

**Abstract.** A city is an organism made of “fabrics”. Social, economic, cultural and environmental fabrics, energy and information networks: the very functioning of an urban structure depends on their interaction. The more such fabrics are interrelated and efficient, the more the organism will be dynamic, versatile and capable of meeting the demands and aspirations of its citizens. While it is unnecessary and perhaps impossible to try and understand the form of such fabrics, it is possible and necessary to understand the logic of their relations. The modes of interaction between fabrics in fact express how citizens inhabit their city, express 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 is one of the main objectives of urban morphology. Urban morphology is therefore the platform where all networks that make up global society naturally find their place: information, energy, environmental, functional networks, which find in urban fabrics their necessary economic, social and cultural *plug-ins*. Fabrics that morphology can ‘read’ and plan in order to respond effectively to the needs of contemporary cities. But fabrics tend to “polarize” in specific locations of urban areas, and “become active” through routes, generating hierarchical systems which are unstable in as much as they are dynamic and constantly changing. Therefore, *polarities*, *routes* and *fabrics* are key concepts on which the city has been founded and transformed for thousands of years: morphology relies on them to read urban phenomena. But above all, it is on such concepts that a design methodology can be established for the construction of the smart, sustainable, livable city of the XXI century.

## INTRODUCTION

For several years now, morphology has acquired a globally recognized role among disciplines involved in urban analysis, by developing and perfecting 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 margins of such disciplines, and only currently, with the irruption of sustainability issues, has become a proper field of research. An “open” field, in which 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. A number of examples move in this direction, all aimed at finding the appropriate analytical tools to provide urban design with both a critical and a methodological foundation: starting with the perceptual approach theorized by Kevin Lynch in the 1960s, moving on to the patterns imagined by Christopher Alexander in 1977, all the way up to Michael Batty’s and Paul Longley’s research on fractal cities (1994) and Batty’s later publication, unequivocally entitled *The New Science of Cities* (2013). Experiments on cities through the use of GIS (Geographic Information Systems) are rather interesting and in particular those carried out by Space Syntax, where overlapping geo-referenced layers

are made into a valuable configuration tool for constructing an Analytical Framework for Urban Design (2010). The limitation shared by all these experiments, however, is their excessive reliance on a one-sided approach to urban phenomena. From Lynch's perceptual theory, to the geometry of fractals, to GIS, the result remains the same, namely an overly specific vision of the city. It is no coincidence that this research is seldom multi-disciplinary and multi-scalar and, with due distinctions, rarely moves from the analytical to the design stage. Indeed, in most cases, the two phases (analytical and synthetic) are kept completely separate, precisely because of the practical impossibility of moving from one to the other without losing consistency and reliability. The city, on the contrary, is a complex and dynamic organization, and does not lend itself to mono-disciplinary and mono-scalar approaches. Moreover, the city can boast three thousand years of history. A history created by the communities that have built, inhabited and transformed a city over time; a history that coincides with the very history of mankind. Therefore, in our opinion, a scientific methodology on which to base urban design should begin by taking into account exactly the reality of the city as it is; the concreteness of its physical structures, expressing many complex social, economic, cultural systems; the essence of its needs, expressing those of the people who live and have lived there over time. The methodology should, in other words, go back not so much to the ever-changing forms of the city, but rather to the rationale underlying its process of urban transformation over the centuries. A rationale to which both the success and identity of each settlement is entrusted. A rationale to be found within the very reality of urban structures. Why look elsewhere for answers that, when properly interpreted, are right before our eyes? This is, perhaps, the main characteristic of the methodology we are proposing and what marks its difference from all the others. The scientific approach is genuinely used to identify the "structural" rationale which has conveyed urban transformations for centuries and dynamically defined their identity. On this rationale, appropriately mapped out, it is therefore possible to base the design of the city. Here, in fact, we see the emergence of a structure, sometimes latent sometimes explicit but rigorously alive and concrete, on which the contemporary city is founded, just like all previous "contemporary" cities gradually made up the city we live in today. However, on closer inspection, since we are in the presence of a rationale based on behavior, related to the way in which citizens live and transform their city, therefore a purely performative rationale, the very structural elements derived from scientific analysis are translated into primary operational tools on which to base the actual design phase. A design phase, therefore, scientifically based, and as such open to all the potential offered by the creative process. The discipline that makes this all possible, in our opinion, is *urban morphology*.

### ***Urban morphology***

A city may be considered unitary in its conception, yet infinitely plural in its phenomonic manifestations. Specific histories and identities are the result of 'readings' of the territory provided by different civilizations over time. Traces of such histories and identities, however, may be recovered and interpreted, and offer a new 'reading'. These "signs" are, in fact, the latent substrata of each urban experience. They tell us about the societies that traced them, about their settlement culture and their territory. Traces, indeed, but laden with semantic val-

ue, and hence an interesting vehicle for knowledge. Interesting because they basically have no formal constraints but on the contrary point to the “structural” substance of the city and its inhabitants. Morphology is the discipline concerned with the interpretation of these traces. In particular, it is based on the idea that the city is a structure made of related parts, modified through history according to recognizable laws; therefore, it can be scientifically investigated. Morphology thus focuses on the rationale driving the process of urban transformation, in search of “behavioral invariables” reiterating in time and space, on which to reconstruct the latent structure acting as underlying support for urban phenomena in their unfolding (Maretto 2012a). 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 social, economic, civic *fabrics*: a morphological structure. But urban morphology involves all the physical scales of dwelling, 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.

Finally, a morphological structure is necessarily a multi-disciplinary structure. After all, the city is multi-scale and multi-disciplinary, 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 morphology to be of great interest in all matters related to issues of sustainability in general and sustainable urban design in particular.

### ***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 the earth's population the technologies of raw earth, wood and stone still represent not only the present, but 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, 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; when the technology of that culture is able to reproduce it and, if necessary, develop it (Maretto 2014). Why urban morphology, then? Because a morphological analysis of ur-

ban 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. 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, that can only be fully accomplished through a renewal of civic awareness, a different use of resources, a different pattern of settlement on the territory. 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, 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 which can serve as the basic strategy for sustainable city planning in the XXI 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); on the other, a complementary sequence of forms related to association and civil organization (from families to urban communities). Sequences that find in the concept of “social neighborhood building” the lowest common denominator of sustainability: the sustainable unit, on which urban strategies of environmental control on a larger scale can be based. Morphology thus becomes the necessary plug-in for registering all the different “networks” that characterize the contemporary city - from IT 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. Therefore, the city is not a “zero emission settlement machine” (Maretto, 2012b). On the contrary, a city is the expression of complex and stratified social, economic and cultural “fabrics”. Their constant interaction, their innovation and transformation over time, is what determines, to a large extent, the success or failure of an urban reality.

## KEY CONCEPTS

All urban organisms can be viewed fundamentally as anthropic settlements on the territory; originally, settlements on natural land, transformed into civic land through human intervention. Yet settlements, starting with the choice of location, require some experience of the environment they become part of; they require at least minimal knowledge of the territory, its resources and productive potential. Knowledge initially acquired through ‘readings’, carried out by nomadic populations while hunting and gathering, and that have become over time an integral part of every urban culture. If the idea of settling in a certain location already presupposes the intention of using the land, such intention can only imply a plan to organize the territory, it can only envisage a rudimentary system of land division, a network of land ownership, however basic it might be. Layout, reclamation, “colonization”, by a settlement, of its relevant territory initially follows the same criteria of its subsistence patterns, through which it acquires full possession of the morphology of the natural land, thus identifying the rationale of its formation and defining its primary structure. A structure that is the basis of any subsequent land and social organization. Yet this structure, even in the rural settlements of the most primitive sed-

entary 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. A community that therefore tends to “gather and identify”, to aggregate in public places. The latter will gradually multiply, differentiate, be arranged by hierarchy as society expands, becomes richer and develops a complex civic structure, accurately mirrored in its system of polarizations, routes and fabrics. Since the appearance of the first permanent primitive settlements, three key concepts emerge that will characterize all human settlements up to the XX century: the concept of polarity, the concept of route, the concept of fabric. These are the three founding elements, one might say, of the discipline of urban morphology; we are beginning to delineate the underlying structural logic on which, over the course of millennia, cities have been built.

### *Polarities*

“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, and the more ‘urban’ the life of an urban aggregate is from the sociological viewpoint” (Bahrtdt, 1966; translated by Alex Lehrnerer, 2009, p.180). 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”, where land was undeveloped although often carefully farmed. Such view generally tended to discern the essence of the location, fixing its special features in a “characteristic image”, an image of significant pictorial quality. The choice of the observation point was therefore of crucial importance, as was the selection of elements that were the master key to the complex social, economic and cultural system of which the city was a manifestation: a unique and recognizable image embedded in memory. Towers, walls, bell towers, domes, minarets, and so on, stand out from urban polarities as recognizable and identifiable elements stating their presence and their role within the social and architectural fabric of a city. 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. Historically, their task is to emphasize the city’s presence on the territory by “unifying in separating” city and countryside, as seen through the entire history of urban iconography. Therefore, we might say that a building, in itself, should not ‘stand out’ unless it represents a social polarity; conversely, a polarization should be distinguished in the environment from the overall building context, according to the mutual interdependence that links the urban fabric to its primary elements. Hence, polarities can have a centralizing or a delimiting effect on 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 neighborhoods (the cathedral church, the parish, the Bishop's or the Lord's Palace, the *Broletto* (Municipal palace), the Market, the Stock market etc..). Conversely, buildings of a specialized nature (city walls, lazarettos, monasteries, military barracks, etc..), due to their greater dimensions and their function within the civic fabric, were usually placed at the edge of town, occupying the urban fringe belts, particularly important because they marked the urban boundary and the sites where exchange with the territory occurred. Therefore, depending on its location within the urban fabric, each building and each public space

achieve an identity and measure the extent of their urban role, an ever-changing role, transformed over time by the dialectic of change within the building and social context.<sup>1</sup> Therefore, the richer and more varied a *civitas* is, the clearer and more noticeable must the symbols be, allowing citizens to ‘come together’ and find their identity in the *urbs*. However, in small-sized towns the relation between fabric and collective themes is clearly perceivable, since such themes have substantial visibility and presence, which confirm and consolidate the image of the *urbs* as a unitary system; in cities of greater size, on the contrary, the perception of the relation is undoubtedly more difficult. The organic value of the city as a whole will thus be entrusted to local themes embodied in its fabric (parish churches, libraries, "town halls", museums, etc.); their task will be to reveal their connection to the wider urban system. But in situations of high polycentricity, where various urban communities (for reasons that are ethnic, religious, cultural, etc.) 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 (if on a lower level), even in the absence of a distinctive building. Moreover, the relation between fabric and polarity is often largely influenced by the general political climate: in situations of highly centralized power, the tendency might well be to condense all community life in emblematic poles, that is in public spaces hierarchized on an urban scale; the exact opposite can occur in situations of strong decentralization. In London for example, during the XVI and XVII centuries, the different urban communities were generally brought together and identified by parishes, which were responsible, among other things, for census control of citizens, therefore acting as an indispensable link to the major political and social urban hierarchies. Hence, two key elements emerge when studying the concept of urban polarity. The first is the dynamic relation that is established between polarities. The very supporting structure of an urban organism depends on it. And it is thanks to the relation between polarities that urban structures can actually survive and change. It is on the basis of such relation that a city can be read according to its basic large-scale formative processes.<sup>2</sup> The second key element is the relation that develops between polarities and urban fabric. The relation is reciprocal: the fabric indicates the various potentials for polarization, however only through the physical construction of polarities that the potential can materialize and the fabric can be realised. Except of course the fabric will once again ensure the survival of polarities, supporting their function over time.<sup>3</sup> We can therefore see how 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 center and periphery, polarity and anti-polarity: dialectical (and hierarchical) systems, concerning urban areas that are relatively self-sufficient and might give rise to an “urbanity”, but systems that remain complementary to the wider urban organism. Autonomy and complementarity are at the basis of the formation, over time, of an organism that is flexible, dynamic, open to change, yet always consistent in its development process. This organ-

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<sup>1</sup> Many landmark buildings of collective significance, when faced with the decline of the functions that generated them, have maintained their urban structural value; this is the result of a “dispositional value” (Rossi, 1966) the building fabric has given them throughout the centuries, and hence of an urban culture that has supported and nurtured their meaning over time.

<sup>2</sup> The historic center of Parma is a case in point. Two radial polarities, situated on the periphery and distant from each other in time, clearly mark the two major phases of urban expansion.

<sup>3</sup> In Parma, once again, a diachronic reading of such relations along the major urban axis (Via Emilia) allows us to analyze, to a good approximation, the different periods of expansion from a purely “structural” point of view. Note, in particular, the relationship that develops between internal and external polarities and the formation of new building fabrics.

ism is the contemporary city, with its sudden transformations and its age-old rationale. A city which is “the object of nature and the subject of culture; it is individual and group; lived and dreamed: a human thing par excellence”<sup>4</sup> (Levi-Strauss 1968).

### ***Routes***

Routes are an instrument which allows us, perhaps more than any other, to understand and interpret the process of anthropization of a territory in its “structural” aspects. Aspects which are able to create a synthesis of a society’s many dimensions at a given place and at a given time, in order to grasp the elements of continuity and discontinuity in its relation to pre-existing and subsequent societies, and ultimately understand its settlement morphology. The more a context is anthropized, the more the rationale of route formation is accurate and concise, eventually becoming recognizable and assessable within urban fabrics. In general, a distinction can be made between planned systems and spontaneous systems. We will focus especially on the latter. In fact, when analyzing the underlying logic beneath the formation of urban fabrics over time, “informal” and everyday aspects must be especially taken into consideration, as they have a key role in all of the city’s transformations and they are the direct expression of the vitality of an urban society; therefore, understanding such aspects and knowing what direction to give them, where possible, can mark the difference between success or failure of an urban regeneration project. Overall, we can identify a few ‘basic’ route typologies generally found in all spontaneous building fabrics, from medieval towns to contemporary informal cities. Routes are part of the very rationale of settlement and therefore constitute an appropriate basic structure for reading and consciously planning urban transformations. Hence, given any two nodal points (urban or territorial), the route linking them in the most direct possible way will be termed a matrix route. As a rule, it is formed independently of building on its margins, nevertheless some form of utilization of its margins will be likely to occur soon, if not in terms of construction, certainly in terms of production. And later, when building does develop, it should be viewed not so much as the first instance of utilization of the route margins, but as the result of transformations in the plotting of agricultural land; the new building therefore stands as evidence of actual change in the land fabric. A matrix route, in fact, despite its purpose of ensuring a quick and possibly straight connection from one polarity to another, is deeply connected and influenced by the morphology 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. As a consequence, any building activity that will subsequently involve the margins of a matrix route will mediate the selection of orthogonal lots of quadrangular shape, in order to follow the route’s trajectory. This will normally determine a relatively continuous pertinent strip, essentially parallel to the route’s outline, the depth of which will depend on diachronic variations, at any given time, in the lot type (building type) determining its shape at any given time.<sup>5</sup> However, at least at first, building along a linear route tends to have a limited longitudinal extension. In order to

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<sup>4</sup> *Elle est à la fois objet de nature et sujet de culture; individu et groupe ; vécue et rêvée : la chose humaine par excellence.*

<sup>5</sup> A pertinent strip that will be asymmetrical, that is on only one side of the route, in the presence of a strong morphological dissymmetry of its two margins, as in the case of a route flanking a water course or the sea, or a steep slope.

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 therefore center 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, thus called because conceived from the very beginning as planned routes for building, likely to form a fabric. They will typically develop orthogonally to the matrix route they insist upon, with the respective pertinent strips positioned at the edge of the main route’s pertinent strip. The need for optimum use of the new building fabric will entail, however, a preference for parallel placement of the new building routes, rather than for orthogonality to the matrix route; variations in the latter will not necessarily determine any change in the outline of the urban fabric. In particular, if the matrix route, flexing, should lead to a change in its (orthogonal) building direction, an inflection point will be formed in correspondence to the boundary of the ‘main’ pertinent strip, on which the new route will be traced. Finally, building routes will tend to be as rectilinear as possible, in order to allow for orthogonal arrangement of building lots. The average distance between one building route and another, within the same fabric, will obviously correspond to twice the size of the pertinent strip; *in embryo*, the future dimension of an urban ‘block’ will be codified. 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). In particular, when a route is formed at the edge of building, it will tend to develop a single pertinent strip, on the opposite side of the lateral boundary of previously built houses; when, on the contrary, serial building, possibly hasty, will have already exceeded the maximum linear distance (from a nodality) for the proper functioning of a building system, the route can be formed by demolishing two houses opposite each other, giving up the pertinent strip. The route will no longer be necessarily rectilinear and continuous, but may be fragmented between one building route and another. At this point, the concept of urban block has finally emerged. Before the building blocks of the XIX and XX centuries, and often even then, the pertinent strips of each route certainly showed a more cohesive relation to each another, when compared to the ‘block in progress’: roads were always the privileged sites for neighborhood unity, and even those magnificent communal courtyards, which made such an important contribution to the history of European cities at the turn of the XX century, will rarely achieve such urban and civic significance. Terms such as *borgo* and *contrada* indicate how the module for the formation of urban fabrics is the building route rather than the block. What distinguishes the concepts of “road” and, more generically, of “route” is precisely the fact that building, although diversified, occurs along the margins, which turns a road into an “urban route” in all its possible manifestations.<sup>6</sup> The city, however, is a dynamic organism which, through constant transformation of its urban structures, acquires the ability to evolve and last over time. It is therefore necessary to introduce a fourth and final type of route: the restructuring route. This is the typical route that is superimposed on a previous fabric when it is deemed necessary to create a direct link between pre-existing and new polarities. By its very nature it tends to exhibit different building types, more recent and more specialized,

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<sup>6</sup> In many cities - as remarked by G.Caniggia - the term *via* (way) has long been adopted for outer routes, dubbed *borgo* (village) when it turns into a building matrix route and *contrada* (district) when it becomes an internal connecting route between two roads; the terms always indicate both the route and its buildings.

and its very road section, since it depends on a more up to date “type”, will tend to expand and differentiate. Finally, it will be likely to run diagonally to the built environment, forming, as a result, trapezoid-shaped lots. A restructuring route is therefore often the privileged site for constructing specialized buildings. This is true for two reasons: first, the tendency is to compensate, through buildings that produce greater income, for the surplus obtained through restructuring; second, such specialized buildings generally have a preference for smaller blocks, such as the ones inevitably generated when restructuring pre-existing fabrics, in order to fully occupy them. The planned city, on the contrary, can be considered from a morphological point of view as a special component of the informal city. This means that, except for urban projects of an openly ideological or utopian nature, the construction of its fabrics is significantly, if not totally, spontaneous, where spontaneous does not necessarily mean chaotic, random, “disorderly”. On the contrary, the level of regulation depends on the degree of civic development of the society planning construction: particularly advanced systems develop “spontaneous” fabrics that are sufficiently ordered; the ordering element is not so much due to building regulations, more or less systematic, but rather it is based on continuity with a *modus operandi* in use for centuries, which leads to the adoption of well developed and efficient building types, the direct expression of the society’s degree of civic maturity. This is true, at a later date, when urban planning will not occur through a network of restructuring routes, as in the case of the Haussmannian plan for Paris. This is why only two grid systems are distinguished, “equivalent” or “hierarchical”, within which building fabrics can be constructed. It is not the grid’s shape, in fact, that matters, but its "structural" significance within the city. Thus, a dynamic and vital structure lies at the core of urban transformation in spontaneous cities. A concrete structure, directly related to both the settlement and life-demands of an urban community. Knowing how to read and increment such structure is a fundamental prerequisite for the sustainable design of urban fabrics and contemporary cities.

### ***Fabrics***

A city is an organism made of “fabrics”. Social, economic, cultural and environmental fabrics, energy and information networks: the very functioning of an urban structure depends on their interaction. The more such fabrics are interrelated and efficient, the more the organism will be dynamic, versatile and capable of meeting the demands and aspirations of its citizens. While it is unnecessary and perhaps impossible to try and understand the form of such fabrics, it is possible and necessary to understand the logic of their relations. The modes of interaction between fabrics in fact express how citizens inhabit their city, express 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.

If the distinction between internal and external polarities is crucial for defining a city as an organism, the reasons behind the formation process of its building structures, its fabrics, lie within the “nodality”-“anti-nodality” dialectic, where nodality does not necessarily coincide with the center, and anti-nodality does not necessarily correspond, in a strict sense, to the periphery. It 's a matter of basic behavioral priorities, and therefore of hierarchies derived from such priorities. A fundamental distinction must be made between the two concepts of “node” and “pole”: “by node we mean any singular point on a continuum” (G. Caniggia, 1979). If we assume a

continuum to be any generic route, a node will be its intersection with other routes. If the routes in question are urban routes, their homogeneously built walls will give the continuum, and the "node" will be emphasized by the increasingly specialized features of the building (or buildings) built at the point of intersection. Furthermore, if we assume an entire building fabric as a "continuum", the "nodes" will be identified by the location of such "specialized" buildings, constructed in correspondence to an equal number of "nodalities", in order to organize and connect them to the wider urban fabric. Hence, by extension, the concept of "pole", a sublimation of the term "node": when a greater number of nodalities converge, the location takes on a greater urban relevance and becomes a "polarity". Nodalities and anti-nodalities can therefore be "punctual" but they can also be "linear". When, for example, punctual nodalities tend to concentrate along a same route, then they take on the role of "linear nodality".<sup>7</sup> This state of nodality will be paralleled by a greater fabric specialization, which will regularly decrease as the distance from the nodality increases, finally reaching the opposite condition of "anti-nodality". The latter will coincide with an absence of specialization and the progressive decline of urbanity. The nodality is the "center", the anti-nodality is the "periphery"; the former is axis, the latter is boundary, and so on. It goes without saying that between two centers there is always a periphery, that is between two nodes there is always an "anti-node", regardless of their geometric location within the city: the nodality-anti-nodality dialectic involves all spontaneous urban fabrics, whether they are located at the center or at the edge of the urban organism. Their very vitality depends on such dialectic, which determines, at least partially, the vitality of an urban organism. An organism whose fabrics are transformed by the development of an articulated system of hierarchies (axes-boundaries, nodes-antinodes, center-periphery). The system's complexity will mirror that of the historic and civic articulations and stratifications it expresses. In other words, the greater the urban core, the more complex and structured will its hierarchical organization be; vice versa, the component elements of medium to small-sized urban cores will have a simpler hierarchical system. Therefore, centuries of work on urban structures leaves us building fabrics that are ever-changing, congested and re-elaborated according to the logic of necessity; they are, perhaps, the most striking evidence of a city's history.

### *The neighborhood-building unit*

There is a system of built structures which has the essential task is to mediate the transition between the citizen's (or family's) individual, sociological dimension and the city's public dimension. The more complex the public dimension is, the more important the role played by the structures in the functioning of an urban organ-

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<sup>7</sup> Therefore a settlement's "main street" fully takes on its urban role, and consequently its role as "linear" nodality, only when a number of significant polarities are placed along its length. And after all, the medieval cross-shaped street arrangement became an appreciable "figure", capable of visually imposing itself on the fabric, only when at least one of its axes was thematized (through polarities), or both axes became the common thread running through a series of collective themes, which find full expression precisely in the cross shape. The same can be said for another great urban theme, those "monumental streets", or aristocratic-building neighborhoods, which, beginning in the sixteenth century, characterized many European cities. If we look for instance at Paris, at the examples of *Rue de Francs-Bourgeois* and *Rue de Rivoli*, we notice that the presence of a line of grandiose palaces or in any case of grandiose architecture on an urban scale is not sufficient to establish their "monumental" character; on the contrary, it is necessary for the street to be part of a succession of manifest urban polarities. Hence, if *Rue de Francs-Bourgeois* finds its conclusion and "recognition" when it merges into *Place Royale (Place des Vosges)*, *Rue de Rivoli* reaches its epiphany when connecting to the Louvre, on the one hand, and to *Place Louis le Grand* on the other.

ism. Such structures, at the same time physical and social, are the result of “social building neighborhoods”, and have been entrusted for centuries with an important role in building the city. The neighborhood, in fact, although it represents the indispensable link between families (small-scale) and communities (large scale), is generally non-institutionalized, and essentially recognizable only in a building context. Identifying the neighborhood unit was, for centuries, the fundamental tool used for urban and building planning. Perhaps the most considerable historic example is that of Venice, where between the XIV and the XVIII century the Republic or other public institutions (*Scole*, arts and crafts guilds etc.), built a number of famous and beautiful social housing units, generally centered around ‘intentional’ neighborhood spaces: the courts, whose origin can be conceptually traced back to the Romans’ interpretation of the lagoon environment. Other significant examples, which appeared thanks to private enterprise, are medieval *Béguinages* and later Dutch *Hofjes* (a term that literally means “inner courtyards”), as well as the well-known *Begijnhof* in Amsterdam, all the way up to the very famous Augsburg *Fuggerei*. But perhaps even more significant, in addition to the Venetian court, are other planned building organisms such as the British square, with its common areas well enclosed by the walls of houses (often serial and therefore unitary in their “collective” image), open to the city through proper entrance ways and polarized at the center by a collective service: the garden, the communal well in Venice, and so on. Neighborhood social building 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 neighborhood is. It is, so to speak, an “everyday” need to belong, which cannot always be 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 neighborhood space. A space to carry out all those co-housing activities which used to be, at least to a certain extent, implicitly part of extended family systems and have now become indispensable in a contemporary metropolis: nurseries, workspaces, laundries, sport facilities and more. Neighborhood social buildings represent, moreover, the sustainable urban unit of contemporary cities. Their nature, both collective and unitary, in fact allows for the implementation of a first strategic level of sustainability, which downscaled to individual buildings would not in fact be very effective. Rainwater and gray water collection, centralized heating systems with clean energy production, “neighborhood” based and meticulous collection of waste, are just some of the needs the construction of a neighborhood unit can meet. Yet all ancient streets, since they represent a building identity acquired over time, are essentially neighborhoods, places where mutual relations, encounters, communication and exchanges in general take place, to the extent that specific work activities are brought together: see the countless examples of “Blacksmiths”, “Bakers”, “Apothecaries”, “Wool” streets... a legacy that medieval toponymy has handed down across all of Europe, all the way up to the well-known examples of aristocratic neighborhoods such as *Strada Nuova* in Genoa, or the series of “architectural squares” such as Place des Vosges in Paris and, later, the various *Places Royales* in France, or *Plaza Mayor* in Spain, and the like. Finally, mews are also an interesting case in point; traditionally linked to squares and terraced houses in London, when they permanently

lost their pre-existing specialized role and turned residential, starting in the 1970s, they became perfect, if small, neighborhood units, complete with entrance gates and a central collective space: a sort of “neighborhood within the neighborhood”, confirming the great popularity this type of structure will enjoy in contemporary cities. The value of social neighborhood building therefore lies in its intermediate position, both from a social and urban point of view, between citizens and *civitas*, public and private spheres, communal and individual rights, between the utmost open and permeable urban space and the utmost closed space, focused on its pertinent features. Social neighborhood building is 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 XXI century.

## **Hierarchies**

Finally, a concept runs through the issues discussed so far and strongly influences them: the concept of hierarchy. Hierarchy, in actual fact, means assigning priorities. It might be long or short-lived, but it is never static, on the contrary it is essentially dynamic in nature. Every human being, indeed, thinks and acts in terms of priorities. This is how we understand the reality that surrounds us and, more importantly, how we transform it through our actions. Without assigning proper priorities, the world would appear to be a compact indecipherable mass, a tangled skein we are unable to unravel. 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; they also offer dynamic references on which to base the project of transforming the 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; therefore, they represent an effective area where a synthesis can occur between the civic priorities of a community and its members and the building hierarchies originating from such priorities, successfully prioritizing all urban structures. 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 in that point. The latter determine the distinction between “node” and “pole”, but also their duration in time. Two “internal” polarities may have a strong hierarchical 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 “empty” spaces to be occupied. These spaces continue to play a key role in the design of cities, whether they are large urban plazas or they simply

have local relevance, inasmuch as they identify particular urban sectors (a *contrada* [district], a *sestiere* [quarter], a *campo* [field] and so on), or, finally, when they take on a specialized role as in the case of the many *piazze di mercato* (market places) or *prati* (grass) (*Prato della Valle* in Padua, *Prato della Fiera* in Ferrara etc.). The quality of a public space is often reflected and enhanced by the presence of a building of public relevance (polarity), which often embodies the role of that public space. But urban polarities, as mentioned, are established by the system of routes, which therefore remain, in this case as well, the prime factors in assigning urban hierarchies. This is confirmed when we look at fabrics as a whole. The process of spontaneous formation of urban fabrics takes place, as previously stated, according to a nodality - anti-nodality dialectic. A dialectic, however, that is at the very core of assigning priorities and/or hierarchies, the very topic of our inquiry. In addition, 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. Routes are the first to qualify public spaces. Routes, finally, confer temporary and dynamic order to building fabrics. Routes, polarities and hierarchical open spaces are therefore instrumental to how a fabric is formed, transformed and hierarchized over time; such fabric will hand down an open, dynamic system, capable of constantly holding together the civic and social aspects of a city with its architectural and urban features. But if fabrics determine the hierarchy of all urban structures what, then, determines the hierarchy of routes? Cities are open and highly interconnected organisms. All their characteristic dynamics act simultaneously on a number of levels. If it holds true that routes are at the origin of every human settlement on the territory, that they are the means through which nomadic societies experienced territorial resources and, once they became sedentary, selected, on an informed basis, a location for their very first settlements, it also holds true that the hierarchization, at a later date, of urban paths runs parallel with the hierarchization of the society that built them, in a constant and continuous interaction. Therefore, 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) will typically be occupied by highly specialized buildings, even to the complete exclusion of private residences. Building routes originating from said route are most likely to exhibit a good mix of both specialized and residential functions, while the degree of specialization will decrease in diagonal paths, 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 “center” and “periphery”, “nodality” and “anti-nodality” are not geometric: it is therefore possible to find nodes and anti-nodes in the very center 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 rise 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 morphology relies on them to read urban phenomena. They also are, as a consequence, the thematic framework for a methodology aimed at planning the smart, sustainable, livable city of the XXI century.

## The MORPHOLOGICAL MAP

All the issues addressed so far serve as the basis for devising an analytical tool we shall call a Morphological Map. A tool that records all the basic information discerned through the key-concepts, while also listing and analyzing all the characteristic “structural” elements of the morphology of a given urban environment. Such elements, as mentioned, are direct expression of “fabrics”, since they are the primary vehicle for the identity and efficiency of an urban organism. Open, dynamic, constantly changing fabrics, reflecting the societies that support them; fabrics the Morphological Map aims to trace, as a system in progress whose main purpose is to provide a morphological basis open to amendments, and a point of departure for subsequently configuring those functional layers which, on a case by case basis, characterize the life of a city. A map offering complementary ‘levels’ of reading, each to be analyzed 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; it is open to a great number of sub-levels, in order to better define its qualities according to need. Hence, a morphological-structural map, allowing at any time the transition from smaller to larger scales (and vice versa) that are typical of urban phenomena, yet never losing track of the whole picture. Therefore, functional requirements become issues to be solved within a broader instrumental framework, rather than design tools; they become part of a more complex and organic plan: the city and all of its constituent parts. This is very important, since sectorial and functionalist approaches to urban design are often only apparently effective, while, on the contrary, they lose sight of the inevitable retrofitting factors that interventions on complex systems involve. Such factors, at times, end up being even greater and more damaging than the specific problem the intervention in question set out to solve. Thus, it should be noted that the very structural elements used to analyze a given urban context could become valuable design tools. Indeed, on closer inspection, structural knowledge of an urban environment, with its resulting Morphological Map, allows to ‘structurally’ plan its transformation. It will hence be possible to draw up an analytical map and a design map, in a relation of absolute continuity both logically and structurally, to act as the basis for urban design. The advantages of such a system are apparent. On the one hand, it makes planning by stages possible, without ever losing sight of the overall picture, without overlooking the retrofits that might be necessary in any urban intervention; all this while also implementing a constant strategy to monitor and verify the project, thanks to the relationship of reciprocity between all morphological levels. On the other hand, it makes it possible to correct, edit, sharpen the project without having to start all over again every time. Moreover, because they are ‘morphological levels’, therefore, as previously stated, strongly hierarchized structural elements, it is always possible, when focusing on a specific layer, to accurately scale down what is being worked on without any loss of ‘orientation’, so to speak. In other words, if at any time intervention on the fabric of a single block is necessary, one will always know what “type” of block it is and its intrinsic properties, what “type” of routes it rests on and what this involves in terms of fabric, whether the condition is one of nodality or of anti-nodality, and so on: a sort of “compass”, allowing for morphologically informed choices, no matter how specific and particular the intervention may be. The Morphological Map, hence, will lend continuity, rationality, flexibility, operational efficiency, and ultimately identity to urban designs. Urban

morphology should be at the basis of the sustainable design of contemporary cities precisely because it addresses the very substance of urban fabrics, the rationale that determined their transformation over time, and uses such rationale as a flexible, dynamic, concrete planning tool. An informed plan, where all the different scales of dwelling are held together and never confounded, where the social, economic and cultural aspects of a city are linked to its physical, environmental and technological features. Without ever losing sight of its ultimate objective: planning the smart, sustainable, livable city of the XXI century.

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