N = L_4 + G_6 + [2] = L_6 + G_6 = 12 \quad \text{(fabric polarity)}
\]

The α coefficient allows, on the one hand, to correct any errors of analysis made upstream of the nodality survey, and on the other hand, to identify conditions subject to increase. Conditions for which it is possible an intervention of urban regeneration aimed at enhancing the characteristics of a given place through changes and functional increments, spatial increases and so on. Changes that might be morphologically congruent and thus realistically feasible (and desirable) with minimal risk. The form is, in fact, an expression of all those ‘tissues’ that create a city: social, economic and cultural fabrics finding in the physical form of the tissues the place where to play those endless possibilities of relationship, which are, in fact, the life of a city. The morphological congruence appears, therefore, a useful factor to ‘scientifically’ establish any urban regeneration project and for this purpose, the calculation of nodality values through the nodality survey becomes a very important instrument. The methodology has been tested on the Sant Adrià de Besos Regeneration Project, where three projects have been developed by three different design groups on the same methodological base (details on the case study will be offered in Sect. 14.3, ‘Methodological tools’).

The aim of Project One (Fig. 14.5) is to create an urban edge to the district of Sant Andria de Besos. This margin is thought to accommodate the main context lines as they approach the sea until they become new pedestrian routes crossing the project and, finally, wooden piers over the sea. Functional hinge of the new system is the coastal road with the new fast tramway. It is intentionally left empty of building in order to don’t conflict with the transverse direction of context streets. So the large green courtyards are open upwards to enhance the functional nature of the
coastal axis and semi-open to the waterfront as collective courts with facilities for citizens. The system is then crossed by three major axes. The first, the most relevant at the urban level, creates a sort of long ‘road-square’, entirely pedestrian, designed to connect the Forum 2004 area with the northern Marina. It is the heart of the new district, where the main commercial and tertiary activities are located. Continuous building walls highlight its mainly polar character. The second path is the long waterfront. It is the place intended for major recreational activities, sports and small commercial areas. The third level route is the promenade. It slightly sets back from the coastline, crossing the large green collective courtyards. It is the ideal place for relaxing activities, for children and families, away from the summer heat and definitely more dynamic waterfront activities. These three paths converge to the centre in the garden square dominated by the imposing presence of the three chimneys of Sant Andria de Besos Power Plant, now disused, whose structures have been maintained and transformed into cultural activities. A careful study of the main environmental components (sunshine, prevailing winds, albedo values, etc.) within the urban courtyards led the architectural design, guided the casing choices and allowed the selection of materials in order to ensure a truly sustainable urban project.

Project Two (Fig. 14.6) draws on the decision to create an urban boulevard balancing the new district with the rest of Sant Adrià de Besos. All major paths are ‘vertical’ penetrations toward the waterfront, which is strongly hierarchical, thanks to the exclusive use of the wood for the flooring and the location of all major sports and recreational activities. The major commercial activities are planned along the boulevard, where all the infrastructural facilities are located. A second settling situation, at a more local character, focuses on the grafting of the pedestrian vertical
penetration systems through the dilation of routes in small squares. A third and last hierarchical level is given, from the green courtyards system, the neighbourhood unit, which determines the building fabric and innervates, through a hierarchical grid, the entire project area. At this level, in addition to making entirely pedestrian the new district, the main environmental control choices are given. The latter is aimed at a conscious design of outdoor spaces and at the congruent choice of the opening levels of the buildings facades. A final element relates to the identification of the disused Great Plant as a new urban polarity to be devoted to culture, whose square recovers the general urban design by the introduction of materials and textures able to specialize the urban fabric without interrupting its continuity.

Project Three (Fig. 14.7) is very different from the previous for two reasons. First, it restores the urban boulevard through a compact front opened to the new building tissue and to the routes, penetrating the existing fabric. Accesses to these paths, when fitted with a certain value of nodality, are always identified by the presence of a small special building, a square and the stop of the new fast tramway. Second, the new district takes on the characteristics of an independent barrio with its own hierarchies, its own relational ratios and settlement strategies, in a closer dialog more with the Mediterranean world, in general, than with that part of Barcelona, in particular. A central axis cuts the settlement putting in connection its major nodalities with heating plant in the middle. A further set of small ‘local’ squares contributes to hierarchize the urban fabric, while an interesting collective courtyards system generates a network of protected paths from winter winds and excessive summer sunshine. All this, to deliver a variety of hierarchical public spaces greatly contributing to the dynamic unfolding of the different ‘levels’ of life and sociability that characterize an urban organism. To complete the project, to the
south, a large urban park is connected with the Besos River Park up to get into the heart of the project while, to the east, a new fish market connects the neighbourhood to the Marina. Even in this project, a careful environmental analysis has guided the design choices at the building scale helping to draw the collective courtyards and to design the open spaces system.

14.3 Methodological Tools

From an operational point of view this methodology is supported by an in-the-field workshop, where all the previous concepts and tools are verified and applied to a real case study either from the analytical and from the design point of view (since 2013, Workshops in Architecture and Urban Morphology-WAM have been attended in Helsinki, Barcelona, Krakow, Valencia and Porto).

Areas covered by the workshops are always strictly concrete in order to ensure the scientific utility of the design experience qualifying itself as a progressive test of a scientific/design methodology in urban morphology and sustainable urban design. Particular attention is devoted to ‘water cities’ in order to better define the scope of the research without sacrificing, at the same time, its necessary analytic openness since water is the unifying element of most of the major settlement experiences in history: river towns, coastal towns, lagoon cities form a widespread series of great interest. Each workshop involves, then, one or more institutions (universities, municipalities, foundations and research centers) and it is coordinated by academics, practitioners, experts and tutors. It is held in three stages: a first one,
methodological, during which the participants (MSc students) learn the main instruments of urban morphology and apply them to the ‘structural’ reading of the project area; a second phase, the in-the-field workshop, during which they verify their reading and set up the project’s main frame; a third and final one, entirely dedicated to the environmental design and to the preparation of the urban project (Table 14.1). At the end, the most interesting results are published in a series aimed at documenting the possible educational/operative outcomes of a morphological design methodology for the contemporary city (see, for example, WAM 2014, 2016).

A number of elaborates are then summarized as follows: (i) context morphological map (analysis) and nodality survey; (ii) context functional map; (iii) morphological master plan (Figs. 14.8 and 14.9) and Design Morphological Map (Figs. 14.10 and 14.11); (iv) environmental analysis and (v) urban master plan.

The context morphological map analyses the context in terms of form and creates the basis on which to enter all the available functional data (context functional map). From these two instruments, it is possible to carry out an initial morphological master plan. It is a tool that processes the morphological and functional elements preparing the basis for the subsequent urban project. This morphological master plan is supplied then by a morphological map in order to evaluate the

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<th>Stages</th>
<th>Weeks, lessons, contents, products</th>
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<td>1. Methodological</td>
<td>It is held in 12 weeks&lt;br&gt;It is devoted to the learning of the basic morphological tools and the main software for the environmental analysis/design&lt;br&gt;It is organized in theoretical lessons and practise laboratories&lt;br&gt;At the end of the stage, MSc students will provide a basic morphological map, a first nodality survey and the environmental analysis of the design context&lt;br&gt;First evaluation step</td>
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<td>2. In-the-field workshop</td>
<td>It is held in one week&lt;br&gt;MSc students verify the analyses previously developed and prepare a basic morphological master plan&lt;br&gt;Together with the hosting institution, it is structured in a number of lessons and a continuative (24 h) laboratory activity&lt;br&gt;At the end, students will present their work to a jury that will examine and evaluate their tasks&lt;br&gt;Second evaluation step</td>
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<td>3. Environmental design and urban project</td>
<td>It is held in 16 weeks&lt;br&gt;It is entirely dedicated to the urban and environmental design&lt;br&gt;MSc students provide a detailed master plan (accompanied by a complete morphological map, a nodality survey and the environmental analysis)&lt;br&gt;They will have to deliver a number of accurate panels and an overall model&lt;br&gt;Final evaluation step</td>
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morphological consistency of the new intervention. But the environmental analysis will have to turn this tool into a proper master plan (Figs. 14.12, 14.13 and 14.14). It will be the intelligent response to environmental data to conform the new urban environment, both from the volumetric point of view and from the basic architectural one and both for what concerns the design of public spaces. The result is an
urban master plan that is morphologically, functionally, architecturally and environmentally conscious. A tool on which to place all the complexities of the contemporary city without losing the ability of place-making.
Fig. 14.12 Sant Adrià de Besos, Barcelona—Project 3—environmental analysis: general data

Fig. 14.13 Sant Adrià de Besos, Barcelona—Project 3—environmental analysis: highlighting criticality of a block-type
14.4 Conclusions

The risk of a design methodology always goes in the possibility that constraints imposed by a unitary approach are so invasive that they heavily condition design choices. If this can be a problem when working at an architectural scale it becomes clearly unacceptable when designing at the urban scale. The city is complexity, variety and dynamism par excellence and to give it a unique interpretation is never convincing (and often useless). On the contrary, a methodology able to work on the ‘structural’ substance of an urban organism, on traces left on the fabric by its own formative rationale, by the way in which citizens live and transform the city every day, can be very useful for the project of urban transformation: a methodology that is able to read the formative logics of those fabrics and transfer them into a cartographic tool for the understanding of the urban context (a knowledge that is non-formal, non-historiographical, non-functional) and that is capable of translating these logics into design instruments for the contemporary city. A project, therefore, based on the structural knowledge (morphological) of the urban fabric as the expression of many other social, economic, cultural ‘tissues’, interpreting them by drawing a new morphological map (project). A map that is in structural continuity with the previous one (analysis) so as to become itself the new map (the new ‘context’) for subsequent interventions of urban transformation, according to a process of morphological continuity that we believe constitutes the most interesting and perhaps original element of this experience.

Fig. 14.14 Sant Adrià de Besos, Barcelona—Project 3—environmental analysis: design solution of the criticality identified in the block-type
Another aspect to highlight is the two-way relationship established between the environmental analysis and the morphological analysis. It is by their interaction that the urban project acquires its foundation and meaning. It is in the complementary use of both disciplines that, we believe, an additional factor of originality can be found.

References

WAM (2014) Helsinki South Harbour regeneration project. RAM Publishing, Rome
WAM (2016) Regeneration project of Sant Adrià de Besos District. RAM Publishing, Rome, Barcelona