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Vítor Oliveira

Urban Morphology

An Introduction to the Study of the Physical Form of Cities

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An Introduction to the Study of the Physical Form of Cities

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To my parents—Maria Teresa Araújo and Manuel de Oliveira—my best friends…

To Cláudia, my wife, for sharing my life over the past two decades.

Foreword

Urban morphology as a field of knowledge has grown substantially over the past two to three decades. This is evident not only in the major increase in the number of articles on this subject and the range of journals in which they appear but also in the increase in the number and size of conferences with urban morphological themes. Most of the major conferences, together with the initiation of the international journal *Urban Morphology*, have stemmed from the foundation in 1994 of the International Seminar on Urban Form (ISUF)—the first international organization of urban morphologists. This has also been the catalyst for the formation of numerous national and regional organizations devoted to this field.

There has not, however, been a commensurate growth in the number of books on urban morphology. Indeed it is hard to identify a single book in the English language that could readily be identified as an urban morphology textbook. This lacuna poses problems for students seeking a concise introduction to the field, as well as for researchers moving into urban morphology and seeking an economical review of its objects of investigation, concepts and methods. This deficiency has now been rectified by Vítor Oliveira, who is one of the foremost current contributors internationally to urban morphological research, writing and editing, and also one of a group of academics who have done most to shape ISUF in the course of the second decade of its existence.

In assessing the recent flourishing of the study of urban form, it is important not to lose sight of the antiquity of the object of investigation—the urban area in all its physical manifestations, beginning with its fundamental place in the earliest civilizations. As a subject of study, these most intensively occupied areas of the earth's surface have very long histories, though, as in many other fields of knowledge, the appearance of this type of study in scholarly journals was rare until the end of the nineteenth century. The amount of the earth's surface covered by urban areas has in the meanwhile expanded enormously. Now occupied by over one-half of the world's population, it is no small task to encapsulate in a single short book a concise but wide-ranging account of the physical forms of these urban areas and their methods of study. But Oliveira achieves this by careful choice of examples,

minimal use of technical terms, and effective use of maps, diagrams and photographs.

Integral to the forms of urban areas are the agents and agencies that create and transform them—for instance, the developers, architects, builders, planners and politicians—and these too find a place in Oliveira's coverage. However, arguably one of the most important contributions of the book concerns its bringing together of material that all but established urban morphologists would find very time-consuming to assemble for themselves. The chapter on the different approaches to the study of urban form is a notable example. In addition to introducing 'classic' publications by major individual contributors to the field, summaries are provided of the historico-geographical approach, the process-typological approach, space syntax and pertinent types of spatial analysis. This leads logically to consideration of comparative studies that have been undertaken of different approaches.

There is much here that is expressive of Oliveira's personal sensitivity to the relationship that urban morphology has with various disciplines—geography, architecture and urban planning to mention three of the more important. It is particularly evident in the links he discusses between the explanation of urban form and the ways in which this can be put into practice, not least in urban planning. The reader benefits from the author's personal experience of applying an appreciation of urban form to practical challenges. The scales considered range from individual plots and buildings to intra-urban regions and entire cities. There is also a reaching out to address social, economic and environmental dimensions more widely, exploring urban morphology in relation to such matters as public health, social justice, heritage tourism and energy.

This book is described by its author as a manual. In fact it is more than that. It is true that it does provide a systematic treatment of basic attributes of urban morphology, and in this respect it is unique among books in the English language. However, it has an important place in the literature in another way. It inspires as well as informs. It argues for an approach that is investigative and widely applicable, including in dealing with practical problems, but it is also integrative. And this approach is not only sensitive to history and culture but also amenable to systematic application. The varying identities of urban landscapes are viewed as central to both research and practice. In this and other respects the gap is large between what is espoused here and the realities of planning practice as they have been uncovered in the real world of today. Underlying this problem, Oliveira argues, is the limited extent to which much that is currently being created in the urban landscape is informed by a sound grasp of urban morphology. Among its various merits, this book is a valuable step towards educating new and potential recruits to urban morphology in how they can help to rectify this serious defect.

January 2016

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Any work that summarises thinking developed over a significant period of time owes much to other people. It is impossible to acknowledge all of them. I can do no more than indicate the major sources of inspiration, most of them fellow academics and researchers, whose paths crossed mines at various times.

First, I would like to thank Jeremy Whitehand. The first scientific paper on urban morphology I have read, back in 2003 when I was starting my M.Sc. thesis, was 'Recent developments in urban morphology' by Jeremy Whitehand, published in 'Urban Studies' in 1992. This paper gave my first references in the field describing the work of M.R.G. Conzen and of most members of the Urban Morphology Research Group (UMRG), of Michael Batty and of Gianfranco Cannigia. Three years later, my first paper in a peer-reviewed journal, 'The morphological dimension of municipal plans', was published in 'Urban Morphology', the journal led by Jeremy Whitehand. Over the past decade, in a direct (through personal conversations or through email correspondence) and indirect way (through his notable and extensive work), Jeremy Whitehand has been my main influence in the field of urban morphology. It is my strong conviction that no one has done so much for our field, in the past two decades, as Jeremy Whitehand has done.

Writing this book was made possible by the *Centro de Investigação do Território Transportes e Ambiente* (CITTA) granting me a considerable period of time for writing in 2015. I wish to express my deep gratitude to Paulo Pinho, the director of the research centre and the supervisor of my M.Sc. and Ph.D. thesis concluded in 2004 and 2008, respectively. I would also like to thank another of my former professors, Alfredo Matos Ferreira, who recently died. Back in the mid-1990s, in the *Faculdade de Arquitectura da Universidade do Porto*, Matos Ferreira has shifted my architectural focus from 'buildings' to 'cities'. Over the past 20 years, the passion on cities continued to be part of our conversations.

A number of colleagues in the International Seminar on Urban Form (ISUF) has influenced my morphological thought: Ivor Samuels, Susan Whitehand, Michael Barke, Peter Larkham, Karl Kropf, Michael P. Conzen, Kai Gu, Giancarlo Cataldi, Giuseppe Strappa, Nicola Marzot, Marco Maretto, Paolo Carlotti, Paul Sanders,

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Contents

Abbreviations

ABM	Agent-Based Models
CA	Cellular Automata
CAMUSS	Automata Modeling for Urban and Spatial Systems
CASA	Centre for Advanced Spatial Analysis
CISPUT	*Centro Internazionale per lo Studio dei Processi Urbani e Territoriali*
CITTA	*Centro de Investigação do Território Transportes e Ambiente*
COP	Conference of the Parties
DCP	Department of City Planning
ENPAS	*Ente Nazionale di Previdenza ed Assicurazione Sociale*
EUR	*Esposizione Universale Roma*
INA	*Istituto Nazionale delle Assicurazioni*
IPCC	International Panel on Climate Change
ISSS	International Space Syntax Symposium
ISUF	International Seminar on Urban Form
JOSS	The Journal of Space Syntax
LUBFS	Land Use and Built Form
LUTI	Land Use Transport Interaction
PNUM	Portuguese-language Network of Urban Morphology
POS	*Plan d'Occupation des Sols*
UCL	University College London
UMRG	Urban Morphology Research Group
UN	United Nations
UNESCO	United Nations Educational, Scientific and Cultural Organization

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Chapter 1
Introduction

Keywords Cities · Disciplinary history · Manual · Urban form · Urban morphology

1.1 Motivation

Very few things give me as much pleasure as walking, for the first time, through the streets of a city. The moment when I leave the hotel in the first morning, usually carrying a map, a sketchbook and a camera, has an intense meaning for me, representing the beginning of the discovery of the city… this magnificent creation of mankind. That particular morning and the following days are of intense learning. I try to leave the hotel as early as I can, and to arrive as late as possible. In the numerous walking trips I take some photographs, quick sketches and brief written notes. Leaving a city is always sad, even knowing that my beloved city, Porto, will always be waiting for me. Sometimes, I return to the visited city earlier than I have expected. When returning, I always take the map that I have used in my first visit, and continue to 'draw all the visited streets'. It is good to know that there are always new lines to be drawn…

As my passion for cities continued to grow, taking an increasingly central place in my academic and research work, I have realized, with some perplexity, that there were not many textbooks on the study of the physical form of cities. Initially, I thought that this was lack of knowledge, but quickly, through my research work and through contacts with Portuguese and foreign colleagues, I have acknowledged that there is indeed an absence of manuals on urban morphology.

This book has that particular goal, to be a manual… a manual that be able to introduce the reader into the wonderful world of the study of the physical form of cities. In this sense, the book is first directed to researchers, academics and students of M.Sc. and Ph.D. courses where urban morphology is a fundamental theme, including geography, architecture, planning, engineering, and also history, archaeology and sociology. It is also directed to professionals that, in a systematic way, deal with the physical form of cities: planners, architects, engineers and others.

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Finally, this book is for all those who are interested in cities, and that, like me, always want to learn something more about 'the most complex of human inventions' (Levi-Strauss 1955). To achieve this goal, I have tried to make a simple and small book, using very simple language. This does not mean an easing of the contents, but of how these are communicated—highlighting the essential and eliminating the superfluous elements.

My personal experience is reflected in the book: from my basic training in architecture, to my daily work in the *Centro de Investigação do Território Transportes e Ambiente* (CITTA), to the intense debate in the two morphological research networks in which I am most deeply involved—the International Seminar on Urban Form (ISUF) and the Portuguese-language Network of Urban Morphology (PNUM) to the indispensable trips into the different cities that I had the pleasure to visit…

1.2 Object of the Book

This book is about urban morphology. It is hard to find shared definitions, by different morphological approaches, of 'urban morphology' and of 'urban form'. This book draws on the basic definition that urban morphology means the study of urban forms, and of the agents and processes responsible for their transformation, and that urban form refers to the main physical elements that structure and shape the city—urban tissues, streets (and squares), urban plots, buildings, to name the most important. The theme of the different elements of urban form will be developed in detail in the second chapter. In this book, the word 'city' is used in its wider sense.

The word morphology was first proposed by Johann Wolfgang Von Goethe (1749–1832), the famous German writer and thinker, who devoted part of his work to biology. Goethe used the word morphology to designate the 'science that deals with the essence of forms'. Although it was proposed as a branch of biology, the general and abstract nature of morphology enabled its application in many different fields. Table 1.1 shows a set of definitions of urban morphology proposed by different authors.

Despite the reduced number of manuals, there are many texts on various aspects of urban morphology. Faced with the impossibility of bringing all of these into the debate, I had to make some choices. This book is particularly informed by papers published in scientific peer-reviewed journals written in English language. These papers have three fundamental advantages as a source of knowledge: updated information, scientific validation, and consideration of local issues under a wider framework. Yet, emphasizing these advantages does not mean that a significant disadvantage, underlined by authors such as Jeremy Whitehand or Michael Conzen, is ignored: it is easier for an author who has English as his native language to prepare a text in this language. This leads to the existence, in these journals, of what the two authors describe as 'anglophone squint' (Conzen 2011; Whitehand 2012). However, it also seems fair to say that in most of the scientific journals in this field of knowledge a paper is not rejected by the lack of quality of English writing.

Table 1.1 Definitions of urban morphology (*Source* Marshall and Çalişkan 2011)

	Definition	Source
General	'The study of urban form' 'The science of form, or of various factors that govern and influence form' 'The study of the physical (or built) fabric of urban form, and the people and processes shaping it' 'Morphology literally means form-lore, or knowledge of the form…what is the essence of that form; does certain logic in spatial composition apply, certain structuring principles?'	Cowan (2005) Lozano (1990) Urban Morphology Research Group (1990) Mayer (2005)
Focus on the object of study (urban form)	'…an approach to conceptualising the complexity of physical form. Understanding the physical complexities of various scales, from individual buildings, plots, street blocks, and the street patterns that make up the structure of towns helps us to understand the ways in which towns have grown and developed' 'Urban morphology…is not merely two dimensional in scope. On the contrary, it is through the special importance which the third dimension assumes in the urban scene that much of its distinctiveness and variety arise'	Larkham (2005) Smailes (1955)
Focus on the manner and purpose of study	'A method of analysis which is basic to find (ing) out principles or rules of urban design' '…the study of the city as human habitat… Urban morphologists…analyse a city's evolution from its formative years to its subsequent transformations, identifying and dissecting its various components' 'First, there are studies that are aimed at providing explanations or developing explanatory frameworks or both (i.e. cognitive contributions); and secondly, there are studies aimed at determining the modalities according to which the city should be planned or built in the future (i.e. normative contributions)'	Gebauer and Samuels (1981) Moudon (1997) Gauthier and Gilliland (2006)

Books and unpublished doctoral thesis deserved special attention in the construction of this manual. In these cases, language proved to be a barrier: only texts in English, French, Italian, Portuguese and Spanish were considered. Finally, communications in scientific conferences in this field of knowledge—such as the International Seminar on Urban Form, the International Space Syntax Symposium (ISSS) and the annual conference of the Portuguese-language Network of Urban Morphology—were considered and incorporated in the book.

1.3 Structure of the Book

The book is organized in nine chapters. After this brief introduction, the second chapter focuses on the different elements of urban form. The presentation of these different elements follows an order of increasing resolution of urban form. It starts with a description and explanation of the different urban tissues that we can find in our cities. It then increases the resolution and moves to the natural context and to the system of public spaces that constitutes each urban tissue, analysing both the spaces for circulation and for permanence. The chapter moves then to the urban plots which are, in our cities, the physical expression of individual property and, as such, distinct from the public or collective space. Once again increasing the level of resolution, the chapter moves to the buildings that constitute the urban tissue of a city including not only exceptional buildings but also current buildings.

The third chapter focuses on the different agents and agencies responsible for, and on the complex processes of, urban transformation. It analyses how each one of us takes part in the process of transformation of the urban landscape: as a promoter of an action of transformation of the urban forms, as an architect responsible for the design of new physical forms, as the builder of these forms or, in a more indirect way, as a planner designing a city vision and guiding private activity in his day-to-day practice of development control, or as an elected politician defining a political strategy for the city. In addition, the chapter aims at understanding the processes of urban transformation: how do we organize ourselves as a society to build a balance between a comprehensive view of the city, usually a planned view, and a number of different contributions, eventually associated with a higher spontaneity. It is argued that this balance between unity and diversity is essential in a city that wants to be attractive in morphological terms.

After introducing the main objects of study in urban morphology—the urban forms, the agents and processes of transformation—the fourth chapter of the book analyses the evolution of cities over history. The structure of the chapter draws on seven historical periods that are relatively consensual for different researchers: (i) early cities, with a particular focus on Mesopotamia and China; (ii) the Greek cities, (iii) the Roman cities, (iv) the Islamic cities, (v) the Mediaeval cities, (vi) the Renaissance cities, and finally, (vii) the nineteenth century cities. The main goal of the chapter is to understand how the main elements of urban form—streets, plots and buildings—were combined in each of these periods and what the main characteristics of these elements were.

The fifth chapter addresses contemporary cities, with both inherited and emerging urban forms, investigating the main urban agents and city-building processes. Three case studies were selected: three clearly distinct cities, with different weaknesses and threats, and with specific strengths and opportunities. These cities are New York, Marrakesh and Porto. Founded in the early seventeenth century by the Dutch settlers, the city of New York has been continuously growing, in a remarkable process of urban evolution, marked by the 1811 plan (establishing its orthogonal layout), that culminated in today's magnificent metropolis, structured in

five main areas (Manhattan, Brooklyn, Queens, Bronx and Staten Island) and the place of residence for more than eight million inhabitants. The urban forms of Marrakesh are clearly different from the urban forms of New York. Marrakesh, one of the four imperial cities of Morroco, was founded in mid-eleventh century by the Almoravids. Ten centuries of urban history are today present in the remarkable medina of Marrakesh. The city with almost 1 million inhabitants is also composed of areas developed in the twentieth century, such as the *Guéliz* and the *Hivernage* neighbourhoods. The urban forms of the third city, Porto, are very different from the urban forms of the American and Moroccan cities described in this chapter. Founded in mid-eleventh century, as Marrakesh, Porto grew from a small castel town to an area 12 times larger in a period of two centuries. In a unique location facing the Atlantic Ocean and the Douro River Porto is, today, the centre of a metropolitan area with 1.7 million inhabitants.

After a first set of chapters focused on the object (the city), the sixth chapter changes the emphasis to the researcher (the urban morphologist). The chapter is divided into three parts. The first part addresses a number of works that are classics in urban morphology and in urban studies. The first of these books was written in the late 1950s, five books were prepared in the 1960s, one was written in the late 1970s and the last of these books was prepared in the early 1980s. The eight books are: *Studi per una operante storia urbana di Venezia* by Saverio Muratori; 'Alnwick Northumberland. A study in town plan analysis' by MRG Conzen; 'The image of the city' by Kevin Lynch; 'Townscape' by Gordon Cullen; 'The death and life of great American cities' by Jane Jacobs; *L'architettura della cittá* by Aldo Rossi; *Formes urbaines: de l'îlot à la barre* by Jean Castex, Jean Charles Depaule and Philippe Panerai; and, finally, 'The social logic of space' by Bill Hillier and Julienne Hanson.[1] The second part of this chapter presents the main morphological approaches that have been developed over the last decades, from the historico-geographical approach (promoted by the Conzenian School) to the process typological approach (promoted by the Muratorian School); from space syntax to the various forms of spatial analysis (including cellular automata, agent-based models and fractals). Finally, the last part of this chapter introduces a key topic—against a background of different theories, concepts and methods—the need to develop comparative studies. The knowledge of the strengths and weaknesses of each approach will certainly enable those who want to develop a morphological study, to select the most appropriate options given the specific nature of the object under analysis.

The seventh chapter focuses on a fundamental issue for the field of urban morphology that has been receiving increased attention in literature, the passage from description and explanation of the morphological phenomena to the definition of prescriptive guidelines for the production of new urban forms. Two eminently practical activities that can benefit from morphological support are identified: urban

[1]The references listed above are as follows: Muratori (1959), Conzen (1960), Lynch (1960), Cullen (1961), Jacobs (1961), Rossi (1966), Castex et al. (1977) and Hillier and Hanson (1984).

planning and architecture. While the first is a potential receptor of morphological theories, concepts and methods developed for the city scale, the second would be informed by morphological approaches developed for the building scale.

The eighth chapter addresses the contributions of urban morphology to fundamental dimensions of our collective life in cities, in particular the social dimension, the economic dimension and the environmental dimension. Bearing in mind the practical achievement of this purpose, five specific issues from these three generic dimensions are selected: public health, social justice, heritage tourism, climate change and energy. The chapter discusses how to strengthen the channels of communication between each one of these issues and the field of urban morphology.

Finally, the ninth chapter presents the main conclusions of the book, somehow bringing together the synthesis presented in each of the previous chapters, and reflecting on the produced work as a whole. This chapter includes the identification of a number of lines for future research within the science of urban form.

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Chapter 2
The Elements of Urban Form

Abstract This chapter focuses on the different elements of urban form. The presentation of these different elements follows an order of increasing resolution of urban form. It starts with a description and explanation of the different urban tissues that we can find in our cities. It then increases the resolution and moves to the natural context and to the system of public spaces that constitutes each urban tissue, analysing both the spaces for circulation and for permanence. The chapter moves then to the urban plots which are, in our cities, the physical expression of individual property and, as such, distinct from the public or collective space. Once again increasing the level of resolution, the chapter moves to the buildings that constitute the urban tissue of a city including, not only exceptional buildings but also, current buildings.

Keywords Buildings · Elements of urban form · Natural context · Plots · Streets · Urban tissue

The different elements that constitute the physical form to our cities are the theme of this chapter. Each of the main elements of urban form is isolated from its context, enabling a more effective analysis and understanding. This analytical exercise is not 'neutral' and it somehow implies the previous existence of reading instruments to organize and structure these elements. Yet, we have tried to minimize the role of the 'researcher' and to focus on the 'object', the city. The role of the 'researcher', and of its instruments for description, explanation and even for prescription, will be discussed in Chap. 6, which will consider the different ways that different researchers use to deal with the same object, the city.

2.1 The Concept of Urban Tissue

Cities are, in morphological terms, extremely complex objects. In other words, cities are objects composed of different objects or of different parts. It is possible to identify a number of relationships between these objects 'from the part to the

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whole' and to recognize a hierarchy in these relations. To deal with the complexity of cities, urban morphology uses this hierarchical view of the city, structured according to a set of fundamental physical elements.

At a general level, the city is composed of urban tissues. Karl Kropf, in his paper 'Urban tissue and the character of towns', strongly influenced by the Italian tradition, defines urban tissue as an organic whole that can be seen according to different levels of resolution. These different levels correspond to different elements of urban form. The higher the level of resolution, the greater the detail of what is shown and the greater the specificity of morphological description (see also Fig. 7.4 in Chap. 7). At a very low level, the urban tissue includes only the streets and street blocks. At a high level of resolution the tissue might include a number of details such as the construction materials of an open space or building (Kropf 1996).

In general, all cities and their tissues are constituted by a set of elements of urban form—streets,[1] street blocks, plots and buildings. Yet, in each city these streets, street blocks, plots and buildings are combined in a specific way, originating different types of tissues. Some of these tissues are clearly identifiable and are able to offer their cities a unique character. Each of these urban phenomena is deepened by the 'time' factor, as a large number of our cities are indeed the result of a long process of construction, developed over centuries, and where different layers are continuously overlapping without erasing the previous layer. The notion of 'palimpsest' is often used in urban morphology to explain this continuous construction over time (we will get back to the notion of palimpsest in Chap. 6 when presenting the work of Gustavo Giovannoni).

Figure 2.1 presents, approximately at the same scale, eight cities in four different continents, with some urban tissues that are clearly recognizable: Brasilia, with a relation between (or a percentage of) open space and built form clearly favourable to the former; Djenné, in Mali, with a central and very compact urban occupation in clear contrast with the periphery left without buildings; Venice, with its exceptional geographical context marked by the strong presence of water and with an extremely compact urban tissue; New York, with an extremely regular pattern of streets and of buildings alignment and a wide range of buildings height (New York will be analysed in detail in Chap. 5); Barcelona, with its rigorous grid—forming octagonal open spaces in the street crossings—only broken by the large diagonal and with its homogeneous alignment of buildings; Paris, with the large radial streets conformed by a built form with uniform alignment and height; Rome, with a very dense layout of small street blocks interrupted by a number of monuments and squares that offer the city a high level of intelligibility; and finally, Sana'a, in Yemen, in clear contrast with the first urban tissue (Brasilia), with a relation between open space and built form that is clearly favourable to the latter.

[1]In a broad sense, including the open spaces for circulation (streets, avenues, boulevards…) and the open spaces for permanence (squares).

Fig. 2.1 Urban tissues of eight different cities, approximately at the same scale: Brasilia, Djenné, Venice, New York, Barcelona, Paris, Rome and Sana'a (*Source* Google Earth)

The same way we can find different urban tissues in different cities, located in different continents, we can also find different urban tissues within the same city. Figure 2.2 shows—once again, at the same scale—four different tissues within the apparently homogeneous city (in morphological terms) of New York. These tissues are included in only one of the five boroughs of this American city—Manhattan.

Fig. 2.2 Different urban tissues in New York city, approximately at the same scale: Downtown, Soho, Harlem and Stuyvesant Town (*Source* Google Earth)

The first tissue is in the Downtown area around Wall Street. Wall Street takes its name from the seventeenth century wall located in this street. The fact that it hosts the centre of the global financial markets justifies its current importance. The area that surrounds it, with a very rich urban history, is characterized by a pattern of narrow streets, forming street blocks of irregular shape and of small size, including a reduced number of plots and buildings. These buildings correspond to very large volumes given by their large plans and heights.

The second urban tissue is the Soho area around one of its most notable streets, Greene Street. This area consists of more regular street blocks, with larger areas than in the previous tissue, with a reasonable number of plots and buildings. The buildings height is similar to the streets width. A fundamental factor for the high quality of the built environment of this area is the excellence of its iron buildings erected between 1869 and 1895. Another factor that should be noted is the great mixture of uses, which contributes, in an undeniable way, to the urbanity of this area.

The third urban tissue is the famous black neighbourhood of Harlem, in particular the area around the 125th Street (or Martin Luther King Boulevard). Unlike the previous area, this part of New York is clearly marked by the residential use, except for the 125th Street which is a truly commercial street. The street blocks of Harlem are larger than the ones in Soho, and include a higher number of plots and buildings. Yet, there are a significant number of vacant plots which, somehow, contributes to disqualify the urban environment of this neighbourhood.

Finally, the fourth urban tissue is Stuyvesant Town, a private residential development located east of Gramercy Park. Contrarily to the previous tissues, in

Stuy Town the open space prevails over the built space (although this dominance is on a much smaller proportion than the one in Brasilia, mentioned above) and the area does not have a plot structure. The number of street blocks and the number of buildings are much reduced when compared with the previous areas. The building development, of large dimensions (comprised between the 14th and 20th streets), has a strong formal homogeneity.

2.2 The Natural Context

The natural context is the first condition for the establishment and organization of the different elements of urban form. The land relief, the quality and suitability of soil and subsoil, the climate, the solar and wind exposure, the type of natural landscape—all these factors influence how a settlement is established, from its foundation, from the first paths and streets (and, subsequently, from all the infrastructures that will be built in the streets) to the way land is subdivided into a number of different parts, to the various buildings that are built in these plots, and even to the materials that—at least, until the last century—will give expression and surface to all these forms.

In each initial intention of human settlement, in different historical periods, the land relief has its own configuration as well as a geometry that influences the location and the form of that settlement. In the master and doctoral theses that Rosália Guerreiro presented to the Instituto Universitário de Lisboa—'O território e a edificação' and 'Urbanismo orgânico e a ordem implícita' respectively—she synthesizes a number of key elements on this influence of land relief in human settlements, which we summarize, very briefly, in the two following paragraphs (Guerreiro 2001, 2011).

Generally, the land relief can be divided into two categories. In addition to the basic forms of land relief or of micro-relief (a hill, a promontory…) there are a number of composite forms, the macro-relief or the structural relief. The formation of these forms is associated with endogenous forces that originated the process of geomorphologic formation of the continents. The structuring lines of the territory are the ridge lines—corresponding to imaginary lines, more or less continuous, connecting the maximum elevation points and dividing the flow of water in opposite slops—and the lines of thalweg—linking the lowest elevation points, promoting the natural drainage of water to downstream. The ridge lines, as well as the thalweg lines, are associated in branched hierarchical systems forming the orographic and hydrographic systems. The points where ridge lines and thalweg lines are ramified are the notable points of the territory, usually referred to as distribution centres and encounter centres. There is also a third system of territory lines—the contour curves, cutting perpendicularly the ridge and thalweg establishing the relationships between them.

In different human settlements, the definition of the first paths follows this natural structure of the territory strengthening its own configuration and geometry. Indeed, these lines that structure the territory—ridge, thalweg and contour curves—represent the lines where the effort to overcome the slope is smaller. As such, for

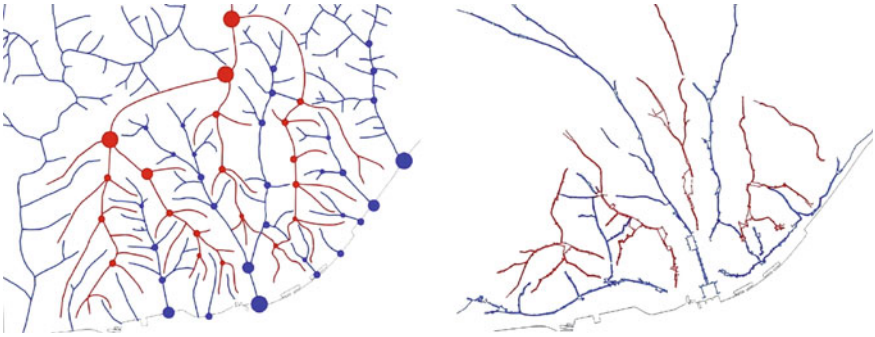

Fig. 2.3 Physiography of the physical support (ridges and thalwegs; distribution centres and encounter centres) and of the street system (ridge streets and thalweg streets) of Lisbon (*Source* Guerreiro 2011)

centuries, these were the lines of movement. The place where these lines of movement get together—the notable points of the territory—became the central places (Fig. 2.3).

Figures 2.4 and 2.5 illustrate the importance of land relief to human settlements. It is impossible to imagine the urban forms of Machu Picchu (Peru), Masada (Israel), Saint-Michel (France) or Lhasa (Tibet) without considering the land relief. The city of Machu Picchu, built in the fifteenth century (and abandoned in the following century after the Spanish conquest) by the Inca civilization in the Andes, at almost 2500 m above sea level, is one of the most remarkable examples of integration between human settlement and natural support. The city was structured in a set of terraces, ramps and stairs, around a central 'square' and included about 200 buildings distributed by religious, agricultural, industrial and residential areas. The second example is Masada, a fortified settlement built by the Jews in the Judean Desert near the Dead Sea at about 400 m altitude. Similar to Machu Picchu, Masada had a short period of occupation, being conquered by the Romans in the first century. A key element in the life of this settlement was a sophisticated water supply system.

The building development consisting of the *Potala* Palace, the *Jokhang* Temple and the *Norbulingka* built by the Tibetan monks from the seventh century onwards on the Red Mountain at 3700 m of altitude, is another notable example of the relationship between man and nature. Finally, the last example, linking Figs. 2.4 and 2.5, is Saint Michael. Saint Michael is a small settlement in Normandy, France, developed around a Benedictine abbey, in Gothic style, built between the eleventh and the sixteenth centuries. The uniqueness of this settlement is due not only to the dialogue with the land relief, as in the three previous cases, but also with water—when the water rises the settlement site becomes an island.

As in the previous cases we cannot imagine Varanasi or Venice without their relation to water (see Fig. 2.5). Indeed, the Italian city, founded in the fifth century, constituted by 120 small islands and a wide set of channels, is a singular case of

Fig. 2.4 Relationships between urban forms and natural context—land relief: Machu Picchu, Masada, Lhasa and Saint-Michel (*Source* Photographs by Filipa Neiva (**a**), Urszula Zdzieborska (**b**), Jan Reurink (**c**) and Cláudia Lira (**d**))

Fig. 2.5 Relationships between urban forms and natural context—water: Venice and Varanasi (*Source* Photographs by Sara Guedes (**a**) and Jorge Correia (**b**))

relationship between human occupation and the lagoon where it is settled. Also very intense is the relationship between the city of Varanasi and the Ganges River. While the urban forms of this Indian city seem to touch the river, the life of its inhabitants is inseparable from the Ganges, using it in numerous actions including bath, laundry and funeral services.

Depending on the concept of city (bounded, in a very simplistic way, between an organic model and a rational model) the influence of the natural context on the city can be more or less significant. This influence can also vary between different parts of the same city. Let us return to the example of Manhattan in New York. The establishment of a settlement on an island clearly influenced the way how, in the oldest part of town, faced with shortage of land, buildings started to be higher and higher. However, if we move to another part of the island, for instance, a northern area where in the early nineteenth century the regular grid, characteristic of the city, started to be implemented, we can see that the rugged relief was not an obstacle for the construction of that grid. Furthermore, if we continue to move north, we arrive at the magnificent Central Park, where the 'apparently natural' physical support was in fact built by man.

2.3 The Streets System

It is through the streets system (in the generic sense, including avenues, boulevards…) that we travel, and start to know, a city. Streets define the different street blocks that constitute a city and distinguish what is public, and is therefore accessible to all citizens, from what is private or semi-public. Streets are, in broad terms, the public and democratic space of the city, the place where we all met, with all our differences, and where we all interact in social terms.

All these possibilities of interaction are restricted when we move from the streets to the interior of buildings. Bill Hillier, the founder of Space Syntax, recently wrote, in a paper submitted to the International Space Syntax Symposium (ISSS), that social differences have no expression on streets. This British author argues that streets 'do not reflect the society' (or the most negative aspects of society), and that, on the contrary, streets can gather in space what society insists in dividing. In addition, Hillier argues that the livability of the streets is probably the most relevant indicator of the presence of a strong civil society (Hillier 2009).

In morphological terms, and in a temporal perspective, streets are the most stable element of urban form. While the physical process of city building is something that 'takes time' involving permanent transformation—it has a past, a present and a future—the streets system of a city is the one that offers greater resistance to this process of urban transformation, attaining a great temporal stability. The plots system has a lesser durability than the streets system, and the buildings system has a lower stability over time than the two first systems.

There is a wide variety of streets, with different shapes and sizes, with different ways of relating with the other streets in the surroundings, and also with different urban functions. The analysis of each of the main elements of urban form that we are developing in this chapter does not ignore that, for instance, the character of a street is influenced by other elements of urban form shaping it. This character is actually influenced by the plots on one or on both sides of the street; by the buildings—by their height and by the relation between their height and the width of the street; by the way buildings are located in plots, sometimes near to the plot frontage, offering the street a higher sense of enclosure, sometimes far from the plot frontage, offering greater openness to the street; or by the 'doors' that these buildings open to the street. Another important issue when analysing the streets system that will be developed in later chapters is how in each street the space for pedestrians and the space for vehicles—public or private, motorized or non-motorized—are distributed. Allan Jacobs' 'Great streets' is an example of a notable book on the streets of our cities (Jacobs 1993).

Figure 2.6 presents a diverse set of streets in four different cities. The first images refer to the intersection of two of the most important streets of New York: the Broadway, which crosses the whole island of Manhattan in the north–south direction, being the only street with an irregular pattern on the orthogonal grid of the city designed in the early nineteenth century; and the 5th Avenue (with 10 km

Fig. 2.6 Different streets in different cities, approximately at the same scale: Broadway, intersection with the 5th Avenue, in New York; the *Champs Elysées* in Paris; the Via *Rinaldini* in Siena and the *Reguliersgracht* in Amsterdam (*Source* Aerial views—Google Earth; Photographs by the author)

long and 30 m wide) which is perhaps the most famous of the eleven avenues that structure New York in the north–south direction.

The two following images refer to the *Avenue des Champs Elysées* in Paris, one of the most important symbols of the Baron Haussmann' s intervention in the French capital in the second half of the nineteenth century (see Chap. 3). This is an axe of 2 km long and 70 m wide (in its western part which is clearly more urban), conformed by a fairly homogeneous set of buildings. The buildings height is clearly inferior to the street width, which gives the *Champs Elysées* a strong sense of openness. It has a strong presence of trees and with very different functions including shops, cafes and cinemas. This avenue is part of a longer axe with a fundamental importance in the city, linking *La Defense* and the *Louvre* Museum.

The third set of images refers to a small medieval street in Siena, the Via *Rinaldini*. This street is directly linked with the famous square of the city (that will be analysed in the following paragraphs). *Via Rinaldini* is less than 50 m length and is 5 m width. Despite the clear differences in relation to the two previous streets, we should highlight that the cross-section of this street is somehow close to the cross-section of the 5th Avenue where the buildings height is clearly higher than the street width.

Finally, the fourth set of images refers to the *Reguliersgracht*, one of the streets of Amsterdam, within the so-called 'ring of canals', an area that started to be built in the early seventeenth century. The built environment of Amsterdam—as well as of other Dutch cities—is marked by a sound presence of water. As such, the cross-section of the street (the street is about 30 m wide and 600 m long) is clearly different from the previous examples, as it includes the canal and, on each side of it, a street with three different spaces: one for pedestrians, one for vehicular traffic (distinguishing it form the urban environment in Venice where there is no vehicular traffic in the historical city) and one for car parking.

The public spaces system of a city includes not only the open spaces for movement, which we designate, in a simplified way, as streets, but also the open spaces for permanence, which we designate as squares and gardens. All this diversity of streets that we have described in the previous paragraphs can also be found in the case of squares.

Figure 2.7 presents four squares in three different continents. The first of these is Times Square, in New York, located at the intersection of Broadway with the 7th Avenue. While in morphological terms the square is no more than the intersection of the two streets with no particular conditions inviting for staying in the square (somehow similar to what happens in Picadilly Circus, in London), the truth is that at any time of day or night, Times Square is full of people (as we can see in this photograph taken at night). In terms of urban functions, the square is located in the heart of the Theater District and it includes a number of cultural and commercial activities contributing not only to the dynamics of this space, but also to the consolidation of the image of the square through a significant number of attractive neon lights. Our collective imaginary of this New York square is undoubtedly informed by the traditional party in the New Year's Eve, when a crystal ball falls from the top of the number 1 of Times Square.

Fig. 2.7 Different squares in different cities, approximately at the same scale: Times Square in New York, *Place Georges Pompidou* in Paris, *Piazza del Campo* in Siena and *Meidan Emam* in Isfahan (*Source* Aerial views—Google Earth; Photographs **b**, **d** and **f** by the author, Photograph **h** by Jorge Correia)

The second square included in Fig. 2.7 is the *Place Georges Pompidou*, in Paris, near the former market of *Les Halles*. This square is clearly different from the previous, both in morphological terms and in functional terms. Indeed, the *Place Georges Pompidou* has a clearly defined shape, a rectangle of about 175 m long and 70 m wide, and a slope upwards from the entrance in the *Centre Georges Pompidou*, that establishes its eastern limit, up to the buildings of the *Rue Saint-Martin* that constitute its western boundary. This immense sloping surface is one of the fundamental characteristics of the square and is the key element that invites people to different activities, from the simple lay down to different artistic performances. In terms of function, this square is clearly distinguishable from the first because it has a strong artistic dimension, due to the presence of the remarkable *Centre Georges Pompidou*, built in the late 1970s. As a complement, the *Place Igor Stravinsky* (at south of *George Pompidou*, in Fig. 2.7) including a set of modern sculptures and the Stravinsky Fountain with 16 mobile sculptures, should also be referred.

One of the most famous squares in the world, particularly among those studying the physical form of cities, is the *Piazza del Campo* in Siena. This Italian square, from the twelfth century, has the shape of a shell and it is delimitated by a number of notable buildings (*palazzi*) with different heights, from five to seven storeys. Similarly to the *Place Georges Pompidou*, this square is constituted by a wide sloping surface—following the topography of the city—which has the lowest point in the northern part, in the entrance to the town hall, the *Palazzo Pubblico*. One of the most famous events that takes place in the square is the *Palio*, a horse race which dates back to Roman military exercises.

The last example included in Fig. 2.7 is the *Meidan Emam* in Isfahan, Iran. This square of great dimensions, 520 m long and 160 m wide, has a rectangular shape (as the *Place Georges Pompidou*) and it is delimitated by a continuous building volume of two storeys high with a double colonnade. A number of exceptional buildings stand out in this set—two notable mosques, classified by the United Nations Educational, Scientific and Cultural Organization (UNESCO), and a palace. The northern part of the square gives access to the *Bazaar* of Isfahan. In addition to accommodating some exceptional functions, the square is intensively lived by the local people for many different activities. Contrarily to the three previous cases there is not a strong presence of foreign tourists in Isfahan.

As we can find substantially different urban tissues or streets in the same city (as we have seen in the example of New York), we can also find different squares with clearly distinct forms and functions in different parts of the same city. The following paragraphs, and Fig. 2.8, illustrate this phenomenon in Paris.

The first example included in Fig. 2.8 is the *Place Vendome*, located in the *Tuileries* area. This square was built in the early eighteenth century (it is the latest example of this set). It has a rectangular shape (octagonal cut in the corners) with 140 m long and 120 m wide, it is crossed by one street only—the *Rue de la Paix*, and it is composed of a group of buildings with a great homogeneity in terms of architectural language and of the number of storeys. In terms of urban functions, *Place Vendome* is the home of a number of fashionable shops.

Fig. 2.8 Different squares in Paris, approximately at the same scale: *Place Vendome*, *Place des Vosges*, *Place des Victoires* and *Place Dauphine* (*Source* Aerial views—Google Earth; Photographs by the author)

The *Place des Vosges*, built in the early seventeenth century in the *Marais* area, is the second example. With a dimension that is slightly higher than *Place Vendome*, *Place des Vosges* is a square of 140 m, and it is configured by an extremely homogenous group of buildings comprising 36 houses (nine in each of the four sides) containing an arcade around the whole perimeter of the square. The centre of *Place des Vosges* is a green space. The access to the square from the *Rue de Birague* is made through the arcade. As such, the square is delimitated by one important street only, the *Rue du Pas de la Mule*, at north.

The third example is the *Place des Victoires*, located in the *Tuileries* area, nearby *Place Vendome*. This square, with a circular shape, has smaller dimensions than the previous two (approximately 75 m diameter) and, as in these two cases, it is defined by a set of buildings, of four and five storeys, with great homogeneity in terms of architectural style. The square was built in the seventeenth century in order to frame the statue of Louis XIV. Although it is a very interesting example in terms of urban form hosting a number of important fashion shops, the square is not much more than a roundabout.

The *Place Dauphine* is located in the oldest part of the French capital, the *Ile de la Cité*. This last example of our set is clearly different from the previous three cases: the square has a triangular shape (with an area that is larger than the Place des Victoires and smaller than the other two cases); and the buildings shaping it have a higher diversity than the previous ones, both in terms of numbers of floors and of architectural language.

The following paragraphs and Fig. 2.9, illustrate the same phenomenon in Rome. As mentioned above, Rome is a city of a very dense layout made of small street blocks interrupted by a number of notable squares. Let us focus on four of those squares, *S. Pietro, Campidoglio, Navona* and *Rotonda*. The *Piazza S. Pietro*, with a dominant religious nature, is located east of the *Tevere* River, within the Vatican territory. The square, the *basilica* and the colonnade (four columns deep) shaping it, were built in the sixteenth and seventeenth centuries. The square has a complex shape, made of two different shapes, an ellipse (of 200 m long and 150 m wide) and a trapezoid (where the parallel sides have approximately 100 and 115 m long and are distanced 100 m).[2] The square is part of a wider composition, being the western limit of a strong axe defined by the Via *della Conciliazione*, which is bounded at east by the *Castel Sant'Angelo*. While the exact centre of the square is marked by an obelisk, two different fountains appear to be the two centres of the ellipse.

The second example included in Fig. 2.9 has a rather different nature, shape and size. The *Piazza del Campidoglio* is located in the historical kernel of Rome. The square and the three surrounding *palazzo* were built or restored in the sixteenth century, constituting then a new civic centre for the city. It now gathers civic and museologic functions. The *Piazza del Campidoglio* has a trapezoidal shape; the bases of the trapezoid have approximately 55 and 40 m and are distanced about

[2]A third shape, linked with the Via *della Conciliazione*, could also be considered.

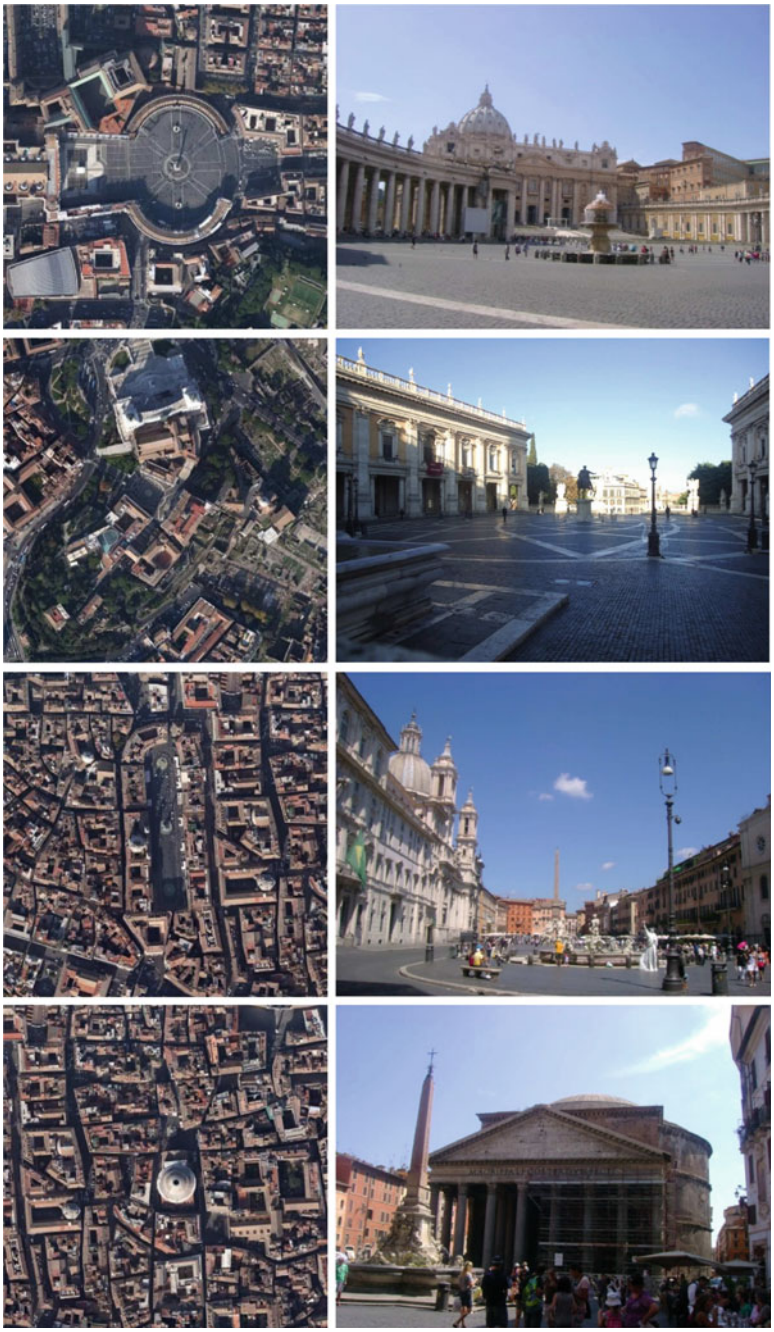

Fig. 2.9 Different squares in Rome, approximately at the same scale: *Piazza S. Pietro, Piazza del Campidoglio, Piazza Navona* and *Piazza della Rotonda* (*Source* Aerial views—Google Earth; Photographs by the author)

75 m (it is substantially smaller than *Piazza S. Pietro*). The square has a notable pavement with an oval geometric layout and, in the centre, an equestrian statue. Limited at east by the *Pallazo Senatorio*, the axial composition of this set includes, at west, a wide-ramped stair (the *cordonata*) connecting the square to the Via *del Teatro di Marcello*.

Contrarily to the four Parisian squares presented above, the four Roman examples have a strong touristic dimension. That is the case of *Piazza Navona*, located north of *Corso Vittorio Emanuelle II,* which has an intense social life. The square as we know it was established in the seventeenth century. Its peculiar shape, a long rectangle of about 250 × 50 m with round ends (a proportion of about 5:1, where the largest dimension is higher than the largest dimension of *S. Pietro*), draws on the ruins of a stadium erected in the first century. Three notable fountains (*Nettuno*, *Quatro Fiumi* and *Moro*, from north to south) have a central role in this remarkable baroque set. Besides the numerous cafés, restaurants and shops, the building set of *Navona* includes the church of *Sant'Agnese in Agone*.

The last example is *Piazza della Rotonda*, located 250 m east of *Navona*. The square was defined in the fifteenth century. Yet, the surrounding building fabric dates from earlier periods. That is the case of its main building, the Pantheon (the church of *Santa Maria Rotonda*, giving the name to the square), dating from the first century. As we can see in Fig. 2.9 the square is considerably smaller than the other three examples. It has an irregular shape near to a trapezoid; the bases of the trapezoid have approximately 45 and 35 m and are distanced about 60 m. It has a fountain with an obelisk in the centre. The square has a large number of cafés and restaurants.

2.4 The Plots System

As mentioned above, the plots system of a city is one of the most important elements of urban form, separating the public domain and the private domain (or the different private domains). Nevertheless, the role of this fundamental system is often neglected by the main agents and stakeholders in the process of city building, largely because of the, apparently, reduced urban visibility of plots.

The definition of the plots system in a given territory is an essential element of its urbanization process and has a considerable stability over time. The decision on what would be the new structure of private ownership in a particular territory might involve the subdivision of a set of large plots—for instance, plots of former rural use—or the proposal of a new land division. The subsequent stage of this urbanization process usually involves the precise definition of the different plots: (i) how is each plot related with the street? (what is the dimension of the plot frontage? what is the orientation of the plot in relation to the orientation of the street?); (ii) what is the position of each plot within the plots system? (is it in the middle or in the edge of the street block? is it located in a long side or in a short side of the street block?); (iii) what is the shape of the plot, and what are its dimensions and proportions?

It is essential that we acknowledge that these definitions, taken when each plot is laid down, will condition the future options in terms of the building types that can effectively be built within these plots and, as such, it will have a significant impact on the urban landscape.

Although there are considerable differences between each specific context, in many cities the processes of plot subdivision and of plot amalgamation are not very common. This means that the choices that we make, as agents, in very early stages of the urbanization process will condition, for long periods of time, the urban forms that in the future will be built in the city. It is also import to say that, although the city suffers many kinds of disturbances over its 'life'—such as wars, fires, earthquakes, tsunamis, to name just a few—that could be used as a pretext to erase the pre-existing plots system (or parts of the plots system) and to create a new plot structure, the truth is that, in most of the cases, this does not happen and the pre-existing plots system is maintained.

An important element in the description and explanation of the physical form of the city is the dimension of its street blocks and, within these, of its plots. In general, the dimension of street blocks and of plots increases as we move from the historical centre to the peripheral parts of the city. Yet, there are some exceptions. These exceptions are not negligible and they contribute to the identity of each city —in this regard, the concept of fringe belt will be presented later in Chap. 6. Another important element is the number of plots per street block, as it somehow expresses the greater or lesser diversity of agents and stakeholders—and of urban strategies—that are present in the street block. Contrarily to the dimension of the street blocks, in general, the number of plots per street block decreases as we move away from the historical centre to the peripheral parts of the city.

Figure 2.10 illustrates the plots system of a whole city, central Pingyao. This plan is included in the paper 'Extending the compass of plan analysis: a Chinese exploration' by Jeremy Whitehand and Kai Gu (2007). Located nearly 500 km south-west of Beijing, Pingyao is a city that is notable for the survival of its traditional form. It is roughly a square-shaped walled city, with a significant number of planned streets and plots. Figure 2.10 presents the complex plots system of the city. In central Pingyao, regular patterns of plots seem to be associated with regular patterns of streets. In contrast, access to subdivisions of plots (more irregular) created in the interiors of street blocks has been achieved by the development of a labyrinth of alleys, including many cul-de-sacs.

Let us now take a smaller part of a city. *Rua do Almada* is a fundamental street in the urban history of my city, Porto. The construction of this street in the second half of the eighteenth century was promoted by the so-called *Junta das Obras Públicas*, a public agency responsible for urban planning and management. The *Junta* was responsible for the opening of new streets and for the regularization of existing paths, designing a street network that has structured the process of urban development of the city until the end of the nineteenth century. The *Rua do Almada* is 800 m long and 10 m wide. It links two different squares, the *Largo dos Loios*, in the south, and the *Praça da República*, in the north. The street consists of ten street blocks and 214 plots. The largest street block of this set is the section contained

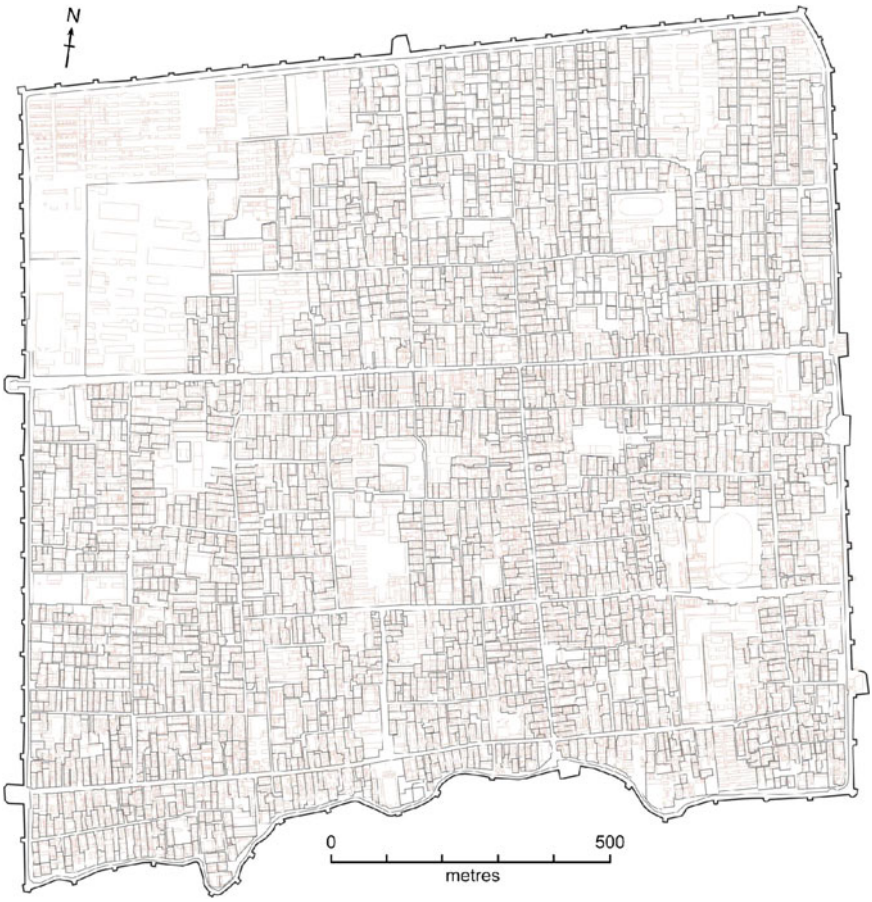

Fig. 2.10 Plot boundaries in central Pingyao, in 2000 (*Source* Whitehand and Gu 2007)

between the *Praça da República* and the *Rua Dr. Ricardo Jorge* including 58 plots. In a significant part of these 58 plots, plot frontage is about 5 m and plot depth ranges between 20 and 90 m. Over more than two centuries in the 'life' of these plots, buildings were conserved recurring to small maintenance works. Yet, eight buildings erected in the last decades of the twentieth century can be found in these 58 plots. However, even in this set of eight buildings, seven were built in the original plots of the eighteenth century, and only one building was erected on a plot resulting from plot amalgamation (of two different plots). In *Rua do Almada* the establishment of a particular type of plot, long and narrow, led to the emergence of a particular type of building. Due to the reduced dimension of the plot frontage, the building type had to adopt an in-depth organization, usually with more than 15 m depth. This in-depth organization of the building has lead to the location, in each

storey, of one (or two) room (s) near the two facades and of a staircase, and of one (or more) rooms in the interior of the building.

The German geographer MRG Conzen, whose work will be analysed in detail in Chap. 6, was one of the main promoters of the study of the plot as a way to describe and explain the physical form of a city. One of the concepts proposed by Conzen was the burgage cycle. The burgage cycle is the progressive built occupation of the back of the plot culminating in a significant reduction of the open space, resulting in the need to release this space and in a period of urban fallow, preceding a new development cycle. The proposal of this concept was based on the study of the town of Alnwick, in particular on the analysis of the plot belonging to Mr. Teasdale in six different periods of time between 1774 and 1956. Although this phenomenon was recognized in Alnwick, the truth is that it occurs in many different contexts, including the plots of Porto. In the city of Porto, the burgage cycle conceptualizes a process of plot occupation and construction of working-class housing in the back of the *bourgeois* building facing the street, without changing the plot structure—the so-called *ilhas*, built in the nineteenth and twentieth centuries.

2.5 The Buildings System

Although buildings do not have the stability in time that streets and plots have, they are one of the most important elements of urban form and, perhaps, the most visible of these elements. In general, the city is made of two different types of buildings, ordinary buildings and exceptional buildings. The main characteristics that distinguish these two types are related to the building form but also to the building utilization. The former type includes most of the buildings constituting the city. The similarities between buildings, within this type, are stronger than the differences between them. This type includes mostly buildings of residential utilization but also commerce and services buildings. The second type includes only a few buildings of the city: those buildings that by their shape—and eventually by their utilization—are clearly distinguishable in the urban landscape. Within this second type there is a smaller set, a very special set of exceptional buildings whose form becomes indistinguishable from the form of the city they are part of. This is the case, for instance, of the Opera House in Sydney.

The position of each building within its plot is of fundamental importance for the character of the urban landscape. In most cities, until the end of the nineteenth century, the continuous alignment of different buildings defined, in a very clear way, the street form. Yet, a number of city theories, developed over the twentieth century, have questioned this traditional alignment of buildings and have led to the introduction of an increasing variation in the position of buildings within plots, questioning the traditional definition of the ‘street’ and of the ‘street block’.

Another important characteristic of buildings is their height and particularly the relationship between their height and the width of street where they are located. The variation of these two measures can introduce significant changes in the urban

landscape. If the height of buildings is much less than the street width we will have little sense of enclosure. Yet, if the height of buildings is greater than the street width, the sense of enclosure will increase. Other important characteristics of buildings are the façade design (important for the urban landscape), the position of the staircase in the interior of the building and the organization of dwellings.

Although in last decades there has been a powerful trend towards an increasing uniformity of buildings at the global scale, we can still find a great diversity of buildings across different countries and different continents. Figure 2.11 includes five photographs of different buildings in different cities and villages, in five different continents. The first is a photograph of Chicago taken from the Lake Michigan. This part of the city, around Lake Shore Drive, has a regular street system with a great diversity of buildings with very different heights. In the middle of the photograph, some skyscrapers seem to emerge within the set of tall buildings. It is the case of the John Hancock Centre of 100 storeys. Although there is also a great diversity in terms of building materials, the urban landscape is marked by the presence of steel and glass. The second photograph is in a rather different geographic and cultural context: Djenné, one of the oldest towns of sub-Saharan Africa, inhabited since 250 B.C. This area includes almost 2000 traditional buildings that were built using earth as the main material. The architecture of Djenné, of its ordinary buildings and of its exceptional buildings (such as the Mosque, in the photograph) is characterized by its homogeneity of materials and colours and by a strong sense of verticality. The third photograph shows a traditional building of the *Batak Toba* people, located in *Samosir* in the middle of Lake *Toba*, in Sumatra (Indonesia). This house, very different from the buildings in the upper photographs, has a boat-shape and it is elevated from the ground. It is mainly built in wood and it has intricately carved gables and upsweeping roof ridges. The fourth photograph presents a set of buildings in the *Stortorget*, a small public square in the *Gamla Stan*, the historical centre of Stockholm. Despite the similar height and alignment of buildings, there are some subtle differences between them such as the use of different colours and the design of the upper storeys and roofs. Finally, a traditional building of the Māori people located in Taumaranui, in New Zealand is included in the last photograph of Fig. 2.11. The design of the roof and of the central column in the main façade (usually two other columns are located in the interior of these buildings), and the sound presence of sculpture distinguishes this building from the buildings of the previous photographs, contributing for the identity of the Māori architecture.

As we have seen when analysing other elements of urban form, we can also find very different buildings within the same city. In addition, it is possible to identify a kind of evolutionary path or a typological process, corresponding to a succession of building types in the same cultural area. Focusing on a particular part of my city, the *Rua de Costa Cabral*, Fig. 2.12 identifies the main residential types of the area and offers a reading of how these building types have evolved over time. The first column of photographs displays the transformation of single-family houses: from the terraced houses built in narrow frontage plots (a), in medium frontage plots (b) and in large frontage plots (d) to the semi-detached houses (f) and the detached

Fig. 2.11 Different buildings in different cities and villages, in five continents: Chicago, Djenné, Samosir, Stockholm and Taumaranui (*Source* Photographs by the author (**a**, **d**), Elisa Dainese (**b**), Janto Marzuki (**c**) and Bryan Woodhead (**e**))

Fig. 2.12 Succession of building types in the same cultural area, Porto (*Source* Oliveira et al. 2015)

houses (h). The second column of photographs presents the transformation of multifamily buildings: from terraced buildings erected on narrow and large plots (c) and (e) to semi-detached buildings (g) and detached buildings (i)—this will be developed in the last section of Chap. 6.

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Chapter 3
The Agents and Processes of Urban Transformation

Abstract The third chapter focuses on the different agents and agencies responsible for, and on the complex processes of, urban transformation. It analyzes how each one of us takes part in the process of transformation of the urban landscape: as a developer of an action of transformation of the urban forms, as an architect responsible for the design of new physical forms, as the builder of these forms or, in a more indirect way, as a planning officer designing a city vision and guiding private activity in his day-to-day practice of development control, or as an elected politician defining a political strategy for the city. In addition, the chapter aims at understanding the processes of urban transformation: how do we organize ourselves as a society to build a balance between a comprehensive view of the city, usually a planned view, and a number of different contributions eventually associated with a higher spontaneity. It is argued that this balance between unity and diversity is essential in a city that wants to be attractive, in morphological terms.

Keywords Agents of change · Cities · Town plan · Urban form · Urban transformation

3.1 Agents of Change

This section focuses on developers, architects and builders (as direct agents) and on planners and politicians (as indirect agents). It tries to understand how each one of these agents pursues its particular goals, what are the motives underlying his behaviour and how a number of, sometimes conflictive, interactions between different agents take form in the built environment. Naturally, each of these groups is not heterogeneous and it is clearly bounded by a particular geographical context. Yet, there are some common characteristics that can be found in each type of agent.

The number of studies addressing the agents of change is lesser than the number of studies devoted to the physical characteristics of the urban landscape or even the processes of urban transformation. Yet, there are some research centres that, over the last years, have been developing consistent lines of research on the issue of

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agents. That is the case of the Urban Morphology Research Group (UMRG) in the University of Birmingham, and particularly of his Head, Jeremy Whitehand. This section draws on some of the main findings of the UMRG in their study of cities in the United Kingdom, particularly in the twentieth century. One paper was particularly relevant for structuring this chapter, 'Recent advances in urban morphology' by Jeremy Whitehand (Whitehand 1992).

3.1.1 Developers

The occurrence of an action in the physical form of the city implies the existence of a developer (or initiator) who decides to make a change. The figure of the developer is somehow more heterogeneous than that of other agents analysed in this section, ranging from a property owner that promotes one single action (the 'owner-occupier') to an individual that devotes his professional life to the launching of new developments (the 'speculative developer'). Eventually, the 'developer' and the 'builder' can coincide in the same individual or organization. The nature and role of developers has changed significantly over history. A recent book, edited by Peter Larkham and Michael Conzen, addresses this changing nature of developers in different periods in urban history—pre-modern, early modern, industrial, late modern and postmodern—analysing the action of kings, of the Church and of industrial developers, to name just a few (Larkham and Conzen 2014a).

The decision to develop a particular action is influenced by many different factors. Economic factors—many of which are cyclical in character—are among the most important factors that are usually considered by developers. Yet, the influence of economic factors may vary according to the type of developer. Economic factors are more important to the speculative developer and are less important to the residential owner seeking to develop sites of which he intends to continue to occupy a part. On the other hand, these economic factors, in particular the land value has a key influence on the future building types and building density (Whitehand 1992).

Another important factor considered by developers is the timing of the development. The success and character of proposals for change are influenced by the life-cycle of fashions. In addition, there is always a time-lapse between attempts to bring about change and actual change. This time-lapse can be due to changes in economic conditions or to vagaries of the process of development control. In the latter case, the length of the time-lapse is largely determined by the interaction between a direct agent, such as the developer or the architect, and an indirect agent such as the planning officer working in the local planning authority. A consequence of these time-lapses is that developments sometimes take place in conditions markedly different from those in which they were conceived (Whitehand 1992).

The developer has also a crucial role in selecting a particular building type or density (which is influenced, as mentioned above, by land value). This selection can be quite polemic, and debates on this issue can be frequently biassed. Yet, it is important to acknowledge that a more frenetic activity does not necessarily entail

more obtrusive development—for example, small detached houses may be more obtrusive in the urban landscape than flats (Whitehand 1992).

One crucial characteristic in developers, and in other agents, is their provenance. Decisions made by local developers may result in different types and styles of alterations or additions to the building stock than decisions taken by developers based far from the site of the proposed change (Larkham 1988).

3.1.2 Architects

The first link between different agents of change is usually between a developer and an architect (in the cases where an architect is hired). After being engaged, the architect tends to act as the agent of the developer dealing with the local authority. He has also an influence in the selection of the builder and particularly of other agents that are not analysed in this book, such as engineers and consultants. Jeremy Whitehand and Susan Whitehand (1983) studied the relationships between developers and architects in two British towns for the period between the First World War and the 1980s. They found that the locations of architects were closely related to those of the developers (this proximity continued, although to a less extent, until the end of the period under analysis), and major differences of distribution can be recognized between the architects employed by developers from inside and outside the towns under analysis—in the latter case there was a strong tendency for the architect to be in the same city as the developer.

The role of architects has changed significantly over history. As Larkham and Conzen (2014b) remind us, until the late modern and the postmodern periods, although the presence of architects has been implicit, their role was somewhat muted. Since the Renaissance, architects' identity and standing as profession have grown in public awareness, and by the twentieth century an increasing number of architects would come to enjoy broad celebrity status on a par with great writers, musicians and painters, and the most creative have become icons in mass cultures.

One important aspect related to the architectural practice is that many more urban landscapes exist on paper than ever come into being on the ground. As Whitehand (1992) states, the main reasons for this seem to be the extensive use of design competitions (in the case of institutional and public areas) and the large number of unimplemented schemes attributable to the development control process (in the case of residential and commercial areas). In the former case, and in addition to the specific nature of design competitions (one proposal is selected while many proposals remain on the paper), there is also the case of non-implementation of proposals due to the long-time span over which some developments are undertaken. In the latter case, the development control process—particularly in areas where local authorities exercise a strong restraining influence—can lead to a number of modifications and complete transformations of proposals, not always in the direction of improved solutions. In some cases, even when developments have begun to take shape on the ground, work can stop in an incomplete state and recommence

some years later, giving rise to inconsistencies between the project of the architect and the erected building. It is important to acknowledge that the urban landscape results from interactions between a number of parties over a period during which the influences upon decision-making are changing, and is commonly different from that envisaged by any of the parties including the architects (Whitehand 1989).

3.1.3 Builders

After the developer has engaged an architect, subsequent links are sufficiently varied in type and in direction of influence to make the notion of a single chain of decision-making inappropriate. While it is clear that the location of a developer has a major influence on the selection of the architect, subsequent links are not necessarily in a set sequence, and the linkages between agents can be quite various (Whitehand and Whitehand 1983).

In relation to the provenance of builders, and according to the studies of the UMRG there has been a long-term increase, over the twentieth century, in the role played by non-local builders. Yet, before the Second World War, in most areas, local firms were still predominant and external firms acted as innovation-diffusion agents. This means that the necessity for the prolonged presence of the builder and of his workers on the site of the constructional work was still a key factor. In their research on the inter-war period in England, Jeremy Whitehand and Christine Carr (2001) found that, in spite of the unprecedented amount of house building in this period, the geographical spheres of influence of builders (and also of architects) were highly localized. Unlike in the nineteenth century and contrasting with what was happening in North America, there is little evidence of speculative building having been undertaken by people whose livelihood was not primarily derived from house building or house selling.

This situation of proximity between the building firms and their houses was gradually changed by the enlargement of the operational areas of firms associated with the tendency for activity to be concentrated among fewer firms (Whitehand 1992).

3.1.4 Local Authority Planning Officers

The fourth type of agent analysed in this book is the planning officer working in a local authority. The action of this agent is mainly of an indirect nature, although in some cases it can constitute a direct action on the physical form of the city. Depending on each specific country (from systems based on the establishment of general rules to systems based on case law and discretion in decision-making) the activity of the local authority can assume different characteristics. Yet, it has always two main functions, development control and planning.

As mentioned above, the interaction between different agents is sometimes conflictive. While this is true for the relations between direct agents or between indirect agents, it is particularly evident for the interactions between direct and indirect agents, reflecting a tension between the process of development and of attempted development. As legislation increased over time, so local authorities become more involved and moved to the centre of the conflict. In the process of development control, planning officers act as mediators between different private interests, notably between developers and occupiers of sites in the vicinity. This can be seen as a wider conflict between the forces of preservation and change—including, for example, that between residents who own potential development sites and those whose gardens are unsuitable for development (Whitehand 1992).

In the case of development control, the influence of planning officers is limited and indirect, particularly in that they are reacting to proposals. In the case of planning, two different situations can be identified. The first corresponds to the preparation of a plan. Contrarily to development control this is a proactive practice involving a reflection on the conservation of the existing urban forms and on the design of new streets, plots and buildings. Yet, it is also an indirect action on the urban forms as it depends on the future action of developers. The second is the design of a proposal—in most of the cases an action on the street system—to be implemented by the local authority. Contrarily to the former, this is a direct action on the physical form of the city.

One of the most common criticisms on the action of the local authorities over the last decades, both in planning and development control activities, is the exclusive focus on physical standards relating to building density, car parking and highways. This meant that local government control over development has paid little attention to the appearance of the built environment (Punter 1986). Another criticism is that attention is devoted principally to individual buildings, sites and monuments, or small areas of special interest, while the historico-geographical structure of entire cities or sizeable parts of cities are largely ignored (Whitehand and Morton 2004).

3.1.5 Local Politicians

The last type of agent analysed in this chapter is the local authority politician. Except in cases of absolutist regimes, where the local politician can have the power to act as a direct developer, its role has an indirect nature and corresponds mainly to a contribution to the definition of a strategic vision for the city designed within the local authority and, eventually, to decision-making on major projects.

Yet, even this contribution can involve situations of conflict. The conflict between the local politician and other agents (as in the relations addressed before) happen not only in relation to direct agents but also in relation to the local authority planning officers. This can happen when planning officers adopt a technical perspective on a particular issue that would be different from the political point of view. In such a case, technical knowledge can be marginalized by politicians who

can produce the knowledge that serves their purposes best. This tension can be framed within a wider conflict between rationality and power.

Recently, I have developed, with my colleagues Mafalda Silva and Ivor Samuels, an evaluation of a form-based plan prepared for and implemented in my city, Porto (Oliveira et al. 2014). This evaluation included an analysis of the main agents of change. The preparation of this plan had begun in 2000 during a socialist administration. At the end of 2001, a conservative administration was elected. Yet, this political change seems to have had minimal effect: though it delayed the preparation and approval of the plan, the typological approach proposed was not questioned. In fact, wider built heritage concerns were introduced and development control in some tissues has become stricter. Nevertheless, in the subsequent 12 years the political support (through political discourse and programmes) of planning practice was not constant. Moreover, it can be said that the potential of this plan, in urban form matters, was not fully understood by the local politicians. Arguably, the complexity of the typological approach made it difficult to communicate in an effective way to non-experts. But it could also be that the local politicians were not fully committed to achieving the main goal of the plan—the maintenance of the character and the urban identity of Porto.

Almost two decades before, Ivor Samuels had developed a similar assessment of a plan (also based on a morphological approach) that he had designed in the beginning of the 1990s for the French town of Asnières-sur-Oise (Samuels and Pattacini 1997). This evaluation stressed the need of gaining a political consensus for the plan to be acceptable by local politicians participating in its adoption and implementation. In the case of Asnières-sur-Oise, the election of a new mayor has introduced a more significant change than the election in Porto, as it questioned the whole morphological approach. We will return to Asnières-sur-Oise in Chap. 7.

3.2 Processes of Urban Transformation

After addressing the different direct and indirect agents of change, this section focuses on the different processes of planned transformation of the physical form of the city: from plans to planning processes including plan implementation and development control framing a number of different contributions.

3.2.1 The Plan

Eventually, the most comprehensive views of cities are condensed in urban plans. Based on the analysis of the existing situation in a particular moment in time, a plan tries to prepare the future of a city in many different dimensions, from physical (including urban form, transports and environment) to social and economic

dimensions. Due to the nature of this book, a greater emphasis is given to the physical dimension.

The urban history of each and every city includes a combination of comprehensive and of individual actions. How much of the physical form of a city is the result of planned or individual actions varies greatly. In addition, and focusing now on a single city, we can say that there are some plans which have a profound and lasting impact on the city and that there are some other plans that have no impact at all.

Table 3.1 presents a list of 20 plans that had, and still have, a profound impact on 20 different cities in four different continents. The main purpose of this list is, not to offer an unequivocal selection of 20 plans but, to give an illustration of the main directions in plan making over the last two centuries.

Yet, we should highlight that, even in each of these cases, the plan in only one part of the process of city-making. In many cases, the plan focuses only on one part of the selected city, the other parts having come about through other plans or in a more unplanned manner. It is also important to acknowledge the diachronic nature of each process of city-making. The process of city formation is generally a combination of large plans and small interventions on streets, plots and buildings.

The Nineteenth Century

The first six plans of the list were elaborated in the nineteenth century—the first for a North American city, all others for European cities. While the plans for New York, Barcelona and Lisbon prepare a number of expansion areas in these cities for the subsequent decades, the plans for London, Paris and Vienna redesign a part of these cities (a more extended area in the case of Paris and more contained areas in the case of the English and Ostrich capitals). While the plans for New York and Lisbon have an exclusive focus on streets, street blocks and plots, there is an increasing attention to buildings as we move from these two documents to the plans for London, Paris, Vienna and Barcelona. As it might be expected, and reinforcing the argument of the last section on the increasing role of architects in the twentieth century, only one of these six plans was designed by an architect, the London plan by John Nash. As we will see, this situation changes radically in the twentieth century.

Thirty years after America had achieved its independence from England, a visionary act was designed for New York. In a time when Manhattan (with less than 100,000 residents) was concentrated at the southern part of the island, Simeon De Witt, Gouverneur Morris and John Rutherfurd—assisted by surveyor John Randel—proposed a new planning paradigm for the city. The New York plan designed a new layout for a new territory that was 20 times larger than the existing city. In this new territory, the plan designed a street system (a set of streets from 14th Street to 155th Street with twelve intersecting avenues), a plot structure for each block and rigorous guidance on building alignments. This plan will be presented in more detail in Chap. 5.

Almost simultaneously, John Nash started redesigning a new street in central London, connecting a new royal park, the Regent's Park, and the Regent's home, Carlton House (demolished in late 1820s when George IV decided to move to the Buckingham Palace). Although it was the design of 'just' one axe, this was one of

the most radical so far seen changes to the urban form of London. The plan included the design of the notable Regent's Park, of the street including two circuses (Oxford and Picadilly) and some notable variations of direction such as the Church of All Souls and the Quadrant, some remarkable residential buildings of classical façades (Cumberland Terrace, Chester Terrace, Park Square and Park Crescent) and, finally, the renovation of the Buckingham Palace.

The other four plans were all prepared in the second half of the nineteenth century. The plan for Paris is somewhere in between the two former plans, proposing the redesign of a large area of the existing city. The plan designed by the Baron Haussmann, the mayor of the city between 1853 and 1869, included a new radial layout of wide streets—as opposed to the narrow and irregular medieval streets—as a key element for maintaining the law and order. It also promoted the construction of new buildings—exceptional buildings (schools, hospitals, markets…) erected by the local authority and common buildings which were object of a process of development control. This process regulated a number of issues such as the relation between building height and street width—a maximum ratio of 1:1 in the cases of streets with more than 20 m width and of 1.5:1 in the case of streets with less than 20 m width.

With the dismantling of the defensive walls around Vienna during the mid-nineteenth century—as it happened in most European cities—a debate emerged on the future of the green 'ring' (*Ringstrasse*) that separated the historical city and the then new city. The plan promoted by Emperor Franz Joseph I proposed the construction of a 5 km long horseshoe-shaped boulevard, starting and ending at the Danube canal, including a number of green areas, private buildings and some notable administrative and public buildings. Two sets of administrative and public buildings should be highlighted: (i) the *Burgring*, with an expansion of the imperial palace and two remarkable museums; (ii) and the buildings around the *Rathaus* Park—the Parliament, the City Hall (*Rathaus*) and the *Burgtheather*.

The dismantling of the city walls in Barcelona was contemporary of the demolition of the walls in Vienna. Yet, contrarily to the Ostrich capital, Barcelona had no significant peripheral areas, except for some small settlements autonomous from the medieval city, such as *Barceloneta* or *Gràcia*. Accordingly, what Ildefons Cerdá proposed in his plan, prepared in the end of the 1850s, was not the mere occupation of the area immediately around the city walls but the expansion, or *ensache*, towards a territory that was about 7 times larger than the existing city (Fig. 3.1). The plan designed a new layout based on a regular pattern of streets of about 20 m width, a street block of 110 m and chamfered corners at 45 degrees, interrupted only by a large diagonal street, somehow similar to the Broadway in New York. The plan also included guidance on the design of buildings, somehow proposing a rupture in relation to the peripheral occupation of street blocks.

The main proposals of Ressano Garcia's plan for Lisbon were the provision of new green spaces and the definition of a new street system, the *Avenidas Novas*; the plan was not intended to support development control through specific building and land use controls. The *Avenidas Novas* were the structural support for the entire northern urban expansion of Lisbon, combining at the same time, a rational design

with the strict respect for the natural environment and for the built pre-existences. Ressano Garcia defined the structural axes for a new city covering an area equivalent to the existing one, along an east-west direction. The city would be modernized through a large peripheral expansion in contrast to Pombal's intervention carried out after the 1755 earthquake, when the historical kernel of the city was totally redesigned. A specific expropriation law allowing the constitution of a lateral strip of 50 m, on each side, reserved for development, supported the construction of the new system of avenues and streets.

The First Half of the Twentieth Century

The second set of plans was prepared in the first half of the twentieth century. Although this set is more heterogeneous than the series of six plans analysed before, three groups can be distinguished: the first group, composed by the plans for Letchworth, New Delhi and Canberra, propose the construction of new cities (despite the proximity between Old Delhi and New Delhi the nature of the latter makes it suitable for this group); the second group includes the documents for Amsterdam, Lyon, Frankfurt, Berlin-Britz and Copenhagen and concerns the expansion of an existing city, from the design of a new housing neighbourhood to the comprehensive planning of a whole metropolitan area; and, finally, the third group composed by the plan for Le Havre corresponds to the reconstruction of a whole city destroyed during the Second World War.

In the end of the nineteenth century, in a context of a wide debate on the problems of large cities, Ebenezar Howard published the influential 'Tomorrow: a peaceful path to real reform' proposing a new model of urban development, the garden city (Howard 1898). The garden city would adopt a satellite location, gathering the benefits of city and country, would be self-sufficient and it would constitute the most economical solution for the growth of a city, while eliminating private speculation on land and housing. Located 50 km from London, Letchworth was the first garden city built according to Howard's model. It was designed by Raymond Unwin and Barry Parker in 1903.

In the subsequent decade, Edwin Lutyens prepared the plan for a new city—New Delhi, the then new capital of the British administration in India. The plan combined a monumental scale (that would be used in the plan for Canberra) expressed in a central mall connected to a number of diagonal avenues (as in the case of the Paris plan by Haussmann) and in a number of exceptional buildings—notably the Viceroy's House—with a low-density pattern of residential buildings based on a series of hexagons separated by broad avenues with double lines of trees.

Almost simultaneously, the Australian Government promoted an international competition for the plan of a new capital, Canberra. The selected plan, by Walter Griffin and Marion Mahony Griffin, rests on a careful reading of the natural context —both relief and water—and on the design of a set of diagonal axes, somehow similar to the ones in New Delhi. Two main axes emerge: a land axis, aligned with the summits of four local mountains and a water axis (crossing the first at right angles) running along the river, which in the plan became a chain of ornamental basins. This set of axes frame also the design of a large triangle which is the

Table 3.1 A list of influent plans in planning history in the nineteenth and twentieth centuries

Year[a]	Plan/City	Authors(s)
1811	New York	John Randel/*The Commissioners*
1814	London (Regent Street)	John Nash
1853	Paris	Georges-Eugène Haussmann
1856	Vienna	Franz Joseph I
1859	Barcelona	Ildefons Cerdá
1879	Lisbon	Ressano Garcia
1903	Letchworth Garden City	Raymond Unwin, Barry Parker
1912	New Delhi	Edwin Lutyens
1912	Canberra	Walter Griffin, Marion Mahony Griffin
1913	Amesterdam (South)	Hendrik Petrus Berlage
1920	Lyon (*Estats-Unis*)	Tony Garnier
1925	Frankfurt	Ernst May
1925	Berlin-Britz	Bruno Taut, Martin Wagner
1945	Le Havre	Auguste Perret
1948	Copenhagen	Peter Bredsdorff
1952	Chandigarh	Le Corbusier
1957	Brasília	Lúcio Costa
1967	Milton Keynes	Llewelyn-Davies
1969	Bologna	Pier Luigi Cervellati
1981	Seaside	Andres Duany, Elizabeth Plater-Zyberk

[a]This date corresponds to the beginning of plan preparation

symbolic heart of the city. The Municipal Government, the Market Centre and the Capitol (now the Parliament House) are located in the vertices of the triangle.

Contrarily to the former three plans (Letchworth, New Delhi and Canberra), the purpose of Hendrik Petrus Berlage, in his 1913 plan, was not to design a new city but to establish a south expansion area of the city of Amsterdam. The plan is based on a complex street system combining different types of geometry, street blocks of about 100–200 m long and 50 m width, interior gardens within the blocks and buildings of a sound uniformity both in terms of alignment and height—four storeys (Fig. 3.1). While having a progressive goal (the building of mass housing) and procedural means (public expropriation and long-term planning) the Berlage plan can be seen as traditional city planning in clear harmony with the nineteenth century Amsterdam.

The relation between the existing city and the planned expansions is quite different when we compare the plans for Amsterdam and Lyon. Based on the theoretical idea of an 'industrial city', Tony Garnier designs a set of proposals for the city of Lyon. The most important of these is the *Estats-Unis* residential neighbourhood which exhibits a rupture with the traditional city building in terms of the main relations between streets and buildings. Curiously, the architecture of these buildings is closer to the classical tradition than the buildings that would be designed by the Amsterdam School for the south of the Dutch capital.

The plan by Ernst May for the periphery of Frankfurt continues the line of planning developed in Lyon, the design of small city fragments mainly composed

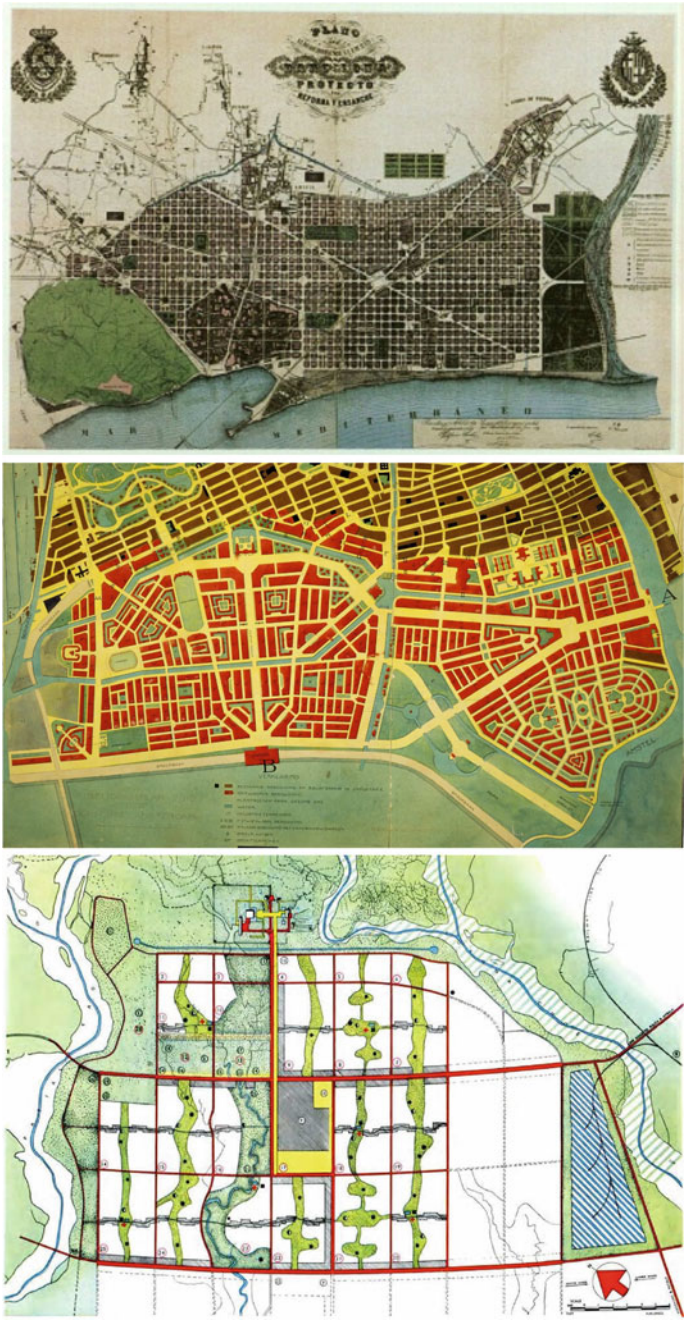

Fig. 3.1 The plans for Barcelona, Amsterdam and Chandigarh (*Source* **a** and **b** Public domain, **c** Boesinger and Girsberger 1971)

of residential buildings, the *siedlungen*. This Modernist plan, and particularly some of the detailed plans developed for each *siedlungen* (for instance *Westhausen*, as opposed to *Romerstadt* which has a more traditional layout) has a crucial importance in planning history, replacing the street block by a new type of urban landscape where buildings are completely disconnected from the street. The set of *siedlungen*, comprising more than 15,000 dwellings, were conceived as housing districts—with only a minimum of facilities, meeting the most basic needs—of a large industrial city, being linked with the latter by a public transport network.

Similarly to the two former cases, the plan for Britz is focused on the design of a housing district, of about 1000 dwellings, in the periphery of Berlin. Despite the rupture with the street block, Bruno Taut and Martin Wagner maintain a close relation between street and buildings, both in the main streets of the *siedlungen*—*Fritz-Reuter-Allee*, containing the well-known 'horse-shoe' building, and *Parchimer Allee*—conformed by multi-family buildings and in secondary streets defined by single family buildings (offering about half of the dwellings of the neighbourhood). This relation is less evident in the south part of the neighbourhood.

The plan designed by August Perret for the French city of Le Havre is of a rather different nature, aiming at reconstructing the city centre that was destroyed in the Second World War. The plan for Le Havre is closer to the traditional city than the three former plans for Lyon, Frankfurt and Berlin-Britz. In Le Havre, Perret designs a new layout of streets and street blocks based on a 100 m modulation very similar to the layout destroyed in the World War, and a set of buildings of a classical style based on modern prefabrication techniques and aiming to create a homogeneous urban landscape.

The last plan of this set of documents prepared in the first half of the twentieth century is the 'finger plan' for Copenhagen coordinated by Peter Bredsdorff. Although addressing the topic of city expansion, the 'finger plan' adopts a very different approach in relation to this set of plans prepared in the first half of the twentieth century and even to the series of plans elaborated in the nineteenth century, offering a comprehensive regional view. The plan resembled a hand, with Copenhagen at the centre (the palm) and five fingers spreading out in the direction of the towns of, from west to east, *Køge*, *Roskilde*, *Ballerup*, *Farum* and *Hillerød*, all within a maximum radius of 40 km. Instead of allowing Copenhagen to sprawl in all directions, the 'finger plan' was to create structured urban growth along fingers, with the S-train network in the middle of each finger and with green areas (farmland, forests and recreational areas) located between the fingers.

The Second Half of the Twentieth Century

This last set of documents, prepared in a time period of three decades, includes four plans for new cities, designed according to modernist planning (Chandigarh, Brasilia and Milton Keynes) and to the approach of the New Urbanism (Seaside), and one plan for the conservation of a city centre (Bologna).

After a number of theoretical proposals developed since the early 1920s, Le Corbusier had the first opportunity to design a whole new city in Chandigarh, the new capital of Punjab, India. The plan of Chandigarh is composed of: a regular grid

of streets rotated about 45° in relation to the cardinal points dividing the city in different sectors of about 1200 × 800 m; a constant presence of green areas; a very low density of buildings—residential buildings of about two storeys and institutional or commercial buildings of about five storeys; and the Capitol, in Sector 1, at the northeast of the grid (Fig. 3.1).

In the mid 1950s the Brazilian government decided to change the status of the capital city from Rio de Janeiro to a new city that would be built in the interior of the country, Brasília. Lucio Costa plan proposed a general organization of the city based on two crossed axes. The north-south axis, the *Eixo Residencial*, is a fast-circulation street supporting the location of residential areas, the superblocks, constituted by sets of six storey buildings on a continuous green space. Each set of four superblocks is a neighbourhood unit and it includes some non-residential buildings for commerce, services and facilities. The east-west axis, the *Eixo Monumental*, includes from east to west: the *Praça dos Três Poderes* gathering the executive, legislative and judicial powers; the *Esplanada dos Ministérios*, a wide rectangular green area surrounded by government buildings; the *Plataforma Rodóviaria*, in the junction of the north-south and east-west axes, gathering transport facilities, and commerce and services areas; and finally, the railway station.

Ten years after, the plan for Milton Keynes is elaborated as part of a programme launched in the 1950s—with the towns of Cumbernauld and Hook—promoting the construction of 'new towns' in England. The plan designs a city for about 250,000 inhabitants located 70 km from London, with two different circulation networks—one for pedestrians and the other for vehicles. The layout of the town centre is developed in a symmetrical way with the central station as a key element. As in the case of Chandigarh and Brasilia, Milton Keynes is a town that is completely different, in urban form matters, from a traditional city built until the end of the nineteenth century.

In the end of the 1960s a plan was prepared for the city of Bologna introducing a particular concern in the planning and architectural debate that was quite opposite from those of the three former plans. The goal of the Cervellati plan was not to conceive a new city, or even to expand an existing settlement, but to conserve the existing city. One of the main ideas of the plan was that the historical identity of the city does not reside merely in the exceptional sixteenth century buildings, but it is also inherent in the ordinary buildings, in this case erected in the seventeenth and eighteenth centuries. A typological approach was developed establishing four categories of building types all related in a unified urban landscape.

In 1980, after being gifted an 80 acre plot, Robert Davis appointed Andrés Duany and Elizabeth Plater-Zyberk to prepare a plan for a small town (2000 people) in the coast of Florida, Seaside. The plan for Seaside—a town that has become a flagship of the New Urbanism movement—stands out as a reaction to the dominant model of urban development in the United States, proposing the return to the qualities of a small town (based on a reinterpretation of local vernacular) and a connected system of streets, which keeps pedestrians and traffic together but privilege the former. The plan is complemented by a form-based code, notably

condensed in one single-sheet. After dividing the town in eight types of urban tissue, the code establishes the rules for transformation in each of these tissues offering guidance on the location and scale of yards and porches, outbuildings and parking, and finally on building height.

3.2.2 Plan Implementation and Development Control

While the set of 20 plans presented before had a high degree of implementation of their main proposals on the territory, this is not always the case. Indeed, the plan is one 'thing' and the planning process, including plan implementation, is a rather different 'thing'. Planning history includes many examples of plans with a low degree of implementation and plans that were never implemented at all.

While the process of plan making depends mostly of the planning team and of the promoter of the plan—bounded by the specific planning system, the planning team interprets the fundamental needs and ambitions of the city, and prepares a coherent document, both in terms of its different parts and of the relation with other plans eventually prepared for the same territory—the process of plan implementation depends on other important factors. One of the main factors influencing plan implementation is the commitment of human and financial resources. The emphasis placed on preparing a good plan should be followed by an equivalent effort for ensuring that the team and the financial means that are needed to support plan implementation are in fact mobilized. The availability of resources over time, the type and diversity of resources that are available, and the relationship between planning practice and allocation of resources are crucial aspects. In financial terms, the most important elements for strengthening this link are the municipal budgets, particularly the relationships between capital and running costs, and more specifically the relative weight of the resources allocated to planning issues. Also important is the way 'time', a valuable resource, is managed over the whole process of implementing the plan.

Another important factor is plan utilization by politicians and professionals in decision-making. The success of plan implementation also depends on a clear identification by politicians and professionals and the document that frames the process of city building. There are some different levels on this issue: the influence of politicians in plan making; the effective use of the plan by politicians; and, finally, the use of the plan by professionals over plan implementation. The last aspect raises the issue of the composition of planning teams. It would be desirable that the local authorities promote the establishment of qualified staff that could effectively internalize a significant part of the planning process, without denying the possibility of working together with academics and the private sector, and to explore innovative planning approaches. As such, the local authority's professionals could participate in a more continuous way in this process. This would certainly contribute to coordination among professionals, the plan and the planning process.

While plan making and implementation in the nineteenth century depended mainly on the power of a few agents, as time went by, it started depending on the participation and involvement of many different agents. Despite some exceptions, particularly in the emerging economies, plans are not being designed and implemented through the isolated action of central or local governments. As we have seen, the processes of development control involve the interaction between indirect and direct agents of change. The framework for this interaction depends on the specific planning system: from contexts, such as the French system, where the plan is the main element defining the rules for this interaction to other contexts, such as the British system, where the plan is just one element of the process, offering an advance structuring of decision-making situations.

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Chapter 4
Cities in History

Abstract This chapter analyses the evolution of cities over almost 5500 years. The structure of the chapter draws on seven historical periods that are relatively consensual for different researchers: (i) early cities, with a particular focus on the Sumerian civilization in Mesopotamia and on the Chinese civilization in the Yellow River; (ii) the Greek cities, (iii) the Roman cities, (iv) the Islamic cities, (v) the Medieval cities, (vi) the Renaissance cities, and finally, (vii) the nineteenth century cities. The main goal of the chapter is to understand, in each of these seven periods, what the main characteristics of the fundamental elements of urban form—streets, plots and buildings—were, and how these elements were combined forming different urban landscapes.

Keywords Early cities · Greek cities · Islamic cities · Medieval cities · Nineteenth century cities · Renaissance cities · Roman cities

4.1 Early Cities[1]

Two factors were crucial for the birth of the earliest civilizations, the climate changes resulting from the last of the ice ages transforming the natural environment into a more favourable context and the development of settled agriculture allowing the production of a food surplus.

These earliest civilizations, and the first cities, were probably developed in different time periods from 3500 BC onwards in seven different places around the world—the Sumerian civilization in southern Mesopotamia (present-day Iraq), the Egyptian (in Egypt), the Harappan in the Indus Valley, the Chinese in the Yellow River, the Aztec in the Valley of Mexico, the Maya in the jungles of Guatemala and Honduras and, finally, the Inca in the coastlands and highlands of Peru (Morris 1972). The first three are the so-called 'dead' cultures out of which evolved the

[1]Two notable books had a particular influence on the writing of this Chapter, 'History of urban form', written by A E J Morris in 1972, and '6000 years of housing', published by Norbert Schoenauer in 1981.

V. Oliveira, *Urban Morphology*, The Urban Book Series,
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Greek, Roman and Western European Christian civilizations. Mesopotamia is important not only because of that but also for its influence on the Arabian Peninsula where Islamic culture originated in the seventh century AD. The three American cultures are also 'dead' being destroyed by the Spanish conquers in the sixteenth century. The culture of Chinese civilization is an exception in these seven civilizations as it lasted from the late third millennium BC to the twentieth century without permanent interruption. In this section we focus on the Sumerian and the Chinese civilizations.

4.1.1 The Sumerian Civilization

The next paragraphs will focus on the Sumerian civilization, established in 3500 BC, and in particular in one of its city-states, Ur (Fig. 4.1). The city of Ur, located in the confluence of the Tigris and Euphrates rivers, had its most prosperous moments between 2500 and 2000 BC. In one of these flourishing moments it had a maximum population of 34,000 inhabitants and a population density of 370 inhabitants per hectare (Schoenauer 1981). The city of Ur was divided into three different parts: the walled city, the *temenos* (a religious precinct) and the outer city. The walled city had an irregular oval shape, about 1300 m long by 900 m wide. It stood on a mound formed by the ruins of the preceding buildings and it had a strong presence of water, both of the Euphrates and of one canal. It contained two harbours in the north and in the west. The *temenos* occupied most of the north-western quarter of the city and it contained the only public spaces for permanence of the city (Morris 1972).

The streets of the city within the walls were narrow and had an irregular form. Yet, a basic hierarchy of streets could be detected; the main commercial streets were larger than the residential streets. The residential buildings had a strong sense of privacy and their entrance was located in the narrow streets—even in the case of houses located in the corner of two streets. These houses had one or two storeys and a ground plan built around a central court including a variable number of rooms (sometimes with more than ten rooms). In the case of a two storeys house a staircase located near the entrance would lead to the first floor. The archaeological remains indicate that sometimes two houses were gathered to make a larger house. These houses appear to have been occupied by the middle class rather than by the wealthy. The main characteristics of this type of house (with some variations) have been maintained for almost 6000 years and can be found in the traditional houses of Baghdad.

One of the main contributions to the knowledge of the urban history of Ur was given by archaeologist Leonard Woolley (Woolley 1929, 1963). One of the sectors excavated by Woolley in Ur revealed that along the main streets existed different chapels, a school with two different rooms, a large tavern, a restaurant and cellars.

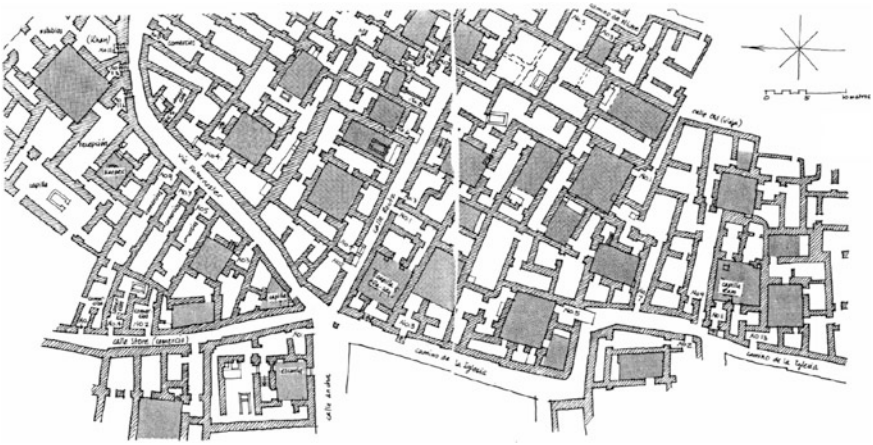

Fig. 4.1 The Sumerian cities: Ur—part of the city (*Source* Schoenauer 1981)

4.1.2 The Chinese Civilization

After many centuries of war between different states, the unification of China took place in the third century BC. The construction of the Great Wall started in 220 BC (and continued until the seventeenth century) using sections of earlier fortifications to form a united defence system against invasions from the north.

The Chinese city had a strong interrelation with the countryside. It was also based on a strong hierarchy of three different parts of increasing dimension, the *hsien*, the *yi* and the *tu*. The three parts—and also the subdivision structure of the countryside—had a squared, or an almost squared, shape. This was based on the ancient belief that the Earth was squared and the sky was circular. Another important issue in the structuring of the Chinese city is that it had a pre-established growth limit.

The Chinese city had a defensive wall and a north–south orientation. The street system was a regular grid, where the fundamental streets lead to the gates of the city. There was a strong presence of commerce in many streets, particularly in the larger cities. The residential areas were marked by the presence of walls with few fenestrations.

The Chinese house was a residential complex, surrounded by a wall of 3 or 4 m high, comprising different buildings surrounding one central patio (in the case of families of a higher status the house could have two patios). The plan of this complex was structured around a central axis in a symmetric way. After entering in the complex, and before moving to the patio, one would face the so-called 'wall of spirits' (the only exception in this symmetrical composition) preventing the entrance of demoniac spirits in the house. Buildings had one storey only and the Chinese would consider presumptuous if someone intended to build a house higher than the city wall. The relation between buildings and patios in the Chinese house

seems to be based on climatic issues, as the patios in the north of the country were larger than in the south. In addition, the roofs of buildings located in the south had a shape that offered further protection against sun exposure.

Each complex would correspond to a family, usually a large family as the married sons would share the house with their parents. The building located closer to the street was the less important containing the areas for the servants and for the domestic tasks. The two perpendicular buildings were occupied by single and married sons. The most private areas of the complex were the most important and were occupied by the older members of the family. Some authors, such as Durant (1954) argue that, in this period, the quality of life in China was higher than in Greece or in Rome.

Figure 4.2 presents two different cities. The first is the capital city of Chang'an, in the Shaanxi province. Chang'an had an almost squared shape and a significant dimension of about 9200 m by 8500 m. The street system was an orthogonal grid with eleven north–south streets—the five streets in the centre forming a central axis—and fourteen east–west streets. Among these, six main streets provided direct access to the main gates of the city while the rest were subsidiary streets. The street blocks had a rectangular shape with the long axis pointing east–west. The Imperial Palace, facing south, was built at the northern end of the central axis, with the Administrative City adjoining it to the south.

The second city is Beijing. Beijing was structured in four different parts, each one surrounded by its own city wall: (i) at south, the exterior city with a rectangular shape, ten gates and an area of 27,300 m^2, and a more informal character; (ii) at north, the interior city with nine gates and an area of 30,250 m^2; (iii) within the interior city, the Imperial City, accessed by four gates and with an area of about 5000 m^2; and, finally, (iv) within the Imperial City, the Forbidden City, with an area of 1650 m^2.

4.2 The Greek Cities

The emergence of the Greek state-city occurred in the ninth century BC. The *polis*, the Greek state-city, was an urban–rural entity in which the city and its hinterland had a strong interdependence, in political, social and economic terms. One important aspect of the *polis*, as in the Chinese city, was that when the city reached a particular dimension, the process of urban growth would be constrained and a new city would be founded. In a certain sense, the second city would be a colony of the first.

One of the key physical elements of the *polis* was the city wall, an element of irregular shape and variable dimension according to the size of the city (Fig. 4.3). Within the walls, in the highest part of the city, one would find another fundamental element of the *polis*, the acropolis, with a religious and a defensive nature.

The Greek cities could have a regular (closer to the Chinese cities) or an irregular (closer to that of Ur) layout of streets. While Mileto and Priene illustrate the former,

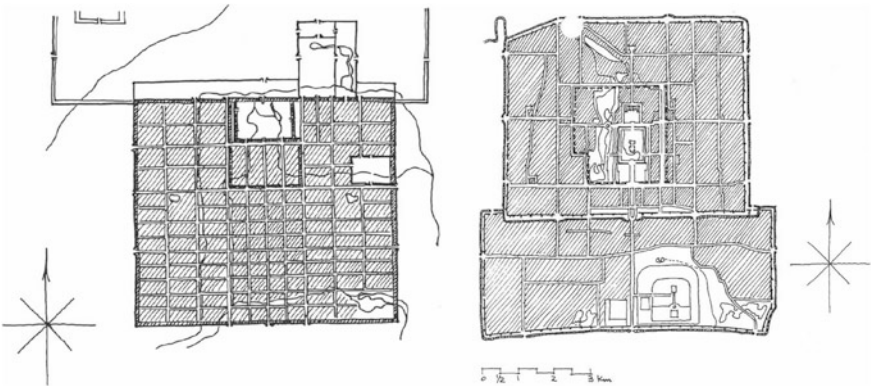

Fig. 4.2 The Chinese cities: Changan and Beijing (*Source* Schoenauer 1981)

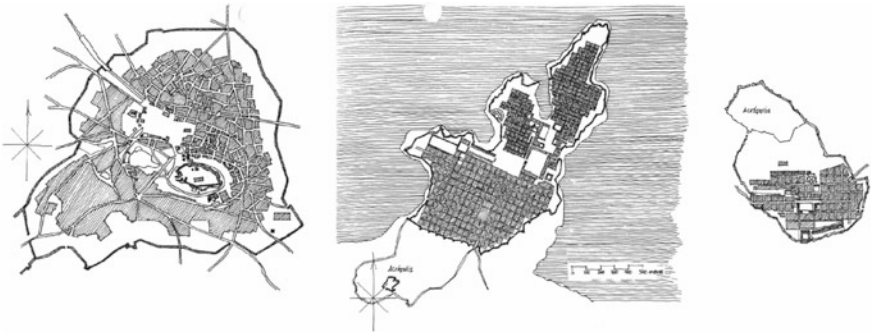

Fig. 4.3 The Greek cities: Athens, Mileto and Priene, approximately at the same scale (*Source* Schoenauer 1981)

Athens is a remarkable example of the latter (Fig. 4.3). While both Athens and Mileto were destroyed by the Persians in the fifth century BC, they were object of different processes of reconstruction: Athens followed the pre-existing pattern of streets and Mileto designed a new layout. There were not many open spaces for permanence in the *polis*; the main exception was the *agora,* the place for gathering of the Greek citizens.

The street block was composed of residential plots—that could have similar, or different, sizes—offered by a particular process of land subdivision. Schoenauer (1981) describes in detail a particular street block in the city of Olynthus. This street block was composed of two rows of five houses each. The streets conforming the block were different—smaller streets in the east–west direction and larger streets in north–south direction. The street block was 91.5 m long and 36.5 m wide. An extremely narrow space—probably for drainage—separated the two rows of houses. Each of the houses had a squared shape of 18.2 m.

The singular buildings of the Greek city—of a cultural, civic, religious and commercial use—adopted strategic locations, independently of the system of streets, whether this was a regular or an irregular system. As such, the different buildings formed an 'organic' and asymmetrical composition, being related by a complex game of distances and empty spaces. This complex composition included a number of privileged paths, making also use of the relief, allowing the progressive discovery of the different singular buildings (Lamas 1993).

In clear contrast, the residential buildings followed closely the layout of streets. Despite some variations, the Greek houses shared a set of fundamental characteristics. They were very simple with no ornamentation. As such, if seen from the street, a poor and a rich house would look very similar. On the contrary, the interior spaces would be very different. The houses, whether in a regular or an irregular street system, were structured by a central patio surrounded by a colonnade, the 'peristyle'. The houses could have one or two storeys—in these cases the patio would also be surrounded by a colonnade in the second floor.

4.3 The Roman Cities

The Roman cities had a strong sacred and symbolic sense. This was expressed both in the delimitation of the perimeter of the city and in the definition of the two fundamental axes that structured the whole city, the *Decumanus maximus* (running in an east–west direction) and the *Cardus maximus* (in a north–south direction). The crossing of these two streets, leading to different city gates, constituted the centre of the city. The *forum*, the privileged open space for permanence, was generally (Pompei, for instance, is an exception) located in this intersection.

The percentage of Roman cities with a regular layout of streets—orthogonal or non-orthogonal—was higher than that of Greek cities. The presence of a regular layout was even more pronounced in the Roman colonies, such as Timgad in modern Algeria, due to the specificity of the processes of land subdivision and to the easiness of construction (Lamas 1993).

The Roman street block was mainly residential. It was divided in a number of plots—not as regular as the streets—where the different residential buildings were erected. The singular buildings seem to be more linked to this layout of street blocks than in the Greek case. The Roman cities included a number of equipments and public facilities—such as theatres, markets, circuses—while the Roman territory was structured by a series of infrastructures, namely bridges, aqueducts and canals.

The typical Roman house, the *domus*, was influenced by the Greek peristyle-house and the Etruscan atrium-house.[2] This one storey house could have

[2]The Etruscans were the first civilization of the Italic peninsula. They started their expansion in central Italy in the ninth century BC and were assimilated by Rome in the sixth century BC.

between one and three open spaces. The larger houses would have two rectangular patios—the *atrium*, smaller, was the centre of the public area while the peristyle, larger, structured the private area of the house—and a small garden, usually in the back of the plot. Building coverage was, as such, very high. While the façade of the house, with a reduced number of doors and windows, and the relation between building and street was very close to the Greek house, the interior of the Roman house had a strong sense of ornamentation, being very different from the Greek house (Schoenauer 1981). Another Roman building type was the *insulae*. This was introduced due to the scarcity of space in cities such as Rome and it could have six storeys high.

Let us focus on one particular city, Pompeii (Fig. 4.4). Pompeii was funded in the sixth century BC, experiencing changes of overlord in the centuries that followed. In 89 BC it was conquered by the Romans. In 79 AD, Pompeii was buried by the eruption of Vesuvius.

There is no consensus on the number of inhabitants of the city, but it could have had a maximum number of 25,000 people. Pompeii was roughly oval in shape. It had about 1300 m long by 650 m width, with an area of about 64.5 hectares enclosed by a double wall. There were eight gates into the city (one of which linking the city and the port) leading to well-paved main streets with sidewalks. Via *di Mercurio*, in the northwest part of the city leading to the *forum* (located in the southwest part of the city and not in the crossing of the *Decumanus maximus* and the *Cardus maximus*), was the widest street with 9.7 m wide, and about 250 m long. Other main streets had widths of about 7.9 m, while the minor ones which served only to give access to houses, varied between 5.5 and 3.6 m. The *Decumanus maximus* was the Via *dell' Abbondanza*, linking two gates—*Porta Marina* and *Porta Sarno* and the *Cardus maximus* was the Via *Stabiana* linking *Porta Vesuvio* and *Porta Stabia*.

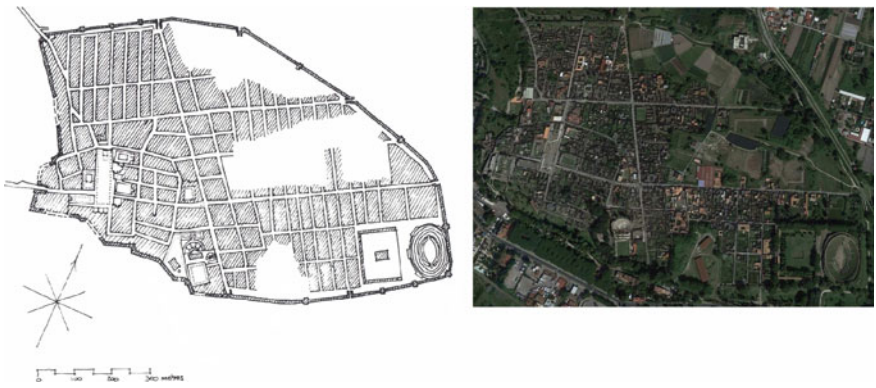

Fig. 4.4 The Roman city: Pompeii (*Source* drawing—Schoenauer 1981; *aerial view*—Google Earth)

The street system, built in different time periods, defined street blocks of different sizes. The street blocks in the older part of the city, around the *forum,* were smaller and had irregular shapes. On the contrary, in the north-western part of the city, near *Porta Vesuvio* (in the so-called archaeological region 6), there are six street blocks of a regular elongated shape of about 140 m long and 35 m width. At south of these six blocks another set of five rectangular blocks is developed with approximately the same width but of shorter length—about 90 m. Two of these blocks are occupied by two plots, and two buildings only, the House of Pansa and the House of Fauno. The House of Pansa had a set of 'shops' facing the Via *delle Terme*, contained more than 50 rooms and it was structured around the three usual open spaces of the Roman house (of significant dimension), the *atrium*, the peristyle and the garden. As in the case of Sumerian and Greek houses, sometimes two or more houses were gathered to make a larger house.

Schoenauer (1981) presents a synthesis of the land use in Pompeii: 21 % of land was occupied by public open spaces for circulation and permanence, 63 % by built-up area, and 16 % by private open space including *atria*, peristyles and gardens.

To conclude, we can say that the Roman house shares with the former cases in Mesopotamia, China and Greece, two interrelated fundamental characteristics that cannot be found in the subsequent cases in medieval Europe: the patio—offering favourable sun exposure and a particular microclimate—and a strong sense of privacy structuring the house in two different areas.

4.4 The Islamic Cities

Many Islamic cities are cultural descent of the Sumerian cities of ancient Mesopotamia. Morris (1972) distinguishes between original—shared with these ancient cities—and later urban form determinants of Islamic cities. Original determinants include not only the topography, climate and construction materials (all three of a 'natural world' origin), but also the absence of orthogonal grids, of legislation in the sense of a formally codified civil law, of aggrandizement and considerations of civil aesthetics, and of social segregation. Later determinants comprise the urban guidelines contained in the *Qur'an* and the *Hadiths* (the sayings of the Prophet) that together form the basis of the *Shari'a*, the Islamic Holy Law which covers all aspects of the public and private, communal and personal lives of the Muslims.[3] Morris (1972) distinguishes three types of Islamic cities based on their origin: urban settlements of organic growth (exemplified by *Erbil*, ancient *Arbela*), cities of Graeco-Roman planned origins which were taken over by the

[3]The prophet Muhammad was born around 570 AD in the city of Makkah and died in 632 in the city of Medina (the two Islamic Holy cities of Saudi Arabia). The contents, but not the final arrangement of the *Qur'an* go back to Muhammad.

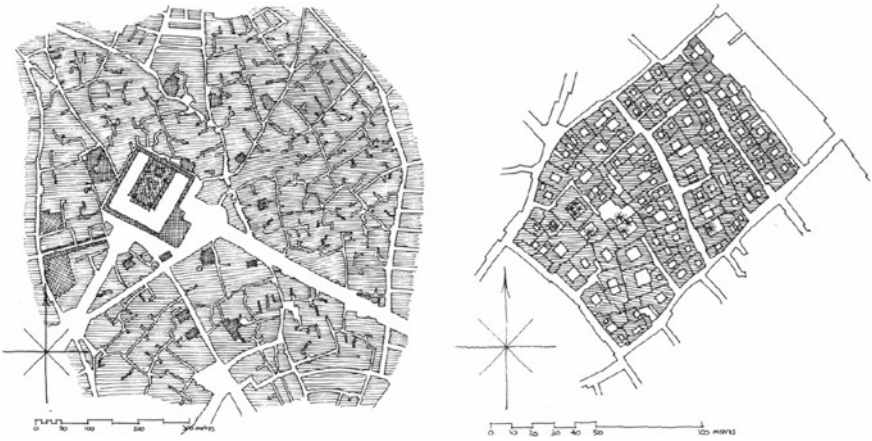

Fig. 4.5 The Islamic city: *Al-Kazimiyah* (near Bagdad), the medina and part of the residential sector (*Source* Schoenauer 1981)

Muslims as their empire expanded (for instance, Aleppo or Damascus); and third, new cities founded in conquered lands by the Muslims armies (for example, Baghdad or Tunis).

The defensive system of an Islamic city differed little from that of the medieval European city (pre-artillery), and included a relatively simple wall, strengthened by towers, with defensive additions at the gates. With few exceptions, the *Kasbah* (the citadel of the ruling elite) was positioned against or astride the city wall, a characteristic seemingly inherited from ancient Mesopotamia, that was in direct contrast to Western European form where the citadel was in the centre.

All elements of urban form of the Islamic city were influenced by the *Shari'a*. The intricate street system, determined by the aggregation of residential buildings, was mainly composed of two types of streets: the thoroughfares, with a width of 7 cubits[4] (3.23–3.50 m), allowing passage of two laden camels; and the *culs-de-sac*, with a width of about 4 cubits (1.84–2.00 m), allowing passage for one laden camel. In this system of extremely narrow streets, the presence of a square, facing a mosque or comprising a market, would be an exceptional public space element (Fig. 4.5).

A key element was the *suq*, providing the sale of different commodities. There was an established hierarchy of localization in respect of nearness to the Mosque. The individual shops composing the *suq* were of small size ranging upwards from 1.5 m^2 and they were arranged in different ways: as linear *suqs* on either side of a through street from a city gate to the Mosque; as area *suqs* where back-to-back rows

[4]The cubit is an ancient unit based on the forearm length, from the middle finger tip to the elbow bottom.

face each other and where gates can be provided for overnight security; *suqs* where the shops were against the perimeter wall of special buildings (Morris 1972).

The fundamental building of the Islamic city was the Mosque. Its general arrangement consisted of a covered prayer hall along one side of a colonnaded courtyard. Sometimes, it had an open courtyard with one or more fountains for purification before prayer. It also included one or more minarets. Related to the Mosque, there were a number of other building types, including the *Hamman,* the public bath-houses used separately by men and women, and the *Madrasa*, a college for advanced study of Islamic law and sciences (Morris 1972).

Plots of Islamic cities were very irregular both in terms of form and size. Except for a courtyard, building coverage was extremely high and each house would occupy the whole plot. The house of the Islamic city was deeply rooted in the house of ancient Mesopotamia, promoting the privacy of domestic domain. The house was structured by a courtyard and it was divided into two parts, the *salamlik*, the public part, and the *haramlik*, reserved to the family. In larger houses, these parts were physically separated and structured around different courtyards, while in smaller houses they corresponded to different floors. The building façade was very simple contrasting to the richness of the interior. The climatic comfort was one of the main concerns of the house, including a number of measures to achieve that purpose. For instance, each room could change its function according to the time of the year (Schoenauer 1981).

4.5 The Medieval Cities

The fall of the Roman Empire—due to demographic decline, wars and plagues, and moral decadency—had a profound impact on the Western Europe: the Roman urban heritage and its linkages to the former Oriental civilizations were lost, and the role and importance of cities changed dramatically as the Barbarians were mainly rural. With the exception of cities that were under the influence of the Eastern Roman Empire (such as Constantinople, present-day Istanbul) and of the Arabs (for instance, Cordoba or Palermo), cities were constantly destroyed by Barbarians. In some cities, the former settlements were significantly reduced and structured within singular constructions such as amphitheatres (Arles and Nimes) or palaces (*Spalato*, present-day Split) that were transformed in defensive elements.

In the tenth and eleventh centuries, the political stability and the increase of commerce activity had a strong contribution to the resurgence of cities. According to Benevolo (1982), the population of Europe grew from about 22,000,000 in 950 to 55,000,000 in 1350. This process corresponded to some different situations: (i) former Roman cities that were continuously occupied or that after being abandoned have been re-occupied; (ii) new settlements that emerged in the periphery of Roman cities (for instance, on the 'other' bank of the river); (iii) former Christian sanctuaries, located outside of the Roman city, that have been developed into cities; (iv) rural villages that have grown; and, finally, (v) new cities, such as the French

bastides, funded for commercial or military purposes, usually based on a rigorous geometrical plan (Lamas 1993).

The city walls reinforce their importance in the Middle Age, constituting a fundamental element of defense and separating the city from the countryside. In many cases, when the city achieved a maximum capacity a new ring of walls was built outside the former offering new opportunities for growth.

The streets of a medieval city were very different from the streets of Roman, Greek or of early cities that we have seen in this chapter. While the overall pattern can differ from, or resemble, the pattern of former cities, the relation between buildings and streets is very different. The medieval houses had a more direct relation with the street offering, in many cases, a commercial use in the ground floor. The building was located in the front of the plot leaving its rear part empty. Buildings could have different heights and different façade design. The city square was also very different from the *forum* or the *agora* having, in most cases, an irregular shape resulting from the gathering of different streets. The square was usually associated with the market which is the materialization of the idea of the city as a place for commercial exchange.

The debate on the planned or spontaneous nature of the medieval city has always attracted many promoters. For instance while Sitte (1889) or Munford (1961) sustain the existence of planned proposals in the construction of cities in the Middle Ages, Morris (1972) argued for a more spontaneous nature.

Figure 4.6 presents two different medieval cities, *Ragusa*, present-day Dubrovnik in Croatia, and *Rothenburg ob der Tauber*, in Germany. Dubrovnik, situated on the Dalmatian coast, became an important Mediterranean Sea power from the thirteenth century onwards. Dubrovnik is structured by an east–west street, the *Placa ulica*, dividing the city into two different parts: a northern part with a more regular street layout with narrow streets and stairs (due to the strong relief); and a southern part, at a lower level, with an older and more irregular street layout, and with a higher building density. *Placa ulica* is 300 m long and has a variable width, from 11 to 18 m. It links the west gate and the port, in the east (the city had a third gate located near the port). It has a strong commercial use. The civic centre was near the port and it was constituted by a number of interconnected squares gathering different monumental buildings. The Dubrovnik house was 6.8–9 m (30–35 *palmus*) width and 10–12.8 m (40–50 *palmus*) high. The buildings of the *Placa* had three storeys: the ground floor was occupied by commerce and access, through the perpendicular streets, to the house; the first floor contained the reception and living rooms; and the second floor included the dining room, kitchen and bedrooms (Schoenauer 1981).

The city wall of *Rothenburg ob der Tauber* had five gates and more than 30 towers and bastions. The street system is very different from the Dubrovnik layout constituting a radial system centred in the *Marktplatz*. The main streets of this system, linking the square market with different gates, were *Untere Shmiedgasse* (650 m long) in the south, *Hafengasse* (350 m long) and *Galgengasse* (400 m long) in the east, and *Klingengasse* (200 m long) in the north. The street blocks had irregular shapes and very different dimensions. Blocks around the market square,

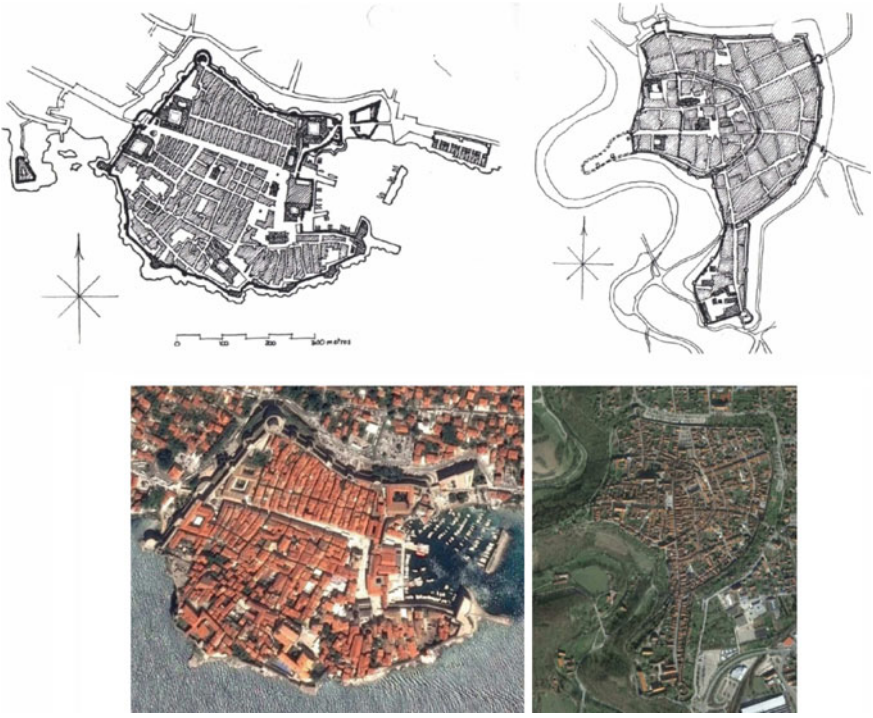

Fig. 4.6 The medieval cities: Dubrovnick and *Rothenburg ob der Tauber* (*Source* drawings—Schoenauer 1981; *aerial views*—Google Earth)

within the first city wall were smaller and more irregular. Schoenauer (1981) analyses a number of buildings in the city and finds a particular building type with a patio. Yet, as he states, contrarily to the Roman, Greek and earlier examples in China and Mesopotamia, this house is mainly related with the street and the patio had merely a service function.

4.6 The Renaissance Cities

Although the term Renaissance is used in this section for the entire period, architectural history usually divides it into four different phases: Early Renaissance (fifteenth century); Late Renaissance (sixteenth century); Baroque (seventeenth century and early eighteenth century); and a more heterogeneous phase, including different styles such as Rococo and Neoclassical (in mid and late nineteenth century).

Morris (1972) identifies five different areas of Renaissance action on cities: fortification systems; regeneration of parts of cities by the creation of new public

Fig. 4.7 The Renaissance cities: *Palma Nova* and *Neuf-Brisach*, approximately at the same scale (*Source* Google Earth)

spaces and related streets; restructuring of existing cities by the construction of new main-street systems which, extended as regional routes, frequently generated further growth; the addition of extensive new districts, normally for residential purposes; and the layout of a limited number of new towns (see Fig. 4.7 for *Palma Nova* and *Neuf-Brisach*).

The defensive strategy of Renaissance cities was based on a new type of fortification system, more complex, promoting larger distances between the city and the enemy lines (Fig. 4.7). This had a direct impact on the structure of the city. While the medieval wall could be substituted through successive concentric rings, the Renaissance fortification system was, due to its high cost and its constructive complexity, more static. As such, it constituted an effective limit for the horizontal expansion of the city, leading to increasing building heights and population densities.

The street system of Renaissance cities included three fundamental elements. The first is the primary straight street. The construction of these streets was bounded by sound aesthetic concerns and they were seen as an 'architectural whole'. Perspective effects were emphasized by the location of terminal features, both architectural and sculptural, in the form of statues, fountains and obelisks. The second is the regular grid. Morris (1972) identifies three main uses for the regular grid: as the basis of residential districts added to existing urban areas; for the entire layout of a limited number of new towns; and finally in combination with a primary street system, for the layout of other new urban areas. The third is the enclosed space. On the basis of their urban mobility functions, Morris groups Renaissance urban spaces under three broad headings: traffic space, forming part of the main urban route system and used by both pedestrians and horsedrawn vehicles; residential space, intended for local access traffic only and with a predominantly pedestrian recreational purpose; and, finally, pedestrian space, from which wheeled traffic was normally excluded.

The building façade becomes a crucial element in the Renaissance city, gaining an autonomous nature expressed by its careful design and organization. The Roman concern on the visual order of the urban space—present, for instance, in the *forum* of Pompeii, through the use of a common arcade linking the different buildings—is reintroduced, first in Sienna, in the regulation of the buildings conforming the *Piazza del Campo* (see Fig. 2.7) after the conclusion of the city hall, and then in the Italian cities.

Figure 4.7 presents two new towns constructed in the Renaissance, *Palma Nova* and *Neuf-Brisach*. Palma Nova was constructed in the turning from the sixteenth to the seventeenth century, as a fortified garrison outpost of Venice's defences. Its perimeter is a nine-sided polygon and its central square is a regular hexagon (of 85 m side). These shapes are linked by a complex arrangement of radial streets. Six streets, 350 m long, lead out from the centre to an angle of the wall, or, alternatively, to the centre of one side of the polygon. Additionally, twelve radial streets start from the innermost ring of three concentric streets. A set of secondary squares is formed in the centres of house blocks. 45 street blocks, of different size and shape, are defined. The main civic buildings are grouped around the central square.

The construction of *Neuf-Brisach* started one century after the establishment of *Palma Nova* as part of a number of fortified buildings and sites along the eastern, northern and western borders of France. Despite the similar shape of the fortification —this is an eight-sided polygon—the street system of *Neuf-Brisach* is quite different from the one of the Italian city adopting an orthogonal grid around a central square. Nine northwest–southeast streets and nine northeast–southwest streets structure the layout of the city within the fortification system. The central square, *Place d'Armes Général de Gaulle*, has the size of four blocks. Another square with the size of one block is located at east of the main square. This system defines a set of 48 street blocks of similar size and almost squared shape (about 50 × 55 m).

4.7 The Nineteenth Century Cities

The nineteenth century cities were different from their predecessors in terms of scale and of the overall city form. The evolution of military strategy and the design of new types of weapons had significantly reduced the utility and effectiveness of city walls. As these become obsolete, the need for land due to the industrialization processes and to the huge demographic growth was progressively fulfilled outside the wall. Later, the wall itself was destroyed being replaced by new elements of urban form (see the case of the Vienna ring presented in Chap. 3).[5] Without the definition of a perimeter, the built area expanded over the territory and the suburbs

[5]In addition to Vienna, London and New York (focused in this section), Chap. 3 gathers data on the urban history of two other cities that had a sound development in the nineteenth century, Barcelona and Paris.

emerged. In the suburbs, the traditional elements of urban form acquired new meanings and functions: the street was a simple path; the square was no longer a place for gathering and social interaction; the street block was progressively abandoned; the single family house, located within the plot, had no direct relation with the street—a wall or fence (and not the building façade) separated the public and the private space; in the overall, that low-density landscape was not able to offer a physical structure to the area or a sense of urbanity to its residents (Lamas 1993).

Industrialization and the significant demographic growth caused severe problems: lack of housing, facilities and infrastructures; deterioration of the built environment; lack of hygienic conditions and health problems; extreme poverty; to name just a few. These problems would lead to a social reaction, mainly through the proposal of new communities based on a set of social and economic reforms. Due to the significant demographic growth in cities there was an unbalance between housing supply and demand, giving rise to 'real estate speculation'. The processes of land subdivision and building construction were seen in the nineteenth century as instruments of investment.

In the end of the nineteenth century, London and New York were the largest cities in the world—the first with 4.2 million inhabitants, the later with 2.7 million inhabitants; yet, New York had a higher percentage of growth starting from about 100,000 inhabitants in 1812. In the first half of the nineteenth century, many of the rich residents of New York's Lower East Side began to move north, leaving their low-rise row houses. The arriving immigrants concentrated on that area, moving into the row houses that had been converted into multiple-apartment tenements (a similar process occurred by that time in many geographical contexts), or into new tenement housing built specifically for that purpose. A typical tenement would be erected on a 7.62 m (25 ft) wide and 30.48 m (100 ft) long plot—a plot defined according to the city regulations. The building would have six storeys high. A stairway would lead to a hall serving four dwellings per floor. The three or four rooms within each dwelling would have an in-depth organization (many would call it a 'railroad' tenement). Only one of the rooms would have daylight. Usually, each of these dwellings would accommodate more than one family. Another building type was the so-called 'dumbbell tenement' (the name came from its dumbbell shape). This building type was very similar to the former; yet, it was pinched in the middle, introducing long and narrow light shafts and the possibility of opening windows in more rooms.

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Chapter 5
Three Cities

Abstract The fifth chapter addresses contemporary cities, with both inherited and emerging urban forms, investigating the main urban agents and city-building processes. Three case studies were selected: three clearly distinct cities, with different weaknesses and threats, and with specific strengths and opportunities. These cities are New York, Marrakesh and Porto. Founded in the early seventeenth century by the Dutch settlers, the city of New York has been continuously growing, in a remarkable process of urban evolution, marked by the 1811 plan (establishing its orthogonal layout), that culminated in today's magnificent metropolis, structured in five main areas (Manhattan, Brooklyn, Queens, Bronx and Staten Island) and the place of residence for more than eight million inhabitants. The urban forms of Marrakesh are clearly different from the urban forms of New York. Marrakesh, one of the four imperial cities of Morroco, was founded in mid eleventh century by the Almoravids. Ten centuries of urban history are today present in the remarkable medina of Marrakesh. The city with almost one million inhabitants is also composed of areas developed in the twentieth century, such as the *Guéliz* and the *Hivernage* neighbourhoods. The urban forms of Porto are very different from the urban forms of the American and Moroccan cities described in this chapter. Founded in mid-eleventh century, as Marrakesh, Porto grew from a small castel town to an area twelve times larger in a period of two centuries. In a unique location facing the Atlantic Ocean and the Douro River it is the second largest city of Portugal and the centre of a metropolitan area with 1.7 million inhabitants.

Keywords Cities · Marrakesh · New York · Porto · Urban form

5.1 New York

After being explored by Giovanni da Verrazano, for France in 1524, and by Henry Hudson, for the Netherlands in 1609, the area that would be named New Amsterdam (and renamed New York in 1664) was settled by the Dutch West India

V. Oliveira, *Urban Morphology*, The Urban Book Series,
DOI 10.1007/978-3-319-32083-0_5

Fig. 5.1 Reproduction of the *Afbeeldinge Van de Stadt Amsterdam in Nieuw Neederlandt* by Jacques Cortelyou, 1665–1670 (*Source* Public domain)

Company in 1625. In the next year, Peter Minuit, the first Director-General of New Netherland, purchased Manhattan Island from a local tribe.

Figure 5.1 presents a map of New Amsterdam in the end of the Dutch occupation in the mid-seventeenth century. New Amsterdam was a small settlement surrounded by water at east, south and west and by a wall (in what would be Wall Street) at north. The pattern of streets was very irregular. One main street emerged in this irregular set, the *Breede Wegh* constituting a pre-existence of the former indigenous occupation (the *Weekquaesgeek*). Later it would be called Broadway. The map in Fig. 5.1 shows a set of 20 street blocks of irregular size and shape, with different number of plots—also of different sizes and shapes—and with a higher density of buildings in the southern street blocks. Fort Amsterdam stands out as an exceptional built structure. Despite the construction of new streets, the street pattern of today's Lower Manhattan is very similar to this pattern of the seventeenth century.

In 1664 New Amsterdam was conquered by the British and renamed New York. Under the British Government the city flourished and the population had a significant increase. From about 1000 inhabitants in 1650 it grew until 20,000 inhabitants in its late colonial days (see Table 5.1). Figure 5.2 presents a map of the city in those days. On the one hand, it shows a moderate expansion of the urban area—the city was about three times larger than New Amsterdam 100 years earlier—extending until the Commons (now the City Hall Park). On the other hand, it shows the beginning of a new pattern of orthogonal streets and street blocks promoted, not by public action and planning but, by private initiative. This is the case of the areas between Broadway and Hudson River, in the west part of Manhattan, and to the east of Bowery Lane, in the eastern part of the island.

Table 5.1 Evolution of resident population in New York, 1790–2010 (*Source* Department of City Planning, DCP)

1790	33,131
1800	60,515
1810	96,373
1820	123,706
1830	202,589
1840	312,710
1850	515,547
1860	813,669
1870	942,292
1880	1,206,299
1890	1,515,301
1900	3,437,202
1910	4,766,883
1920	5,620,048
1930	6,930,446
1940	7,454,995
1950	7,891,957
1960	7,783,314
1970	7,894,798
1980	7,071,639
1990	7,322,564
2000	8,008,278
2010	8,175,133

After the independence from Britain, this preference for a regular layout would have its greatest expression in the beginning of the nineteenth century. In 1807 the New York State Legislature appointed and empowered three commissioners—Gouverneur Morris, Simeon De Witt and John Rutherfurd—to prepare the future of the city, with a deadline of 1811 to complete the plan. They hired John Randel Jr as surveyor general. The 1807 Act set few design guidelines, fixing the plan's baseline at the edge of the dense settlement at Houston St., anticipated squares and three types of streets, and established specific implementation procedures.

The plan was based on an apparently futuristic growth scenario. At a time when the city with a population of 96,000 inhabitants crowded south of Canal St, the plan envisioned it reaching 155th St and forecasted a population of 400,000 in 1860. The population of Manhattan in 1860 would be 813,500, doubling the Commissioners' projections for that year (Ballon 2012).

The plan proposed a division of the territory north of Houston St into a grid layout of 12 avenues wide and 155 streets long. Figure 5.3 shows the pre-existent layouts (dark grey shaded blocks) and the proposed grid—almost 2000 new blocks. Although the grid looks uniform, it contains two primary patterns that create variety. The first is the streets width: the avenues are 30 m wide, the standard cross streets are 18 m and the major cross streets are 30 m (they exceed both the norms in

Fig. 5.2 Reproduction of 'A Plan of the City of New York and its Environs', by John Montresor, 1766 (*Source* Public domain)

Lower Manhattan and the minimum stipulated by the 1807 Act). The second is the blocks dimensions: all blocks are 60 m wide (north to south), but their lengths (east to west) varies, diminishing from the centre of the island to the shorelines. One key characteristic of the plan was that all of its streets and avenues were numbered rather than named.

Due to the high land values of Manhattan the plan has restricted the number of squares and parks, believing that the Hudson and East rivers provided sufficient open space. The existing small and scattered parks were retained.

The plan did not dictate plot dimensions, but the blocks had a modular system, all are divisible by 6 and 7.5 m—20 and 25 ft (Fig. 5.4). A standard plot was 30 m deep (half of the block depth) and 6 or 7.5 m wide. The regulations on buildings height were related to the streets width: taller buildings in the avenues and lower rise buildings in the side streets.

Plan implementation was a long process—it took about 60 years for the grid to be built up to 155th St—including significant modifications: (i) the insertion of

Fig. 5.3 Reproduction of 'The Brigdes map' by William Bridges, 1811 (*Source* Public domain)

Broadway (which would become the counterpoint of the grid, particularly in its diagonal stretch from 10th to 72nd Street[1]); (ii) the construction of two new avenues linking the northern and southern parts of island (Lexington, between 3rd and 4th avenues, and Madison, between 4th and 5th avenues); (iii) the creation of new open spaces—neighbourhood parks and squares (from Union Square to Bryant Park), in a first stage, and Central Park (covering an area of three blocks wide and 51 blocks long, and promoting the role of the 5th Avenue as the meridian separating the east and the west sides), in a second stage; (iv) the enlargement of some axes (Park Avenue north of 47th Street, Lenon Avenue, Adam Clayton Powell Boulevard, and 17 of the east-west streets); and finally, (v) the removal of the

[1]Broadway crosses from 4th to 10th avenues, producing seven exceptional intersections as follows (from 4th to 10th): Union Square; Madison Square Park, marked by the remarkable Flatiron building; Herald Square; the notable Times Square; Colombus Circle, in the southwestern entrance of Central Park; Lincoln Square; and finally, Verdi Square.

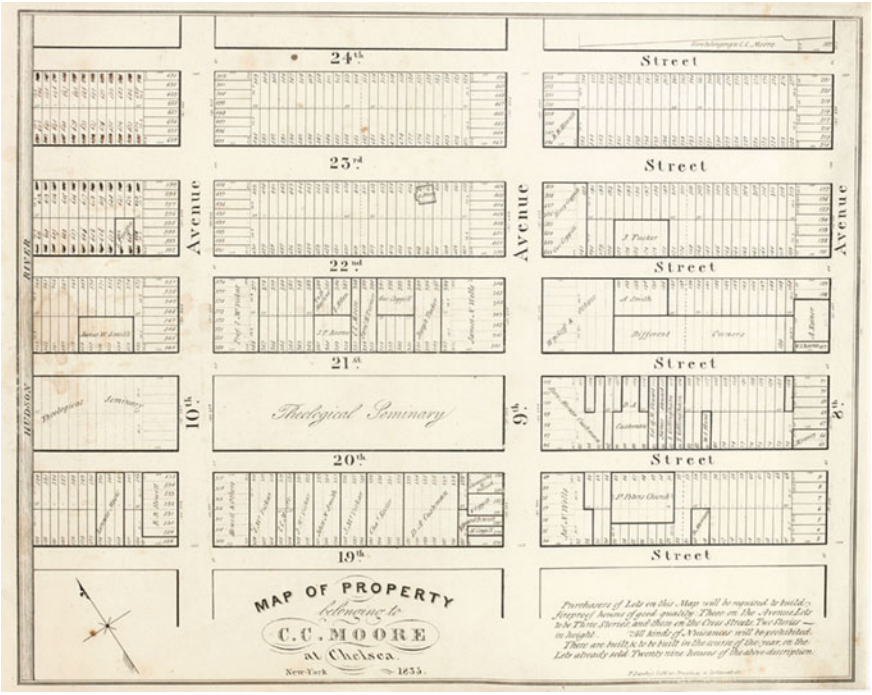


Fig. 5.4 Reproduction of the 'Map of property belonging to C.C. Moore at Chelsea', 1835 (*Source* Public domain)

military parade ground (or its dramatic downsize to Madison Square Park), the Observatory and most of the proposed squares.

Despite the levelling of hills and filling of valleys to produce a more horizontal surface, today's topography still has a striking resemblance to conditions in the early nineteenth century. Most of the streets of the plan ran through private property. To build these streets, the State Legislature defined the street opening system, an early form of eminent domain allowing the construction of streets and squares for the city and the financial compensation of the owners (Ballon 2012).

New York first expanded along the East Side. Its low and flat topography invited construction, unlike the West Side's rugged hills and valleys. The 1830s brought about a residential housing boom and in the end of the decade the city had opened gridded roads to 52nd Street. The improvement of the West Side only began in the mid-1860s. The erection of the Dakota in 1884 had a symbolic nature, an elegant apartment building in the rural backwater of the West Side. The establishment of Morningside and St. Nicholas Parks and the undulating Riverside Drive are some examples showing of the presence of the topography. Similarly, the planning of Upper Manhattan (north of 155th), carried out more than 50 years after the 1811 plan, would give more pre-eminence to its rugged landscape (Ballon 2012). In the end of the nineteenth century the Brooklyn Bridge physically linked Manhattan and

Table 5.2 Evolution of resident population in the five boroughs of New York, 1990–2010 (*Source* DCP 2012)

	1990	2000	2010
Bronx	1,203,789	1,332,650	1,358,108
Brooklyn	2,300,664	2,465,326	2,504,700
Manhattan	1,487,536	1,537,195	1,585,873
Queens	1,951,598	2,229,379	2,230,722
Staten Island	378,977	443,728	468,730
New York City	7,322,564	8,008,278	8,175,133

Brooklyn. In 1898, these two, joined by the Bronx, Queens and Staten Island, consolidated into the five borough metropolis.

The technological advances of the twentieth century exaggerated the grid, as skyscrapers climbed higher with the help of steel skeletons and passenger elevators. Before 1916, the grid could be extended straight up into the sky along the boundary lines of streets and plots. In 1916, the first zoning law was approved restricting the height of buildings, requiring them to step back as they rose in order to protect a measure of sunlight on the street and lower stories. There were five variations of the formula applied in different districts, based on the width of the street and the angle of the setback. In 1961 a new zoning law was approved aiming to encourage builders to incorporate open space into their plots, allowing them to build taller towers (Ballon 2012).

Another important element in the twentieth century was the incorporation of superblocks into the grid, created by erasing some street sections. While some were formed for monumental buildings (New York Public Library, Grand Central Terminal), others contained monumental ensembles (Columbia University, Rockefeller Center, Lincoln Center). From the 1930s through the middle of the century, some sections of the grid were obliterated to create large housing projects. Although the housing superblocks fit neatly into the orthogonal street system, they changed the grain of the city; they did not have the grid's walkable character or their mixed-use quality. In the turning from the twentieth to the twenty-first centuries the prevailing trend has been to reasserty the grid, as the recent developments of Battery Park and Ground Zero demonstrate (Ballon 2012).

In the turning to the twenty-first century New York achieved eight million inhabitants (Table 5.2). This number increased 2.1 % in 2010, with 2.5 and 2.2 millions of residents in Brooklyn and Queens (the two largest boroughs in terms of total land area), 1.6 and 1.4 millions in Manhattan and the Bronx, and about 470,000 inhabitants in Staten Island. The population of the city as a whole and of each of the five boroughs has always been increasing between 1990 and 2010 (the city as a whole has been increasing since 1790, except for two decades, 1950s and 1970s). Manhattan holds the highest population density. The highest densities within the island can be found in Upper West Side, Upper East Side and on the eastern strip between Sutton Place and Stuyvesant Town (respectively Community Districts 7, 8 and 6).

The diversity of the different neighbourhoods of New York is one of its most important characteristics. The brief description that follows moves from south to north in Manhattan, and from there to the Bronx, Queens, Brooklyn and Staten Island.

The built environment of Lower Manhattan is marked by the pattern of streets of both Dutch and English settlements (Fig. 5.5b). It was the site of the first capital of the United States and, after 1792, of the financial capital of the world. It includes the Ground Zero that, after the terrorist attacks in September 2001, is emerging in the area showing the strength of the city. At north-east of Lower Manhattan we will find the Seaport and the Civic Center. This was mainly developed after independence. The area gathers the City Hall, different court houses and some key buildings, such as the Woolworth Building. It has a strong linkage with the water and in its northeast part it receives the Brooklyn Bridge. Lower East Side—located north of the Seaport and the Civic Center and south of the 1811 grid—is the traditional gathering point for newly arrived immigrants of many cultures. Little Italy and Chinatown are the most visible examples of the presence of these communities. Soho and Tribeca[2] are two of the trendiest (and most expensive in which to live) neighbourhoods of New York, with an intense artistic life, full of galleries, cafés and shops. Soho is also widely known due to its remarkable architecture, one of the world's most significant set of buildings in wrought iron (Fig. 5.5d).

Let us move north of Houston Street. Greenwich Village combines the south-western part of the 1811 grid, around the vibrant Washington Square, with a more irregular pattern of streets, around Sheridan Square (Fig. 5.5f). It has been a gathering place for 'free spirits' of all kinds. Unlike Greenwich Village, Gramercy and the Flatiron District are dominated by the pattern of streets defined by the 1811 plan. While Gramercy is mainly a residential area structured around the park built in the 1830s, the area around the Flatiron Building and Madison Square has a mixture of uses. South of Central Park we find the Theater District. The Theater District first began to attract theatres and restaurants to the neighbourhood after the Metropolitan Opera House moved there in 1883. The district includes some of the most important buildings (New York Public Library, Rockefeller Center), squares and parks (Times Square, Bryant Park) of New York. At east of the Theater District we find Midtown. It is an area marked by a large set of skyscrapers, from the Chrysler Building erected in Lower Midtown in 1930 to the Lever House and the Seagram Building built in Upper Midtown in the 1950s. It has a number of fundamental musems such as the Museum of Modern Art (MoMA). It is clearly marked by the presence of the 5th Avenue and it is inhabited by a high-income population. This high-income population has lived in Upper East Side since the turning to the twentieth century. Today it is gathered in the 5th and Park avenues. Madison Avenue holds a number of shops and galleries. The area gathers some important museums located in remarkable buildings such as the Guggenheim, the Whitney and the Metropolitan.

[2]SoHo and TriBeCa are the names for 'South of Houston' and 'Triangle Below Canal' (the triangle of streets below Canal Street).

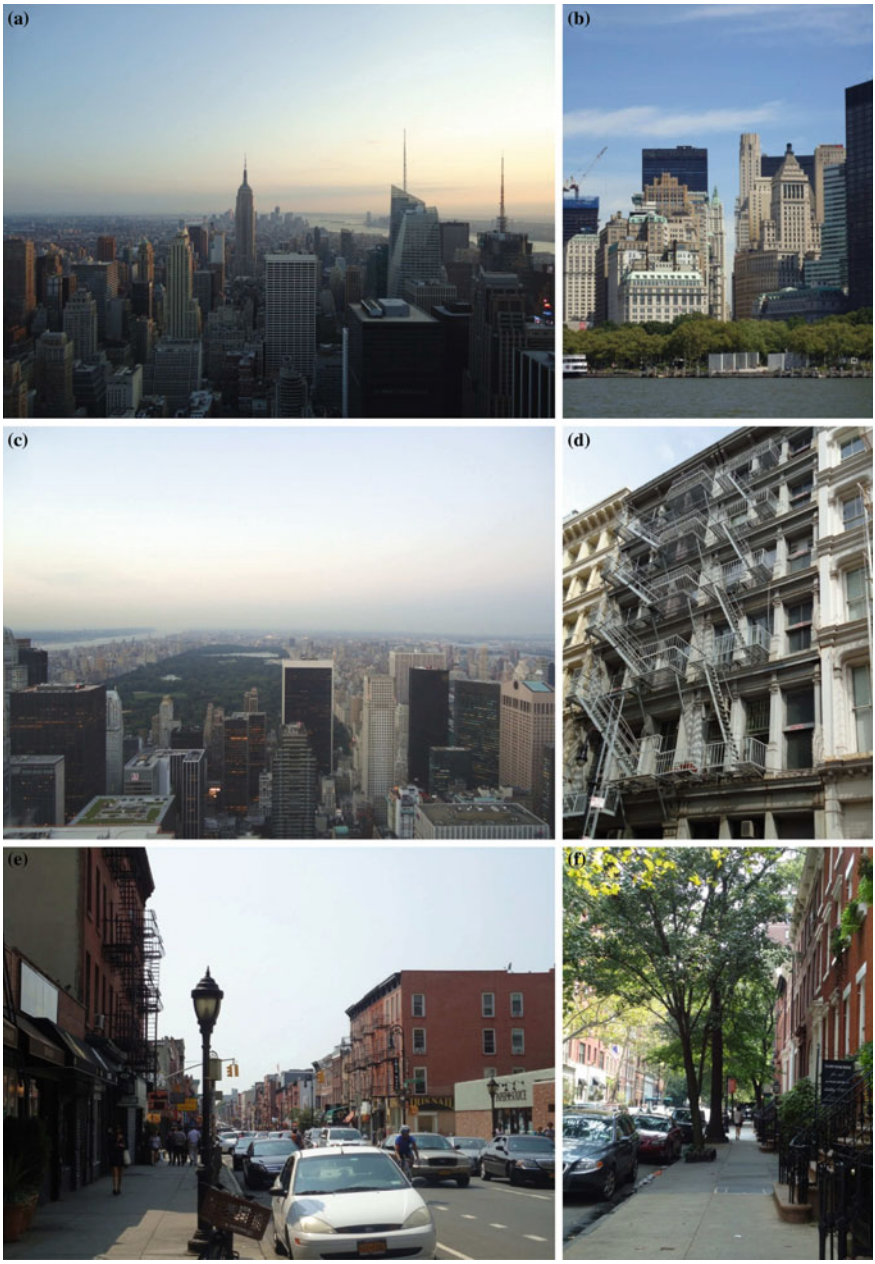


Fig. 5.5 New York: **a** the southern part of Manhattan, **b** Lower Manhattan, **c** the northern part of Manhattan, **d** Soho, **e** Brooklyn, **f** Greenwich Village (*Source* Photographs by the author)

Despite its latter occupation, after the construction of the elevated trains and of the Dakota Apartments a number of buildings have been progressively built in Broadway and Central Park West. Today, the Upper West Side is a very diverse place from high-income population in Riverside Drive and Central Park West to mid- and low income in Amsterdam Avenue. It is also the place of fundamental cultural buildings such as the Lincoln Center and the American Museum of Natural History. The northern part of the island is the Harlem, the vibrant centre of African-American culture. The neighbourhood is structured by the 125th St (Martin Luther King Jr Boulevard) that includes key buildings of the culture of the city, such as the Apollo Theater.

The Bronx is almost two times larger than Manhattan. Its pattern of streets is clearly different from Manhattan, more fragmented and structured by main undulated streets. It holds some singular buildings and open spaces such as the Yankee Stadium, the Botanical Garden and the Bronx Zoo. Queens has the largest area and the second highest population of the five boroughs. One of its more dynamic areas is Long Island City, connected to Manhattan by the Queensboro Bridge or 59th St Bridge. One of the major expressions of the artistic life of Queens is the PS1 MoMA, a part of the Museum of Modern Art. Brooklyn (Fig. 5.5e) is the largest borough of New York in terms of population (it would be the fourth largest city of the United States if it was a city by itself) and the second largest in terms of area. It is probably the area with the soundest ethnical diversity. Three of the most important areas of the borough are Downtown Brooklyn, Brooklyn Heights and Park Slope, near the remarkable Prospect Park. Both Brooklyn and Queens have a pattern of streets somehow close to the dominant pattern of Manhattan. Finally, Staten Island has a street system more fragmented that the Bronx street system. It is a borough with an area larger than the Bronx and with about 470,000 inhabitants.

5.2 Marrakesh

Marrakesh is located in southern Morocco, between the Atlantic Ocean and the Mediterranean Sea and at the foot of the Great Atlas mountains. It is one of the four imperial cities, together with Fes, Meknes and Rabat. The city, which gave its name to the Moroccan Empire, was founded in mid eleventh century by the Almoravids, a Berber[3] dynasty established in 1056 that lasted until 1147. The city became the capital of these conquering nomads who would succeed in stretching their empire from the Sahara to Spain and from the Atlantic to Algeria. The original layout of the medina dates back to the Almoravid period, which included the construction of the city walls (built in 1126–27), a large palace (destroyed), a mosque, and the so-called *khettaras*, a sophisticated system of subterranean channels for irrigation

[3]The Berbers are an ethnic group indigenous of North Africa.

that is still in use. Youssef ben Tâchfine and, particularly his son, Ali ben Youssef were the main promoters of the urban development of the city in this dynasty.

In 1147 the so-called Red City was taken by the Almohads (1147–1269). While most of the existing monuments—palaces and mosques—were destroyed by the victors, Marrakesh was maintained as the capital and it did experienced unprecedented prosperity. The magnificent Koutoubia Mosque[4] was built in this period upon the ruins of the Almoravid foundations. The Almohads built new quarters extending the city wall, the Kasbah (1185–90) which was a prolongation of the city to the south with its own ramparts and gates (*Bab Agnaou*, *Bab Robb*), its mosque, palace, market, hospital, parade ground and gardens (UNESCO 2009). Contrarily to the Almoravid buildings, constructions erected by the Almohads had a great simplicity and no decoration.

After the Almoravid and the Almohad dynasties, the city has gone through different cycles of decline or stagnation and of prosperity. The first period of decline came with the Merinid dynasty that ruled the empire for more than two centuries and established Fez as the main city. The last years of this dynasty in Marrakesh were marked by famine and ruin.

The Saadians conquered the city in 1522. The new dynasty has given the city a period of great prosperity, including some major works, namely: the reconstruction of the notable Ben Youssef *Madrasa* in the northern part of the Medina; the construction of the *El Badi* Palace, in an abandoned Almohad garden northeast of the Kasbah, inspired in the Alhambra (Granada); and the erection of the Saadian Tombs, whose precious architecture is isolated from the rest of the Kasbah by a wall. The *Mellah*, or Jewish quarter, was built in the end of the sixteenth century for the largest Jewish population in Morocco. It is one of three areas of the traditional city, together with the medina and the Kasbah (Gottreich 2007; Métalsi et al. 1999). Figure 5.6 shows what is probably the first cartographic representation of the city in the second part of the sixteenth century.

A period of stagnation came in 1688 with the Alawite dynasty (which is still the ruling house of Morocco) favouring, first, the city of Fes, then Meknes, and finally Rabat. Nevertheless, some sultans of the dynasty have developed important works giving the city a new mosque, *madrasas*, palaces and residences harmoniously integrated into the homogeneous unit of the old town, which was surrounded by 10 km of clay and lime and beaten-cob ramparts. The great traditional areas of greenery—the palm groves, the *Menara* and, to the south, the *Agdal* gardens—were located beyond the walls (UNESCO 2009). In the end of the nineteenth century the *Al-Bahia* Palace was erected, northeast of the *El Badi*. The nineteenth century is also marked by internal fights encouraged by different European countries.

In the first half of the twentieth century, under the umbrella of the French protectorate, a new city outside (northwest) the medina was designed. The *Guéliz*

[4]It is one of the largest mosques in the Muslim West (90 m large and 58 m width) and can receive 20,000 persons. The Mosque minaret is more than 70 m high. The harmony of its proportions, 5:1 according to the Almohad canons was the model for the construction of the Giralda in Seville and of the Hassâne tower in Rabat.

Fig. 5.6 Reproduction of the Antonio da Conceiçâo map, 1549–1589 (*Source* Public domain)

neighbourhood was conceived by Marshall Lyautey, Captain Landais and the planner Henri Prost. Figure 5.7 shows the plan of the city after the construction of the *Guéliz* neighbourhood linked with the medina by the *Doukkala* gate.

Nowadays, Marrakesh is a vibrant city of about one million inhabitants. It is an extremely sensorial city with intense colors and odours. The patterns of streets, plots and buildings within and outside the medina are significantly different (Fig. 5.7). The elements of urban form within the medina are a remarkable example of an Islamic City as described in Chap. 4. The medina of Marrakesh is surrounded by the city wall, a notable structure of irregular shape with 10 km length, 6–9 m high and 1.5–2 m wide. Ten monumental gates establish the connections between the medina and the immediate surroundings.

The exterior open spaces within the medina are mainly composed of two rather different elements, the intricate pattern of narrow streets and the large *Jemaa-el-Fna* Square—see Fig. 5.8 for an aerial view and Fig. 5.9 for some daily life photographs. The medina is indeed a notable example of the liveability of open spaces. The relation between built space and exterior space is clearly favourable to the first, in a proportion that distinguishes the interior of the medina from both western cities and the 'city' outside the medina, namely the *Guéliz* and the *Hivernage* neighbourhoods. *Jemaa-el-Fna* is a rather unusual square. It has a very irregular shape,

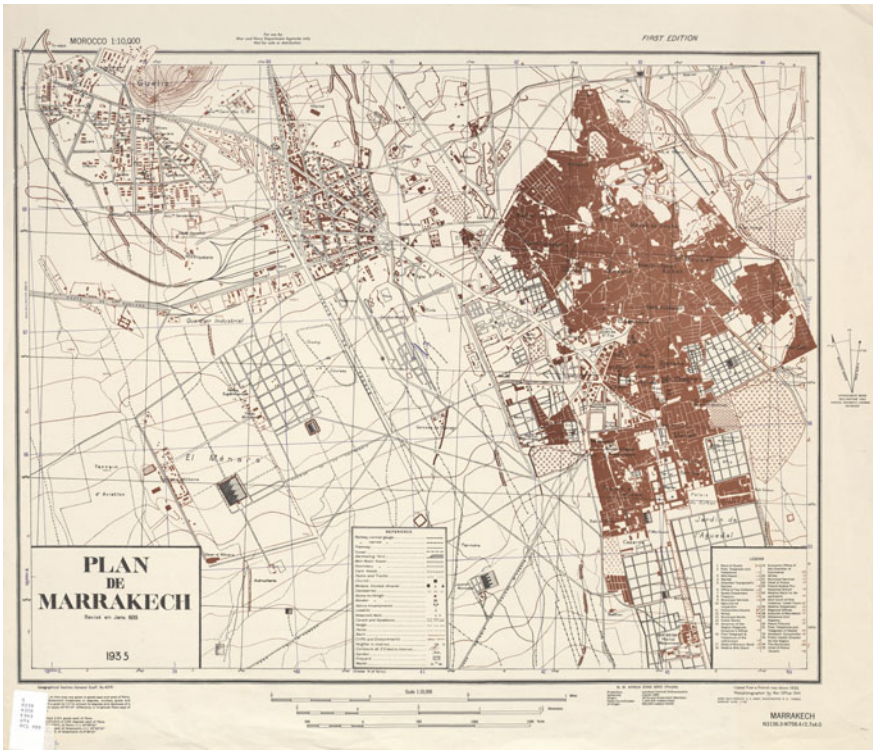


Fig. 5.7 Reproduction of the Plan de Marrakesh, 1935 (*Source* Public domain)

Fig. 5.8 Marrakesh: the intricate pattern of narrow streets and the large *Jemaa-el-Fna* Square (*Source* Google Earth)

Fig. 5.9 Marrakesh: **a** *Jamaa-el-Fna* Square; **b** and **d** streets in the Medina; **c** street in the *Gueliz* neighbourhood; **e** Ben Youssef *Madrasa*; and **f** the *suqs* (*Source* Photographs by the author)

with more than 250 m in its largest axe, and it is configured by rather ordinary buildings. Yet, as Times Square in New York, it is always crowded both by residents and tourists at any time of the day. Activities in the square change during the day, from market in the morning to musical and cultural performances in the evening.

One particular type of street, as described in the previous chapter is the *suq*, composed of a large number of individual shops and organized according to the products for sale (Fig. 5.9f). The *suqs* of Marrakesh with their narrow streets are located north and east of Jemaa-el-Fna. The most ancient areas of the *suqs* are located between *Suq Smarine*, in the south, and the Ben Youssef Mosque, in the north, and include the *Rahba Kedima*, the 'old square' (a former slave market that is a centre for different types of healers).

Contrarily to other imperial cities, the *Kasbah* and the medina are strongly connected in Marrakesh. Except for the palace, the streets of the *Kasbah* are very similar to those of the Medina. This is also the case of the *Mellah* that has lost its original population becoming very similar to the other areas within the Medina.

The Ben Youssef area is one of the most important cultural and spiritual areas within the Medina. Three singular buildings are predominant in this area, the Marrakesh Museum, the Ben Youssef Mosque and the Ben Youssef *Madrasa* (Fig. 5.9e). The *Madrasa* is one of the most remarkable buildings of the city. It has a squared shape and two storeys. It is organized around a symmetrical axe including the central patio with a rectangular pool, the prayer room and the *mihrâb*. Two galleries of student cells, both in the ground floor and in the first floor, are structured around this axe.

The *Bab Doukkala* connects, literally, two different worlds, the Medina and the *Guéliz* neighbourhood. Indeed, the radial patterns of streets—built around the 16 November Square and the Mohammed V Avenue—and the relation between open space and built space is significantly different outside and inside the medina. The built environment of the *Guèliz* (and *Hivernage*) is less adapted to the climatic conditions than the one of the medina. Despite the intense transformation of the building stock of *Guèliz* for the production of office buildings and multifamily residential buildings that occurred in the last decades it is possible to find some modernist single-family buildings surrounded by gardens erected in the first half of the twentieth century (Fig. 5.9c).

The high-income *Hivernage* neighbourhood extends the *Guèliz* south. Although it presents a similar pattern of streets, plots tend to be larger and the building coverage lower. Despite the qualification of streets (for instance with trees), many of these are configured by high walls with no visual contact between the street and the different plots and buildings. Further than the luxury houses the *Hivernage* includes hotels, clubs, theatres and casinos. At west of the neighbourhood, and 2 km of the *Bab Jdid*, the *Ménara* gardens, with the large reservoir built in the twelfth century and the green roof palace erected in the nineteenth century, constitute a remarkable piece of landscape design.

5.3 Porto[5]

Despite some previous forms of human occupation developed since the eighth century BC, the history of Porto as a town began in 1123 with the attribution of the so-called *foral*. The town in the twelfth century was a small settlement with 3.5 hectares. By then, it was mainly constituted by a small castle town surrounded by a Romanesque city wall with four gates. The city wall was probably built in the sixth century and it included a cathedral, a residential building for the clergy, a small market and a number of small houses. Outside the wall the land had mainly agricultural uses. One of the most important streets within the Romanesque wall was *Rua D. Hugo*. It is a small (about 300 m long) and very irregular street, not only in terms of plan but also in terms of the topographical differences. The form of the 20 plots of this street is also very irregular, including plot frontages from 3.5 to 70 m. The diversity of its buildings is also substantial. Building coverage is, in most of the cases, very high, although there are some exceptions. In terms of the buildings height it goes from one to four storeys, although the large majority of buildings are two storeys high.

In the fourteenth century (1336–47), a new city wall with sixteen gates was built, including an overall area that was twelve times superior to the former. The new walled area included the Ribeira which was by then the main port of the city. The increasing port activity in the beginning of the sixteenth century, mainly based on the Porto wine trade with Britain, led to the introduction of some changes in the medieval city, such as the construction of new streets within it and some improvements in the city wall. One of these streets was *Rua das Flores*. In morphological terms, *Rua das Flores* was substantially different from *Rua D. Hugo*. The construction of *Rua das Flores* started in 1521 linking two existing squares (with a sound religious presence), the *Largo de S. Domingos* and the *Praça de S. Bento da Avé Maria* which included one of the gates of the city wall. The street is 350 m long and 9 m width, and it is constituted by 100 plots. The permanence of its plot structure over the centuries is remarkable. In 500 years of urban history all (but one) plots kept their original form. Plot frontages are considerably less diverse than the ones in *Rua D. Hugo*. Yet, they have some variety. In general, plot frontages are larger in the part of the street originally designated *Rua das Flores* than in the part of the street initially named *Rua dos Canos*. The variety of building types is lower than in the *Rua D. Hugo*. The height is, as it might be expected, higher than within the Romanesque wall, varying between two and six storeys.

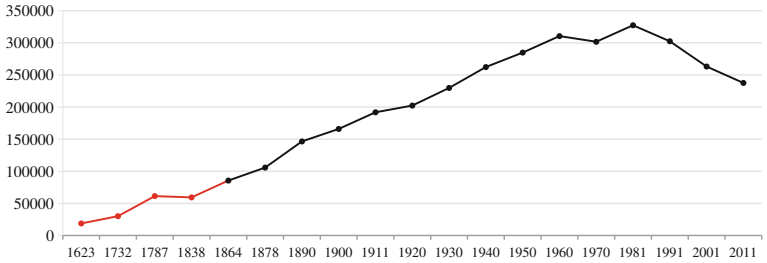
Despite some references to two different maps from the eighteenth century, the first map of Porto, encompassing what was then the whole city, was prepared in the beginning of the nineteenth century, in 1813, by George Balck—the so-called *Planta Redonda* (Fig. 5.10). Eight decades later, the map of 1892, designed by Telles Ferreira, would be a milestone in Portuguese cartography (Fig. 5.11).

[5]A first version of this paper was published in the journal 'UrbanForm and Design' under the title 'The urban form of Porto' (Oliveira 2015).

Fig. 5.10 Reproduction of the *Planta Redonda* by George Balck, 1813 (*Source* Public domain)

Fig. 5.11 Reproduction of the *Carta Topographica da Cidade do Porto* by Telles Ferreira, 1892 (*Source* Public domain)

Table 5.3 Evolution of resident population in Porto, 1623–2011. The first official census in Portugal took place in 1864 (all data prior to this census is represented in a brighter colour)



In the beginning of the eighteenth century, the economic development of the city, supported by Brazilian gold and diamonds, allowed the construction of a set of Baroque buildings or the reconstruction of existing buildings (or of its facades) in a Baroque style. In the eighteenth century Porto had a significant increase of population: in about one century it grew from less than 20,000 inhabitants to about 30,000 inhabitants (Table 5.3). As a consequence, the local authority asked for the intervention of the Crown and in 1758 the *Junta das Obras Públicas* was established as the public agency responsible for urban planning and management. The *Junta* focused on two different areas, the historical kernel and the territory outside the city wall. Figure 5.12 shows, in black, the fourteenth century wall and, in a brighter colour, the new streets that were built in the second half of the eighteenth

Fig. 5.12 The new streets designed by the *Junta das Obras Públicas* (*Source* Barata 1996)

century and in the first half of the nineteenth century. The *Junta*, supported by favourable legislation on land and building expropriation, designed not only the street itself but also a street facade (including the width and height of buildings, the design of doors and windows, the design of balconies, to name just a few) for the different buildings in each street. It also provided land subdivision processes into regular plots with a standard width (between 5 and 6 m) and a variable depth. These plots are very different from the ones that can be found within the first and the second city walls. In 1784 the vision and the main guidelines of the *Junta* were gathered in the *Plano de Melhoramentos*. The work developed by the *Junta* over eight decades is one of the most interesting periods in the urban history of Porto.

A symbolic street of this period is the *Rua do Almada* (already mentioned in Chap. 2) which has the name of the first president of the Junta, João de Almada e Melo. The street was designed in 1761, as part of the *Bairro dos Laranjais* plan, and built in 1764. With more than 800 m long, linking the walled city to a new square at north, it is far longer than *Rua das Flores* and *Rua D. Hugo*. The average width of the street is very similar to *Rua das Flores*. As mentioned in Chap. 2, *Rua do Almada* includes ten street blocks and 215 plots. A significant part of these plots has a front of 5 m and a depth ranging between 20 and 90 m. This type of plot led to the emergence of a particular type of building. Due to the small size of the plot frontage, the building had to be developed 'in depth', which means that this type of building typically has a depth of more than 15 m.

The history of Porto in the first half of the nineteenth century was marked by two military events, the second Napoleonic invasions in 1809 (Portugal was invaded by the French three times between 1807 and 1813), and the civil war involving conservative and liberals carried out between 1826 and 1833. The civil war, and the victory of the liberals, led to the establishment of a Constitutional Monarchy in Portugal and to the extinguishment of the *Junta* in 1833.

In the urban expansion of Porto outside the second city wall, after the opening of the first streets designed by the *Junta*, the new streets were planned and built on a territory structured by five roads leading to different cities in the north of Portugal, *Matosinhos*, *Viana do Castelo*, *Braga*, *Guimarães* and *Penafiel*. The urban landscape was marked by the development of industrial activities and by the emergence of a new housing typology, locally called *ilhas*. This typical residential solution for the working class consisted in rows of houses built on narrow and long plots connected to the street through strips of open private space, and located on the back of larger *bourgeois* town houses facing the street.

Despite some common features there is a sound diversity of the existing *ilhas* both in terms of size and form. The left part of Fig. 5.13 presents the main types of *ilhas*: (i) the *ilha* within one single plot; (ii) the *ilha* in two plots, organized by one open corridor in the middle of the houses; (iii) the *ilha* in two plots, organized by two open corridors giving access to two rows of back-to-back houses; and finally, (iv) the *ilha* built in one single plot that, contrarily to the former cases, does not have a main house facing the street. The right part of the figure presents: first, the

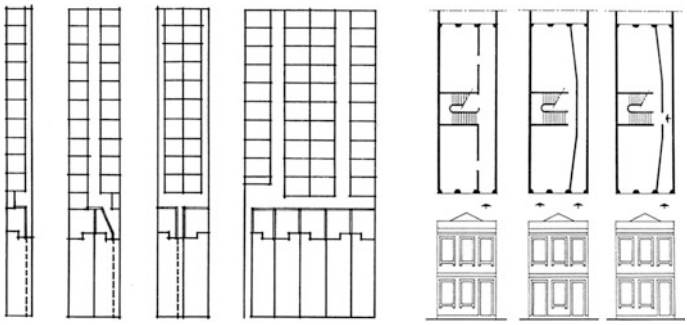
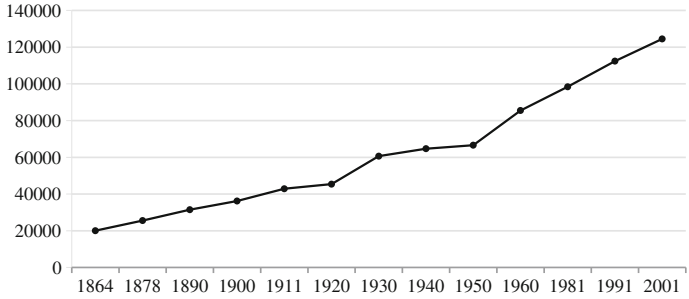


Fig. 5.13 The *ilhas* of Porto (*Source* Teixeira 1996)

Table 5.4 Evolution of dwellings in Porto, 1864–2001 (data for 1970 is not available)



original plan and façade of a middle-class house; second, the design of a second door allowing the access to the *ilha*; and third, the same door on the façade allows the access to the main house and to the *ilha*. In the end of the nineteenth century, Porto had 140,000 inhabitants; this number would continuously grow until the 1960s (Table 5.3).

In 1892, the northern and western expansions of the city were supported by two main axes, *Avenida da Boavista* and *Rua da Constituição*. The construction of *Boavista* (*Rua da Boavista* and *Avenida da Boavista*) and of *Constituição* took a long period in time. The first map of Porto, the *Planta Redonda*, already represented the eastern part of the Boavista axe (Fig. 5.10). This street linked the *Praça da República* with one of the five gateway roads to some of the most important nearby cities in the north of Portugal. In 1813, Boavista was 11 m width, 500 m long, and 80 % of it had already been occupied with buildings. More than 150 years later, in 1978, the street length was thirteen times higher, being that, the main enlargement has corresponded to the period between 1839 and 1892. Although the beginning of

the construction of *Rua da Constituição* can be traced to 1843, the first map to include this street was the 1892 map. Despite its apparent unitary form, *Constituição* had been built in three moments: first its central part between a square, *Marquês*, and another gateway road, *Antero de Quental*; then, a western extension; and, finally, a eastern expansion. The percentage of building facade along the street was not very high, particularly in the eastern part. The street length had remained the same between 1892 and 1932, and it had increased between 1932 and 1978. The percentage of building façade has been growing in a regular rhythm, from 20 % by the end of the nineteenth century, to 58 % by the end of the 1970s.

The urban fabric of Porto, in the first half of the twentieth century, is marked by the construction of the first social housing blocks, trying to eradicate all the *ilhas* from the city. In a first phase, these housing interventions corresponded to single-family houses with one or two storeys, erected in the peripheral parts of the city. Table 5.4 presents the evolution of dwellings in Porto between the second half of the nineteenth century and the beginning of the twenty-first century. In this period, the number of dwellings in Porto increased to a number six times higher than the initial. The most significant change occurred between 1950 and 1960, corresponding to an increase of 28 % and to the construction of 19,000 new dwellings. The smallest variation occurred in the previous period, 1940–1950, representing an increase of 2 %—2000 dwellings.

The first multifamily housing block promoted by the Porto City Council was built in 1940 providing 117 dwellings for the working class. During the 1940s, two other neighbourhoods were built. In the 1950s, on the contrary, there was a massive public investment on housing, contributing for the significant increase above mentioned. Part of this investment corresponded to an important housing programme designed for the city of Porto, the so-called *Plano de Melhoramentos*, which lead to the construction of 6072 dwellings in 16 separate neighbourhoods. This second phase of housing promotion continued throughout the next two decades corresponding to larger neighbourhoods composed by several apartment blocks usually four storeys high and clearly separated from the street. These dwellings were always very small and following a strict standard interior layout.

The end of the twentieth century is marked by the construction of heavy road infrastructure partially overlapping the traditional urban fabric of Porto. This whole set of fast circulation roads represents a radical change in mobility policies and in the structuring and organization of the urban fabric. Concerning major facilities and public equipments, the city acquires two new university campus, a new museum of contemporary art, and an urban park on the west side nearby the seafront.

Despite some variations in the 1960s and in the 1970s the city achieved its maximum population in the beginning of the 1980s with 330,000 residents. Since then, Porto has been continuously losing population to its metropolitan area, particularly to the surrounding cities of *Maia*, *Valongo*, *Matosinhos* and *Vila Nova de Gaia* which, in the period between 2001 and 2011, had population increases of

between 4.7 and 12.6 %. In 2013, Porto had 220,000 inhabitants and its metropolitan area had 1.7 million inhabitants, which is a rather unusual proportion between a city and its metropolitan area (almost 1:8).

If we look at the data of the last census in 2011, we can see that the 238,000 inhabitants of Porto—45.5 % men and 54.5 % women—were aggregated in 101,000 families, meaning that the average number of persons per family is 2.4. In the beginning of the decade the city had 138,000 dwellings organized in 44,000 buildings, meaning 3.1 dwellings per building, expressing a sound presence of single-family housing and small-dimension multifamily housing.

The following paragraphs describe the main parts of the city. The historical centre of the city corresponds to the area once contained within the fourteenth century wall (Fig. 5.14a). The streets and plots of this area are very irregular. There is a high building density. Buildings are narrow, normally three storeys high, although some are five storeys high. Although buildings are always positioned on the frontage of the plot, building coverage is very high. This is a part of the city where change has been, and should continue to be, slow. *Mouzinho da Silveira*, at the end of the nineteenth century, and *D. Afonso Henriques*, in the middle of the twentieth century, were the last streets to be built.

The *Baixa* (Downtown) is located north of the historical centre in the immediate surroundings of the demolished fourteenth century wall. This is a part of the city that was partly built according to plans prepared in the second half of the eighteenth century and includes buildings dating from then until the beginning of the twentieth century. In this area, streets and blocks are regular, the plot is normally a rectangle with an average width of 6 m and a depth that can attain 100 m. Most of the blocks have a continuous commercial use on the ground floor. It includes the civic centre of the city that was built in the first half of the twentieth century after the demolition of a number of street blocks (Fig. 5.14c). It also includes a number of small and medium size gardens such as the *Palácio de Cristal* (Fig. 5.14e).

Steadily after the 1960s—and the construction of a new bridge linking this area with the city of *Gaia* in the south bank of the *Douro*—the *Boavista* area emerged as the main financial and services centre of the city. The area is structured around the *Rotunda*, a large green roundabout with a diameter of more than 200 m, gathering eight different streets with a sound variety in terms of patterns of plots and buildings. In the last years some exceptional buildings such as the *Casa da Música* were erected in this area reinforcing an image of modernity (Fig. 5.14f).

Traditionally, the residents of the western part of the city hold higher income than the inhabitants of the eastern part of Porto. The size of a dwelling is also larger in the western part. The western part of the city combines, from north to south, the city park—linked to the seaside, a regular grid built after the end of the nineteenth century, and the *Foz Velha* with an irregular patterns of streets, plots and buildings very similar to that of the historical centre.

Fig. 5.14 Porto: **a** and **b** the historical centre; **c**, **d** and **e** *Baixa*; and **f** Boavista (*Source* Photographs by the author)

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Chapter 6
The Study of Urban Form: Different Approaches

Abstract While the previous chapters focused on the urban forms (and on the agents and processes) the sixth chapter focuses on those studying these urban forms. It is divided into three parts. The first part addresses a number of works that are classics in urban morphology and in urban studies. The first of these books was written in the late 1950s, five books were prepared in the 1960s, one was written in the late 1970s and the last of these books was prepared in the early 1980s. The eight books are: *Studi per una operante storia urbana di Venezia* by Saverio Muratori; 'Alnwick Northumberland. A study in town plan analysis' by MRG Conzen; 'The image of the city' by Kevin Lynch; 'Townscape' by Gordon Cullen; 'The death and life of great American cities' by Jane Jacobs; *L'architettura della cittá* by Aldo Rossi; *Formes urbaines: de l'îlot à la barre* by Jean Castex, Jean Charles Depaule and Philippe Panerai; and, finally, 'The social logic of space' by Bill Hillier and Julienne Hanson. The second part of this chapter presents the main morphological approaches that have been developed over the last decades, from the historico-geographical approach (promoted by the Conzenian School) to the process typological approach (promoted by the Muratorian School); from space syntax to the various forms of spatial analysis (including cellular automata, agent-based models and fractals). Finally, the last part of this chapter introduces a key topic—against a background of different theories, concepts and methods—the need to develop comparative studies. The knowledge of the strengths and weaknesses of each approach will certainly enable those who want to develop a morphological study, to select the most appropriate options given the specific nature of the object under analysis.

Keywords Approaches to the study of urban form · Classics in urban morphology · Comparative studies · Historico-geographical approach · Process typological approach · Space syntax · Spatial analysis

V. Oliveira, *Urban Morphology*, The Urban Book Series,
DOI 10.1007/978-3-319-32083-0_6

6.1 Classics in Urban Morphology and in Urban Studies

6.1.1 'Studi Per Una Operante Storia Urbana Di Venezia'

Studi per una operante storia urbana di Venezia by Saverio Muratori was first published in 1959 and then again in 1960. The book closes a 10 years cycle of architectural research, historical study and cultural and didactic campaign that goes back to 1952 when Muratori was called to the professorship of Distributive Characteristics of Buildings at the *Istituto Universitario di Architettura di Venezia*. He would leave to the University of Rome, as Professor of Architectural Composition, in the end of 1954. In 1950, Muratori had to define the programme for this course. One of the main ideas was that the urban and architectural crisis was mainly due to the modernist assumption that an analysis of the city dividing it according to its main elements isolating them from their context would lead to a more effective planning practice. Another key idea was its definition as a course of history of buildings, including exceptional and ordinary buildings.

After a reflection on a number of theoretical and methodological issues, the book analyses the city of Venice dividing it in eight main areas. Particular attention is paid to the system of parishes constituting the *Area Realtina*, from *Quartiere di S. Bartolomeo* to *Quartieri di S. Giovanni Crisostomo* (Fig. 6.1) and from these to *Quartiere di S. Sofia e S. Caterina*. One of the fundamental elements of this comprehensive study is a set of plans at the scales of 1:10,000 and 1:4000. The plans refer not only to the existing situation in Venice at the end of the 1950s but go back to the eleventh century, the twelfth (and thirteen) century and the sixteenth century. In addition to this set of plans of the city and of its different *quartieri* (an element of urban form of crucial important and with a high autonomy), the book includes a number of plans, elevations and sections of some Venetian buildings types at the scale of 1:500.

Muratori argues that the initial settlement could be reconstructed as a strongly rational archipelago of parishes. In face of this, the gothic Venice somehow expressed a crisis in planning while the Renaissance Venice was a remarkable synthesis of a continuous and polycentric city.

Muratori investigates the rationality of history though the reconstruction of the process of derivation of both architectural and urban form, from previous built structures to more recent complex configurations. The process of derivation retains the traces of a form's inception in simple original arrangements by updating them over the centuries (Marzot 2002).

A set of fundamental urban concepts are defined in the book—type, urban tissue, organism and operative history. According to Muratori, a certain type could not be identified except within a particular application, in the urban tissue. The urban tissue could not be identified except in its involving context, in the urban organism. The urban organism would only become real in its historical dimension, as part of a temporal construction that is always grounded on the conditions suggested by the past. This led to the argument of a strong relation between history and planning/architecture.

Fig. 6.1 *Studi per una operante storia urbana di Venezia—Quartieiri di S. Giovanni Crisostomo*, from the eleventh century to the 1950s (*Source* Muratori 1959)

Following the publication of *Studi per una operante storia urbana di Venezia* two other important texts were published in the subsequent years. The first was *L' edilizia gotica Veneziana* by Paolo Maretto in 1960, published as a complementary book of the operative history of Venice and constituting a systematic

survey of the historical buildings of this Italian city (Maretto 1960). The second is *Studi per una operante storia urbana di Roma* by Muratori, Renato Bollati, Sergio Bollati and Guido Marinucci, completed in 1963 and constituting a comprehensive atlas of the Italian capital (Muratori 1963).

6.1.2 *Alnwick, Northumberland—a Study in Town-Plan Analysis*

'Alnwick, Northumberland—A study in town-plan analysis' by MRG Conzen was first published in 1960 and then again in 1969. Its perspective and contents were clearly influenced by Conzen's training and early research in Berlin, during the second half of the 1920s and the early 1930s (see the next section of this chapter). The second edition of the book, as Conzen states, has provided him an opportunity for revision of concepts and terminology, reinterpretation of some earlier plan-units, and for introducing a glossary of technical terms (118 items) which may be regarded as a concise formulation of morphological theory (Conzen 1969). The book has been recently translated to Chinese and Italian, and a Portuguese translation is being developed.

The book is an attempt to fill a gap in urban morphology. It is driven by the problems of how the plan of an old-established town has acquired its geographical complexity, what concepts can be deduced from such an inquiry to help in the analysis of town plans in general, and what contribution the development of a plan makes to the regional structure of a town. It is an attempt to explain the present structure of a town plan by examining its development (Conzen 1960).

The book is divided in three parts. The first part discusses the aim, scope and method of town-plan analysis. It introduces the tripartite division of the urban landscape—one of the fundamental elements of Conzen's theory—focusing particularly on the town-plan. The town-plan is defined as the topographical arrangement of an urban built-up area in all its man-made features, containing three distinct complexes of plan elements: (i) streets and their arrangement in a street system; (ii) plots and their aggregation in street blocks; and (iii) block plans of buildings.

The second part analyses the growth of Alnwick's built-up area according to five morphological periods (expressing the way on how each period leaves its distinctive material residues in the landscape): (i) Anglian, (ii) Norman to Early Modern, (iii) Later Georgian and Early Victorian, (iv) Mid- and Late Victorian and, finally, (v) Modern. This analysis of the physical growth of Alnwick from Anglian times to the 1950s is informed by a number of key concepts, some new, such as the burgage cycle (the life cycle of a plot held by a burgess), others constituting developments of existing ideas, such as the fringe belt (an element formed at the urban fringe of a town or city during a period when the built-up area was either not growing or growing only very slowly).

The third part of the book analyses the existing town plan of Alnwick. This detailed study identifies 14 major types of plan units and 49 subtypes (Fig. 6.2). The major types are as follows (the roman numbers are in the key of Fig. 6.2):

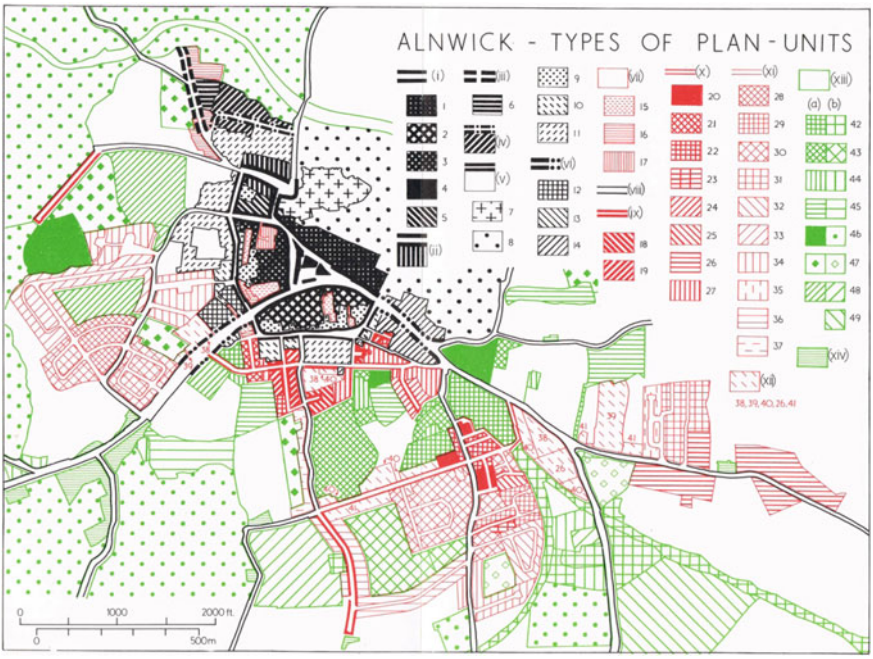

Fig. 6.2 Alnwick, Northumberland. A study in town-plan analysis—types of plan units (*Source* Conzen 1960)

(i) Medieval High Street Layout, with triangular market; (ii) Medieval *Suburbium*; (iii) Simple High Street Layout; (iv) Extramural Borough Street, with special siting; (v) Closed Fringe Belt, with consequent ring road; (vi) Traditional Arterial Ribbons; (vii) Later Alterations of Old Town; (viii) Pre-Victorian Frame Roads; (ix) Late Georgian and Early Victorian Residential Accretions; (x) Mid and Late Victorian Residential Accretions; (xi) Modern Residential Accretions; (xii) Composite Ribbons without Traditional Plots; (xiii) Intermediate and Outer Fringe Belts; and, finally, (xiv) Farmsteads and Other Agricultural Buildings. Drawing on this division—and as such on the three elements of the ground plan—Conzen proposes a geographical structure based on a set of plan divisions grouped into four orders. The three parts of the book comprise 21 maps, including fourfold-out maps, three in colour.

Two particular features distinguish the book from previous and subsequent studies on the physical structure of urban areas: the extent to which processes were conceptualized, and the meticulous way in which terms used to describe them were researched (Whitehand 2009a). The essential message of the book is that the numerous morphological features of urban places at all scales can be reduced to a logical system of explanation, which can lead to an incisive and nuanced understanding of the relationship between urban communities and the physical fabric they create and recreate around them as social needs change over time (Conzen 2009a).

In the 'Conclusion', Conzen opens two lines of research that he would develop in the subsequent years: the need of this theory of plan analysis to be connected with a full investigation of the associated patterns of land use and building types to produce a complete interpretation of the townscape; and the need to extended the theory to cover different functional types of towns, and towns of different cultural areas.

6.1.3 The Image of the City

'The image of the city' by Kevin Lynch was first published in 1960. Contrarily to the two former cases on Venice and Alnwick this is not an urban morphological book in the strict and narrow sense of these words. Yet, the work of Lynch, as that of Cullen and Jacobs (to be presented in this section), is a questioning of the modernist conventional wisdom as realized in the post-war clearance and rebuilding programmes. The three works contributed to a paradigm change in urban design that begins to recognize the virtues of our inherited urban fabric (Samuels 2009).

'The image of the city' is about the look of cities, the importance of this look, and the possibilities of changing it. Lynch argues that giving visual form to the city was, then, a new and special kind of design problem. In the course of examining this problem the author looks at three American cities—Boston, Jersey City and Los Angeles—proposing a new method to deal with visual form at the urban scale and offering some principles of city design.

The book is structured in five different parts. The first part introduces the reader on the main issues on the image of the environment. The visual quality of the American city is considered by studying the mental image of the city which is held by its citizens. One central visual quality is particularly explored in the book: 'legibility' (also called 'imageability') meaning the ease with which the different parts of the city can be recognized and organized into a coherent pattern. A distinctive and ordered environment helps the resident to orient himself, to place parts of the city into coherent categories, and to acquire a sense of security that he can relate to the surrounding urban world.

The second part of the book focuses on the three case studies. Lynch studies the central areas of Boston, Jersey and Los Angeles, talking with their inhabitants, trying to understand the role of environmental images in our urban lives. Two basic analysis are carried out: a systematic field reconnaissance of the area on foot by a trained observer, mapping a number of different elements; and a lengthy interview with a small sample of city residents (60 persons for the three cities) to evoke their own images of the physical environment.

A five-element classification of the contents of the city images that are related to physical forms is offered in the third part: (i) paths, the channels along which people move throughout the city; (ii) edges, the boundaries and breaks in continuity, such as rivers and train tracks; (iii) districts, the areas characterized by common characteristics; (iv) nodes, the strategic focus points for orientation, like squares and

junctions; and, finally, (v) landmarks, the external points of orientation, usually easily identifiable physical objects in the urban landscape, such as distinctive buildings, statues or landscape features. Figure 6.3 presents a reading of the visual

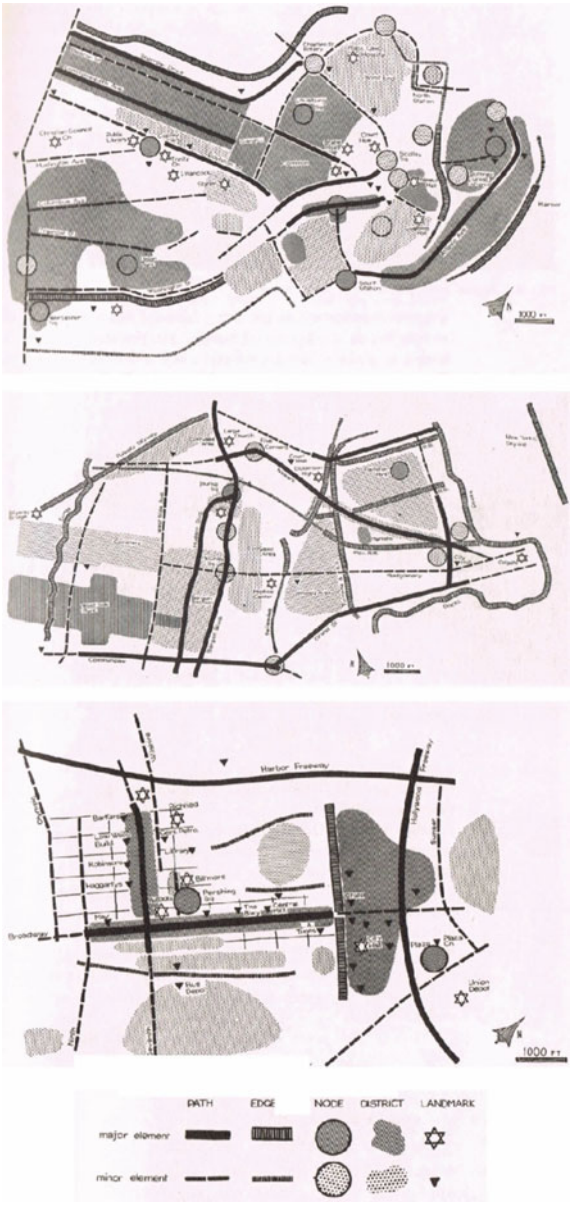

Fig. 6.3 The image of the city—the visual form of Boston, Jersey City and Los Angeles (paths, edges, nodes, districts and landmarks) as seen in the field (*Source* Lynch 1960)

form of Boston, Jersey City and Los Angeles structured according to these five elements.

The design of these five elements (with a particular focus on the paths) in an interrelated way, the form qualities (from singularity to names and meanings), the sense of the whole, the metropolitan form and the process of design are the main issues of the fourth part. This process of design includes what might be called a visual plan for the city and the metropolitan region—a set of recommendations and controls on urban form. The fifth part of the book offers a synthesis of the new vision and scale.

In synthesis, it can be said that two fundamental questions prompted this book: what does the city's form actually mean to the people who live there (?) and what can the city planner do to make the city's image more vivid and memorable to the city dweller (?). To answer these questions Lynch formulated a new criterion, legibility, and made evident its potential value as a guide for the building and rebuilding of cities. Yet, 20 years later, Lynch would publish the 'Good City Form' where he would enlarge the number of dimensions of the city's performance significantly decreasing his emphasis on legibility (Lynch 1981).

6.1.4 Townscape

'Townscape' by Gordon Cullen was first published in 1961 and then again in 1971 with a new introduction, reinforcing the main arguments that were presented in the beginning of the 1960s.

The book—profusely illustrated with drawings and photographs—begins by describing the basic ingredients of townscape, continues by showing these ingredients as assembled in the wider context of the town scene, and finishes by revealing the full 'poetry' of townscape, first in studies of existing towns, and then in proposals for new projects. One of the main objectives of Cullen is to be able to manipulate the elements of the town so that an impact on the emotions of its users is achieved. Indeed, the purpose is not to dictate the shape of the town or environment, but simply to manipulate it within established tolerances.

The book proposes an art of relationship aiming at taking all elements that create the environment (buildings, trees, nature, traffic, advertisements, to name just a few) and weave them together in such a way that 'drama is realized'. This art of relationship depends on three fundamental concepts, serial vision, place and content. The serial vision is strongly related to optics and motion, in particular to the movement of a person through different parts of the city. Figure 6.4 illustrates this concept: when walking from one end of the town plan to another, even at a uniform pace, a sequence of revelations is provided. This is suggested in the serial drawings

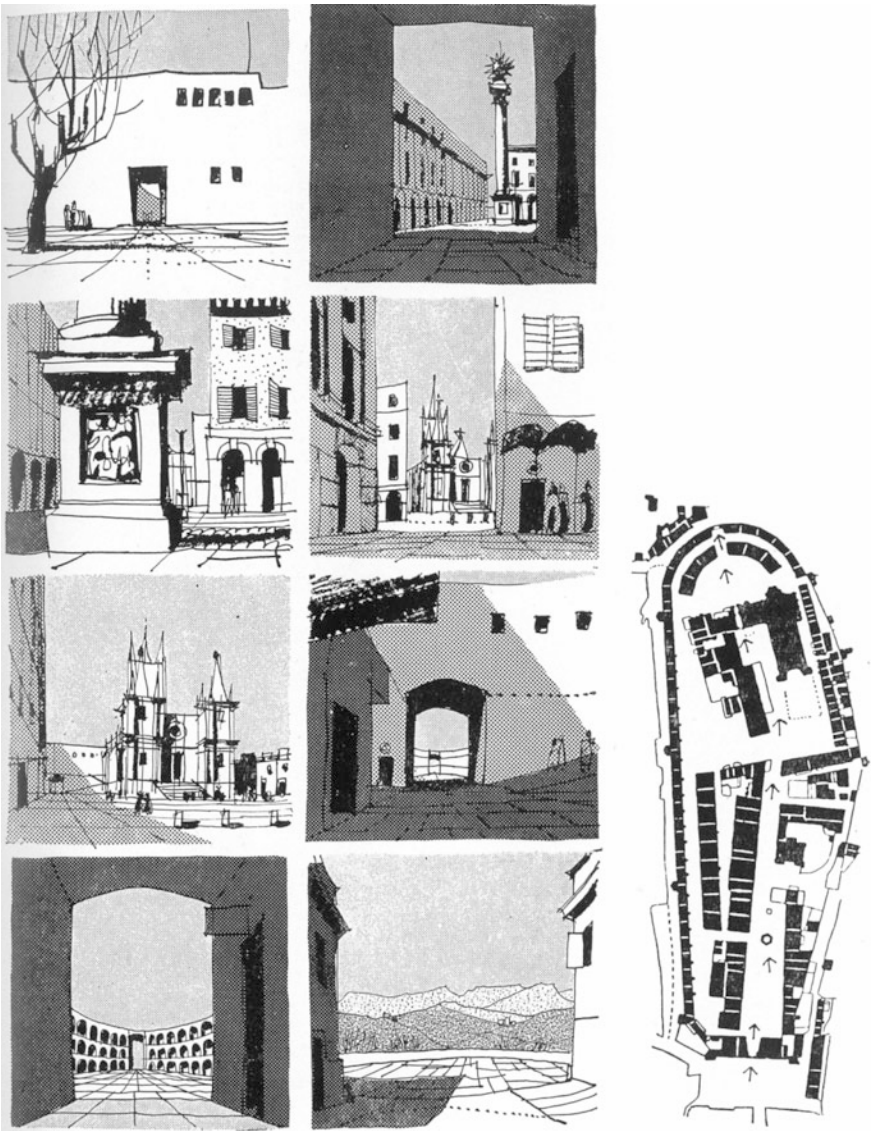

Fig. 6.4 Townscape—serial vision (*Source* Cullen 1961)

opposite (each arrow represents a drawing), reading from left to right. This serial view can be divided in two different elements: the existing view and the emerging view.

The concept of place (or position) concerns our reactions to the position of our body in the environment, dealing with a range of experiences stemming from the major impacts of exposure and enclosure. Cullen argues that if we would design our towns from the point of view of the moving person, the whole city would become a plastic experience, a journey through pressures and vacuums, a sequence of exposures and enclosures.

The concept of content refers to the specific fabric of towns—colour, texture, scale, style, character, personality and uniqueness. As most towns are of old foundation, their fabric shows evidence of different periods in its architectural styles and the various patterns of the layout.

As in the case of Lynch—and contrarily to Muratori and Conzen—Cullen offers a normative approach. As in 'The image of the city', 'Townscape' is grounded on the individual capacity of visual perception, in such a way that the town is approached as an object of perception of its inhabitants.

6.1.5 The Death and Life of Great American Cities

'The death and life of great American cities' by Jane Jacobs was first published in 1961 (Jacobs 1961). Similarly to the books by Lynch and Cullen, 'The death and life of great American cities' is a classic in urban studies—addressing the physical, social and economic dimensions of cities—and not in urban morphology. The book is an attack on the theory and practice of city planning and rebuilding that was being developed in the end of the 1950s and the beginning of the 1960s. It is also an attempt to introduce new principles of city planning and rebuilding. In setting forth these different principles, Jacobs writes about ordinary things of cities, such as the kind of streets that are safe and the kind of streets that are unsafe or why some slums stay slums and other slums regenerate themselves even against financial and official opposition. The book is an attempt to understand how cities work in real life, because that would be the only way to learn what principles of planning and what practices in rebuilding could promote social and economic vitality in cities. Jacobs argues that cities should be the laboratory in which city planning should have been learning and forming and testing its theories. On the contrary, practitioners and academics were ignoring the study of success and failure of their approaches in real life.

After an introductory section, including a brief review of the most influential ideas on modern city planning and architectural design, the book is divided in four different parts. The first part is about the social behaviour of people in cities. This analysis has a focus on public spaces, particularly on streets. Jacobs establishes three main qualities for a safe street: (i) there must be a clear demarcation between

what is public space and what is private space; (ii) there must be eyes upon the street, eyes belonging to the natural proprietors of the street; and (iii) the sidewalks must have users on it fairly continuously, both to add the number of effective eyes on the street and to induce the people in buildings along the street to watch the sidewalks in sufficient numbers.

The economic behaviour of cities is the theme of the second, and most important, part of the book. This part of the book addresses the issue of diversity, discussing some of its main generators (or conditions for diversity): (i) mixed primary uses, ensuring the presence of people who go outdoors on different schedules and are in the place for different purposes, but who are able to use many facilities in common; (ii) small street blocks, ensuring frequent opportunities to turn corners; (iii) buildings that vary in age and condition, including a good proportion of old ones so that they vary in the economic yield they must produce; and, finally, (iv) dense concentration of people, for whatever purposes they may be there.

The third part focuses on some aspects of decay and regeneration in the light of how cities are used, and how they and their citizens behave in real life. The analysis focuses on a number of powerful forces that can influence, positively or negatively, the growth of diversity and vitality in cities.

Finally, the last part suggests a number of changes in housing, traffic, design, planning and administrative practices, and discusses the 'kind' of problem that, according to Jacobs, cities pose—a problem in handling organized complexity. Jacobs argue that for understanding cities we must: (i) think about processes and contexts; (ii) work inductively, reasoning from particulars to the general; and (iii) seek of 'unaverage' clues involving very small quantities, which reveal the way larger and more 'average' quantities are operating.

6.1.6 *L' Architettura Della Cittá*

L' architettura della cittá by Aldo Rossi was first published in 1966 (Rossi 1966). The theoretical and methodological framework for this book started to be designed a decade earlier when Rossi joined the influential journal *Casabella-Continuitá*, by then directed by Ernesto Nathan Rogers. This framework was then consolidated in the first half of the 1960s in his research and teaching activity, in Arezzo and Venice (where he was teaching assistant to Carlo Aymonino), and in his early architectural practice. Subsequent translations (for instance to the American, German or Portuguese editions) contained new elements supporting the main arguments of the book.

The main purpose of the book is the foundation of an urban science within the context of the human sciences. In this urban science, the city—or the construction of the city over time—is understood as architecture. While receiving contributions

of different fields of knowledge, from geography (particularly of French geography) to history, one of the fundamental purposes of the book is establishing the boundaries and the specific contents of the body of architectural studies that are part of this urban science. The book itself is seen as a project of the architecture of the city. The contrast between particular and general and between individual and collective constitutes one of the main points of views for the study of the city that are proposed in the book. This contrast is expressed in many different aspects: in the relations between public and private realm, in the contrast between the rational project of the urban architecture and the contextual values of the *locus*, between public buildings and private buildings.

The book also proposes an analytical methodology, balancing quantitative and qualitative approaches, framed by a theory of the urban artefacts, by the identification of the city as an artefact, and by the division of the city into different parts, mainly primary elements and residential areas. Yet, it is sustained that the whole is more important than each of the different parts.

L' architettura della cittá is divided in four main parts. In the first part, Rossi focuses on the topics of description and classification, addressing, as such, the fundamental issue of building typology as a fundamental basis for the architectural project. For Rossi the type is the 'idea' of architecture itself, what is nearest of its essence. In this debate, it is argued that, contrarily to the then dominant architectural thought, form is autonomous from function (in the Portuguese translation, this is remarkably illustrated with the case of Split, the palace which changed function to a city, as we have seen in Chap. 4). In this part of the book, Rossi has a brief reference to one of the other 'classics' presented in this section, 'The image of the city' by Lynch, addressing the way people are oriented in the city, and the formation and evolution of their sense of space.

The second part of the book is centred on the structure of the city in its different parts, with a particular focus on the primary elements and on the residential areas. The architecture of the city and of the place where it is developed and the city as history are the main themes of the third part. Finally, the book addresses the issues of urban dynamics and of policy options, including the history of the ideal cities and the urban utopias.

6.1.7 *Formes Urbaines: De L'îlot à La Barre*

Formes urbaines: de l'îlot à la barre by Jean Castex, Jean–Charles Depaule and Philippe Panerai was first published in 1977 (Castex et al. 1977). The three authors were then based on the recently created *Ecole d' Architecture de Versailles* and had close links with the Italian tradition (Darin 1998). Over the years, *Formes urbaines:*

de l'îlot à la barre has been translated to different languages, including Italian, Spanish, Dutch, German and Serbo-Croat. In 2004, an English version with a new chapter on the Anglo-American context (focusing on four case studies) and some additional texts written by Ivor Samuels and Philippe Panerai was published (Panerai et al. 2004).

The book is about the erosion and disappearance of a well-defined spatial organization—the urban block, typical of the classical European city (see Fig. 6.5). For the authors, the block is not an a priori form but a resulting system, capable of organizing parts of the urban territory. It is a part of the urban area 'isolated' from the neighbouring parts of the territory by streets. Thus, the block is not an architectural form, but a group of plots and buildings. It has a proper meaning only when it is in a dialectical relationship with the street network. The block of the traditional city is rarely homogeneous and the buildings of its perimeter obey some rules, especially, those of that economic logic that has shaped the surrounding streets (Panerai et al. 2004).

The book tries to understand how streets have lost importance and how buildings have progressively distanced themselves from the city. The book also proposes a new scale of architectural analysis, an intermediate scale corresponding to the local organization of urban tissues, different from the scale of the grand layouts and monuments and from the scale of domestic details.

Formes urbaines: de l'îlot à la barre is divided in two main parts. The first part, structured in five chapters, offers a detailed analysis of five major case studies in city planning (three of these were presented in Chap. 3), making evident a first stage of transformation of the block, in the nineteenth century, and a second stage where it progressively opens up until it disappears altogether, in the twentieth century: (i) the Haussmannien Paris (1853–1882); (ii) the garden cities of Welwyn and Hampstead (1905–1925); (iii) the extension of Amsterdam (1913–1934); (iv) the different *siedlungen* of the new Frankfurt (1925–1939) from *Romerstadt* with a more traditional layout to *Westhausen* clearly based on the isolated building; and, finally, (v) the *cité radieuse* and the *unités d' habitation*. Figure 6.5 contains a schematic sequence of this process of transformation. The second part of the book is a discussion on the metamorphosis of the block, the practice of space and the development and diffusion of architectural models.

The appeal of the authors in favour of the closed block was taken up three years later in their study of Versailles, which divides the history of the city into several periods, each of which is examined through the development of urban form and housing types (Castex et al. 1980). The authors highlight that this town has developed not as a whole but as collection of urban fragments.

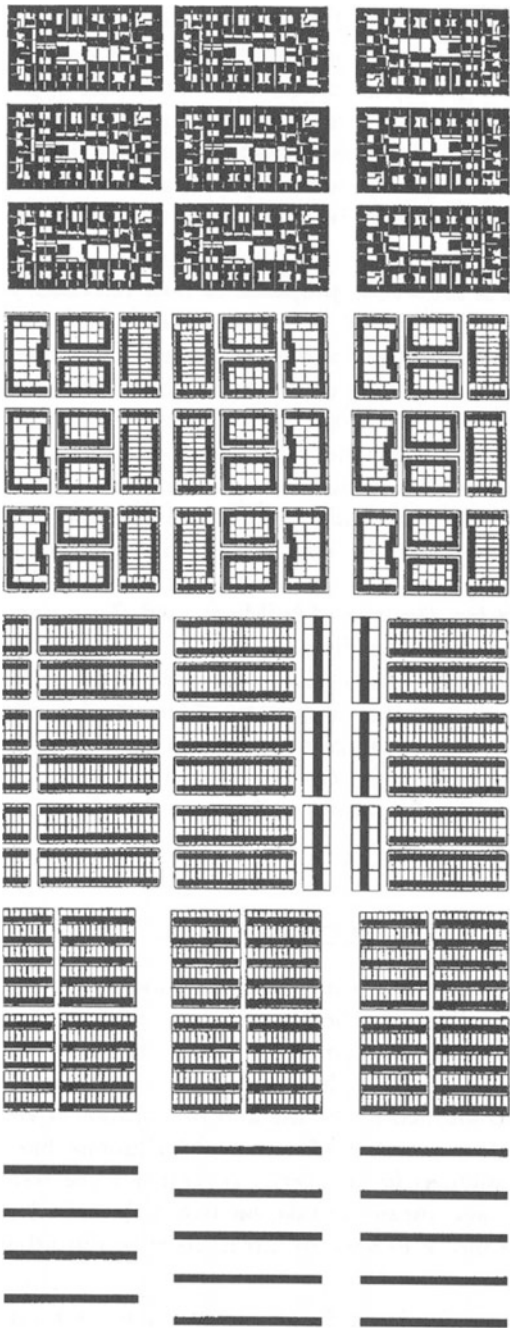

Fig. 6.5 *Formes urbaines: de l'îlot à la barre*—hommage to Ernst May (*Source* Panerai et al. 2004)

6.1.8 *The Social Logic of Space*

'The social logic of space' by Bill Hillier and Julienne Hanson was published in 1984. The book somehow synthesizes a line of research that have started in the Unit of Architectural Studies at University College London, in the 1970s, with the main purpose of understanding the influence of architectural design on the existing social problems in many housing estates that were being built in the United Kingdom.

The main goal of the 'The social logic of space' is to outline a new theory, and new methods, for the investigation of the relation between society and space. It attempts to build a conceptual model for the investigation of this relation on the basis of the social content of spatial patterning and the spatial content of social patterning. Then, it tries to establish a method of analysis of spatial pattern, with emphasis on the relation between local morphological relations and global patterns. It establishes a fundamental descriptive theory of pattern types and then a method of analysis. These are applied first to settlements and then to building interiors. On this basis, it establishes a descriptive theory of how spatial pattern carries social information and content (Hillier and Hanson 1984).

The book is structured in eight chapters. The first chapter establishes a framework for the redefinition of the problem of space, bearing in mind the construction of a broad theory of the social logic of space and the spatial logic of society. 'The logic of space' (Chap. 2) introduces a new concept of order in space, as restrictions on a process that would otherwise be random. The third chapter proposes a new method to deal with the physical structure of a settlement without losing sight of its local structure and to describe space in a way that makes its social origins and consequences a part of that description. The axial map and some syntactical measures are introduced in this chapter (see Fig. 6.6 for the application in *Gassin* and Barnsbury). 'Buildings and their genotypes' moves the discussion from settlements to buildings, adapting the analytic method to building interiors. The method shows how buildings can be analyzed and compared in terms of how categories are arranged and related to each other, and also of how a building works to interface the relation between the occupants and those who enter as visitors. The fifth chapter outlines a general theory of buildings in terms of their spatial form by considering the elementary building and its social relations, and by examining a number of cases as they evolve from the basic form to different types of complexity. A general framework of relating different kinds of order is established in the sixth chapter. It deals, in a unified way, with both material and conceptual components of the spatial arrangement, and with randomness and order. 'The social logic of encounters' shows how certain fundamental social ideas may be given a kind of spatial interpretation through the notion of differential solidarity. The authors argue that societies are never one single form of solidarity but relations between different forms of solidarity, and that space is always a function of these differential

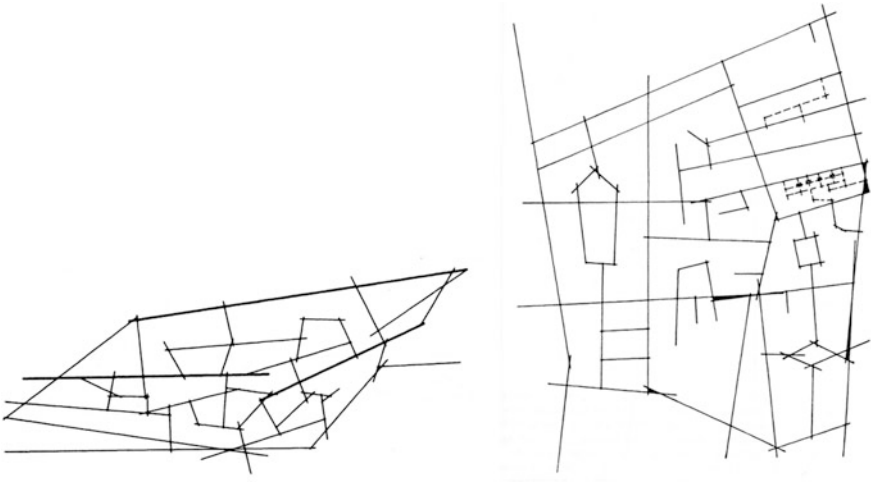

Fig. 6.6 The social logic of space—the axial maps of *Gassin* and Barnsbury (*Source* Hillier and Hanson 1984)

solidarities. Finally, the last chapter proposes a general theory of the different spatial pathways required by different types of social groups. In synthesis, the book aims at providing a coherent model for linking together and making sense of the different phenomena of contemporary space, phenomena which were normally given a simple functionalist or economic explanation.

The theory of society and space outlined in 'The social logic of space' would be developed in two notable books published in the 1990s, 'Space is the machine' by Hillier and 'Decoding homes and houses' by Hanson (Hanson 1998; Hillier 1996a, b). The former offers a configuration theory of architecture and urbanism. The later examines the evolution of domestic space organization and family structure in Britain.

6.2 Different Morphological Approaches

The second part of this chapter presents the main morphological approaches that have been developed over the last decades: the historico-geographical approach consolidated after the seminal work of MRG Conzen, the process typological approach structured around the work of another seminal figure—Saverio Muratori, space syntax and the various forms of 'spatial analysis' (using Kropf, 2009 designation) including isovists, cellular automata and agent-based models.

6.2.1 Historico-Geographical Approach[1]

This subsection is divided in three different parts. After considering the early influences of the German human geography, attention is given to the concepts that Conzen has developed such as the fringe-belt, the morphological region and the burgage cycle. The developments and characteristics of the school of urban morphological thought that is grounded in the work of Conzen, with a particular focus on the Urban Morphology Research Group and on the central role of Jeremy Whitehand, are presented in the third part of the subsection.

The Antecedents of MRG Conzen[2]

The German human geography of the last decade of the nineteenth century is marked by two fundamental texts (Table 6.1). In 1894, the historian (and this is the only disciplinary exception in a context dominated by geographers) Johannes Fritz published *Deutsche Stadtanlagen*, a comparative study of more than 300 German cities. The key innovation of this study is the use of the plan of the city and of cartography as a primary source of information for urban history. One of the findings of the study is the proposal of a classification of cities based on the type of plan. Five years later, and clearly influenced by Fritz text, Otto Schlüter published *Über den Grundriß der Städte*. This fundamental paper develops the line of research on the plan of the city initiated by Fritz, including the identification of the different parts that constitute the city centre. Whitehand (2007a, b) argues that this work was a pioneer of what would be designated, years later, as the morphogenetic approach. Another important aspect in the work of this geographer is the conviction that the study of the city necessarily involves the study of a wider territory.

In the first decade of the twentieth century, *Die Geographische Lage der großen Städte* by Friedrich Ratzel continues the line of research that had begun in the late nineteenth century. One of the major contributes of this 1903 text, is the fact that it focuses not only on the location of cities, but also on the reasons and the characteristics that lead to the selection of the original site for the foundation of human settlements.

In the following decade, two texts intending to go beyond the study of location and of genetic issues were published. Each of the texts studies in considerable detail one single city, Vienna and Danzig (present-day Gdańsk). In 1916, Hugo Hassinger published an art-historical atlas of Vienna. In this book, the geographer identifies in the plan of Vienna, the architectural styles and the age of the buildings, through the

[1]In the last 15 years Jeremy Whitehand has published two papers—'British urban morphology: the Conzenian tradition' and 'Conzenian urban morphology and landscapes'—and offered (at least) one oral presentation in conference—'Conzenian research and urban landscape management'—that outline a review of the historico-geographical approach promoted by the Conzenian School (Whitehand 2001, 2007a, 2014). These texts had a considerable importance in the structuring of this subsection.

[2]This part of the subsection is based on a Viewpoint that I have written with Cláudia Monteiro that was published in the *Revista de Morfologia Urbana* in 2014 (Oliveira and Monteiro 2014).

Table 6.1 German human geography 1890–1939

Decade	Year of publication	Author (Institution)	Studies on cities
1890–1899	1894	Johannes Fritz (Strasbourg)	*Deutsche Stadtanlagen* German city layouts
	1899	Otto Schlüter (Halle)	*Über den Grundriß der Städte* On the ground plan of cities
1900–1909	1903	Friedrich Ratzel (Leipzig)	*Die Geographische Lage der großen Städte* The geographical location of large cities
1910–1919	1916	Hugo Hassinger (Vienna)	*Kunsthistorischer Atlas von Wien* Art-historical Atlas of Vienna
	1918	Walter Geisler (Halle)	*Danzig: ein siedlungsgeographischer Versuch* Gdansk: an essay on the settlement geography
1920–1929	1924	Walter Geisler (Halle)	*Die Deutsche Stadt: ein Beitrage zur Morphologie der Kulturlandschaft* The German town: a contribution to the morphology of the cultural landscape
	1925	Hans Dörries (Goettingen)	*Die Städte im oberen Leinetal, Göttingen, Northeim und Einbeck* The cities of Leinetal, Goettingen, Northeim and Einbeck
	1927	Hans Bobek (Vienna)	*Grundfragen der Stadtgeographie* Basic questions of urban geography
	1928	Rudolf Martiny	*Die Grundrißgestaltung der deutschen Siedlungen* The layout of the German settlements
1930–1939	1932	MRG Conzen (Berlin)	*Die Havelstädte* The Havel cities
	1936	Herbert Louis (Berlin)	*Die geographische Gliederung von Gross-Berlin* The geographical structure of Great Berlin

use of colour. The result of this analysis is a set of plans that constitutes a fundamental element for the conservation of the built heritage of Vienna. Like his colleagues, Hassinger argues that a plan could show a whole range of aspects that a text, a table or a diagram could not. Two years later, a former student of Schlüter, Walter Geisler, published one of the most important texts of this period (Geisler 1918). Paradoxically, Geisler refers to the work of all authors described above, except for Hassinger. The book on Danzig is structured in two main parts, divided in seventeen chapters: the first part addresses the physical, geographic, demographic and economic conditions of Danzig; the second part focuses on the spatial organization and structure of the city. In addition to a wide set of tables and photographs of Danzig, the book contains a fundamental innovation for the time it was prepared, a number of plans drawn by the author including the identification of land and building utilization, and the number of storeys of residential buildings in the central area of the city (Fig. 6.7).

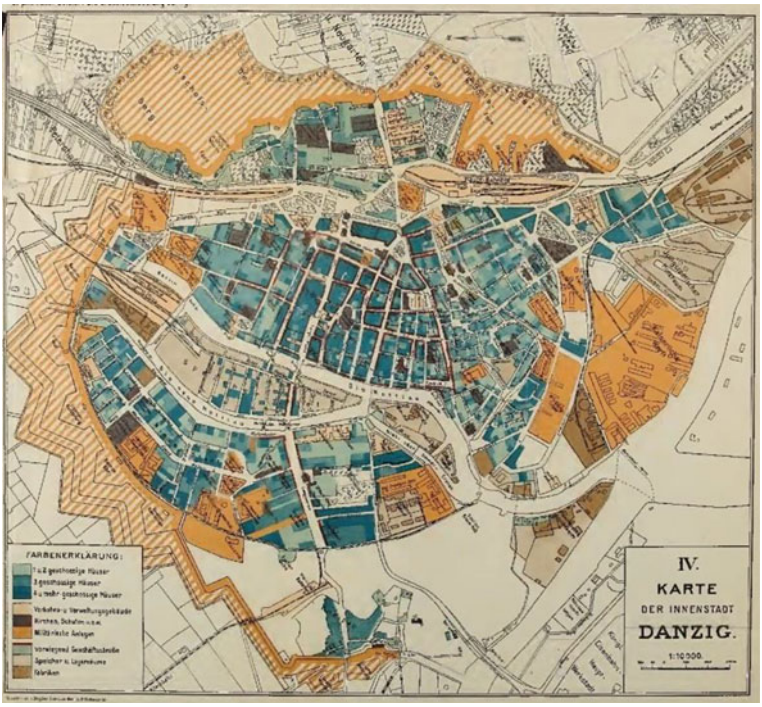

Fig. 6.7 The plan of *Danzig* (*Source* Geisler 1918)

In 1924, Geisler published a new and influential book on German cities, *Die Deutsche Stadt*. The book proposes a classification of these cities based on the sites selected for their foundation, on the ground floor and on the types of buildings. In 1925, Hans Dörries recovered the line of research developed by Hassinger and Geisler in the previous decade identifying in the plan of a number of historic cities the age and the architectural styles of their buildings. In 1928, after a series of preliminary studies on cities of the Westphalia region, Rudolf Martiny published a text on the structure of German settlements. Like Geisler, 4 years earlier, Martiny intended to define a set of generic elements on German cities. Almost simultaneously, Hans Bobek published a paper on basic issues in urban geography. Hofmeister (2004) argues that this paper has laid the foundations for a change of direction in one of the dominant lines of German human geography. In general, from that date until the last decades of the twentieth century, the issue of urban functions gained predominance in relation to urban form matters.

Yet, two texts with a fundamental role in the origins of the historico-geographical approach and of urban morphology itself were still prepared in the 1930s. The first was the thesis of MRG Conzen completed in 1932 (a year before the geographer had migrated to England), where he analyses the plan and the building fabric (the first and second elements of its tripartite division of the urban

landscape) of twelve cities located northwest of Berlin. As in the case of Geisler, Conzen uses different colours to represent the number of storeys and the different building types of these cities. The second is the text by Herbert Louis (one of Conzen' s mentors) on the geographical structure of Great Berlin. In this book chapter, Louis introduces the concept of *Stadtrandzone* (fringe belt), an element of urban form composed of plots with a wide variety in terms of geometry and dimensions, and whose formation at the edge of a built-up area is associated to a period of stagnation or of slow growth of this area and to how, some years later, that same area restarts its process of growth.

The work of German geographers in the early twentieth century had a crucial importance for the establishment of urban morphology as a science that studies the physical form of cities, as well as the actors and processes shaping it. This work had a strong influence not only in Germany (although a later influence) but also in other countries. In a review based on a number of national synthesis published in the journal 'Urban Morphology', under the designation 'The study of urban form in …', I have identified a strong influence of these German authors on urban morphological studies developed in Poland, Ireland and England (Oliveira 2013). It is precisely in England that this influence gained its utmost expression in the work of MRG Conzen. Despite the fact that from the 1930s onwards, the morphogenetic approach would lose weight in German human geography, it would gain a new vitality in the following decades in the work that the geographer German, then emigrated, would develop in England.

The Ideas of MRG Conzen

MRG Conzen was born in 1907 in Berlin. Between 1926 and 1932 he studied geography, history and philosophy at the University of Berlin. Among his teachers were Albrecht Penck and Herbert Louis. After the rise of the Nazi Party in 1933, Conzen emigrated to Great Britain. Between 1934 and 1936 he studied Town and Country Planning at the Victoria University of Manchester. He then started a consultancy activity in regional and town planning in Macclesfield, Cheshire. Simultaneously, he engaged in a postgraduate research in historical geography at the Victoria University of Manchester. The beginning of the Second World War introduced profound changes in the life of Conzen, who was a German émigré living in England. In this period, Conzen lost his work in planning and eventually went back to geography, teaching, first in the University of Manchester (1940–1946), then in the University of Durham (1946–1961), and finally in the University of Newcastle upon Tyne (1961–1972). Conzen died in Newcastle upon Tyne in 2000.

Conzen has published few, but quite important, texts.[3] Among these, 'Alnwick, Northumberland—a study in town-plan analysis' presented in the previous section,

[3]These include 'The growth and character of Whitby', 'The plan analysis of an English city centre' and 'Morphogenesis, morphological regions and secular human agency in the historic townscape, as exemplified by Ludlow' (Conzen 1958, 1962, 1988). A collection of texts by MRG Conzen is offered in a book edited by his son, MP Conzen published in the last decade (Conzen 2004).

stands as one of the most important books on urban morphology published so far. The work of Conzen as a whole offers a comprehensive framework for the study and design of the physical form of cities.

One of the key aspects of this framework is the tripartite division of the urban landscape, including the town-plan (or ground plan), the building fabric and land and building utilization. As mentioned above, the town-plan is defined as the topographical arrangement of an urban built-up area in all its man-made features, containing three distinct complexes of plan elements: (i) streets and their arrangement in a street system; (ii) plots and their aggregation in street blocks; and (iii) block plans of buildings.

Another crucial aspect is the development of concepts on the process of urban development. In this book, we will focus on three of these concepts: fringe belt, morphological region and burgage cycle. As mentioned above, the fringe belt concept was first recognized in Berlin in 1936 by Louis, but was developed to a far greater degree of sophistication by Conzen in his studies on Alnwick and Newcastle upon Tyne.

The fringe belt concept draws on the acknowledgement that the outward growth of an urban area is very uneven in its progress. Indeed, the growth of a city is made up of a series of outward expansions of the residential area separated by marked pauses. A fringe belt tends to form at the urban fringe during a period when the built-up area is either not growing or growing only very slowly. It includes within it many relatively open areas, often vegetated, such as parks, sports grounds, public utilities and land attached to various institutions (Whitehand 2007a, b).

In his study on Alnwick, Conzen identified three distinct belts—an inner and a middle fringe belt, embedded within the built-up area, and an outer fringe belt at the present edge of the town (see Fig. 6.8). The Inner Fringe Belt developed around the 'fixation line' (another concept developed by Conzen) of the medieval town wall. Conzen's fundamental contribution was to incorporate fringe belt patterns within the city into an elaborated morphological theory of interactions between formative and transformative spatial processes of all kinds as evidenced in the detailed cartographic record of a city's physical evolution. As part of this, he developed an intricate classification of processes in fringe-belt formation and subsequent modification in Alnwick and, later, in Newcastle upon Tyne. Conzen continued to apply the concept in several other British areas including Ludlow, Conway and metropolitan Manchester (Conzen 2009b).

For Conzen the climax of the exploration of the physical development of an urban area was the division of that area into morphological regions, or landscape units (Whitehand 2001). A morphological region is an area that has a unit in respect of its form that distinguishes it from surrounding areas. Between the late 1950s and the late 1980s Conzen demonstrated in traditional British cities how the way in which the urban landscape is traditionally stratified, reflecting the distinctive residues of last periods, and giving rise to a hierarchy of morphological regions—that can be represented in a composite map including regions of different order. While in Alnwick, Conzen has identified a four-tier hierarchy of regions mainly based on the town plan, in Ludlow he identified a five-tier hierarchy based not only on the town

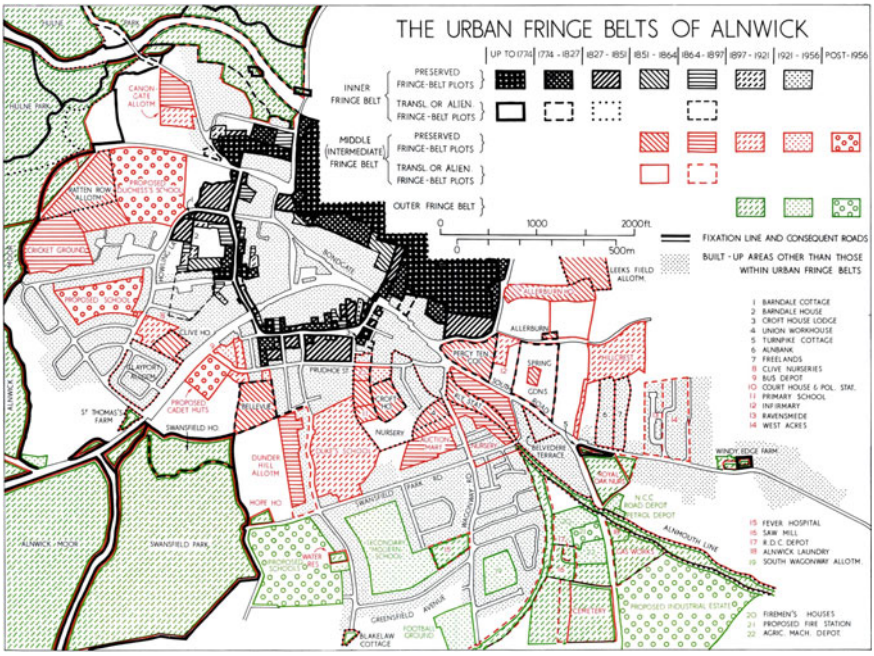

Fig. 6.8 The urban fringe belts of Alnwick (*Source* Conzen 1960)

Table 6.2 The contribution of different morphological attributes to urban landscape characterization (*Source* Adapted from Whitehand 2007b)

Attribute	Persistence	Contribution to hierarchy (rank)
Ground Plan	High	Mainly high and intermediate
Building Fabric	Variable, but often considerable	Mainly intermediate and low
Land Utilization	Low	Mainly low and intermediate

plan, but also on the building fabric and on the land and building utilization. Table 6.2 synthesizes the contribution of different morphological attributes to urban landscape characterization.

One of the distinctive characteristics of Conzen' s work is the detail of the analysis. In this context, the relationship between plots and the block plans of buildings assumed a fundamental role. This relationship was conceptualized in the 'burgage cycle': the burgage being the landholding of an enfranchised member of a medieval borough; the cycle consisting of the progressive filling-in with buildings of the backland of burgages, terminating in the clearing of buildings and in a period of urban fallow prior to the initiation of a redevelopment cycle. In Alnwick, the burgage cycle is illustrated with the evolution of the Teasdale's Yard, in Fenkle Street, between 1774 and 1956. This cycle is a particular variant of a more general phenomenon of building repletion where plots are subject to increasing pressure,

often associated with changed functional requirements, in a growing urban area (Whitehand 2007a).

The Urban Morphology Research Group

In the last four decades, the morphological approach established by Conzen has been consistently developed by the UMRG in the University of Birmingham. The UMRG was funded in 1974 by Jeremy Whitehand who had always been a central figure in the development and consolidation of the group and in the promotion of the Conzenian tradition. The group, which is the principal centre in the United Kingdom for the study of historico-geographical aspects of urban form, gathers a number of notable researchers in the field including Karl Kropf, Keith Lilley, Ivor Samuels, Peter Larkham, Susan Whitehand, Terry Slater and Tony Hall. The group has a significant set of international linkages, including with M P Conzen in the University of Chicago. The UMRG plays a major role in the organization and development of the 'International Seminar on Urban Form', including its annual conferences and its influential journal 'Urban Morphology' edited by Jeremy Whitehand.

The next paragraphs describe the development of the three concepts presented in the last subsection, fringe-belt, morphological region and burgage-cycle. Research on fringe belts has been mainly developed by Whitehand, MP Conzen and Slater. In the 1970s Whitehand explored the relationship between fringe belts and pulsations in urban construction cycles demonstrating also the link to the urban economy (Whitehand 1977). More recently, he developed an explicit concern for agency in the fringe-belt process, undertaking studies that probed the interactions of landowners, developers, financiers and planners in the land use and development processes (Whitehand and Morton 2003, 2004, 2006). In terms of scale of application, Whitehand extended the application of the concept from towns and cities to large urban settings, such as Tyneside conurbation, Glasgow and Birmingham. In terms of the variety of contexts, he also extended the application to cities in France, Russia and Zambia. In 2009, MP Conzen published a comparative assessment of the concept's performance in the different cultural settings in which it has been applied, reflecting on the efficacy and limits of the concept itself to identify and account for variations in the texture of urban form across urban areas in these diverse cultural contexts (Conzen 2009b)—Fig. 6.9 offers an outlook on fringe belts in different European metropolitan areas. We will get back to this paper in the final section of the chapter. Finally, in 2013, Tolga Unlu, a UMRG member based on Mersin, offered a state of the art on this concept highlighting the distinctive characteristics of four types of emphasis—spatial, economic, social and planning (Unlu 2013).[4]

[4]Outside the context of the UMRG, Karin Meneguetti and Stael Pereira da Costa have recently published a paper where the concept is successfully tested in the context of a city planned in the middle of the twentieth century, Maringá (Meneguetti and Costa 2015). The authors state that the planned city configuration may be compared to the formation of ancient walled cities, attesting the strength of fixation lines in the creation of inner fringe belts.

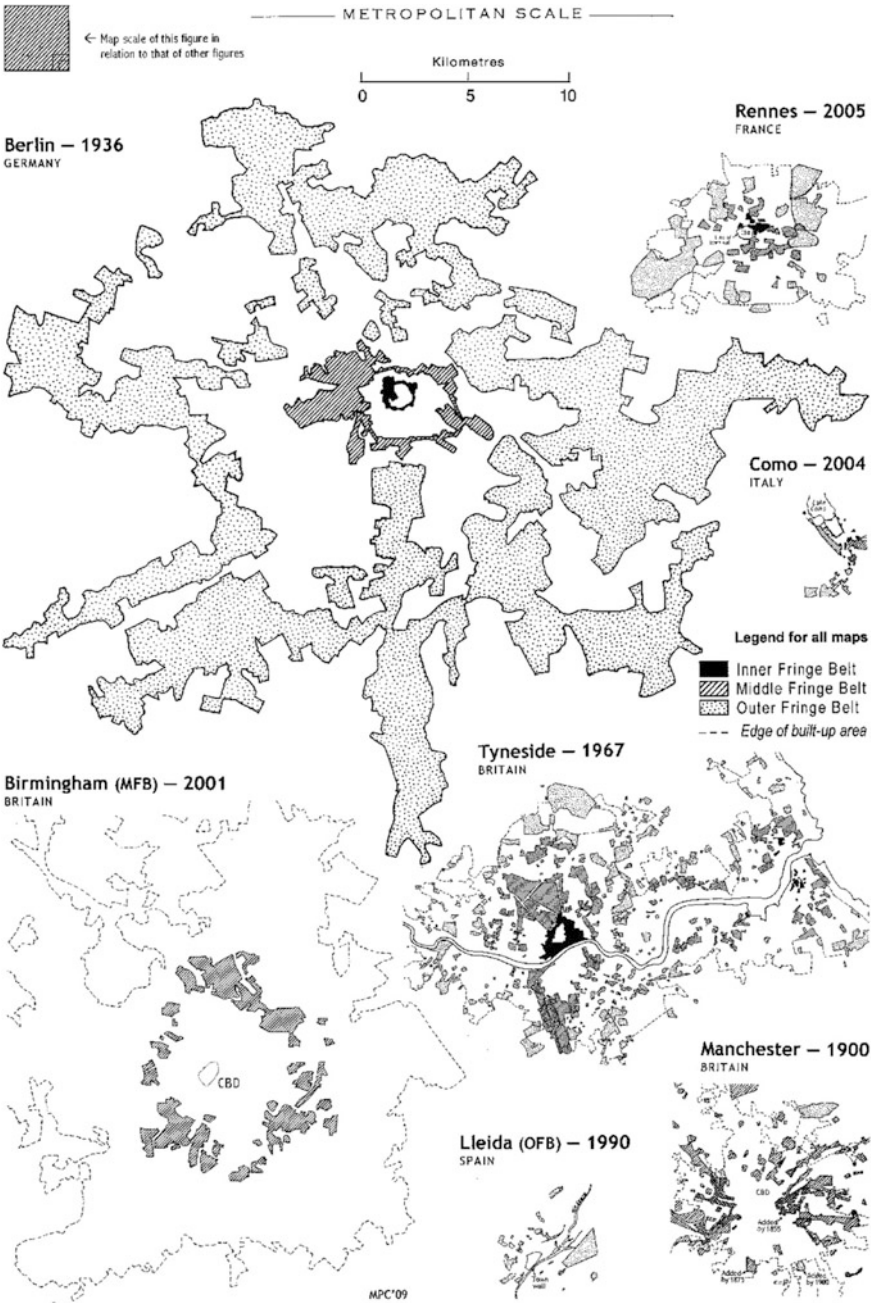

Fig. 6.9 Fringe belts at the metropolitan scale: European cases (*Source* Conzen 2009b)

In the last decades, there have been applications and adaptations of the concept of morphological region and the method of morphological regionalization in all continents, and demonstrations of their potential in conservation and heritage planning. One important study was developed by Nigel Baker and Terry Slater in the beginning of the 1990s (Baker and Slater 1992). Taking the core of Worcester as a case study, these authors provide evidence for interpreting some plan units as planned extensions created within a short period and others as products of piecemeal development. The level of detail in explaining the application of the method is rather unusual. In a comprehensive review of Conzen's method of regionalization and of its developments over two decades, Whitehand (2009b) states the need for a much greater clarity in the methods of characterizing and delimitating these units, and for wider appreciation of their role in planning (the plan for Barnt Green, by Jeremy and Susan Whitehand, stands out as notable example of this potential of application). Two years later, Peter Larkham and Nick Morton extended Whitehand's study exploring the process of drawing boundaries and addressing a key issue: the extent to which morphological regions, at least at the higher levels of any hierarchy, can accurately be delineated by field observation and map study (Larkham and Morton 2011).

Terry Slater continued the line of research on plots—particularly on the boundaries and dimensions of plots—showing how metrological analysis could be used to reconstruct the histories of plot boundaries. By analyzing measurements of plot widths in Ludlow, Slater was able to speculate about what was in mind of the medieval surveyor when the area was first laid out for development and infer both the original plot widths and how they were subsequently subdivided (Slater 1990).

6.2.2 Process Typological Approach[5]

This subsection is divided in three parts. The first and second parts are on the seminal works of Saverio Muratori and Gianfranco Caniggia analyzing their activity in terms of research, teaching and architectural practice. Finally, the recent developments of the approach, including a second and third generation of researchers, are described.

[5]This subsection is mainly based on two different papers: 'Saverio Muratori and the Italian school of planning typology' by Giancarlo Cataldi, Gian Luigi Maffei and Paolo Vaccaro published in 2002 in 'Urban Morphology' (Cataldi et al. 2002) and 'Saverio Muratori: il debito e l'eredità' by Giancarlo Cataldi included in the book 'Saverio Muratori Architetto' published in 2013.

It should be referred that the designation 'process typological' is not consensual among the promoters of the approach and that other designations, such as planning typological, design typology and procedural typology, are frequently used. In addition, the designation 'Caniggian School' is, sometimes, preferred in relation to the designation 'Muratorian School' which is, eventually, more comprehensive.

Saverio Muratori

Saverio Muratori was born in 1910 in Modena. Between 1928 and 1933, he studied architecture at the *Regia Scuola Superiore di Architettura* at *Valle Giulia*, Rome. Among his teachers were Arnaldo Foschini, Enrico Calandra and Gustavo Giovannoni. In the second half of the 1930s he started collaboration with Ludovico Quaroni and Francesco Fariello, also developing a number of plans and projects on his own. During the years of post-war reconstruction, Muratori was deeply involved in the house plans of the *Istituto Nazionale della Assicurazioni* (INA)—a programme coordinated by Foschini. In 1952 he was called to teach in Venice returning to Rome two years later. The years in Venice were fundamental for the theory and practice of Muratori—the *Studi per una operante storia urbana di Venezia*, presented in the previous section, and the competition for Barene di S. Giuliano, that will be described in the next chapter, are part of this most fecund period. As Muratori ideas and work radically removed from fashionable trends he was confronted by students and colleagues leading to his increasing isolation. Muratori died in Rome in 1973.

As mentioned above, among the teachers of Muratori was Gustavo Giovannoni. Giovannoni's most important work, *Vecchie cittá ed edilizia nuova*, is a treatise of urban design (Giovannoni 1931). Starting from a historical framework, it deals with the principles of urban growth and transformation as they emerge from an analysis of different geographical situations over a long-time span. Giovannoni argued that tradition and modernity could cooperate within a concept of organicity in which the historical centres were sites for acts of contextualism and the new expansions could be realized through satellite quarters. The main problem would become the investigation of the seam between the new quarters and the old urban structure—as had been the case in the past. By analyzing specific case studies he formulated the ideas of the permanence of the planimetric pattern and of the city plan as a palimpsest, where the dense stratification of different layers would reveal the progressive, partial accretions and erosions of the initial implantation (Marzot 2002).

In his paper *Saverio Muratori: il debito e l'eredità*, included in the book *Saverio Muratori Architetto*, Giancarlo Cataldi (one of the main proponents of the process typological approach) divides the activity of Muratori in five different periods corresponding to five different decades (Cataldi 2013). The first period (1930–1940) designated as 'the professional experimentation' corresponds to the first years after Muratori receiving his degree. In this period, he prepared a series of articles for the journal *Architettura* on the, then, most recent architectural projects in Europe. His planning and architectural practice over this decade included the plans for *Aprilia* and for the mining town of *Cortoghiana* and a set of projects marked by the interest in the composition of Italian squares, as major urban themes, in which the

surrounding consolidated environment is the contextualized reason for the square and the monumental buildings surrounding it.[6]

The second period, in the 1940s, is marked by the development of a theoretical and operational perspective. In this period, Muratori wrote a number of essays where the ideas of towns as living organisms and collective works of art, and of planning new buildings in continuity with the building culture of the place seem to emerge. Simultaneously, Muratori had his first teaching experiences as assistant of Foschini and Calandra, his former teachers at *Valle Giulia*. The INA-Casa programme including a number of Roman districts, such as *Tuscolano*, are launched in the end of the 1940s. By then, the church of *S. Giovanni al Gatano*, in Pisa, is erected. The building tries to capture the fundamental characteristics of Romanesque architecture.

The city is the main theme of the third period of Muratori's activity. In this period, Muratori designs two major public buildings, the *Ente Nazionale di Previdenza ed Assicurazione Sociale* (ENPAS) (Fig. 7.9), in Bologona, and the headquarters of the Christian Democratic Party at the *Esposizione Universale Roma* (EUR) district. As in the case of the church in Pisa, these projects embrace two of the most significant periods in the history of Italian architecture—the Gothic, in the former case, and the Renaissance, in the later. After an initial stage where a conceptual gap between these complex and original buildings and the plans for entire quarters could be found, at the end of the 1950s, and notably at the competition for *Barene di S. Giuliano*, a strong link between research and both architectural and planning practice has been established. The plan comprised the recreation in a modern version, on the sides of the lagoon, of three particularly significant moments of Venice's urban history (we will get back to this plan in Chap. 7). After a first experience in Venice as professor of Distributive Characteristics of Buildings, in the beginning of the decade, Muratori returned to Rome in 1954 to replace Foschini as professor of Architectural Composition.

Territory and civilization are the fundamental themes developed by Muratori in the 1960s. Drawing on the experience on Venice, *Studi per una operante storia urbana di Roma*, published in 1963, constitutes a comprehensive atlas of the Italian capital (Fig. 6.10). By then, Muratori started to concentrate his philosophical reflections on wider issues outside the specific disciplinary field of architecture. *Achitettura e civilità in crisi*, analyzing the processes of self-awareness, and *Civilitá e territorio*, sustaining the idea of the architectural crisis as an expression of a more general crisis, are two examples of this wider line of thought (Muratori 1963, 1967). For Muratori, the only way to solve the crisis lay in the capacity of human beings to establish, on a global scale, a balanced relationship with their territories (Cataldi et al. 2002).

[6]For an analysis of Muratori's practice, particularly his planning practice, see the book 'Saverio Muratori, a legacy in urban design' and the paper 'Saverio Muratori: towards a morphological school of urban design' both authored by Marco Maretto (2012, 2013).

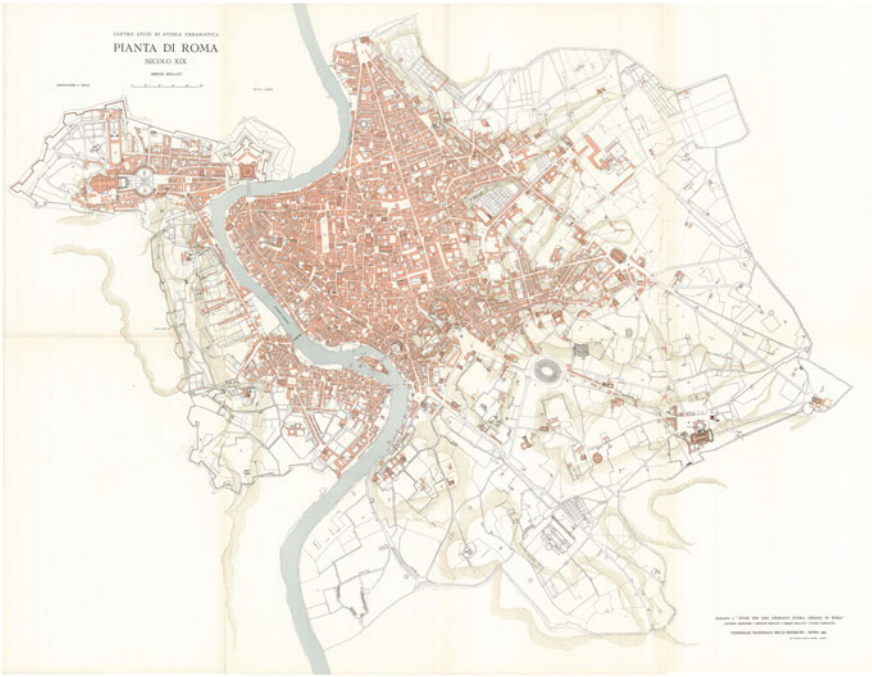

Fig. 6.10 *Studi per una operante storia urbana di Roma* (*Source* Muratori et al. 1963)

In his last years, Muratori devoted himself to teaching, in a rather difficult context, and research. This final stage of his teaching activity was strongly based on synoptic charts and diagrams. In research, in the unconcluded projects of *Atlante territorial* and of *Tabelloni,* Muratori was trying to establish a universal classification of man-made structures.

Gianfranco Caniggia

In the early 1960s, in Rome, Muratori's team of assistants began to form. One of these assistants was Gianfranco Caniggia. Caniggia was born in 1933 in Rome, having enrolled in the faculty of architecture at *Valle Giulia* in the early 1950s where he would found Muratori as one of the professors. At the time, the main Italian architects, including professors such as Muratori, were fully committed in developing the *Istituto Nazionale delle Assicurazioni* (INA)-Casa housing scheme.

In 1963, after his first architectural works with his father Emanuele (the residential building in Via *della Trinità dei Pellegrine* in Rome and the elementary schools and the hospital in Isola Liri) and with Adelaide Regazzoni (the residential and commercial building in Albiolo, Como), Caniggia concluded *Lettura di una città: Como* (supervised by Muratori), his first major contribution to urban morphology and building typology (Caniggia 1963). The 'switchback' interpretation of the process of urban development enabled him to grasp in face of Roman row

houses, the persistence of the *domus* as a type of substratum (Cataldi et al. 2002). This was a fundamental intuition that opened a line of research on the formation procedures of medieval courtyard houses in European historic cities, that would be explored in the the book *Strutture dello spazio antropico* published in the subsequent decade (Caniggia 1976). As an assistant of Muratori in the 1960s, Caniggia started to work on the issue of urban tissues (as Renato Bolatti and Sergio Bolatti), while Paolo Maretto focused on aspects of architectural language and Alessandro Giannini on the territorial scale.

In the 1970s, Caniggia had to leave Rome, and teach first in Reggio Calabria (1970), then in Genoa (1971–1978) and finally in Florence (1979–1981). Yet, this long trip would be one of the reasons for the diffusion of the process typological approach all over Italy. In Genoa and Florence, Caniggia developed a line of research in his courses, specifying the methodology for the interpretation of cities and their components. He progressively managed to accumulate sound teaching experience, forming the material for the preparation of *Composizione architettonica e tipologia edilizia*, written with Gian Luigi Maffei, and divided in two volumes. The first volume, on the interpretation of the basic buildings, was published in the end of the 1970s (Caniggia and Maffei 1979a, b).[7] The book is structured in terms of geographical scale: it starts at the scale of the building (the historical development of building types) and works up through aggregations of buildings to entire settlements as entities, and finally to relationships between settlements, especially the routeways that link different settlements.

Cannigia returned to the faculty of architecture of Rome in 1982. One year after, he published the second volume of *Composizione architettonica e tipologia edilizia*, focused on the design of the basic buildings (Caniggia and Maffei 1984). Caniggia developed one of his fundamental architectural projects in the 1980s—the Quinto quarter in Genoa. Here, he had the opportunity of putting into practice what he had learnt about the peculiar characteristics of the Genoese urban environment.

One of the main concerns of Cannigia was to transmit the ideas of Muratori in architectural terms, starting from the conviction that their diffusion was somehow obstructed by comprehension difficulties inherent in Muratori's thought. Caniggia therefore tended to simplify and reduce the theoretical system, highlighting its more directly operative aspects. In this sense, significance lies in the use and importance in his writings of the terms and concepts of type, building fabric and basic building—the formative matrix of specialized building (Cataldi et al. 2002).

Table 6.3 identifies a number of differences between the work of Muratori and of Caniggia. Muratori deductively aimed at conceiving a philosophical system capable of interpreting the history of civilization process-wise through architecture. Caniggia, in contrast, inductively set up a typological method capable of

[7]The first volume of *Composizione architettonica e tipologia edilizia* was translated into English (Caniggia and Maffei 2001), including a glossary of technical terms, and also to French and Spanish.

Table 6.3 Basic distinctions between Muratori and Caniggia (*Source* Cataldi 2003)

Muratori	Caniggia
Theory	Method
Organism	Structure
Organic	Serial
Architectural organism	Building type
Architecture	Building
Territory	Town

interpreting human environmental transformations in terms of design for architectural purposes (Cataldi 2003).

Cataldi (2003) identifies six major contributions of Caniggia to the process typological approach: (i) the examination and development of Muratori's concepts of type, typology, structure, tissue, series and seriality; (ii) the establishment of the method of processual typology; (iii) the discovery and recognition of the *domus* courtyard substratum as the matrix, within Roman planning, of all subsequent basic types; (iv) the distinction between basic and specialized building; (v) the theory of medievalization regarding the spontaneous utilization procedures of planned structures; and, finally, (vi) the method of interpretation by phases of a city's history in connection with basic typological processes.

Gianfranco Caniggia died prematurely in 1987. His last writings, mainly unpublished, were collected by Gian Luigi Maffei in the posthumous volume *Ragionamenti di tiplogia* published one decade later (Maffei 1997).

Recent developments

As in the case of Caniggia, in the beginning of the 1970s, the other assistants of Muratori had to leave Rome. The reform in architectural studies in 1970 created new faculties and, as such, new opportunities for teaching. Luigi Vagnetti, a colleague of Muratori, had a fundamental role in this process inviting, in a first moment, Paolo Maretto (and Caniggia) to Reggio Calabria and, in a second moment, Alessandro Giannini and the Bollati brothers to Genoa and Florence. The work of Maretto had two clear interests, the organization of the typological studies according to the four fundamental interrelated scales of man's context and linguistic experimentation. The city of Venice has had, since his student days, a key role in his research (Fig. 6.11).[8] The reading of the territorial scale was the main theme developed by Alessandro Giannini, including research on Ethiopia and Italy (*Liguria* and *Ostia Antica*). Renato and Sergio Bollati had a focus on the theme of urban tissues with systematic research and architectural practice in Rome, Venice and a number of Calabrian and Sicilian cities.

The recent developments of the process typological approach were framed by two different organizations, the *Centro Internazionale per lo Studio dei Processi*

[8]This is the case of the above mentioned *L' edilizia gotica veneziana*, published as a complementary book of the operative history of Venice by Muratori, and of *La casa veneziana nella storia della città* (Maretto 1960, 1986).

Fig. 6.11 L' edilizia gotica Veneziana (*Source* Maretto 1960)

Urbani e Territoriali (CISPUT) and *ISUF Italia*, a national network of ISUF. CISPUT was founded in Pienza in 1981 by Giancarlo Cataldi—its coordinator—and a number of Italian and American colleagues. The intention was to provide occasions for architects and architectural historians to meet and make comparisons, and to verify from the point of view of various disciplines the outcomes of Muratori's method (Cataldi et al. 2002). Despite the dynamic activity of CISPUT over almost three decades—including more than 20 conferences in different Italian cities, from Pienza to Modena—the group has been progressively losing importance. After a first foundation in 2007, in Rome, *ISUF Italia* was refunded in 2014 in a conference in the Italian capital that I had the pleasure to attend as invited speaker. The re-foundation of *ISUF Italia*—under the presidency of Giuseppe Strappa—coincided with the launching of the preparation of the annual conference of ISUF in Rome 2015 and with the launching of a new journal, 'U+D Urbanform and Design', devoted to the relationship between architecture and urban morphology.

The origins and development of CISPUT and *ISUF Italia* are clearly marked by two Italian researchers, Giancarlo Cataldi and Giuseppe Strappa. Based in Florence, Cataldi has played a leading role in the promotion of the process typological approach over the last two or three decades. A former student of Muratori, the president of ISUF (at the time of writing this book) has devoted a significant part of his work in reconstructing the history of the Muratorian School. His main research interests include territorial interpretation and typological processes including the theme of primitive architecture. The city of Pienza has a central role in Cataldi's work—see, for example, *Pienza Forma Urbis* (Cataldi and Formichi 2007). Based in Rome (after an experience in Bari), Strappa has been developing the notions of organism and, particularly, of process in architecture—see, for instance,

L'architettura come processo (Strappa 2014). His research has focused on the cities of La Valetta, Trani and Rome and on some small towns of the Lazio region. Another researcher with a crucial role in this second generation is Gian Luigi Maffei. As mentioned above, Maffei has integrated and published Caniggia's unfinished studies after his death. In addition, Maffei has published two books on Florentine and Roman (co-authored with Paolo Carlotti and Lucian Bascià) houses that analyze the evolution of the residential buildings against the background of the evolution of these two cities (Maffei 1990; Bascià et al. 2000).

Finally, it is possible to distinguish a third generation of followers of the process typological approach who did not directly know Muratori or Caniggia. Two of the most important are Nicola Marzot and Marco Maretto, the son of Paolo Maretto. As in the case of Cataldi, Strappa and Maffei they both continue to promote different aspects of the work of Muratori and Caniggia. Marzot has been contextualizing the process typological against other Italian approaches, namely the theory developed by Aldo Rossi that was analyzed in the previous section (see for example, 'The study of urban form in Italy'—Marzot 2002). On another line of research, exemplified by the paper 'Saverio Muratori—a legacy in urban design' Maretto explores the architectural practice of Muratori at an urban scale, analyzing a number of plans ranging from *Aprilia* to *Barene di San Giuliano* (Maretto 2013). In addition to this reading of the work of Muratori and Caniggia, they both have been exploring the theme of sustainability, the relation between the historico-geographical and the process typological approaches, and the relation between research and practice.

6.2.3 Space Syntax

This subsection is in three parts. It starts by describing the origins of space syntax and the seminal texts by Bill Hillier and Julienne Hanson, moving then to the main developments of this configurational approach over the last two decades and to a description of its main characteristics.

The origins of space syntax

While the core of a more quantitative approach to urban form analysis was, in the 1960s, in the centre of 'Land Use and Built Form' (LUBFS), at Cambridge University, directed by Leslie Martin and Lionel March, at the mid-1970s, it gained a new impetus with the creation of the 'Unit for Architectural Studies', at the University College London (UCL), directed by Bill Hillier.[9] Space syntax research began in this unit, with the main purpose of understanding the influence of architectural design on the existing social problems in many housing estates that were being built in the United Kingdom.

[9]Bill Hillier got his BA and MA in Architecture at the University of Cambridge, in 1961 and 1964. He received his DSC in Built Environment at the University of London in 2003.

Besides an interesting set of seminal papers published in the 1970s during the first years of this research programme (Hillier 1973 and Hillier et al. 1976) three books by Bill Hillier and Julienne Hanson must be highlighted, 'The social logic of space' (Hillier and Hanson 1984), 'Space is the machine' (Hillier 1996b) and 'Decoding homes and houses' (Hanson 1998). The first of these was already presented in the previous subsection. The second book, 'Space is the machine', is a synthesis of the development of space syntax throughout the 1980s and the beginning of the 1990s, highlighting the configurational and analytical (and opposed to normative) dimensions of this theory. The book is in four parts. The first part, 'Theoretical preliminaries', deals with the most basic questions which architectural theory tries to answer: what is architecture and what are theories (?). The second part, 'Non-discursive regularities', sets out a number of studies in which regularities in the relation between spatial configuration and the observed functioning of built environments have been established using 'non-discursive techniques' of analysis to control the architectural variables. The third part, 'The laws of the field', uses these regularities to reconsider a fundamental question in architectural theory: how is the vast field of possible spatial complexes constrained to create those that are actually found as buildings (?). Finally, the last part of the book, 'Theoretical syntheses', draws together some of the questions raised in the first part, the regularities shown in the second and the laws proposed in the third part, to suggest how the two central problems in architectural theory, namely the form-function problem and the form-meaning problem, can be reconceptualised. In synthesis, the book is concerned with what buildings and cities are like, why they are as they are, how they work, how they come about through design, and how they might be different.

The third book, published two years after 'Space is the machine', examines the evolution of domestic space organization and family structure in Britain through many accounts of historic houses, examples of speculative homes, and innovative, contemporary domestic architecture. 'Decoding homes and houses' shows how domestic space provides a shared framework for everyday life, how social meanings are constructed in the home and how different sub-groups within society differentiate themselves through their patterns of domestic space and lifestyles.

Main developments

In the preface to the e-edition of 'Space is the machine', prepared in 2007, Hillier identifies the main contributions to space syntax method and theory in the 1990s and 2000s. In terms of method—frequently corresponding to the development of new software—he highlights the texts of: Turner (2004), Turner and Penn (1999) and Turner et al. (2001) on the process of syntacticizing the visibility graph analysis and on the proposal of the Depthmap software (these methods and software are described in the second part of this subsection); of Dalton (2001) on angular analysis; and of Figueiredo and Amorim (2005) on continuity lines resulting from the aggregation of axial lines. In terms of theory, the texts of Peponis et al. (1997, 1998a, b) on geometrical issues, of Batty (2004a, b) on graphs, of Hillier (2002) on

urban form and of Hillier (1999) on the relationships between space, movement and land use patterns should be highlighted.

Currently, there are two main arenas for debate within the space syntax community. The first is the biannual 'International Space Syntax Symposium' (ISSS). These symposia were launched in 1997 in London and in the last two decades they have taken place in three different continents: America (North and South America), Asia and Europe. The second arena is 'The Journal of Space Syntax' (JOSS), a biannual journal launched in 2010, edited first by Julienne Hanson, then by Sophia Psarra and, finally, by Daniel Koch.

While in the early days, space syntax had mainly focused on pedestrian movement patterns, nowadays its main lines of research include spatial cognition, methodological developments (including modelling and software development), building morphology and performativity, social cohesion and exclusion, crime and order, to name just a few. The two latter issues are developed in the next two paragraphs.

A set of papers published in a number of the journal 'Progress in Planning' edited by Laura Vaughan shows how space syntax can be used in the study of the spatial dimension of segregation (Dalton 2007; Hillier and Vaughan 2007; Marcus 2007; Vaughan 2007). Drawing on a study of a small American city, Ruth Dalton shows how an alternative perspective on integrated transport can lead to unusual, albeit effective, solutions to social and economic exclusion. Bill Hillier and Laura Vaughan propose an explanatory model for the ability of a city to accommodate social differences by organizing patterns of accessibility according to the degree of co-presence required by the activity contained in each space. Lars Marcus shows that when public space is designed to be segregated rather than part of an integrated network of streets, it can have profound effects on the ability of housing estate residents to form social ties. Taking London as a case study, Laura Vaughan identifies a line of poverty with a strong spatial dimension, distinguishing between poor, spatially segregated streets and more prosperous, spatially integrated streets (we will get back to the work of Laura Vaughan in Chap. 8).

In his key study on space and crime, Hillier (2004) suggests the absence of a correlation between crime and density, and only a poor correlation between affluence and crime. Contrarily to these current assumptions, Hillier defends a very strong correlation between layout type and different types of crime. Each particular type of crime and the associated built environment characteristics has been studied by different authors—street robbery by Sahbaz and Hillier (2007), residential burglary by López and Nes (2007), thefts from cars by Nubani and Wineman (2005), and antisocial behaviour by Hanson and Zako (2007). This set of studies uses the space syntax approach by itself or in combination with other methods, it goes from micro to macro scale of analysis, and it is able to provide evidence from different geographical contexts throughout the world.

The main characteristics

The focus on space and the relationships between space and movement are two fundamental aspects of the space syntax approach. In seminal texts, such as Hillier

and Hanson (1984), this focus on space emphasized the boundaries between the emerging space syntax and other approaches. These authors believed that most of these approaches were discussing space in terms of its defining surfaces. Others were debating space on its own and not the relationships within buildings and urban areas, which was the purpose of space syntax. Hillier and Hanson (1984) defend a theory that a descriptive autonomy for space can be established, enabling the consideration of a wider morphological variety to reflect the different relationships between space and society. In synthesis, a new view of architecture and of the city is proposed, emphasizing those urban spaces where people move through and where social and economic activities are carried out. Spatial configuration is a key concept in this approach, meaning the relationships between two spaces within a system considering their relationships with all the other spaces in that same system (Hillier et al. 1987). Spatial configuration is thus a more complex concept than 'spatial relationship' that considers only two spaces.

Space syntax presents some innovations at the level of the relationships between urban space and movement, either pedestrian or vehicular. Contradicting the then current theories that pointed to the existence of flows to and from attractor land uses as the main explanation for these relationships, space syntax suggests that the configuration of the urban layout itself is the main generator of movement patterns. Hillier et al. (1993) designate the movement generated by the layout configuration as natural movement. They sustain that movement has a morphological dimension or, in other words, is a functional product of the intrinsic nature of the layout. As such, the question of movement and of space use in general, cannot be separated from the question of urban form itself.

The way that spatial relationships within a building or an urban area are represented is another distinctive element of space syntax. This representation is translated into an axial map (Fig. 6.12) which is constituted by the least set of axial lines that covers the whole system, in a way that any convex space is crossed by one of those lines (Hillier and Hanson 1984). The axial line corresponds to the longest line that can be drawn through an arbitrary point in the spatial configuration.[10] The axial map can be translated into a graph, which is a finite set of nodes, called vertices, connected by links, called edges. A number of topological measures can be extracted from that graph to quantify the characteristics on the spatial configuration. The definition of topological measures intends to quantify the spatial pattern of relationships of a system. Global (radius n) and local (radius 3) integration, connectivity, (global) intelligibility are some of the topological measures used in axial analysis.[11] Global integration measures the relative depth of each axial line to all

[10]In practice, the axial map is a representation of the street network made just of lines. One of these lines is chosen as the starting point. This line will be intersected by a number 'n' of other lines, which are labeled Depth 1. Each of these n lines will then be intersected by 'm' lines, which are labeled Depth 2, and so on. In other terms, each line in the map is numbered according to how many changes of direction separate it from the starting line.

[11]The proposal of new measures and the development of existing ones had changed the role of these measures in the whole apparatus of the space syntax community.

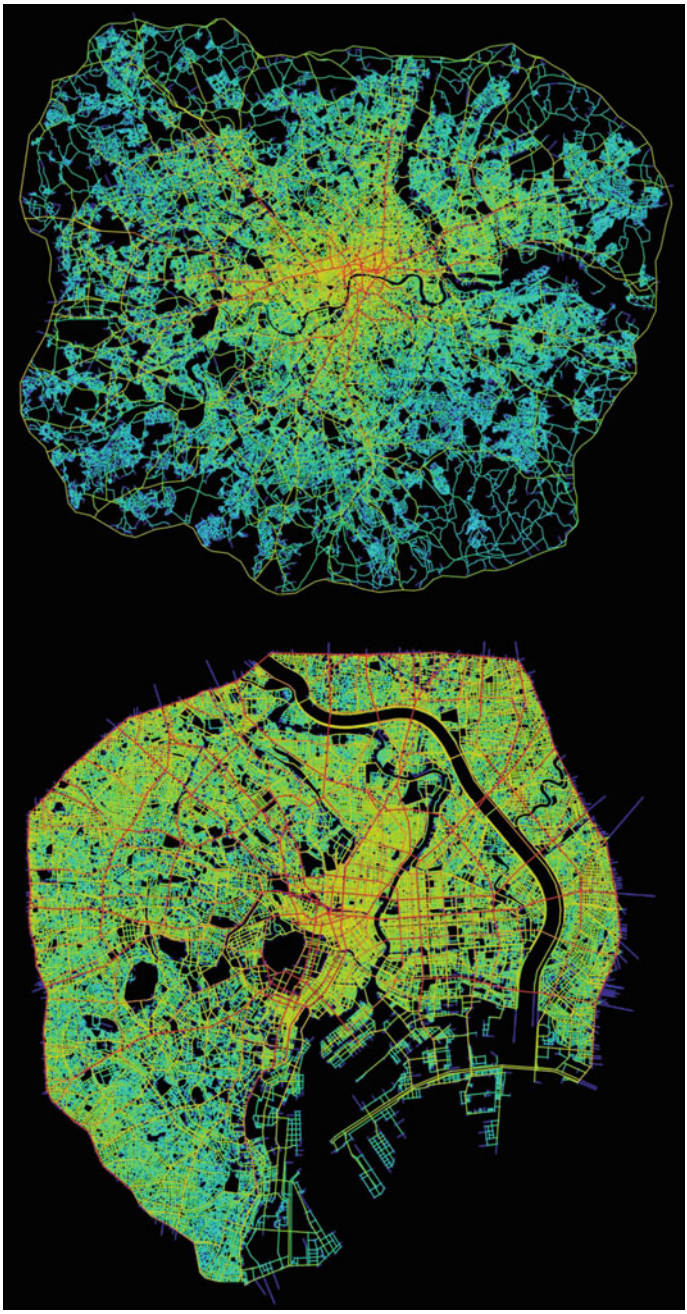

Fig. 6.12 The axial maps of London and Tokyo (*Source* Hillier 2014)

other lines of the system. Local integration measures the accessibility of each line up to three steps away. Connectivity measures the degree of intersection or one step possibilities of each axial line. Global intelligibility, expresses the degree of linear correlation between connectivity and global integration, and is defined as the degree to which what we can see and experience from the spaces that make up (or are connected in) the system and what we cannot see—the integration of each space into the system as a whole.

Perhaps, the most recurrent theme in space syntax literature throughout the last years has been the axial map. While some suggestions have contributed to the overall improvement of the axial map, others have not been incorporated by space syntax, for many different reasons. A key issue in the definition and generation of the axial map has been the passage from handmade drawings to computer-aided drawings. Some authors have criticized this passage, allegedly because it did not bring a higher objectivity to the drawing and production of axial maps, and because it still allows different users to obtain different maps based on the same cartographic representation. The key contributions to improvement of the axial map and to the acquisition of a greater rigour came from some leading proponents of space syntax, such as Carvalho and Penn (2004) and Turner et al. (2005). Carvalho and Penn (2004) sustain the idea of scale invariance in a range of line lengths composing a sample of different maps. Culminating a two decades process to translate the definition of the axial map in mathematical terms, Turner et al. (2005) demonstrate an algorithm for the construction of an axial map of architectural space.[12]

Another key issue has been the edge-effect (Eisenberg 2007; Ratti 2004). Drawing on the analysis of an ideal urban system in two distinct situations—self-contained, and in communication with another system—Ratti (2004) argues that space syntax results are influenced by the size of the area of the city under consideration. Over the years, a number of approaches have been proposed to deal with this: extending the network model for analysis with a 'catchment area of the catchment area' around the area of interest (Hillier et al. 1993), using a radius of analysis working as a moving boundary to calculate local measures (Penn et al. 1998; Hillier and Penn 2004; Turner 2007), or a specific 'radius radius' based on the mean depth of the most integrated line in the system (Hillier 1996a, b). In a recent research, Gil (2015) demonstrated that some measures are affected differently by the edge-effect, and that the same measure is affected differently depending on the type of distance used.

Another theme of the debate is the opposition between metric and topological measures, particularly at a global scale. At a global scale, corresponding to the so-called foreground network, space syntax proponents (see Hillier 1999 and Hillier et al. 2010) have been exclusively exploring topological measures. Nevertheless and somehow reflecting the dual form of the urban street networks, the same authors have been including topological measures weighted by metric length in

[12]This algorithm is associated with Peponis et al. (1998a, b)'s method for the construction of axial maps.

their local analysis of urban space. This improves the perception of a background network of primarily residential space, responsible for the specificities of the different parts that constitute the urban patchwork (on the spatial definition of these urban areas see Yang and Hillier 2007).

The incorporation of tri-dimensional information in space syntax's graphic representation is another theme of the debate (see for example Hillier and Penn 2004; Ratti 2004, 2005; Wang et al. 2007). On the one hand, one of the major purposes of space syntax is to understand the influences of spatial configurations on social life. As such, its main proponents have been opposed to the introduction of other variables in the spatial model. On the other hand, some authors believe that the absence of tri-dimensional information, namely building heights, weakens the research results, particularly at the level of movement patterns. Based on their study on five London areas, Penn et al. (1998) contend that pedestrian movement is influenced by building height, the level of the area and by pavement width at the level of the individual road segment. Nevertheless, the study shows that both variables have a minor influence when compared with configurational variables.

In general, space syntax separates spatial and land use analysis. Hillier and Penn (2004) contend that this separation has been particularly productive in studying the impact of configuration and movement on land uses (Hillier 1996b) and the generation of centres and sub-centres (Hillier 1999), and in analyzing the spatial dimension of a process by which spatial configurations first shape, and then are shaped by, land uses (Hillier 2002).

In the last decade, segment analysis has been utilized by an increasingly number of researchers. A significant part of the impetus for this increase came from the use of the DepthMap software. The basic element in segment analysis is the street segment between intersections. DepthMap generates the segment map automatically from a least line or axial map or from road centre line data. DepthMap allows three definitions of the distance between each segment and each of its neighbours: (i) metric, that is the distance in metres between the centre of a segment and the centre of a neighbouring segment; (ii) topological, assigning a value of 1 if there is a change of direction between a segment and a neighbouring segment, and 0 if not; and, finally, (iii) geometric, assigning the degree of the angular change of direction between a segment and a neighbour, so straight connected are 0-valued and a line is a sequence of 0-valued connections, so that the linear structure of cities is captured. It then uses these three concepts of distance to calculate two kinds of measure: syntactic integration, or mathematical closeness, which measures how close each segment is to all others under each definition of distance; and syntactic choice or mathematical betweenness, which calculates how many distance-minimising paths between every pair of segments each segment lies on under different definitions of distance. So using the metric definition of distance we find the system of shortest path maps for integration and choice, with the topological definition we find the system of fewest turns maps, and with the geometrical definition we find the system of least angle change maps (Hillier 2009). In a recent paper, Figueiredo (2015) proposed a bridge between axial and segment maps based on a unified graph model. By using simple justified graphs, he shows that topological steps on axial maps are

equivalent to changes of direction on segment maps in a directional distance model or, in other words, axial maps are 'compressed versions' of segment maps.

6.2.4 *Spatial Analysis*

This subsection includes three forms of spatial analysis—cellular automata, agent-based models and fractals—each one corresponding to a different part of this text. Yet, the three forms of spatial analysis are not mutually exclusive and may be used in a complementary way. It is important to acknowledge that the spatial analysis approach is more heterogeneous than the other three already presented in this section.

As in the case of Whitehand, Cataldi and Hillier, it is also possibly to identify a key researcher in the promotion of this approach—Michael Batty. Between 1962 and 1966, Batty studied Urban and Rural Planning at the University of Manchester. In 1983, he concluded his PhD, in Urban and Rural Planning, at the University of Wales. Since 1985 he is the editor of the journal 'Environment and Planning B: Planning and Design' which has been one of the main stages for the debate of this approach. Over the last two decades, after teaching in five different institutions (in Manchester, Reading, Waterloo, Cardiff and Buffalo) Batty has been based at the Centre for Advanced Spatial Analysis (CASA) at UCL (as in the case of Hillier).

Using a range of methods and models, Batty seeks to understand the spatial structure and dynamics of cities as complex, emergent phenomena, in which the global structure develops from local processes (Fig. 6.13 shows the London local centres). He sees the city as a problem of organized complexity and applies the concepts of emergence and evolution in moving towards solving that problem. The models employed and cited by Batty in the book 'Cities and complexity' are stated to have a loose correlation with the scale of the phenomenon modelled (Batty 2005). The models might represent city regions or areas within a city. Cells in a model most appropriately represent plots or something between those and census tracts or other administrative aggregations depending on the source of the data (Kropf 2009).

Considering the evolution of spatial models, Batty (2008, 2012) states that, in general, there has been a change from aggregate cross-sectional comparative static models of spatial systems to models that are disaggregate and dynamic. This has marked the transition from land use transportation interaction models (LUTI) to Cellular Automata (CA) and Agent-Based Models (ABM). This has also represented a change in scale and focus and in the case of CA models, these shift the focus from social and economic processes to physical land development. ABM models are more generic, but in terms of urban modelling, most applications are at the fine spatial scale at the level of pedestrians and local movement.

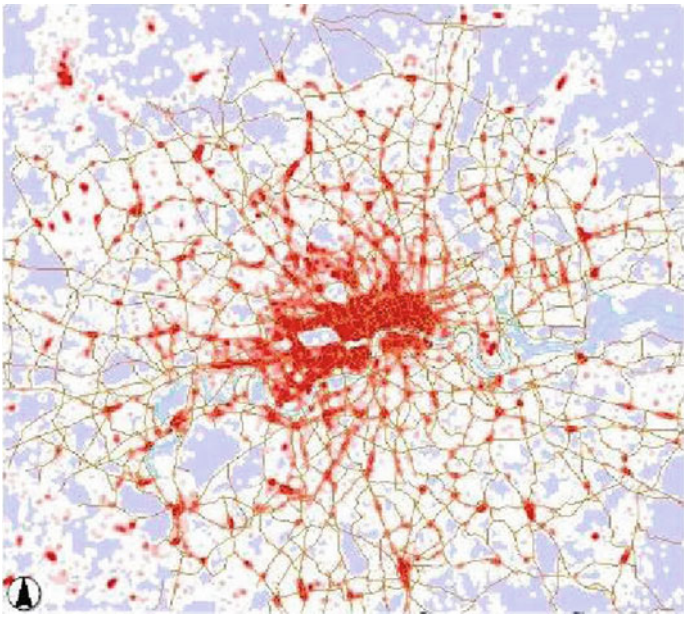

Fig. 6.13 The map of London centres by Michael Batty (*Source* Hillier 2009)

Cellular automata[13]

The history of CA goes back to John von Neumann's theory of self-reproducing automata and his co-operation with Stanislaw Ulam at the time when they were working with concepts of artificial life and idealizations of biological systems. The theory of self-replicating automata describes conceptual principles of a machine that was able to self-replicate. Alan Turing was also already working with automata in the 1930s when he defined a simple abstract computer later known as the Turing machine where the idea of the automaton comes close to what we today consider as CA (Iltanen 2012).

CA models are a tool for the dynamic modelling of urban phenomena that try to capture the complexity of spatial phenomena. CA models have an extremely simple formulation that makes its perception to the area of urban studies very easy. There are five basic components: (i) the cells, (ii) the states of the cells (on or off), (iii) the neighbourhood (the adjacent cells), (iv) the transition rules (such as the number of

[13]The organization of this part of the text draws on two introdutory texts to the theme of cellular automata written by Nuno Norte Pinto—*Modelos de autómatos celulares como ferramentas de análise da forma urbana* (Cellular automata models as tools for the analysis of urban form) and *Modelos de autómatos celulares para a simulação da evolução das estruturas urbanas* (Cellular automata models for the simulation of the evolution of urban structures) (Pinto 2013; Pinto et al. 2015). In 2012, Pinto has coordinated the first symposium exclusively dedicated to Cellular Automata Modelling for Urban and Spatial Systems—the CAMUSS. The proceedings are gathered by Pinto et al. (2012).

neighbours required for turning the cell on), and, finally, (v) time. Cells are partitions of space in which some phenomena occur—for instance, territorial administrative units. In each instant, each cell has a state from a finite set of possible cell states—the different occupations that land can have. The neighbourhood establishes the extent to which spatial interactions between cells, considering their states (for instance, the interactions between different land uses) are accounted for. The usual neighbourhood is defined as the Moore neighbourhood which means that all cells at the eight compass points around the cell in question or as the von Neumann neighbourhood which are the four cells north, south, east and west of the central cell. Transition rules change the cells states over time, simulating territorial dynamics. Time offers these models a dynamic character. The combination of these components allows modelling form—through cells and neighbourhood—and function—with cell states and transition rules (Pinto 2013).

The designation 'cellular' contributes with the spatial structure of the concept; the designation 'automaton' indicates the ability to process this code (the states of the cell) according to a set of transition rules. A model in which the space is constituted by different cells will be a cellular automata model. CA models had a very intense research in different areas of physics and mathematics, benefiting from the development of computing from the 1950s to the 1970s. Wolfram's work compiled in his fundamental book 'A new kind of science' (Wolfram 2002) and John Conway's 'Game of Life' (first published by Gardner 1970 in the journal 'Scientific American') are two notable examples. The 'Game of Life' consists of randomly planting a series of cells which are alive on a lattice and determining how they grow and survive dependent on those cells around them. If a cell is alive, then it stays alive if two or three cells in its neighbourhood are alive (survival). It dies if there is less than two cells (isolation) or more than three (overcrowding, congestion) in its neighbourhood. A cell comes alive if there are exactly three cells in its neighbourhood already alive (reproduction). The popularity of the 'Game of Life' rests on the outstanding variation of the behaviour and in the patterns it can produce with these simple rules.

Despite some experiences in the 1950s and the 1960s (Hagerstand 1952; Lathrop and Hamburg 1965), CA were first applied in urban studies by Waldo Tobler in his work 'Cellular Geography' (1979). Tobler proposes a new geographical model receiving inputs from the 'Game of Life' and from von Neumann concept of neighbourhood. After this work, a number of authors started to implement CA models in the simulation of urban phenomena, particularly after the mid-1980s, when microcomputing widens the use of computational calculation: Helen Couclelis (1985) argued for the combination of CA and system theories to study urban systems; White and Engelen (1993) published the first constrained model, combining micro-and macro-scale mechanisms in cell state transition rules. Couclelis (1997) lists a number of key issues (concerning space and its modelling, neighbourhoods and their definition, and transitional rules and their universality) for CA models to be more realistic in how they deal with space and how they capture the dynamics of spatial phenomena—how they can be more useful to urban studies and planning practice.

Agent-Based Models

Throughout the twentieth century geography has incorporated ideas and theories from other disciplines. These ideas have strengthened the significance of both modelling and understanding the impact of individual agents and the heterogeneity of geographical systems at different spatial and temporal scales. ABM models allows for the simulation of the individual actions of diverse agents, and the measuring of the resulting system behaviour and outcomes over time. Essential to the progression of ABM has been the development of automata approaches more generally. An automaton is a processing mechanism with characteristics that change over time based on its internal characteristics, rules and external input. Automata process information input to them from their surroundings and their characteristics are altered according to rules that govern their reaction to these inputs. Two classes of automata tools have dominated the research literature—CA (presented in the last paragraphs) and ABM (Crooks and Heppenstall 2012).

While there is no precise definition of the term 'agent', there are some features that are common to most agents: agents are autonomous, heterogeneous and active. Agents can be representations of any type of autonomous entity (people, buildings, plots, to name just a few). Each of these inanimate and animate agents possesses rules that will affect its behaviour and relationships with other agents and, or with, its surrounding environment. The surrounding environment defines the space in which agents operate, serving to support their interaction with the environment and other agents (Crooks and Heppenstall 2012).

ABM models have many of the characteristics of CA models except that the environment and population sides of the system are kept apart. The population sector is essentially that which contains these agents whose behaviour is specified in considerable detail. Agents tend to be mobile in a spatial sense and even if they do not physically move in space, they can be associated with different spaces and their change over time can reflect an implicit process of movement. In this sense, the environment is treated more passively than the population with the population driving any change in the environment, although in principle there is no priority for one or the other. The idea of an agent having a specific behavioural profile and acting on this purposively is central to the definition of ABM. In terms of aggregation and scale, ABMs tend to be at smaller scales than the region or the metropolis although some land cover models based on ABM are predicated at these larger scales. They tend not to be constrained in terms of conserving any key quantity although they may be structured to generate or conserve a certain level of population, especially if the focus is on movement in a fixed space as in pedestrian models. Their dynamics and relationships to the wider environment are similar to CA and they tend to be highly disaggregated down to the point where individuals constitute their basic units (Batty 2012).

Fractals

Euclidean geometry is dominated by the concept of things as one, two, or three-dimensional. A line has one dimension, length; a plane has two dimensions, length and width; and a cube has three dimensions, length, width, and height. In the

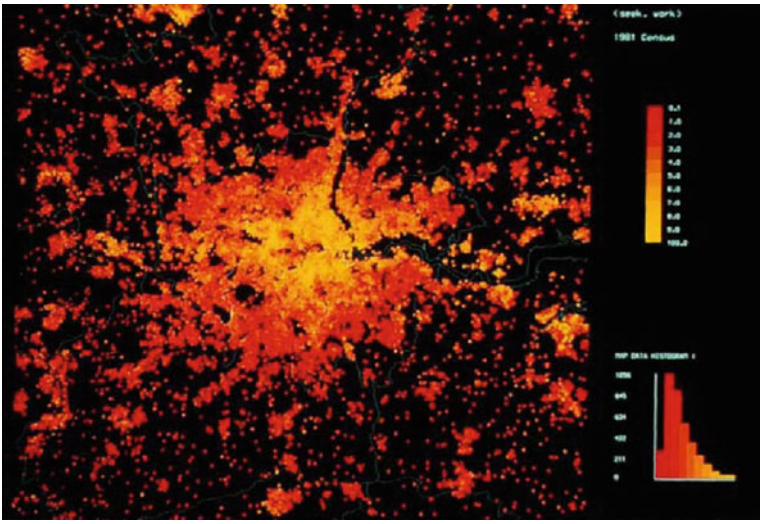

Fig. 6.14 Fractal London: employment densities (*Source* Batty and Longley 1994)

beginning of the 1950s, the mathematician Benoit Mandelbrot launched a line of research that would challenge this vision leading to two important essays in the mid 1970s that would acquire a final form in the book 'The fractal geometry of nature' (Mandelbrot 1982). In this seminal book Mandelbrot argues that many patterns of nature are so irregular and fragmented that, compared with the Euclidian geometry, nature exhibits not only a higher degree but a rather different level of complexity. Mandelbrot proposes a new geometry of nature—arguing for its use in different fields—based on the concept of 'fractal'. The title of his 1977 essay 'Fractals: form, chance and dimension' reveals what would be the nature of the main characteristics of this concept: (i) the form of a fractal is irregular, having a broken appearance; (ii) most fractals are associated to chance and their irregularities are statistical; their shapes tend to be 'scaling'—the degree of their irregularity and/or fragmentation is identical at all scales; and, finally, (iii) the fractal dimension is not an integer value: while in Euclidean geometry (as we have seen), lines, squares and cubes have an integral dimension, fractal patterns falling in the plane have a dimension between 1 and 2, whereas the 'fractal dimension' of fractals in space falls between 2 and 3.

In the subsequent decades fractal geometry has been progressively applied to the built environment. Two fundamental books on fractals were published in 1994. 'Fractal cities: a geometry of form and function', by Michael Batty and Paul Longley, is an initial attempt to apply fractal geometry to cities. Figure 6.14 offers an image of employment densities in a fractal London. Batty and Longley (1994) argue that cities are fractal in form and that much of the pre-existing urban theory is a theory of the fractal city. At the same time, Pierre Frankhauser published *La fractalité des structures urbaines*. Frankhauser (1994) sustains the existence of self-organizing processes, or interior order principles, promoting the development

of 'irregular' urban patterns. As in the case of Batty and Longley, the French author proposes the use of fractals to measure and characterize these irregular structures.

Another line of research has focused on indigenous cities and settlements. In the end of the 1990s, in the book 'African fractals: modern computing and indigenous design', Ron Eglash has shown how fractal patterns, calculation and theory are expressed in African cultures. He does it by moving along a spectrum of the presence of mathematics in culture from unintentional to self-conscious, corresponding to examples of abstract theory in these indigenous knowledge systems (Eglash 1999). Four years later, Clifford Brown and Walter Witschey have demonstrated that Ancient Maya settlement patterns exhibit fractal geometry both within communities and across regions (Brown and Witschey 2003).

'Fractal geometry in architecture and design', by Carl Bovill was published in 1996 focusing, not on cities but, on individual built structures. Bovill (1996) investigates the use of fractal dimension both in evaluating buildings and as potential design generators. This line of research was further extended in the last two decades—Joye (2011) offers a review on the different ways in which fractal geometry has been used to analyze and create actual architectural form.

Finally, fractals have been used to analyze the characteristics of streetscapes. This has been mainly developed by Jon Cooper over the last fifteen years. Cooper started by using fractal analysis to assess the complexity of urban and natural skylines, moving then to an examination of the fractal properties of street edges and, finally, to an analysis of street vistas linking the calculation of fractal dimension to the perception of levels of visual variety present in everyday urban streets (Cooper and Oskrochi 2008).

6.3 Comparative Studies of Urban Form

As we have seen in the two last sections, the diversity and complexity of the physical form of cities is somehow reflected in the variety of morphological approaches to describe and explain it. This dynamic attitude in the formulation and development of new theories, concepts and methods is a positive characteristic. Yet, it holds a fundamental weakness as the debate in urban morphology was not able to offer a comparative meta-framework allowing for academics and practitioners to understand: (i) which approaches to use in face of the specific nature of a particular case study; (ii) if it is possible to combine different approaches; and (iii) in which moments, or under which circumstances, should one particular approach be used.

The need to develop comparative studies between these approaches has been raised within many of them, notably by Jeremy Whitehand in his recent papers and editorials in the journal 'Urban Morphology' and in some presentations in ISUF conferences (Whitehand 2009c, 2012, 2015). In 2014, I had the pleasure of coordinating the organization of the 21st ISUF conference in Porto. One of the most interesting parts of the conference was a plenary session on the 'Different approaches in the study of urban form'. The session gathered at the same table the

Fig. 6.15 International Seminar on Urban Form 2014: Different approaches in the study of urban form (*Source* Photograph by the author)

main proponents of the historico-geographical, process typological and space syntax approaches—Jeremy Whitehand, Giancarlo Cataldi and Bill Hillier[14]—and Jurgen Lafrenz, representing a german morphogenetic tradition (Fig. 6.15). After four individual presentations, on each of these approaches, the four researchers joined a roundtable moderated by Pierre Gauthier. The debate addressed a number of key issues for the development of comparative studies, such as the existence of urban morphology as a discipline gathering different approaches, the specificities of each approach, the potential common ground, and the ways of establishing a consistent process of building bridges.

In addressing the need to develop comparative studies of urban form, some projects have focused on the utilization of one morphological approach, or one concept or method, in different types of urban area in different parts of the world. Whitehand (2009b) describes the utilization of the method of morphological regionalization for identifying and mapping urban landscape units in different geographical contexts. Conzen (2009b) offers a comparative assessment of the performance of the fringe-belt concept in the different cultural settings in which it has been applied. He also examines the results of the European Historic Towns Atlas; a programme concerned with the preparation of maps of individual towns at a common scale and similarly designed in order to develop comparative analysis (Conzen 2008).

Other authors have explored the potential, or the real, utilization of different approaches in a single study. Whitehand (2001) and Maffei and Whitehand (2001) explore the relation between the Conzenian morphological period and the

[14]Michael Batty was invited to this session but, unfortunately, he could not join us.

Caniggian typological process. The latter concept sheds light on the former by conceptualizing how the forms that are characteristic of one morphological period are superseded by those characteristic of the next.

In the paper 'Aspects of urban form', Karl Kropf undertakes a critical analysis of publications representative of the four approaches that we have been debating in this chapter. First, he identifies the range of different phenomena that are the object of urban morphological enquiry; second, he identifies an aspect common to all the approaches which can be used as a reference key to coordinate different views in a rigorous way; and, third, he outlines a composite view in which the different approaches support each other to provide a better understanding of human settlements (Kropf 2009).

6.3.1 *Porto*[15]

This subsection describes in detail a comparative study that I have developed with my colleagues Cláudia Monteiro and Jenni Partanen trying to develop Kropf's line of research one step further. We first selected one key concept proposed by each of the four approaches: morphological region (historico-geographical approach), typological process (process typological approach), spatial configuration (space syntax) and cell (spatial analysis). The four concepts were then applied into a single case study in the city of Porto (described in Chap. 5). As in the case of Kropf's research our aim was to understand how to combine and coordinate these approaches so as to improve the description, explanation and prescription of urban form.

The four morphological concepts (morphological region, typological process, spatial configuration and the cell) were applied in *Rua de Costa Cabral* and its immediate vicinity in Porto. This street consists of two different parts separated by a ring road. Attention is focused on the southern and oldest part of the street and on the twelve street blocks fronting it (Fig. 6.16). This part of *Rua de Costa Cabral* is 1400 m long and has an average width of 11 m. The study area includes parts of other streets. The twelve street blocks have an average area of 24,800 m^2 (the largest block is 61,400 m^2 and the smallest block is 3800 m^2), including 671 plots and 730 buildings.

Rua de Costa Cabral was built in the middle of the nineteenth century as an alternative to an older and narrower street, *Rua do Lindo Vale*, which is part of the western boundary of the study area. The area contains considerable morphological variety, including continuous building frontages, broken frontages of single-family housing and areas of isolated buildings.

[15]This subsection draws on the paper 'A comparative study of urban form' published in the journal 'Urban Morphology' (Oliveira et al. 2015).

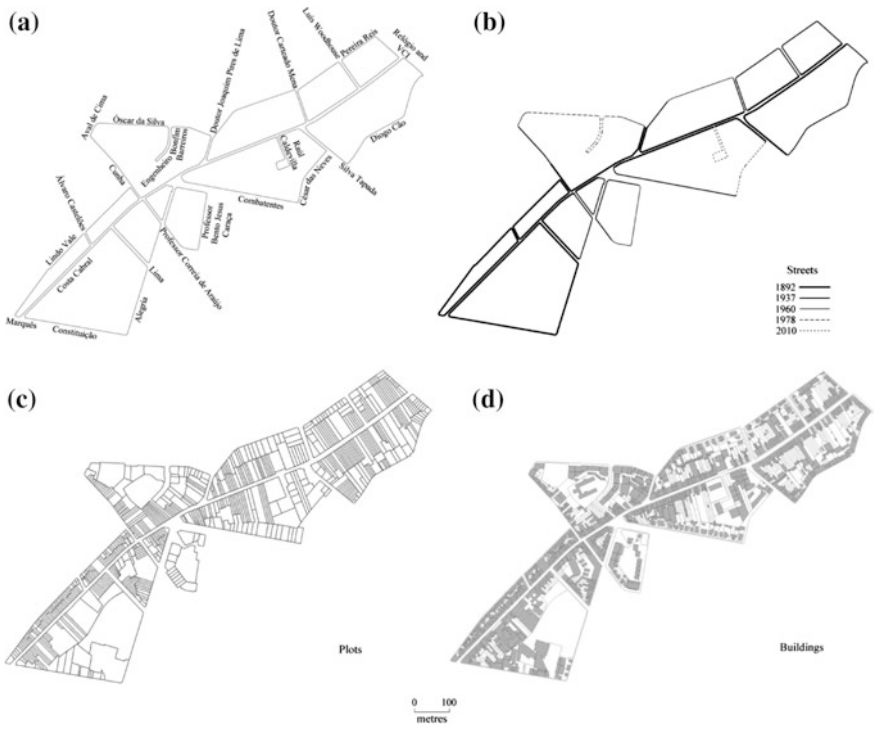

Fig. 6.16 *Rua de Costa Cabral*, Porto: **a** and **b** streets, **c** plots and **d** buildings. **b** Displays the year of construction of each street according to the main city plans (*Source* Oliveira et al. 2015)

Morphological region (historico-geographical approach)

The starting point for the identification of morphological regions is the historico-geographical structure of the landscape. It is a dynamic, rather than a static, approach to the urban landscape. In the case of Porto, the earliest plan was that of 1892. Subsequently nine other plans have been prepared of the city (1903, 1932, 1937, 1948, 1960, 1978, 1992, 1997 and 2010). The analysis draws on this set of plans, on archival documentation and on field survey, to understand the development process of these streets, plots and buildings, both within and around the study area.

The identification of boundaries within the study area is in some respects made more difficult by the elongated shape of the area, which was influenced by the need to delimit an area of practicable dimensions. One consequence of this is that some regions are in fact parts of regions that would extend beyond the study area. The elongated shape does, of course, also affect the other three approaches employed (process typological, space syntax and spatial analytical).

A four-tier hierarchy of regions was identified. The identification of the main regions (order 1) is based on the ground plan (see Table 6.2 for the contribution of different morphological attributes to urban landscape characterization). It takes into

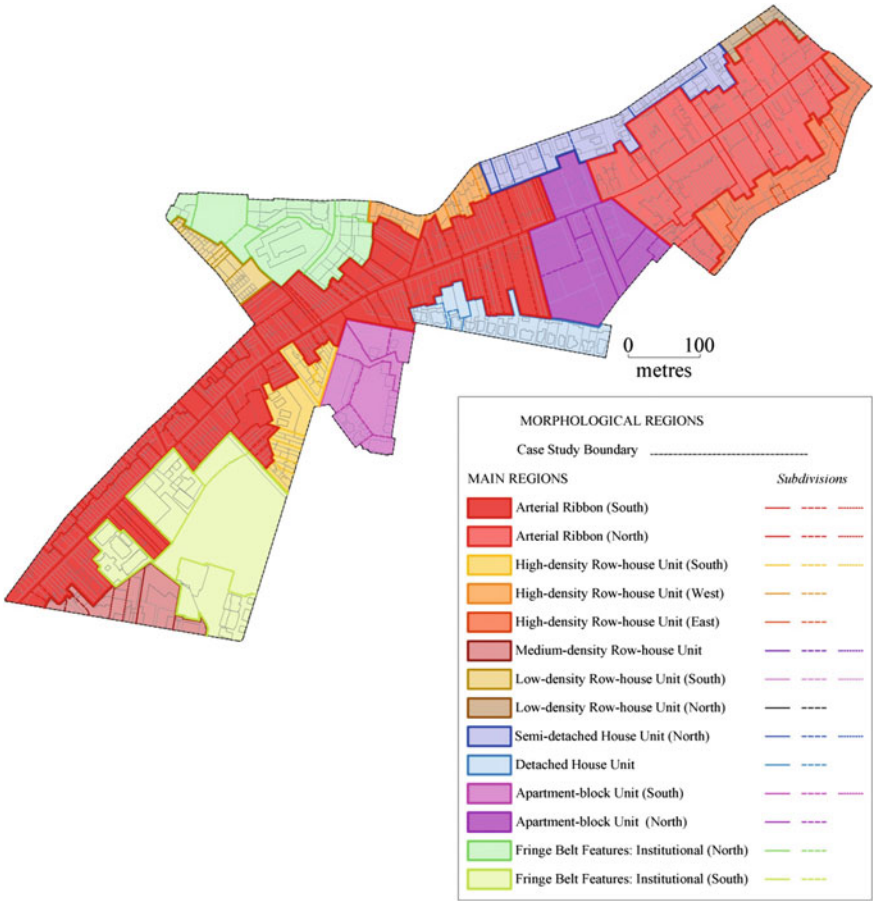

Fig. 6.17 The morphological regions of *Rua de Costa Cabral*, Porto (*Source* Oliveira et al. 2015)

account the form and age of the street, the type of plots, the building block-plans, and the position that buildings occupy in their plots. The ground plan also contributes to the identification of regions of intermediate rank. The criteria for the identification of the second- and third-order regions are the ground plan, the building fabric and, to a lesser extent, the land utilization. The appraisal of the building fabric includes the age of buildings and their volume (particularly their height).

Fourteen first-order morphological regions were identified (Figs. 6.17 and 6.18): (i) two stretches of Arterial Ribbon (north and south); (ii) three High-density Row-house Units, one Medium-density Row-house Unit and two Low-density Row-house Units; (iii) one Semi-detached House Unit; (iv) one Detached House Unit; (v) two Apartment-block Units; and, finally, (vi) two Fringe-Belt features (institutional). While all these morphological regions contain second- and third-order subdivisions, half of them also contain fourth-order subdivisions.

Fig. 6.18 Morphological regions in *Rua de Costa Cabral*: **a** Arterial Ribbon (*North*); **b** High-density Row-house Unit *East*); **c** Semi-detached House Unit; **d** Detached House Unit; **e** Apartment-block Unit (*North*); **f** Fringe-Belt Features: Institutional (*Source* Oliveira et al. 2015)

Let us focus on one of the fourteen first-order morphological regions, the Apartment-block Unit North, comprising nineteen plots. This region clearly separates the arterial ribbon into two regions. The construction of an apartment block in 1955 introduced a rupture in the urban landscape—a new relation between building and street, and a new position of the building within the plot (Fig. 6.18e). Some decades later, a cul-de-sac was built adjacent to this plot. The Apartment-block Unit North comprises five second-order regions. The main criteria for this division are the ground plan and the building fabric. Finally, three of these second-order regions include third-order regions.

Typological process (process typological approach)
The starting point for the identification of the main residential building types in the study area was an analysis of existing residential buildings, mainly based on field survey and cartographic analysis. A set of examples of each type was then studied, including the internal organization of rooms and spaces.

The main differences between the buildings in the study area are: (i) the position that each building occupies within its plot and its relation to adjacent buildings; and (ii) the size and shape of the plot. Particularly in the case of terraced- and row-houses, the width of the plot is fundamental. Figure 6.19 distinguishes between narrow plot frontages in which the plot width is less than 5 m and the façade of the building includes two 'bays' (two doors or one door and one window in the ground floor; two windows in the upper floors—Fig. 2.12a in the second chapter of the book); medium plot frontage and wide plot frontage (more than 10 m).

The two oldest street blocks in the study area, facing *Rua do Lindo Vale*, include one shallow narrow-frontage plot (type 1 in Fig. 6.19) and a number of shallow medium-width plots with buildings of one façade only, including three bays (type 2). The staircases of these buildings, some of which have only one room per floor, are located near the door, perpendicular to the street, or at the rear of the building, parallel to the street. Sometimes, in the oldest areas of Porto, the street blocks have limited depth and plots have frontages facing two different streets. According to Barata (1996) this has led to a fundamental change in the internal organization of houses: the sequence *room* + *stair* is replaced by the sequence *room* + *stair* + *room*, with the stair being located in the middle of the plot parallel to the street (type 3). The new sequence, sometimes with a private backyard, implied the existence of longer plots, but not wider. For example the transformation of type 1b (*room* + *stair*) into type 3 (*room* + *stair* + *room*) took place in plots of similar width.

The first column of Fig. 6.19 refers to single-family houses. The majority of these were built in the early decades of the twentieth century. Single-family terraced, semi-detached and detached buildings share certain characteristics. The sequence *room(s)* + *stair* + *room(s)* is dominant: extra rooms, *alcovas* (with no daylight), are sometimes included. Type 4 is an evolution from type 2 (in a longer plot) and of type 3 (in a wider plot). While the ground floor of some buildings is at street level, in other cases (type 4—Fig. 2.12b, type 5—Fig. 2.12c) the house floor is about 1–1.5 m above street level and there is a basement area. Type 5 is an evolution from type 4, including five bays and a new central location of the door, which allows a new organization of rooms and spaces based on a central corridor. Type 6a is an evolution from type 5, maintaining the door in the centre of the façade and introducing a second door at the side. Type 6b has a single door, at the side. In some of these single-family buildings there is commercial use on the ground floor. In these cases a staircase leads to the first floor where the sequence *room (s)* + *stair* + *room(s)* is common. Types 7a and 7b are the detached houses. They share some characteristics but they have different architectural languages, and 7b is smaller than 7a; usually the façade of the former is set back from the plot boundary.

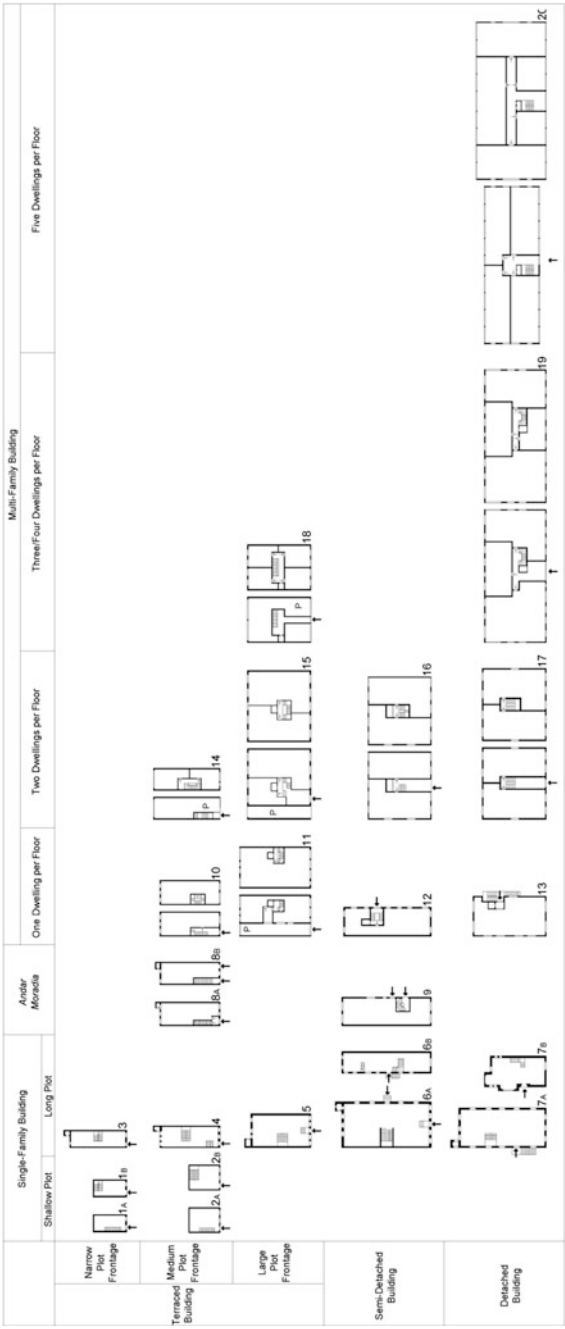

Fig. 6.19 The typological process in *Rua de Costa Cabral*, Porto (*Source* Oliveira et al. 2015)

The transition from single- to multifamily buildings is evident in the *andar-moradia*, a two storey building with two dwellings—one dwelling per floor. Types 8a and 8b draw on type 4. In the first case, the street façade has only one door (as in type 4) and the access to each dwelling is through a common space inside the building. In the second case, the street façade has two doors, one for each dwelling. The staircase of the upper dwelling is perpendicular to the street. Despite its nature, as part of the transformation process from single-family building to multifamily building, the construction of the *andar-moradia* continued over the twentieth century, as in the case of type 9 (drawing on two types, 6 and 8).

From the 1940s onwards a large number of multifamily buildings started to be built in the study area and in other parts of the city. The first buildings were erected in the plots of demolished single-family houses. This occurred in plots with both wide and medium-width frontages (types 11 and 10). In a first phase of development the new buildings contained one dwelling per floor, sharing some characteristics of the *andar-moradia* (types 8 and 9). In a second stage they contained two dwellings per floor—front and rear (sometimes with commerce on the ground floor) in the case of medium-width plots (type 14); left and right, in the case of wide plot frontages (type 15). In plots with wide frontages, there were three or four dwellings per floor (type 18). Influenced by the commercial nature of the study area, many of the new buildings included a commercial use on the ground floor. In the later buildings of this type the staircase was not on the peripheral wall but at the centre of the building.

Semi-detached multifamily buildings did not undergo a significant change over time. However, particularly after the 1970s, a new system of vertical access—a gallery—was introduced allowing a larger number of dwellings per floor (type 20). A comparison between the width of the building frontages of type 20 and type 1 shows that the former is almost ten times wider than the latter.

Over the second half of the twentieth century and in the early years of the twenty-first century there was a decrease in commercial use of the ground floor and increased construction of parking spaces underground and on the ground floor.

Spatial configuration (space syntax)

The Porto axial map of 2010 comprises 4290 axial lines (Fig. 6.20i). The average global integration in the map is 0.745. Four of the streets included in the case study are among the 20 most integrated streets in the city: *Rua da Constituição* (the most integrated street of Porto), *Rua Bento Jesus Caraça*/*Rua Santos Pousada*, both on the boundary of the study area; and *Rua da Alegria* and *Rua de Costa Cabral* (decreasing in integration from south to north, Fig. 6.20j). All streets in the study area have an integration level that is above the average integration for the city. The average local integration in the city is 1.725. While *Rua da Constituição*, *Rua Bento Jesus Caraça* and *Rua da Alegria* maintain their importance at the local scale, *Rua de Costa Cabral* has less significance at that scale. Most of the streets included in the case study, except the two culs-de-sac, have above average local integration for the city. Finally, the average connectivity in the city is 3.598. As in the case of local integration, *Rua da Constituição*, *Rua Bento Jesus Caraça* and *Rua da Alegria* have

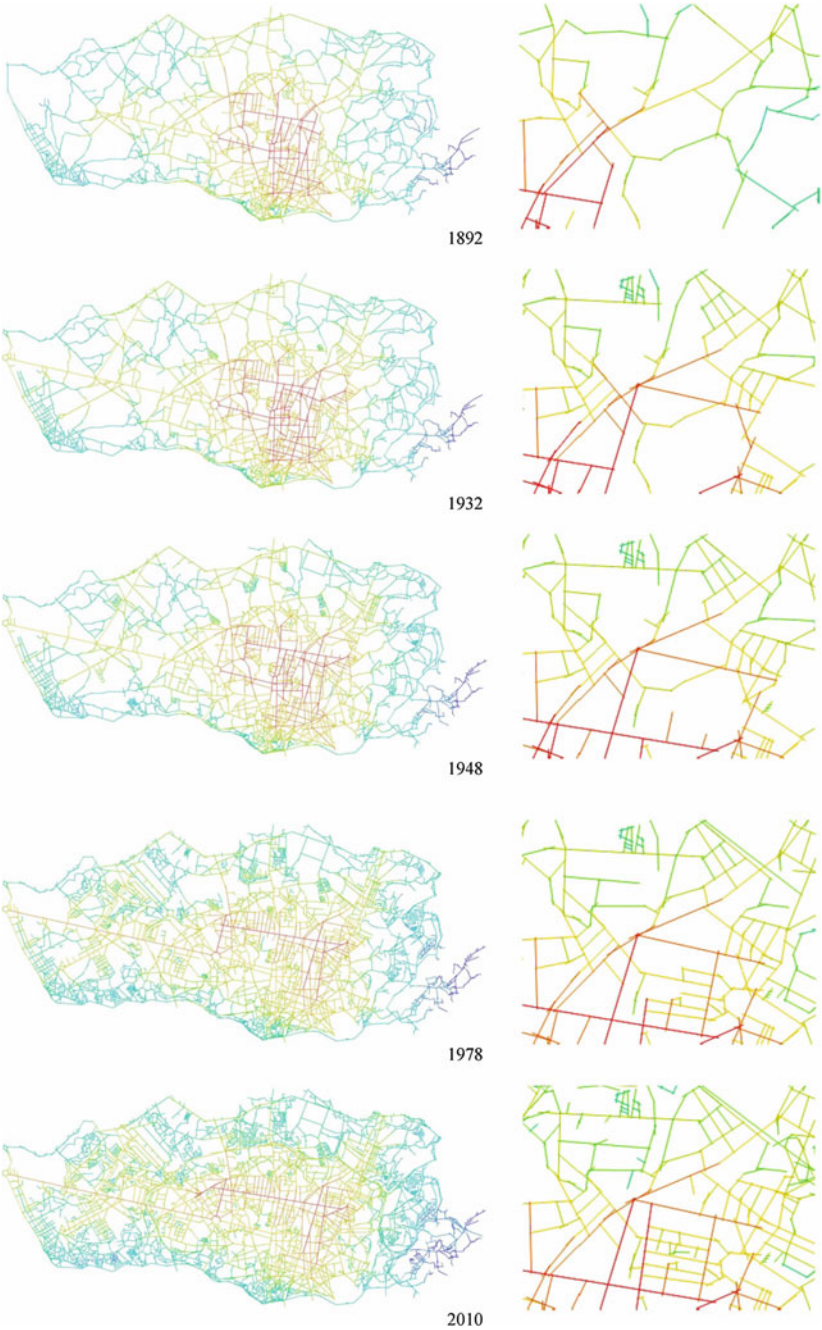

Fig. 6.20 The axial map of Porto: global integration 1892, 1932, 1948, 1978 and 2010—the city and the study area (*Source* Oliveira et al. 2015)

high values of connectivity. Eight streets from the set of 22 streets included in the study area are below the average connectivity for the city, including the two culs-de-sac, three small streets, and three longer streets defining larger street blocks.

In 1892, the integration core (the set of most integrated lines) comprised a number of axes extending from the city centre to *Rua da Constituição* in the north (Fig. 6.20a). Over subsequent decades, that core moved steadily away from the city centre. In 2010, it developed around *Rua da Constituição* and a set of north-south axes linked that road. Thus, the values for global integration, local integration and connectivity have been continuously increasing in the period examined.

The values for global integration in the study area have been continuously above the average global integration of the city, and the values for the structuring axes of this area (*Rua da Constituição*, *Rua da Alegria*, *Rua de Costa Cabral* and *Rua da Lindo Vale*) have been increasing. However, the integration of some streets in the city, for example *Rua da Lindo Vale*, is not as high as it has been in the past.

Angular Segment Analysis was also applied to the study area. The analysis of the Porto segment map comprised integration and choice/betweenness, using metric radius at different scales—micro, meso and macro. The average choice for Porto—irrespective of which metric radius is selected—has been steadily decreasing from 1892 to 2010. Integration follows the same general trend. Three findings of a refined view of the structuring axis of the study area are: first, the three segments of *Rua da Constituição* have different values (*Praça do Marquês* divides the street into two parts); second, the segments of *Rua da Alegria* and *Rua Bento Jesus Caraça* have different values when analyzed according to integration (the segment as a destination) and choice (the segment as part of a path); and third, the southern part of the street of *Rua de Costa Cabral* that is included in the study area (between *Praça do Marquês* and *Rua Silva Tapada*) has higher values than the northern part.

The cell (cellular automata)

The modified CA model (Partanen 2012) applied in *Rua de Costa Cabral* focuses on land and building utilization. It has been modified to incorporate complex transformation rules, quantitatively and qualitatively defined cell states, and cells of irregular shape (the plots). The model has two main premises: (i) similar uses attract each other; and (ii) cyclically, each plot is gradually filled, the building is eventually demolished and the transition cycle of rebuilding, filling up and demolishing the building starts again. The degree of preference for proximity between activities is defined by a preference matrix. The preference matrix acts as a user interface—the user can change the values, and observe the impact of different values on simulation. Hence, it is possible to assess how different planning decisions affect the pattern formation and how the model operates over time. For example, the user can explore the planning decisions and how the model responds if certain activities are allowed to be located closer to each other (higher matrix values), or further apart (lower values). The values are not of an absolute nature but relative to each other (Partanen 2012). In each case, the surrounding cells (within 10 m) form the neighbourhood of a cell.

The application of the model in this case focused exclusively on the plots facing *Rua de Costa Cabral*. The definition of the 'neighbourhood' led to the inclusion of all other plots of the study area and a set of plots that were not studied in the other three approaches presented in this subsection. The model draws on the existing floor area (FA) for housing, retailing, services, industry and warehousing in each of the plots and on the floor area allowed by the plan in force.

Owing to the physical characteristics of the study area (particularly the narrow plots), and the fact that the distance selected to define which plots were considered to be neighbours was only 10 m, each cell has many neighbours, producing a complex network of relations. Another important characteristic of the area is that some of the activities are evenly distributed, creating a diverse combination of actors and volume of activities. A set of 262 plots (38.5 % of the total) were defined as static, that is they were not allowed to change during the iterations but they influence the state of other plots.

Three major scenarios of future development were explored: (i) emphasizing housing, with various values; (ii) stressing the proximity preferences between different working places (retailing, services and industry); and (iii) emphasizing the proximity of housing and ancillary activities (retailing and services). Different simulations of approximately 250 iterations were developed, each producing a separate data set for each activity. The dynamic states were analyzed according to the direction of change in the total FA (calculating how many time steps occur before the increasing trend in the FA changes into a decreasing trend). The self-organizing patterns in the FA dynamics of all land and building uses were analyzed and compared graphically.

The analysis of FA dynamics (increase or decrease) revealed complex states and periodicities. In some states the range of change was very small (a total of 1–4 m^2) and these were considered static. However, contrary to previous findings (Partanen 2012), the correlation between weight values in the matrix and the dynamics was not clear; neither were the states of the plot (changes in the building rate over time), which were mostly mixed (periodic and complex). In relation to the overall pattern formation, distinct patterns were found. For example, dynamic pulses of large frequency oscillation with various lengths; discontinuous, repeatedly emerging phases of linear growth; twofold exponential growth; and apparently disorderly oscillation between periodic and stochastic phases. In relation to the transition dynamics, a reduced systematic dependence was found between the patterns and the matrix values—the system could result in either patterned or apparently random dynamics with the same matrix values for each activity. Overall, the dynamics were extremely diverse and unpredictable. The actual patterns (linear or exponential) are in this case secondary. In the model, the urban form characteristics seem to have influenced the activity locations in more unpredictable ways than expected, since the random effect of activity location was eliminated in the model. New activities emerged only based on previous activities close to similar ones, and the model did not locate the new uses randomly (which might be the case in reality). These findings need more thorough investigation as a basis for further generalization.

The application of CA revealed the influence of urban form, particularly plots, on the speed at which the utilization of land for different purposes changes over time. The spatial organization of the study area was reflected in the CA model in an unpredictable way: the system produced highly organized structures, but the correlation between given weight factors and resulting transitions of the urban system was not as clear as in a previous application of the model (Partanen 2012). The patterns were influenced by the high number of connections between activities.

Discussion

The main points of contact between the four concepts examined in this subsection are threefold (Table 6.4): elements of urban form (the most important class), levels of resolution, and time. The concept of the morphological region shares with the cell the emphasis on the ground plan, particularly on plots and land utilization. Indeed, plots and land utilization are two fundamental elements for the identification of morphological regions at all ranks, and are the basis for the development of the cellular matrices. In contrast, the two concepts have different conceptions of time: in the former, history has a fundamental role in the description and explanation of the urban landscape; in the latter, the main concern is with anticipating future scenarios of urban development. In respect of the local scale of analysis undertaken in this subsection, the concept of the morphological region would seem to be more appropriate.

The emphasis on ground plan is shared by the concepts of the morphological region and spatial configuration. Streets are an essential element for the identification of regions of high and intermediate rank, and streets alone are the basis for the recognition of high accessibility. As in the case of the morphological region and the cell, these two concepts seem to have different levels of resolution and different conceptions of time.

Table 6.4 The main points of contact between the different concepts (*Source* Oliveira et al. 2015)

	Cell	***Spatial Configuration***	***Typological Process***
Morphological Region	**Form**: ground plan (plots) and land utilization	**Form**: ground plan (streets)	**Form**: ground plan (buildings) and building fabric **Resolution**: small- to large-scale analysis **Time**: importance of history
Typological Process			
Spatial Configuration	**Resolution**: medium- to large-scale analysis **Time**: anticipation of future scenarios		

Of the four concepts, those of the morphological region and the typological process seem to have the strongest inter-relation. Buildings are the most consistent link. The typological process draws on the building fabric as a whole to reveal the fundamental building types, the main relations between them and how they evolve over time. The block-plans of buildings (two-dimensional) and the building fabric (three-dimensional) are crucial for the identification of morphological regions at all scales. The two concepts share a similar level of resolution, from the small- to the medium-scale of analysis. In the process typological approach, a number of concepts and methods have been developed to deal with certain morphological aspects at a large-scale of analysis. The two concepts share a particular conception of time in which history offers a sense of continuity in the production of urban forms.

The most fragile relations in this set can be found between the typological process and the cell, and between the typological process and spatial configuration. While it could be that buildings might offer a link between these concepts, the way they are dealt with in the three approaches is considerably different and would seem to preclude the establishment of any effective relation.

Though not explored in this study, the concepts of spatial configuration and the cell share a similar level of resolution, from the medium- to the large-scale of analysis. They also share the same conception of time, anticipating and testing different alternatives for the development of urban areas. But, the two concepts have no common ground in respect of elements of urban form.

A co-ordinating framework

The analysis of existing relations suggests that the concept of the morphological region may have the necessary characteristics to provide a framework to combine and coordinate the different concepts. For Conzen the morphological region was not 'only' a concept—meaning 'an area with a unity in respect of its form that distinguishes it from surrounding areas'—but also the integration of the physical development of an urban area. It united the tripartite division of the urban landscape (town plan, building fabric, and land and building utilization), and it brought together the main concepts that he developed about the process of urban development.

The main purpose of this framework is to analyze, in the most effective way, the physical form of a given urban area. Owing to the nature of each concept and the results that it offers, a sequential application of the four concepts is defended: (i) morphological region, (ii) spatial configuration, (iii) typological process and (iv) cell.

The application of the concept of the morphological region provides a number of results related to the historico-geographical structure of the landscape. The results for each street are mainly concerned with its morphogenesis and the plots and buildings expressing it. However, the application of spatial configuration reveals something that the morphological region does not: the 'accessibility' of each street within the urban system. It might be expected that a higher density of streets, plots and buildings would correspond to a higher accessibility of streets. Although the case study confirms this general relationship, it also reveals exceptions—for

instance, the Detached House Unit, has a low density but is located in *Avenida dos Combatentes* (Fig. 6.18d) which has high accessibility.

Clearly, the results provided by the application of the two concepts are different in nature. If the purpose of the application is not only description and explanation but also prescription, the two concepts both offer important outputs. The morphological region facilitates the definition of rules for the future transformation of the main elements of urban form. Spatial configuration allows the testing of different alternatives for transformation of the street system. The two concepts can be combined in formulating proposals for the development of that street system.

Application of the typological process offers a set of results on building types and their evolution over time. Though this type of output is clearly distinguishable from that provided by the spatial configuration concept, it has a strong relationship to the results obtained by applying the morphological region concept. The *Avenida dos Combatentes* corresponds to a Detached House Unit, including nineteen plots and nineteen buildings. A typological reading of this area revealed the existence of four different types (6b, 7b, 13 and 17) that explain, to a large extent, the different intermediate-rank regions. But it also revealed the typological evolutions leading to the definition of these types. This kind of information can, as in the case of spatial configuration, inform the fine-tuning of a boundary of an intermediate-rank region. If the purpose is prescription, the application of the typological process can, in combination with morphological region delimitations, inform rules for the future transformation of buildings.

Finally, the application of the concept of the cell offers valuable information on the dynamics of land and building utilization. Its insights can contribute to rules for the future transformation of urban functions.

Developing comparative studies of different approaches in urban morphology is a challenging task. The application of four approaches to a study area in Porto seems to suggest the concept of the morphological region as a co-ordinating framework. The main points of contact between the different approaches have been identified and a general methodological procedure has been outlined, but further work is needed to develop this line of investigation. A number of questions arise. First, would some other morphological concept be relevant for the purposes of comparison and co-ordination? Second, would it be pertinent to explore a different focus within some of the concepts (exploring, for example, a focus on buildings, within the concepts of spatial configuration and the cell)? Third, how can this methodological process be developed, enabling a stronger interaction between concepts and developing the interactive capacity of the morphological region? Fourthly, what are the most effective ways to present the results of such an integrated analysis and design? Future research should help to provide answers to these questions and continue to inform the construction of an integrated framework to better describe, explain and prescribe the physical form of cities.

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Chapter 7
From Theory to Practice

Abstract The seventh chapter focuses on a fundamental issue for the field of urban morphology that has been receiving increased attention in literature, the passage from description and explanation of the morphological phenomena to the definition of prescriptive guidelines for the production of new urban forms. Two eminently practical activities that can benefit from morphological support are identified: urban planning and architecture. While the first is a potential receptor of morphological theories, concepts and methods developed for the city scale, the second would be informed by morphological approaches developed for the building scale.

Keywords Architecture · Building typology · Theory and practice · Urban morphology · Urban planning

7.1 Urban Morphology and Planning[1]

Although it would be expectable that planning practice (in a broad sense) would be informed by the latest advances in the science of urban form, the truth is that the two fields have been developing back-to-back. This chapter addresses the gap between urban morphology and planning and reflects on the necessary steps for an effective disciplinary approach. This reflection draws on the analysis of three cases of application of urban morphological theories, concepts and methods into professional planning practice. The selection of these cases was based on a set of criteria corresponding to a diversity of: (i) approaches, (ii) time periods in which they were developed, and (iii) countries and planning systems in which they were applied.

Over the last years the relationship between research on urban morphology and planning practice has attained a significant role in the international debate on urban form. Among other events and developments, this relationship attracted the

[1]This section amplifies the paper *Morfologia urbana: investigação científica e prática profissional* (in Portuguese language) published in the journal *A Obra Nasce*, in 2014 (Oliveira 2014).

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attention of a special issue of the journal 'Built Environment' in 2011, a significant number of 'viewpoints' included in the journal 'Urban Morphology' and, more significant, an ISUF Task Force dedicated exclusively to this issue (Samuels 2013).

And yet, despite the recent interest, this is an issue with a long tradition within the different morphological approaches. In the process typological approach (Cataldi et al. 2002), one of the most notable cases was developed by Muratori in the late 1950s. In 1959, Muratori applied the results of his research on the urban history of Venice, in particular on the three fundamental historical tissues of this unique Italian city, in the competition for *Barene di San Giuliano*. The result was a set of proposals in a clear continuity with the urban history of the city (this case will be developed in the next section).

Within the historico-geographical approach, based on Conzen's work, two concepts have been consistently applied. The concept of 'morphological region' has been applied in a plan for Barnt Green (Whitehand 2009) and in a study for a residential area in Stratford-on-Avon (Larkham et al. 2005). Based on similar principles, the 'urban tissue' has been applied in a number of plans for French cities —including Saint-Gervais-les-Bains (Samuels 1999) and Rennes—and in a series of design guides and 'supplementary planning guidance' for some English cities including Stratford-on-Avon and Rotherham. The application of the morphological region and the urban tissue concepts demonstrated the advantages of building a zoning proposal based on form and not on land use, as it happens in most cases where this planning tool is used. The second concept explored in professional practice is the 'fringe belt'. Kropf (2001) describes its application in the design guide for Stratford-on-Avon. This application demonstrated the importance, for the planning process, of the conservation of key elements of the geographical and historical structure of a city. In addition, Hall (2008) presents the contribution of urban morphology for day-to-day development control, and to the set of incremental decisions that shape urban areas, in the English town of Chelmsford.

This chapter aims at realizing the potential contribution of urban morphology to practice planning. The reflection draws on the analysis of three cases which are presented in the following sections. We have tried to select a set of cases holding a sound diversity in terms of the approach (from process typological to space syntax), of the time period in which the approach is developed (from the 1950s onwards) and of the planning system (more or less flexible, more or less discretionary) that frames its application. The selected cases are: the plan for *Barene di San Giuliano* (Venice, Italy) by Saverio Muratori, framed by the process typological approach, developed in the late 1950s; the plan for *Asnieres-sur-Oise* (France), by Ivor Samuels and Karl Kropf, framed by the historico-geographical approach, prepared in the early 1990s; and the plans for Jeddah (Saudi Arabia), by Space Syntax Limited (coordinated by Kayvan Karimi), framed by the configurational approach the past 15 years.

7.1.1 *The Plan for the* Barene Di San Giuliano *by Saverio Muratori*

In the year of the publication of the seminal book *Studi per una operante storia urbana di Venezia*, Muratori had the opportunity to apply the results of his morphological research in a planning competition for an area located north-east of historical Venice, between the lagoon and mainland settlements—the area of *San Giuliano* (Fig. 7.1). The competition programme defined the creation of a new city for about 40,000 inhabitants including a set of functions characteristics of a modern city that were difficult to locate within the historical centre of Venice.

In this competition, Muratori applied the 'designing in stages' methodology (for a detailed description of the methodology see Cataldi 1998 and Maretto 2013). He prepared, not one single final proposal but, as many proposals as there are stages of urban growth constituting the history of Venice—in this case, three stages and therefore three proposals. Each of the three proposals adopted the designation of *Estuario* (Estuary) and it was a structural reinterpretation (not a copy or a 'pastiche' of the architectural language of the past, as many postmodern architects would do some years later) of the tenth and eleventh century Venice, of the Gothic period and of the Renaissance period, respectively. Muratori won the competition with *Estuario III* and received an honourable mention with *Estuario I*. The second prize was given to Ludovico Quaroni, with whom Muratori had worked in the 1930s.

Estuary I (Fig. 7.2) is an interpretation of Venice in the tenth and eleventh centuries (at a time when the dominant urban development layout was a square

Fig. 7.1 *Barene di San Giuliano* (**a**) and 'historical Venice' (**b**) (*Source* Google Earth)

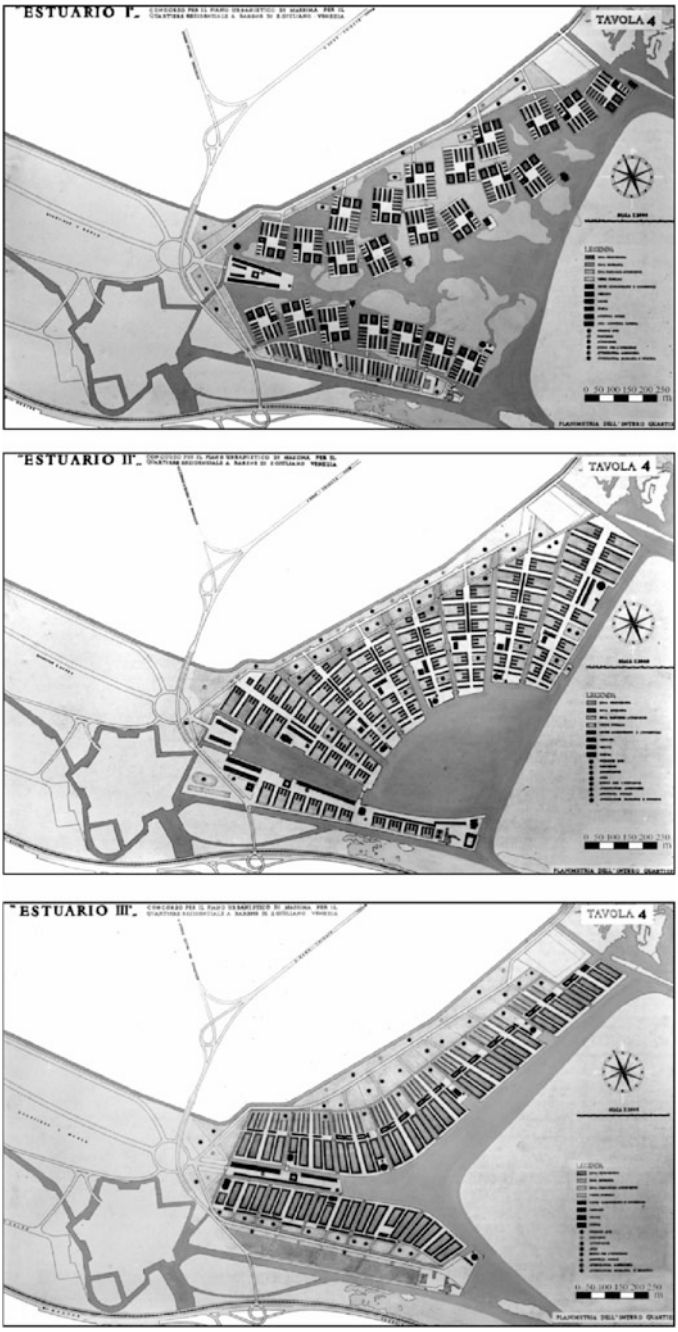

Fig. 7.2 The *Barene di San Giuliano* in Venice: Estuaries I, II and III (*Source* Maretto 2013)

centrally located within a group of islands, with a clear predominance of waterways over land routes), corresponding to a city structured in a number of neighbourhoods comprised of islands linked to one another and to the mainland by bridges, and constituting self-contained units laid out along both banks of the *San Giuliano* estuary. Each island nucleus was a residential unit with an area of about 33,000 m^2.

Estuary II is an interpretation of Gothic Venice (with an urban organization in a comb shape and with a balance between canals and vehicular axes laid out in parallel) proposing a set of self-sufficient neighbourhoods comprised of peninsulas (for about 10,000 inhabitants each) laid out around the lagoon basin with their axis converging. The plan consists of building units with courtyards orthogonal to their peninsula axes. It is composed of a single residential building type, with three storeys and an arcade ground floor.

Finally, Estuary III, the winning proposal, is an interpretation of Renaissance Venice (with a predominance of vehicular axes over the canals, and with a built occupation of the boundaries along the canals, thereby releasing the inner space for land routes) proposing an estuarine city laid out along two strips parallel to the two banks of the estuary, gradually opening towards the lagoon, with a view of Venice. A double pattern of canals (longitudinal and transverse) formed two series of flanking islands, which linked the features of the two preceding designs: the island system and the peninsular system. In addition, the presence of effective longitudinal links aided unity and continuity (Maretto 2013). Despite its quality, the plan (and in particular Estuary III) was not implemented and this area of the *Barene di San Giuliano* had no significant intervention until nowadays, as we can see in Fig. 7.1.

7.1.2 *The Plan for* Asnières-Sur-Oise *by Ivor Samuels and Karl Kropf*

On the turning to the 1990s, Ivor Samuels has coordinated an academic work of the Joint Centre for Urban Design, of the Oxford Polytechnic, in *Asnières-sur-Oise* (Fig. 7.3), a small French commune with a population of about 2400 inhabitants, located 35 km from Paris. One of the participants in this study was Karl Kropf whom in 1986 had completed his master thesis under the orientation of Samuels, and in 1993 would complete a doctoral thesis under the supervision of Jeremy Whitehand. In both theses, Kropf proposes a simplification of the Conzenian concept of 'morphological region' (as an area that has a unity in respect of its plan, building fabric and land utilization that distinguishes it from surrounding areas), and explores its relationships with the work developed by Caniggia. For Kropf (1993) the 'urban tissue' (close to the concept of morphological region) is an organic whole whose form can be described at different 'levels of resolution' (Fig. 7.4). The levels of resolution correspond to the different moments when the different elements of urban form can be identified in a typo-morphological analysis—the streets and street

Fig. 7.3 *Asniéres-sur-Oise* (*Source* Google Earth)

blocks, the plots, the buildings, the different types of rooms and spaces, the structures and, finally, the materials. These different elements are interrelated in a hierarchy, where elements of a lower scale combine to form elements of a higher scale. Using this hierarchy as a framework structure, urban tissues can be defined in a systematic way with different degrees of specificity, describing the elements that constitute them at different levels of resolution. Three specific characteristics can be used to describe each element, its 'position', its 'outline' (shape, size and proportions of the external boundaries of the element) and its 'internal arrangement' (type of component parts, number of parts and relative positions).

After concluding the academic work mentioned above, the team coordinated by Samuels was invited by the president of the local authority to prepare a new *Plan d' Occupation des Sols* (POS) to replace the 1987 POS. The main goal of the new POS was the maintenance of local identity (marked by a sound architectural heritage) avoiding the suburbanization processes that were occurring in the neighbouring municipalities around Paris (Mairie d'Asnieres-sur-Oise et al. 1992). The other objectives of the POS were: to regenerate the older districts and to reinforce the traditional shopping, to revitalize the abandoned industrial areas (with a mix of trade, services, industrial and residential uses) and to integrate the new residential estates with the rest of the settlement (Samuels 1993). In terms of material content, the POS consists essentially of a regulation, a zoning plan and a report. It is important to highlight that, compared with Saverio Muratori plan, the POS has a stronger intention of permanence than of innovation.

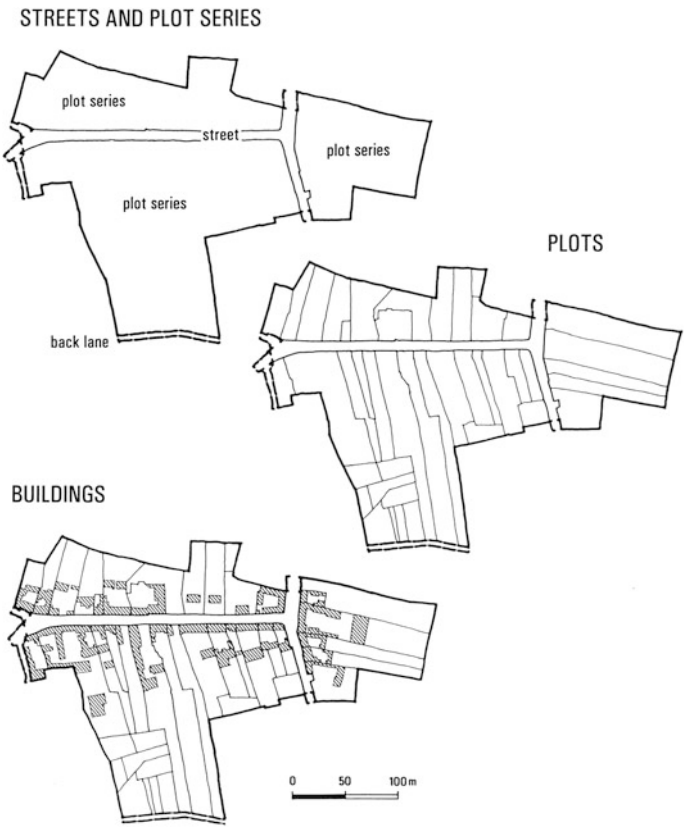

Fig. 7.4 An urban tissue shown at increasing levels of resolution (*Source* Kropf 1996)

Using the concepts of 'urban tissue' and of 'levels of resolution' the team divided the urban form of *Asnières* into six levels of resolution—the whole commune, districts, streets and blocks, plots, building form and elements of construction—which are the bases for both description/explanation and prescription. This means that the references for the new urban forms in each of the parts constituting the territory of *Asnières* are the existing forms in that specific part.

The approach involved a typo-morphological zoning—instead of the traditional functional separation—that lead to the identification of seven areas: four types of urban areas and three types of natural areas. For each zone a number of acceptable and unacceptable urban forms were illustrated—a tradition of the British design guides. There is a far more restricted range of choice at the lower levels of resolution than at the higher levels, which means that there is a greater choice of plot size and building arrangement than of window detail.

Figure 7.5 includes a set of drawings on the historical area known as *Le Village*. For this area of *Asnières*, the plan identifies four possible situations based on the

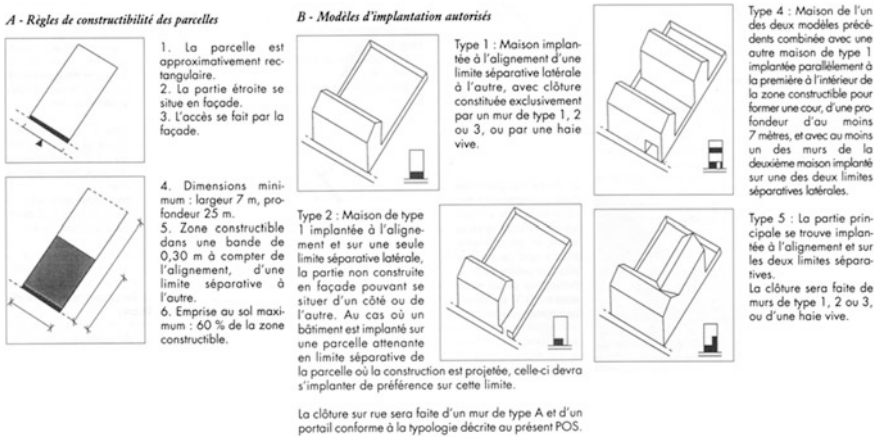

Fig. 7.5 The *Plan d' Occupation des Sols* of *Asniéres-sur-Oise*: *Le Village* (*Source* Mairie d'Asnières-sur-Oise et al. 1992)

'position' of the plot within the block: (i) the plot is located in the front area of the block, (ii) the plot is positioned in the lateral area of the block, (iii) the plot is located in the corners of the block and, finally, (iv) the plot is positioned in a set of exceptional corners identified by the plan. An analysis of the first case—plots located in the front area of the block as illustrated in Fig. 7.5—shows that the new plots will have an approximately rectangular shape with the narrow part of the rectangle in contact with the street, and containing the access to the interior of the plot. The plan indicates that the minimum dimensions of the new plots should be 7×25 m, defines a construction area from the front alignment occupying the whole width of the plot, and defines a maximum building coverage of 60 %. As for the position of the building within the plot, the POS allows four different possibilities: (i) one building located in the plot frontage occupying the whole plot width; (ii) one building located in the plot frontage occupying more than half the plot width, while a wall delimitates the rest of the plot frontage; (iii) one building located in the plot frontage occupying the whole plot width, allowing for a passage in the building ground floor, and one building (parallel to the first) located in the interior of the plot occupying the whole plot width; and, finally, (iv) one L-shape building with one of its parts located in the plot frontage occupying the whole plot width. Samuels (1993) highlights that the POS does not propose a model, but rather a series of choices at each level of resolution—a set of possible parts with instructions for their assemblage. The purpose of the plan is to promote a variety of responses in the levels of resolution where this should happen, ensuring the formal diversity of Asnières.

Five years after concluding the plan preparation stage, Samuels returned to *Asnières-sur-Oise* for an assessment of the plan implementation process (an unusual,

but crucial, procedure in planning practice). Based on a number of interviews to the main agents involved in this process, Samuels discusses a number of fundamental issues such as the need to build a stronger political consensus to support a morphological approach, to ensure the presence of a qualified team for the plan preparation and implementation, and to realize the degree of control of design of detail that is adequate to each specific situation (Samuels and Pattacini 1997).

7.1.3 The Plans for Jeddah by Space Syntax Limited

The issue of informal settlements (clearly different from the problems addressed in the plans by Muratori and by Samuels and Kropf) is a key challenge for planning in an increasing number of cities worldwide. Over the last years, space syntax has been developing research in this area demonstrating that the spatial configuration has a significant role in the gradual and endogenous improvement of informal settlements (Hillier et al. 2000; Karimi et al. 2007). Accordingly, space syntax has been proposing an approach that is based on the identification of the most integrated areas of these settlements and on the subsequent recommendation of a reduced number of physical interventions in these areas (promoting selectivity and efficiency) that would favour their articulation with the overall structure of the city, improving not only their own integration but also the integration of surrounding areas.

In the last decade, Space Syntax Limited[2] was hired by the municipality of Jeddah, Saudi Arabia, to design a strategic planning framework for the city, including a Strategic Plan, a Sub-Regional Plan, a Structural Plan and a set of Local Plans. Jeddah is a city of more than three million inhabitants (and the population is expected to double in the next two decades), located between the holy cities of Makkah and Medina that acts as an important commercial hub for the entire Red Sea region. There are around 50 informal settlements in Jeddah with an estimated population of one million inhabitants. It is therefore an absolutely different reality of the two European cities presented in the two previous sections.

The intervention of the Space Syntax Limited—coordinated by Kayvan Karimi—began with a diagnosis of the city, using axial analysis to understand how the city evolution over time led to current patterns of density, land use and the main socio-economic characteristics of this city. Then, the spatial reasons that seem to support the main barriers to the development of an effective social cohesion were identified. It was found that unplanned areas come out as areas with high measures of local choice while the citywide super grid, underlined by higher values of global integration, run outside these areas, even the ones that are located in the most central parts of the city. In sharp contrast, these areas develop a very distinct local structure,

[2]Space Syntax Limited is a spin-off company of University College London (UCL) that has been established to utilize UCL's research in providing consultancy for real-life projects.

Fig. 7.6 Jeddah: **A** historical centre, **B** informal settlements, **C** former area of the airport and **D** waterfront (*Source* Google Earth)

which is captured by syntactic analysis at a lower metric radius but this structure does not fit into the spatial structure beyond the boundaries of the unplanned settlement (Karimi and Parham 2012).

Finally, the proposal of Space Syntax Limited includes three urban scenarios and recommends a set of intervention areas comprising the historical centre (about 1 Km^2), a number of informal settlements (with a significant size in the city and with a key role separating the historical centre from the rest of the city), a set of central areas, a former area of the airport and a waterfront (Fig. 7.6). Space Syntax Limited therefore uses the urban space (streets and squares, in the broad sense of the words) as a mechanism to minimize the segregation of a part of the population that is extremely poor.

One of the fundamental contributions of this proposal is the way it deals with the informal settlements of Jeddah. One of the key aspects of space syntax is that it constitutes a theory and an analytical methodology, but it does not impose an urban layout. On the contrary, it helps to enhance the qualities (in order to create a higher spatial accessibility and therefore a higher social interaction) of the specific layout of each city. As such, the proposal for the informal settlements tried to identify the most integrated axes of the local structure and then to enhance its articulation with the overall structure of the city (Fig. 7.7).

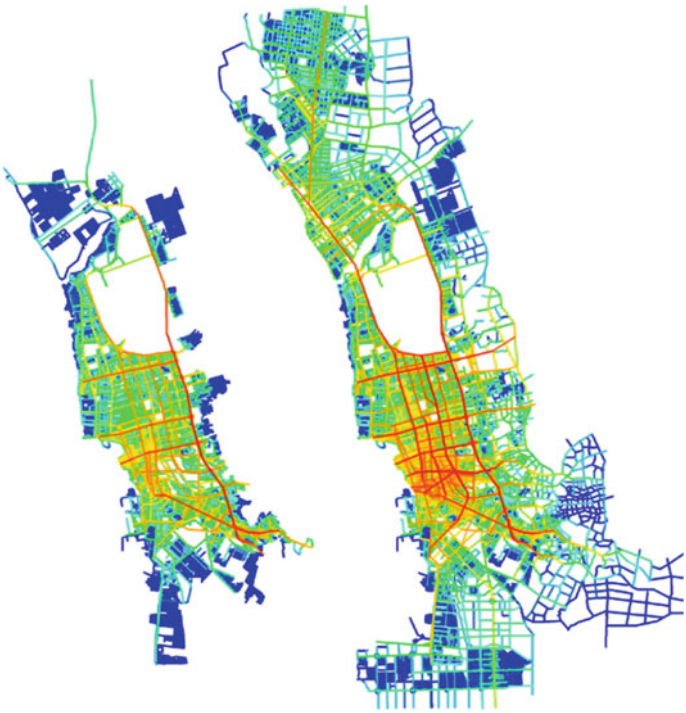

Fig. 7.7 The axial map of Jeddah: alternative scenarios (*Source* Karimi 2012)

7.1.4 Towards Integration

As we have seen in the three previous sections there is, indeed, a link between research on urban morphology and professional planning practice. This relationship exists in different morphological approaches, in different time periods and in different planning systems. However, this relationship is marginal to mainstream planning practice. Indeed, there is a long way to go towards a wider utilization of theories, concepts and methods of the science of urban form into day-to-day planning practice and development control.

This gap between theory and practice does not differ much of what goes on in social sciences and humanities. Although it should be that urban morphology is one of the disciplines feeding planning, in practice urban morphology and mainstream planning exist in largely separate worlds. This is somehow institutionalized and it is expressed in a context marked by organizations that are almost exclusively dedicated to research and education, and organizations that are almost exclusively dedicated to practice, in public or private sectors. In addition, it seems evident that the different approaches and models provided by planning theory in recent decades, despite their usefulness in relation to other professional issues, have not helped in coping with the physical dimension of cities. This means that the reduced channel

of communication between the two activities, urban morphology and planning, and the reduced support effectively offered by urban morphology, were not balanced by planning theory inputs.

Another element that weakens this relationship is the tendency of knowledge towards specialization, something that is common in many disciplines. In a very compartmentalized knowledge structure, the ability to identify relationships with both practice and other research areas is significantly reduced. Four aspects help to explain this phenomenon: a lesser dominance of the English language in urban morphology compared with the physical sciences (making more difficult a global communication); the tendency for researchers to investigate urban form within their own country, usually going along with the tendency for these individual studies to be weekly connected with one another; the fact that researchers do not properly explore the existing channels of communication to present the results of their investigation demonstrating their relevance to contemporary cities and societies; and, finally, the fact that the different disciplines converging in urban morphology (architecture, geography, history, to name the most important) do not prepare their students to build bridges between different areas of knowledge (Whitehand 2010). Against this background, the fundamental challenge is to find a balance between two different poles that will always exist—integration and specialization. It is important to remember that science focuses, primarily, on what is invariant in the universe, and that its purpose is necessarily specialized, rather than worrying on how the different phenomena taking place on the surface of the Earth are related to each other to create the different urban environments where people live in (Whitehand 2006).

This relationship is also weakened by the fact that different morphological approaches are, apparently, scientific in analysis but not in prescription. In fact, over more than one century, urban morphology has developed a number of theories, concepts and methods that can describe and explain, with a high accuracy, the dynamics of urban form. This rigorous description and explanation is able to provide a number of prescriptive guidelines and recommendations. However, there will always be a particular moment in this passage from explanation to prescription in which our own values, as professionals or politicians, will influence the decision-making and the selection for a particular alternative of urban form transformation.

The issue of resources—not only human and financial resources, but also the time factor—is also very relevant. The specific nature of research and of planning practice leads, almost inevitably, to a divergence in the main focus of these two activities (the extent of this divergence depends on the specific institutions involved). For instance, it is not likely that a particular planning department within a local authority would change its priorities and start devoting more resources to the design and development of a new analytical technique on urban morphology than to those that are allocated to the appraisal of licensing projects as part of the development control activity. It is therefore important to try to make the two activities more compatible. After evaluating the process of preparation and implementation of the plan for Asnières, Ivor Samuels has designed a new methodology for

morphological analysis and prescription that was far less consumer of human and financial resources applying it in *Saint-Gervais-les-Bains* in the end of the decade (Samuels 1999).

Finally, another aspect that has come to weaken the relationship between theory and practice is that a significant part of morphological research have focused on the historical centres and on small cities, as it is the case of *Asnières-sur-Oise*. Naturally, the conservation of built heritage will always be a fundamental concern for urban morphology, but there is no reason for the theories, concepts and methods that have been applied in these contexts would not be applied in the analysis and design of emerging urban forms. The truth is that even though emerging urban forms hold combination of patterns that are distinguishable from traditional urban forms, they are both structured by the same elements of urban form that constitute historical areas or small towns—streets, street blocks, plot systems and buildings. The plans by Muratori (for a new city of 40,000 inhabitants) and of Space Syntax Limited are good examples of this statement.

As mentioned above, in recent years the relationship between research on urban morphology and planning practice has achieved a significant role in the debate on urban form. One of the fundamental stages of this debate has been the International Seminar on Urban Form. In the end of 2011, the then President of ISUF (Michael Conzen) created a Task Force to study this issue, coordinated by Ivor Samuels. After half a year of intense debate, in mid-2012, the Task Force prepared a report with four recommendations, to be developed in the following years, in order to contribute to the strengthening of this relationship (Samuels 2013). The first recommendation was the publication of an ISUF manifesto or charter. The main goal of the charter, which can be downloaded at http://isuf2014.fe.up.pt/, is to communicate in a simple and direct way to planning practitioners, what urban morphology has to offer to planning practice—an objective and evidence-based understanding of the dynamics of urban form. As such, the charter does not advocate a style but an approach to understanding.

The second recommendation is to collect relevant information on how urban morphology is included in different courses within different countries. Since most academics and professionals acquire a good many of their approaches and techniques during formal training, it is necessary to understand: what morphological contents are being taught in higher education institutions, what contents should be introduced, and also what contents that are now being taught should be improved.

The third recommendation is the preparation of a good practice catalogue of how and where urban morphology is being used successfully. In early 2013, the Task Force launched the evaluation of four case studies: Porto, Newcastle upon Tyne, Ahmedabad and *Saint-Gervais-les-Bains*. The science of urban form, like other sciences, must be subject of evaluation and testing. This is particularly important if its utility and effectiveness are to be demonstrated to sceptical practitioners. Porto case study was the first to be concluded and published (Oliveira et al. 2014a). The other three cases were presented in the annual conference of ISUF in 2014 (Oliveira et al. 2014b).

Finally, the last recommendation is the preparation of an urban morphology manual. Two new books fulfil some of the objectives of this recommendation, the one that the reader has in his /her hands, and the 'Handbook of urban morphology' by Karl Kropf, a book structured into three main parts—morphological principles, methods (from desktop analysis to field survey and to synthesis) and concrete applications (Kropf 2016).

One final important aspect is the transferability of morphological knowledge. The way how urban morphology has been influencing planning practice does not necessarily conform to the wishes and priorities of those developing their research on urban form. The diffusion process of morphological knowledge is slow and takes place in a non-systematic way. Although this is an issue needing careful consideration, it does not differ much from other social sciences or from the relationship between planning theory and planning practice. In this sense, researchers should continue to develop their efforts building bridges between research and practice, developing systematic assessments as suggested in the third recommendation of the Task Force, trying to understand the needs and aspirations of planning professionals, and constantly testing the relevance and the dissemination potential of the results of their research.

7.2 Urban Morphology, Building Typology and Architecture

The nature of the boundary separating planning and architecture (to simplify two different focuses at the city and at the buildings scale) depends on the country that we are dealing with. There are countries where planning practice is carried out by architects (and engineers and geographers, to name the most important backgrounds) and other countries where planning is performed by professionals holding a planning degree. In other cases, there is a third activity between these two, urban design, making the boundaries more blurred. While the focus of the last subsection has been the city as a whole or parts of the city (we have assumed it as the object of planning, although it depends on the geographic context), this subsection focuses on single buildings, or on limited sets of buildings (we have assumed it as the object of architecture).

We also draw on the acknowledgment that there are a number of architects designing buildings that are remarkable examples of contextualized architecture without the support of urban morphology over the design process. These buildings and architects are not the focus of this subsection. We focus on the explicit use of urban morphology or of building typology in the process of designing buildings. While drawing on the three approaches analyzed in the last subsection, the link between morphological research and architectural practice is, as expected, more evident in the process typological approach and in space syntax. While the former is mainly focused on form, in its structural or tectonic sense, the latter is focused on space.

Fig. 7.8 The *Quartiere Garbatella* in Rome (*Source* Drawing—Menghini 2002; *photograph* by the author)

In a review on the study of urban form in Italy, Nicola Marzot identifies a strong relationship, over the twentieth century, between urban morphology (and building typology) and architecture. This is particularly evident in the construction of a common cultural background around a concept of type that has always had a strong systematic connection to the design of urban form. Yet, Marzot identifies a number of different positions based on different conceptions of type. These are mainly due to interpretations of what a contemporary city could be; in turn this has had an influence on the analysis of urban form. Some misunderstandings in these positions are based on interpreting all building types according to a unique language rather than focusing on the relevant historical ones (Marzot 2002).

The process typological approach has a classical concept of architecture as a tectonic system, a system legitimized by its derivation of principles and rules from the practice of building, according to a strong integration of structural, distributional and volumetric aspects. As we have seen in the last chapter, Gustavo Giovannoni was one of the first to lay the foundations of this approach. His buildings, or sets of buildings, are seen as part of a city that is an organism, a hierarchical space made up of diverse, yet interconnected parts in continuous interaction with the environment and continuously changing. One of the key projects of Giovannoni professional practice is the *Quartiere Garbatella* in the industrial area of *Ostiense*, Rome, promoted by the *Istituto per le Case Popolari* in the beginning of the 1920s (Fig. 7.8).

Fig. 7.9 The *Ente Nazionale di Previdenza ed Assicurazione Sociale* in Bologne (*Source* Drawing —Muratori 1944; *photograph* Cataldi et al. 2002)

At a time when the Modern Movement was attempting to resolve the crisis of the nineteenth century city by designing models for its replacement, Giovannoni [3] has designed a new urban project steering it back to the art of building the city, including historical awareness (in particular of Baroque architecture), technical know-how and artistic sensibility.

The buildings designed by Saverio Muratori, particularly in the late 1940s and throughout the 1950s, are another remarkable example of a sound relation between urban morphology, building typology and architecture. One of these notable cases is the office building designed for the *Ente Nazionale di Previdenza ed Assicurazione Sociale* (ENPAS) in Bologna (Fig. 7.9). The design of the building started in the beginning of the 1950s, after the INA Casa experiences in Rome, when Muratori was teaching in Venice. The building is a reinterpretation of a significant period in the history of Italian architecture, the Gothic period. The building, of about 50 m long and 9 m width, occupies a rectangular plot in the corner of a street block facing Via *dei Mille* and Via *Montebello*. The building has a

[3] *Quartiere Garbatella* was designed by Giovannoni with Maximo Piancentini (the design of the neighbourhood), Costantino Costantini, Gian Battista Trotta, Innocenzo Sabbatini and Plinio Marconi (the design of the buildings).

classical structuring of floors, with the ground floor, the first floor and the upper storey designed in a very expressionist way (in between there are five storeys). As in the case of Gothic architecture there is a strong affirmation of verticality, into nine vertical strips in the larger side of the building, facing Via *dei Mille*, and two vertical strips in the shorter side of the building.

Over the last years, Space Syntax Limited has been exploring a different way of linking urban morphological research with architectural practice through a focus, not on form (based on a concept of type) but, on space. Acting as consultant to a number of architectural offices, Space Syntax Limited has been informing a number

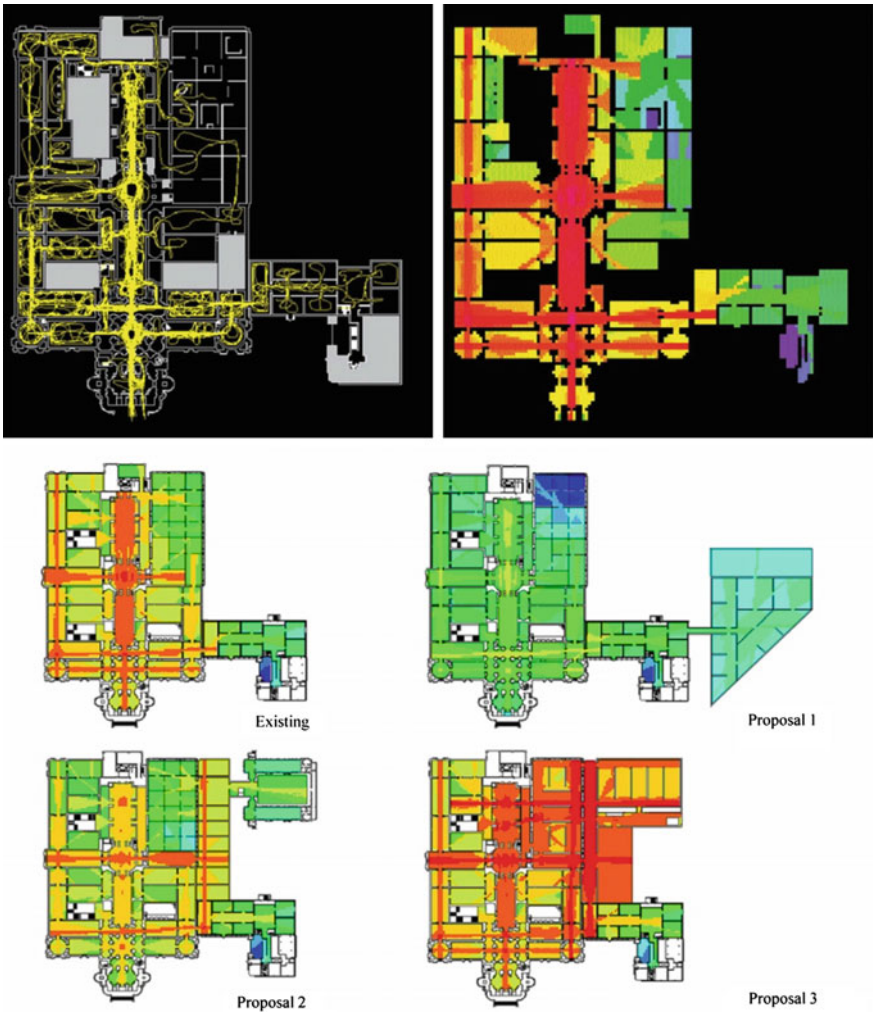

Fig. 7.10 Tate Britain in London: analysis of the existing building and evaluation of three different proposals (*Source* Dursun 2007)

of architectural interventions, including some iconic buildings in London. One of these is the proposal for the extension of Tate Britain coordinated by the architectural office Allies and Morrison. The work involved two different stages, an analysis of the spatial configuration of the existing building and a configurational evaluation of the three proposals designed by the architects. The first stage, an exhaustive analysis of pedestrian movement within Tate Britain, revealed that visitors tend to move along the central axis from the main entrance and intensify especially on the left side of the building (Fig. 7.10). The second stage was an evaluation of three different alternatives: (i) creating a new gallery wing for the permanent collection, having a passage entrance through the Clore Gallery (at north), and an external sculpture court at the back of this wing; (ii) the addition of some of the new gallery spaces on the north side of the building, in a linear organization, and of others at the back of this as a separate wing shaping an open court at the centre; and, finally, (iii) the introduction of a new north wing that will be used as temporary exhibition space, the transformation of the former temporary exhibition area into a permanent exhibition area, and the creation of the external sculpture court between the new gallery wing and the Clore Gallery having a link to a new café and bookshop space. The evaluation has made evident that the third proposal provided the most intelligible layout by making the new temporary exhibition space well integrated and well connected to the core of the building. By introducing a new link between the left side of the Gallery, the Clore Gallery and the new spaces, and by creating a new route to Clore Gallery, the proposal also impacted positively on the existing building by giving the plan a stronger global structure (Dursun 2007).

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Chapter 8
Relationships with Other Fields of Knowledge

Abstract The eighth chapter addresses the contributions of urban morphology to fundamental dimensions of our collective life in cities, in particular the social dimension, the economic dimension and the environmental dimension. Bearing in mind the practical achievement of this purpose, five specific issues from these three generic dimensions are selected: public health, social justice, heritage tourism, climate change and energy. The chapter discusses how to strengthen the channels of communication between each one of these issues and the field of urban morphology.

Keywords Climate change · Energy · Heritage tourism · Social justice · Public health

One major challenge for urban morphology, in the next years, is to be able to identify its most important and morphologically specific contributions to contemporary cities and societies. In fact, it is urgent to strengthen the morphological dimension of the debate and practice (the theme of Chap. 7) on cities. In this sense, urban morphology should pay less attention to criticizing, modifying and transforming the wealth of its already sophisticated concepts, methods and techniques, and pay more attention to potentiate the conditions for the application of its contributions in our daily lives. This process will necessarily involve some simplification, but it does not have to mean a loss in the fundamental contents of the discipline.

There is a need for developing key cross-disciplinary links between urban morphology and the different bodies of knowledge studying the city, promoting effective integrated research. Despite the potential advantages of transferring morphological knowledge to these different disciplines, the fact is that its occurrence is quite limited. In urban morphology—and more generally in the social sciences and humanities—the ability to identify and build cross-disciplinary links, and the awareness of relevant work in other disciplines, are not very common (Whitehand 2010). The fundamental, and realistic, challenge is to find a balance between two distinct poles: integration and specialization. The process of

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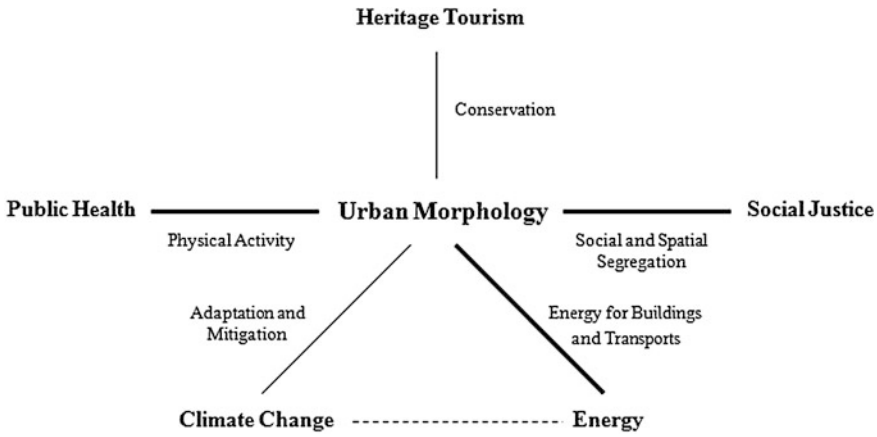

Fig. 8.1 Contributions of urban morphology to our collective life in cities

identification and construction of the specific links should involve the participation of academics, practitioners and citizens. The development of each particular linkage presupposes the capacity of researchers to gather and synthesize broad perspectives, knowledge and skills. Because most researchers, even in urban morphology, are trained in traditional disciplines, they must learn to appreciate differing perspectives and methodologies. A major breakthrough over the next few years would be the provision of a sound morphological dimension to other fields. This could, for many research projects, provide the desired added value and, ultimately, enable further advances in our shared knowledge about cities.

The next three sections explore the potential contribution of urban morphology to five specific issues: public health, social justice, heritage tourism, climate change and, somehow interrelated with the former, energy. These are five selected examples (others could have been chosen) of specific issues of daily life where urban morphology could offer a sound contribution. Figure 8.1 offers a synthesis of these linkages—while the thick lines represent the most consistent linkages, the thin lines represent the most embryonic relations.

8.1 Urban Morphology and Society

The first section of this chapter focuses on two crucial issues in our societies where urban morphology can offer a sound contribution, public health and social justice. Some of the key words in these processes of integration of different areas of knowledge are physical activity and walkability, in the first case, and social and spatial segregation, in the second case.

8.1.1 Public Health

A number of studies in the public health field suggest that significant health benefits can be achieved through the accumulation of moderate physical activity (such as walking and bicycling) in regular short bouts. The benefits of daily, moderate physical activity have the potential to be more effective than more structured, vigorous forms of exercise (such as jogging or aerobics) because of increased levels of adherence to these activities. Indeed, research indicates that people may be more willing and able to adopt moderate physical activities and, once such activities are begun, to maintain them overtime, as compared with forms of vigorous physical activity. An increasing body of research also argues that there is an effective influence of urban form on this type of physical activity and, as such, on public health. Research also shows the reverse—how urban form can discourage physical activity.

Low levels of physical activity threaten our health, both directly and indirectly. A sedentary lifestyle is a well-established risk factor for cardiovascular disease, stroke and all-cause mortality. In addition, the lack of physical activity is also a risk factor for being overweight and obese (Frumkin 2002).

One of the most consistent lines of research in this issue, over the last two decades, has been developed by Lawrence Frank, first in the Georgia Institute of Technology and then in the University of British Columbia. Frank and Engelke (2001) distinguish between two types of barriers to physical activity: personal barriers, which are subjective considerations restricting an individual's motivation or ability to exercise; and environmental barriers, which are real-world conditions that place restrictions on physical activity. It is important to acknowledge that the latter may have disproportionate impacts on different subgroups within the population, most especially for vulnerable groups, such as elderly persons or children.

So, how do the different elements of urban form impact walkability and cycling? Well-connected street networks and small street blocks (two interrelated aspects) offer more intersections and, as such: more direct movement between activities, the reduction of the distance between trip origins and destinations, the provision of alternative pathways of movement, and the limitation of vehicular travel speeds through the closer spacing of intersections. The characteristics of the specific parts of a street are also very important for promoting walkability and cycling. Streets with ample sidewalks, bike lanes, and crosswalks on which pedestrians and cyclists can travel will be perceived as safer—the perception of safety is also influenced by faster or slower automobile travel along the street—and a have a positive impact on these soft modes of transport (Moudon et al. 1997; Frank and Engelke 2001).

Not only streets are important, but also buildings. That is the case of the age of buildings. In general, the average distance one needs to travel for recreational purposes seems to decrease with the age of buildings and of neighbourhood, implying that persons who live in older neighbourhoods have better access to recreational facilities (Handy 1996). Another important characteristic seems to be the position of buildings within plots. While buildings oriented towards and situated next to streets have a favourable impact on walkability, buildings considerably set

back from the streets and often oriented towards parking lots seem to discourage walkability (Moudon et al. 1997). Finally, research also made evident that people living in mixed use neighbourhoods are more likely to be active enough to achieve health benefits (Frank et al. 2005). It is important to highlight that modest changes in the walkability of an urban landscape can translate into important, health-enhancing population-level increases of activity.

8.1.2 Social Justice

There is a sound body of research on the social justice's dimension of the city. David Harvey and Susan Fainstein are two notable examples within this line of research; the work of the latter, around the concept of the just city, having a clearer focus on the physical form of cities. An even more explicit link between social justice and urban form has been developed by Laura Vaughan, at the University College London, under the topic of social segregation. Over the last two decades, after her M.Sc. and Ph.D. theses, Vaughan has been showing a consistent correspondence between social and spatial segregation, distinguishing, in the city, the existence of poor, spatially segregated areas and streets and more prosperous, spatially integrated areas and streets.

Research into poverty areas suggests that despite the many attempts to improve housing quality over the twentieth century, these interventions have failed to substantially alter the geography of poverty (Orford et al. 2002). Lupton (2003) states that the physical characteristics, through their impact on population mix, lead neighbourhoods to acquire certain other characteristics, such as services and facilities, reputation, social order and patterns of social interaction, as people and place interact. While disadvantaged individuals in an isolated area will form one set of social relations (exacerbating the disadvantages of these poor individuals), disadvantaged individuals in a well-connected area may form another set of social relations. Poverty can, for instance, lead to unequal access to jobs and thus to high rates of unemployment in a particular area. In addition, to these findings, Vaughan suggests that: (i) the persistence of poverty areas over time can be explained by a number of aspects including the combination of some spatial factors; and (ii) when these areas are located close to economically active, well integrated streets, such spatial patterning can serve as a necessary mechanism for the social integration of minorities and is frequently part of a natural process of acculturation and integration in the urban environment (Vaughan 2007).

The analysis of poverty areas usually reveals a sound presence of immigrants. It is the location and the spatial segregation of each of these areas which make them more likely to be settled by poorer immigrants. The process of formation of immigrant quarters is a critical stage in the integration of immigrants into society. Research into cases of supposed 'ghettoization' has questioned the simplistic notion of the immigrant residential quarter cutting its inhabitants off from society. In fact, depending on the location and the way in which the street network is utilized,

clustering can enable the intensification of communal activity, socialization, networking and self-support. Analysis has shown that clustering of immigrants during initial stages of settlement—and sometimes beyond the first generation—is part of a process of acculturation and integration. It also shows that for immigrants, settlements in locations which enable economic activity is a necessary step in the immigrant process and often entrepreneurship in ethnically concentrated neighbourhoods not only results in processes of mixed embeddedness and economic integration, but strengthens social networks and reciprocity (Vaughan and Penn 2006; Vaughan 2007; Vaughan and Arbaci 2011). On the contrary, longer term minority clustering can have a negative effect, impeding social mobility, limiting access to work, enabling criminal behaviour or hampering school achievement.

8.2 Urban Morphology and Economy

The second section of this chapter focuses on the relationship between urban form and economy, with an emphasis on the issue of heritage tourism.

Most of research on the relationship between urban form and economy adopts a macro scale of analysis. A good example of this line of research is a recent report, published by the UN-Habitat within the framework of the United Nations Human Settlements Programme, offering a literature review on the economics of urban form (UN-Habitat 2015). The report addresses two major characteristics of urban form at the macro scale, density and centrality (by comparing extreme situations of high and low density, and of mono- and polycentricity) and relate both to size (as measured by population). In relation to density and centrality, the report sustains that high-density forms, including both monocentric and polycentric, offer the best balance of low transport and infrastructure costs, low environmental impact, and high income-generation abilities. Furthermore, the economic costs of moving towards lower densities include increased transportation costs, increased greenhouse gas emissions per capita (a theme of the next section), and rising obesity rates (an issue of the last section), in conjunction with decreasing productivity. On the contrary, the costs associated with high-density levels include congestion and high land prices. Ultimately, more economic benefits than costs seem to be present in high-density areas. In relation to the city size, the report argues that this characteristic is interdependent with both density and centrality. Increases in city size seem to correlate with higher wages, higher proportions of educated citizens, and higher productivity. These result from economies of agglomeration, which are reliant upon increased proximity and scale afforded by larger cities. The report argues that there is no one optimal city size, but efficiency in city size is dependent upon local features and constraints (this is a view supported by Batty 2008). In a similar way, Gordon and Richardson (who, in the 1990s, have authored an influential paper on the debate between compact and sprawl) argue that urban form matters to economic growth. In particular it explains the logic behind how entrepreneurs and others can be spatially poised to succeed (Gordon and Richardson 2012).

8.2.1 Heritage Tourism

At the end of the Second World War, tourism began to flourish and spread to all corners of the world, due to higher levels of affluence, record advancements in transportation and telecommunications technology, and enhanced international relations. Since then, tourism has proved to be one the most powerful economic forces in the world. It touches every nation and community, directly or indirectly, and influences decision making at even the highest national and supranational levels. Due to the global significance of tourism, communities throughout the world have welcomed it as an instrument for economic development. As part of this trend, tourism become compartmentalized into different types, somehow recognizing that it is not an homogeneous or an undifferentiated phenomena. One of the most significant types is heritage tourism. Visitors to historic places and their spending in the areas of lodging, food, admission fees and shopping, contribute billions of dollars every year to the global economy and employ millions of people directly and indirectly (Timothy and Boyd 2006).

Heritage tourism entails visits to sites of historical importance, including built environments and urban areas, ancient monuments and dwellings, rural and agricultural landscapes, locations where historic events occurred and places where interesting and significant cultures stand out. The range of resources that function as attractions in heritage tourism is extensive and the types and dimensions are manifold. The majority of research today focuses on the supply side, focusing largely on interpretation, conservation (on a wide and non-orthodox sense, being one of the keywords for designing a link between heritage tourism and urban morphology), and other elements of resource management, as well as the support services that exist for visitors at historical locations. While research on the demand side has a less developed expression, it has shown that visitors to heritage sites are better educated, bigger spenders, travel in groups, and have average or higher than average incomes (Timothy and Boyd 2006).

While, for urban morphologists, it is widely accepted that cities must change, one of the key problems is how to cope with these changes while retaining older areas and structures in which past generations have invested so heavily. Within the science of urban form, one of the most consistent lines on the topic of conservation of urban areas has been developed, for over more than two decades, by Peter Larkham, first at the University of Birmingham and, then, at the Birmingham City University. In the book 'Conservation and the city', Larkham (1996) tries to understand how is such change initiated and implemented, what effects has it on conserved areas, and how might it be better managed in the future. In doing so he addresses some of the fundamental questions of conservation: (i) what is to be preserved? (and who identifies the preservation-worthy buildings and areas, and whether this identification meets with the approval of the population living, working and recreating in these areas); (ii) to what extent do those influencing development and those affected by it have consistent views about the area in which development is proposed? (iii) how is conservation/preservation to be carried out:

are the buildings and areas identified in any way removed from the natural life cycle of construction, use, obsolescence, decay and demolition? and, finally, (iv) what is the nature and scale of changes proposed and carried out to the physical urban fabric? One important aspect of Larkham's research on conservation is the focus on those involved directly and indirectly with change, under the topic of 'agents of change' (this topic was addressed in the third chapter of our book).

Conciliating heritage tourism and urban form conservation (through key inputs of urban morphology) is a challenging task. Close to Nasser (2003) we highlight the need to protect heritage as a natural resource that if overexploited will be degraded, the acceptance of change and development to ensure continuity, and the need to consider equitable access to heritage resources by the local community and visitors. Finally, it should be said, as Fig. 8.1 shows, that until now the input from urban morphology in heritage tourism was not as consistent as in the previous cases of public health and social justice.

8.3 Urban Morphology and Environment

This section, on the contribution of urban morphology to fundamental environmental challenges focuses on two interrelated issues, climate change and energy. The debate on the former, somehow, frames the discussion on the later.

8.3.1 Climate Change

The science of climate change is now well established. The delivery of the 2007 Nobel Peace Prize to the International Panel on Climate Change (IPCC) marked the end of informed debate on whether climate change is human induced and real. Attention has then moved to what we have to do about climate change. At the Paris Climate Conference (officially known as the 21st Conference of the Parties, COP21), in the end of 2015, an agreement between 196 parties was reached. The agreement provides a pathway, and a mechanism, to limit temperature rise to below 2° (maybe even 1.5). COP21 also sent a signal to markets that it is the time to invest in the low emission economy.

Predicted weather-related events like sea level rise, increased storm events, and extreme heat waves imply an urgent need for new approaches to settlement design to enable human and non-human species to adapt to these increased risks. Adaptation and mitigation are emerging as some of the most pressing issues nations and cities face. While mitigation works to reduce current and future greenhouse gas emissions, including emissions that are generated through the built environment and transportation sectors, adaptation seeks to adjust the built and social environment to minimize the negative outcomes of now-unavoidable climate change. While adaptation and mitigation can be seen as the methods to achieve the intermediate

objective of reducing vulnerability and the risks associated with climate change, resilient communities[1] are the overarching goal (Hamin and Gurran 2009).

Blanco et al. (2011) argue that the way the main elements of urban form—such as streets and buildings—and infrastructure systems are organized can contribute to the emission of greenhouse gases and amplify climate change impacts. The structure, orientation, and condition of buildings and streets can increase the need for cooling and heating buildings, which are associated with the level of energy use (this will be expanded in the next subsection) and can account for a significant proportion of greenhouse gas emissions in a city. The extent of streetscape and the impervious surface of structures can intensify flooding and are direct determinants of the heat island effect (Stone et al. 2010). Conventional wastewater and drainage systems impede natural processes of evapotranspiration and can amplify flooding and drought effects.

8.3.2 Energy[2]

Energy plays a fundamental role in today's world. The way urban areas are built has a great influence on the present and future demand for energy. The influence on transport demand is mainly expressed in trip generation and on built structures in terms of end uses such as heating, cooling and lighting.

While urban morphology focuses on the physical stocks of cities and on the processes and actors shaping them, sometimes ignoring the issue of urban flows, research on energy sometimes adopts sectoral visions of the problem and has not been able to deal effectively with the spatial dimension of cities embracing all the different scales. Most literature on energy has been addressing one of two scales of analysis. At the city scale, scientific research has been exploring the dichotomy between compact and diffuse patterns of urban development, the variations of density (of built forms and of inhabitants), and the land-use patterns, connecting these aspects with transport (including systems management and the construction of infrastructures). At the building scale, recent research tends to cluster around three main lines of investigation: the establishment of different frameworks for classifying built forms (from an urban energy perspective); the design of innovative methods for estimating the energy consumption of buildings; and finally, the analysis of the potential of buildings for improvement. Despite the remarkable

[1]The IPCC describes resilience as the ability to absorb disturbances, to be changed and then to reorganize and still have the same identity. It includes the ability to learn from the disturbance. A resilient system is forgiving of external shocks. As resilience declines the magnitude of a shock from which it cannot recover gets smaller and smaller. Resilience shifts attention from purely growth and efficiency to needed recovery and flexibility (IPCC 2007).

[2]This subsection draws on the paper 'Urban form and energy', that I have authored with Mafalda Silva, published in the journal 'Urban Morphology' (Oliveira and Silva 2013).

advances achieved at both scales of analysis, there seems to be a gap between the two communities of researchers.

In the last few years, a number of studies have started to address intermediate scales of analysis—between the city, taken as a whole, and the building, seen as a self-defined entity—that have been previously ignored, possibly due to the complexity of environmental processes and the lack of data. Osmond (2010), Bonhomme et al. (2011) and Sarralde et al. (2011) propose a set of tools that enable researchers and practitioners to deal with the issue of energy consumption at intermediate scales. The first of these papers proposed the urban structural unit, a descriptive and explanatory framework that considers both the stocks and flows—of energy, information and materials—of the city. The second paper offers the 'Modeling Urban Shape and Energy' (MUSE) as a model to measure the patterns of energy consumption driven not only by the characteristics of transport and buildings but also by a number of features of specific urban microclimates. The third paper proposes a model to measure energy consumption considering not only the characteristics of urban form but also the renewable energy potential of cities. An additional step is taken by Ratti et al. (2005) and Salat (2009). Ratti et al. (2005) use digital elevation models and the lighting and thermal simulation tool to analyse the effects of urban texture on building energy consumption. Ratti and his colleagues consider the following parameters in their analysis: built volume and built surface, passive and non-passive zones, orientation of façade, urban horizon angle, and obstruction of sky view. Following a similar line of research, Salat (2009) uses a number of environmental metrics—such as building shape and passive volume—to explore energy consumption in different parts of the city. Both papers present applications of their methodological proposals in large European cities.

The development of new approaches, theories, concepts and methods should offer greater understanding of the interrelationships between urban form and the level of energy being used to maintain contemporary urban systems (considering both the quantity and the quality of the energy sources). It should also inform the debate on current urban development strategies, promoting the sustainable use of resources, land and energy as key ingredients for long-term prosperity.

Among the different issues under discussion in contemporary debate on cities, energy is certainly one of the most important. Rising energy prices, the urgent need to reduce emissions and mitigate climatic change (the theme of the last subsection), and the large investments that will be needed to make installations and infrastructures fit for the future, make urban energy a key challenge for the present decade.

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Chapter 9
Conclusions

Abstract The ninth chapter presents the main conclusion of the book, somehow bringing together the different synthesis presented in each of the previous chapters, and reflecting on the produced work as a whole. This chapter includes the identification of a number of lines for future research within the science of urban form.

Keywords Cities · Urban form · Urban morphology

There is a gap in the literature on the study of urban form. Despite the existence of many excellent books on many different aspects on the physical form of cities, there are no manuals on this field of knowledge. *This book addresses this gap and intends to be a manual on urban morphology*. Indeed, it offers the reader an overview on a reduced, but essential, set of issues in this field of knowledge. The organization of the book contents draws on my personal experience, teaching urban morphology to students in the last year of an architectural degree, in a discipline structured in 15 lessons over one semester. As an introductory book, it 'stands on the shoulders of giants'. As such, it identifies the fundamental texts the reader should examine if he, or she, wants to further explore each of the main themes of the manual. Perhaps the most obvious examples, in the wide set of references included in the manual, would be the eight classics in urban morphology and urban studies listed in Chap. 6 or the two notable books on the history of urban form by AEJ Morris and by Norbert Schoenauer included in Chap. 4.[1]

The manual is divided in two different parts. While the first part (Chaps. 2–5) focuses on the physical form of cities, the second part (Chaps. 6–8) is centred on urban morphologists and practitioners. This distinction between 'object' and 'researcher' (and, in some cases, 'practitioner') is crucial for the presentation of the book's contents. In the first part of the book, we have tried to understand what the main elements that structure the physical dimension of cities are; how these

[1]The references listed above are as follows: Muratori (1959), Conzen (1960), Lynch (1960), Cullen (1961), Jacobs (1961), Rossi (1966), Castex et al. (1977) and Hillier and Hanson (1984) in Chap. 6; and Morris (1972) and Schoenauer (1981) in Chap. 4.

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elements have been created (who designs them and how each idea is effectively implemented on the ground); and how these different elements have been organized in each of the different periods that are part of our collective urban history. After understanding the object, we have focused on the researcher (and on the practitioner). In the second part of the book, we have addressed the main approaches that urban morphologists have been developing to understand the physical form of cities; the passage from scientific description and explanation to professional practice; and the contributions that urban morphology can give to other fields of knowledge focusing, as we urban morphologists, on the city.

Each of the next paragraphs includes one fundamental idea of the book.

All cities (and all different parts of a city) are constituted by a limited set of elements of urban form—streets, street blocks, plots and buildings, to name the most important. While these elements are the same from city to city, what varies is the way they are combined in different patterns originating different urban tissues. It is our strong believe that our capacity for effectively analyzing existing urban forms or designing new urban forms depends on a correct understanding of the characteristics of each of these elements and of how these can be combined. Over the twentieth century, streets, street blocks and plots have progressively lost their importance, in the processes of analysis and design, in favour of buildings (in particular, of exceptional buildings). We argue for a change of focus, addressing the different elements of urban form in a more balanced way.

The second fundamental idea of the book is that our cities are made of a great variety of contributions from different agents (with different and, sometimes, conflictive interests) and through different processes of transformation. Developers, architects, builders, planning officers and politicians; all interact in different ways in complex processes of city building. Furthermore, our societies tend to organize in different ways to balance comprehensive views of the city, usually planned views, and a number of different contributions, eventually associated with a higher spontaneity. These complex processes should be considered in our analysis of and action on cities.

The analysis of our urban history reveals a clear permanence in terms of the elements of urban form that have been used in the different processes of city building. On the contrary, the characteristics of each of these elements and how they have been combined over almost six millennia have had moments of rupture and periods of permanence. If we assume a simplified view, we can say that all city layouts built up over 6000 years of history could be classified as ‘regular’ or ‘irregular’. On the one hand, we can find regular layouts in Chinese, Greek, Roman and Renaissance cities, although in the case of Greece and Rome we can also identify some cases of irregular layouts—Athens and Rome are, perhaps, the most notable examples. On the other hand, we can find irregular layouts in the Sumerian, Islamic and Mediaeval cities,[2] although in the case of Mediaeval Europe we can also find examples of regular layouts—such as the French *bastides*. As we have

[2]The diversity of the nineteenth, twentieth and twenty-first centuries disables the identification of one single type.

said, the characteristics of the different elements have changed over time. While in the early cities of Mesopotamia and China and, although to a lesser extent, in Greek cities, streets were only the 'space between buildings', their importance increased in the Roman cities, becoming perhaps the most important element of urban form in Mediaeval cities. One of the most profound changes in the different physical elements occurred in the mediaeval era where a number of exceptional buildings and infrastructures have been literally converted into cities. This has been the case of the amphitheatres of Arles and Nimes, or of the palace of *Split*. Another major change in urban form elements has been the disappearance of the courtyard house in Mediaeval Europe. While this had been the main residential building type from early cities to Roman cities, it was substituted by a new type of house in mediaeval times—a house facing the street, with a clearly urban façade, many times with a commercial use in the ground floor, and with an open space in the back of the plot. Only in Islamic cities the courtyard house—a residential type with three millennia of history—continued to be a key element of urban form.

Another important message of this manual is a eulogy of diversity and an alert to a tendency of homogenization of urban landscapes. In Chap. 5 we have looked at three rather different cities. I have drawn on my city, Porto, and have then selected two of the most fascinating and vibrant cities that I have ever visited, Marrakesh and New York. While these African and European cities have almost one millennia of urban history, the American city has only a few centuries of life. Yet, contrarily to Marrakesh and Porto, where the many urban strategies of the different agents seem to have been prevalent, the urban history of New York has been clearly influenced by one single planning document, the 1811 plan. While proposals of urban development developed after the mid-twentieth century (the definition of a more precise date depends on the geographical context) have introduced ruptures in the traditional processes of city building in many different parts of the world, and in our three case studies, in the specific case of Marrakesh these seem to have been more profound. Indeed, the way of combining streets, plots and buildings outside the medina is clearly different from the way these elements are organized within the walls of the city and closer to the way these have been combined in western cities over the last decades. This is obviously a threat not only to the urbanity but also to the identity of this African city.

Urban morphology is a science with more than one century of history. Over this period it has been consolidating a solid theoretical and methodological body and a wide set of concepts and techniques for understanding the dynamics of urban form. The current debate is marked by a set of different morphological approaches that are shared by an increasing number of researchers in different parts of the world. In this manual we have analyzed four of these approaches—historico-geographical, process-typological, space syntax and spatial analysis. While the debate on urban form tends to emphasize the differences between approaches, this books proposes the opposite, working together, drawing on our common ground—the focus on the physical form of cities. In this context, it is argued that the topic of comparative studies of urban form should be part of the morphological agenda for the next years.

In this book, when analyzing the relationship between theory/research and practice, we have distinguished two different links: one to planning practice and another to architectural practice (we have also mentioned that this simplification, somehow, blurs more complex sets of professional contexts that depend on each specific country). We have made evident the existence of a more consistent link to planning, than to architecture, and we have place a more explicit focus on that link. Yet, we have argued that mainstream planning practice is not informed by urban morphology. Neither is it influenced by planning theory. In fact, it does lack a sound theoretical and methodological body to deal with the physical form of cities. So, how could this relationship, between urban morphological research and mainstream planning practice, be reinforced? Close to Ivor Samuels, I would argue for the need to: (i) communicate in a simple and direct way, to planning professionals, what urban morphology has to offer to practice; (ii) gather an on-going collection of case studies of how and where urban morphology is being used successfully; (iii) prepare effective manuals on urban morphology; and, finally, (iv) (thinking in future planning practitioners) understand what morphological contents are being taught in higher education institutions, what contents should be introduced, and what contents that are now being taught should be improved.

It is not obvious to common citizens (neither to most academics) what the contribution of urban morphology to our daily lives in cities is. And yet, Chap. 8 has identified some essential dimensions where this input might be of fundamental importance, notably public health, social justice and urban energy. As we have said before, one major challenge for urban morphology in the next years is to identify and communicate, in a systematic way, its most important and morphologically specific contributions to contemporary cities and societies. This will certainly lead to the establishment of key cross-disciplinary links with the different bodies of knowledge studying the city, promoting effective integrated research.

This is a book on cities; on their physical form and on how we, urban morphologists and practitioners, describe, explain and act on this physical form. It is also an introduction to a remarkable body of knowledge with one century of life. As such, it should be able to lead the reader to many notable books that have been written since the birth of urban morphology in Central Europe in the turning from the nineteenth to the twentieth century. It should also encourage the reader to contribute to make his/hers city a better city and to visit and enjoy other cities in different parts of the world.

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