Roberto Pagani, Giacomo Chiesa
(edited by)

Urban data

Tools and methods towards the algorithmic city

Informazioni per il lettore

Questo file PDF è una versione gratuita di sole 20 pagine ed è leggibile con

La versione completa dell'e-book (a pagamento) è leggibile con Adobe Digital Editions. Per tutte le informazioni sulle condizioni dei nostri e-book (con quali dispositivi leggerli e quali funzioni sono consentite) consulta cliccando qui le nostre F.A.Q.

RICERCHE DI TECNOLOGIA DELL'ARCHITETTURA

diretta da Giovanni Zannoni (Università di Ferrara)

Comitato scientifico:

Andrea Boeri (Università di Bologna), Carlos A. Brebbia (Wessex Institute of Technology, Southampton), Joseph Galea (University of Malta), Maria Luisa Germanà (Università di Palermo), Giorgio Giallocosta (Università di Genova), Maria Chiara Torricelli (Università di Firenze), Jan Tywoniak (Fakulta stavební ČVUT v Praze)

La collana *Ricerche di tecnologia dell'architettura* tratta prevalentemente i temi della progettazione tecnologica dell'architettura e del design con particolare attenzione alla costruibilità del progetto. In particolare gli strumenti, i metodi e le tecniche per il progetto di architettura alle scale esecutive e quindi le modalità di realizzazione, trasformazione, manutenzione, gestione e recupero dell'ambiente costruito.

I contenuti scientifici comprendono la storia e la cultura tecnologica della progettazione e della costruzione; lo studio delle tecnologie edilizie e dei sistemi costruttivi; lo studio dei materiali naturali e artificiali; la progettazione e la sperimentazione di materiali, elementi, componenti e sistemi costruttivi.

Nel campo del design i contenuti riguardano le teorie, i metodi, le tecniche e gli strumenti del progetto di artefatti e i caratteri produttivi-costruttivi propri dei sistemi industriali.

I settori nei quali attingere per le pubblicazioni sono quelli dei progetti di ricerca nazionali e internazionali specie di tipo sperimentale, le tesi di dottorato di ricerca, le analisi sul costruito e le possibilità di intervento, la progettazione architettonica cosciente del processo costruttivo.

In questi ambiti la collana pubblica progetti che abbiano finalità di divulgazione scientifica e pratica manualistica e quindi ricchi di spunti operativi per la professione di architetto.

La collana nasce sotto la direzione di Raffaella Crespi e Guido Nardi nel 1974.

I numerosi volumi pubblicati in questi anni delineano un efficace panorama dello stato e dell'evoluzione della ricerca nel settore della Tecnologia dell'architettura con alcuni testi che sono diventati delle basi fondative della disciplina.

A partire dal 2012 la valutazione delle proposte è stata affidata a un Comitato scientifico, diretto da Giovanni Zannoni, con lo scopo di individuare e selezionare i contributi più interessanti nell'ambito della Tecnologia dell'architettura e proseguire l'importante opera di divulgazione iniziata quarant'anni prima.

Roberto Pagani, Giacomo Chiesa
(edited by)

Urban data

Tools and methods towards the algorithmic city

Table of contents

Part II
Design, product and process: tools and digital practices

Foreword

Lorenzo Matteoli

If the city is a living organism that is born, grows, changes, gets sick and ages, as is the case for any living organism, the "vision", "plan", "design" and related competent institutions, assisted by political and administrative responsibilities needed for their implementation, are the governance tools of urban growth and change; the tools to treat sickness and transform aging into transition to renovated vital assets.

The whole process induces and manages the transition from the present to the future of the city in time windows that span from a few weeks or months, up to 50 years; one or two generations of inhabitants.

No plan, no political institution for its implementation, a wrong plan or a perverse executive policy will lead to future catastrophes. The right vision, supported by the people, assisted with consistent tools and policies, will generally lead to probable and plausible futures; if successful, to preferred and designed futures.

The future is the development of the present. Dominated by the contingent situation and by the cultural, ideological and political conditions defined by it. The culture of the city is the prime mover of the development of the present.

The tools to control the transition to the future are the tools for the description, analysis and processing of the conditions on which action is needed and for the simulation of the new proposed asset - the tools of knowledge.

The city supplies the information needed for the management of the transition to its future. The very pathologies of the urban system are the source of such information: congestion, pollution, morbidity, physical decay, social tensions, criminality, functional and economical inefficiency, cost of servic-

es and infrastructures. Change and transition to new vital urban assets are the consequence of treating emerging pathologies.

The tools available today for the knowledge and management of "urban transition" are much more sophisticated than the tools available five or ten years ago.

Introduction

Roberto Pagani and *Giacomo Chiesa*

This book addresses professionals, students and researchers interested in both theoretical analyses and experiences on new Information and Communication Technologies (ICT), with respect to methods and tools for urban and territorial contexts (e.g. by using parametric tools and GIS). The influence of ICTs on urban design is analysed according to different profiles and disciplinary experiences, aiming at dialing a complex puzzle of different knowledge and actors facing the innovative digital instruments and design methods. Professionals, especially architects and planners, will find in this work a cognitive tool to address the digital innovation in urban design. This relies on theoretical components and instrumental analyses accompanied by case studies at different scales (from vast portions of the territory, to urban districts).

Urban Data deals with the parametric urbanism and the influence of ICT in urban design with a variety of profiles and disciplinary experiences in order to analyse different implications. This book originates, in fact, from the collaboration of architects, urban planners, urban designers, technology experts, economists, geographers, ICT engineers, experts in data analysis, geomatics, and representation, in order to describe engineering, morphological, technical, theoretical, and instrumental aspects of the urban digital planning.

The theoretical analysis addresses the environmental emergency on the urban scale, it elaborates the smart city concept, its implications and the relationship with big amount of data at the urban level. Datization phenomena and new digital tools for design and modelling are also tackled, in conjunction with languages and materialization issues.

The book explores several implications in the use of advanced GIS tools for geography and urban planning, addressing the issue of complex

multi-criteria modelling and interoperability between different systems and databases.

Urban Data is organized into two parts. The first deals with the relationship between **the city and the future** by reviewing basic **design issues in the digital age**. In the second part **instruments and** urban **digital practices** are scrutinized in order to identify, thanks to examples and applications, important innovation trends, related to **design, product, and process** for the urban design.

Lorenzo Matteoli questions about **futures of the city**. He remembers that the city is "the most complex, necessary, diversified, dynamic, variable, ineffable and disconcerting of all the structures built by humankind". Furthermore, the city is "a living organism that responds to the hosted culture, reacting with an ambiguous time delay". As "a cultural, political and financial action decision-centre" the city is able to affect the entire Planet. "For these reasons the idea to control and manage the development and organic life of large metropolitan regions has always been a challenge to political and professional ambitions and a scope for research and technology." At the same time, Matteoli remembers that the city is "the product of the inhabiting society and its expression too, a political statement and subject to political conditions, a technological challenge and a place of technological achievement". "The real possibility to control the many operational and development modes of great metropolitan regions through planning and design has always been whimsical and arguable". In this sense it can be said that "urban design and planning play a vital role in the culture of the city".

Cities in what future is also a main concern for **Roberto Pagani**. **The future of urban areas** is based on a balance between the "sustainable city and the smart city", the last having "in the word "datum" its core and in the economy linked to datum its successful matrix". The "smart cities" as well as "the link between the ICT industry and the city's development programs, the augmented reality used for developing new urban knowledge" have strongly influenced the industry and its relationship with the city. As recalled by Pagani, "for this innovation, the available data networks, chaotic, but good enough, are disruptive technologies, unthinkable in the past, that can be used to make decisions, strategies, and lines of action." This second chapter introduces, in fact, "the basic concepts of smart cities and elaborates the possible transformations of cities in the direction of an intelligent control".

To represent the "Smart City" concept, Pagani adopts an interpretative scheme, already proposed by Carlo Cipolla for other areas of application. It consists of a diagram that shows the individual advantage in relation with the collective advantage, based on a Cartesian system representing local variables.

This diagram identifies four cities, according to the four Cartesian quadrants. "The quadrant ++ (individual advantage / collective advantage) symbolizes the smart cities, combining the advantage of the community to that of the individual citizen. The diagram - + (individual disadvantage / collective advantage) indicates the pioneer city. The quadrant + - (individual advantage / collective disadvantage) identifies the exploitative city. The quadrant - (individual disadvantage / collective disadvantage) is the damaging city".

The cultural action that outlines the futures of the city and the innovative forces that generate the city of the future need to be connected with the professional practice of urban planners. In this sense, **Giacomo Chiesa** elaborates on **the innovation in the urban** professional **practice** induced by new digital technologies, and shows the relation of new planning process with a performance-based methodology. Furthermore, in the third chapter the main impacts of ICTs on human processes are analysed, by adapting the four axes introduced by The OnLife Initiative on an urban design scale. These are determinants that can influence the building shapes according to different temporal and geographical scales. Chiesa remembers that "the act of design, which is the nodal point of the architect's work and the goal of methodological studies of architectural technologists, is characterized by a high degree of complexity and articulation. Design practice involves, in fact, several implications at different scales. These implications are related to the difficulties of integrating into an organic vision the different combined competences and knowledge that are essential to elaborate a project that meets quality requirements. (…) The rapid development of new solutions, tools and techniques, mainly linked to the digital revolution, are drastically affecting the contemporary architectural and urban planning practice at all levels". Facing this change, it is necessarily to innovate the professional practice, not only in order to incorporate new tools linked with the digitalization, but also to avoid the risk of extinction of the architect, as a professional, in favour of others, as it was highlighted, at least provocatively, by David Celento in his essay "Innovate or Perish" (2007).

The professional practices and the opportunity to develop visions for the future of the city, are based on tools for representation and modelling. Starting from this statement **Anna Rosa Candura**, geographer, and **Orio De Paoli**, technologist, investigate the **representation** modalities **of geography** and the relationship between models and reality. As stated by Candura and De Paoli, " The history of taxonomies speaks of the need to identify (geographers would use the term "regionalise") an object in order to describe and analyse it. However, this results in a series of crystallisations that have changed or are changing, sometimes into stereotypes and sometimes into prejudices. It would seem, therefore, essential to take a regular look at these changes (because it isn't just a lexical matter), in order to prevent the simple operation of creating order in the study field from turning into a series of unchangeable (and apparently incontrovertible due to some divine order) constrictions/chains". Authors remember that "The geographic map is not just a representation but our perception of reality, and when we look at it we can identify much more than the neutral information relating to the geomorphological structure of the planet and the reciprocal positions of the countries; we read things from our own point of view, using our own style of reading and applying a mental hierarchy of the territories. Size doesn't matter, if one thinks that a territory like the Antarctic continent, while possessing a fascinating geopolitical condition and imposing size (approximately 14 million square kilometres), is the territory least known by most people (educated and otherwise)". For this reason, authors foresee two things to do:

1 "learn about the historical link between the representative model and the reality (taking into account the geographic method of investigation that envisages constant reference to the primitive relationship between mankind and the territory, considering all reciprocal influences);
2 identify the variable parts of the model and those that can be adapted to the new reality (as happens with architectural models that can be broken down)".

Recalling similar aspects, **Matthew Claudel**, researcher at MIT, **Marco Maria Pedrazzo** and **Niccolò Suraci** investigate methods for **representing information**. They assert that " the practice of architecture is defined by tools for representation". Furthermore, they remember in this fifth chapter that "every project is a sequence of aggregating information, synthesizing insights and representing a product. The deliverable is one step abstracted from concrete: architects do not deliver buildings, but produce a set of

drawings that describe the design proposal". Argumenting on innovation in the design practice they state that "it can be understood as a language for communicating spatial ideas, and the process hinges on the representational tool". As was evoked by Christopher Alexander, a mathematician, linguist, and architect, "the building profession should focus explicitly on the organization of information and the relationships between stakeholders. Through projects such as 'Pattern Language,' Alexander contended that the primary task of the architect is to circulate information, and that his purview should encompass the means of transfer as much as the information itself". For authors, the radical innovation in practice, as well as the development of platforms for the integration of a wider range of stakeholders in the design process, "need new representational tools – ones that democratize input and dynamically manage a complex matrix of contingencies, akin to Alexander's 'semi-lattice' concept". They define this digital platform as a live associative model assuming a radical reconfiguration of the "architect's relationship to information, stakeholders, and builders, ultimately transforming the process and products of architectural design".

While the first part of the book focuses on the issues related to the concepts of future, vision, and digital innovation linked with the construction and design practice, culture and perception of the city, the second part of Urban Data addresses specific variations upcoming from the implementation of these radical changes.

Aurelio David and **Alessandra Oppio** introduce some **project instructions to transform the city**. Starting from the research of Christopher Alexander, authors recall that in contemporary urban practice it is increasingly hard to successfully plan a city or an area. This increasing difficulty is linked with the process of globalization and some of its main dynamics "intensifying changes on the economic and social structures taking place in cities". The chapter considers cities "as complex, open multidimensional systems which growth and transformations are difficult to manage". For David and Oppio, " this situation results in the unreliability of traditional rational-comprehensive approaches to support spatial transformation, and calls forth innovative methodologies to cope with such dilemmas by providing a solid rationale for decision makers, especially in the intelligence phase of planning processes". This need for innovation, both in tools and practice, which was strongly highlighted in the first part of the volume, it is also

treated in this sixth chapter by introducing "the use of an open source software based on graph theory to bring together Spatial Multicriteria Analysis and the Pattern Language design methodology. The Spatial Multicriteria Analysis allows a solid support for territorial analysis, goal definition and scenario simulations by integrating Geographic Information Systems tools with Multicriteria techniques". The need for explicit methodology in the design practice, described in the third chapter, is here combined with the design tools and methods described by David and Oppio. They consider, in fact, as "Pattern Language theory provides an explicit and intelligible set of spatial instructions embedding multiple levels of knowledge to inform all the players involved in the decisional processes on how to plan the city". The Multicriteria Analysis and Language Patterns are "two theories [that] can be coupled together because of the specific structure of Patterns, which allows design specifications to be constantly edited and subjected to quantitative analyses".

In the seventh chapter, **Giacomo Chiesa** and **Luigi La Riccia** introduce a methodology for studying **urban landscape data**. In this chapter innovative tools are presented. Authors emphasise that "the "discrete" approach, like the one generally used in traditional urban planning strategies, has often demonstrated discrepancies between the expected results and the achieved issues. (…) Nevertheless, innovative tools, such as those related to big data and parametric urban issues, can support an innovative "active" approach, oriented to the use of computerized systems and continuously implemented scenarios that are able to deal with the fluidity of the contemporary urban context". Referring, at least indirectly, to the geographical thought presented in the fourth chapter and to the importance of the representation introduced in the fifth one, Chiesa and La Riccia start from the aesthetic-perceptive paradigm, outlined as "a different way of looking at the landscape, enhancing the evasive character of contemporary society, which is hardly reducible to conventions or codes". Authors point out that "Geo-referred information, resulting from social networks, contains, at least theoretically, a series of data, generally unstructured, which can be used for the construction of specific mental maps and / or for the identification of points of view, landmarks and other relevant points, "as perceived by people". These data can be elaborated for use in viewshed analyses and for the identification of safeguard zones". This chapter applies some analytical techniques based on 3D-GIS software and a tool for the datization of information from social networks. These methodologies can be used, as mentioned by authors, "to identify

the most suitable areas, from the landscape preservation point of view, or to localize elements or visible network infrastructures for the production of renewable energy (wind turbines, photovoltaic panels, etc.). Moreover, they can also be used to define the most suitable typologies and classes of invasiveness for the local energy retrofitting of building stocks".

A different disciplinary approach, but closely related to **the observation of urban real estate matrices** is the one proposed by **Rocco Curto** and **Elena Fregonara**. Their chapter shows the case of the "Turin Real Estate Market Observatory (OICT), "an example of a permanent structure for monitoring and analysing the real estate market, on the basis of the experience of identifying a methodology for describing cadastral Microzones in the city of Turin – approved by the City's Municipal Council in 1999 – and following boundary identification, in accordance with the Presidential Decree 138/1998 and the Regulation issued by the Ministry of Finance". As the authors underline, "a database containing temporal and geographical referenced data can help public administrations and private investors – that constantly refer to regulatory and economic measures – in structuring decision-making procedures, based on the market's conditions. As a matter of fact, a managed knowledge of the market can help operators or private citizens in their real estate investment choices, as well as public/private subjects in their planning and programming interventions". The example described by Curto and Fregonara considers that the "use of alphanumeric/ cartographic databases and the possibility of georeferring market's observations enables to overcome the applications of descriptive statistics, enabling to experiment advanced statistical models even with multi-varied and spatial characteristics". This contribution allows to relate the use of data and parameters to the market at urban scale, representing a consolidated example on the extensive application of visions and tools offered in previous chapters.

In the ninth chapter, **Anna Osello**, **Andrea Acquaviva**, **Matteo Del Giudice**, **Edoardo Patti** and **Niccolò Rapetti** elaborate on the **visualized information of the city**. As reported by authors "Information Communication Technology (ICT) is becoming a key factor to enhance energy optimization in cities". In fact, "thanks to ICT it is possible to access real-time information about building environmental characteristics and energy consumption (at building scale) as well as about district heating/cooling and electricity grid (at district/city scale)". The issues related to the real-time data collection and the management at the urban scale of the implementation

processes are here exemplified referring to energy flows at the district scale. Osello et al. describe the experience of the DIMMER project (District information Modeling and Management for Energy Reduction) that "represents an E-volution of the use of BIM, extending its use from buildings (building scale) to districts (urban scale)". The key aim of this project is, as noted by the authors, "to create a web-oriented interface able to collect data and information on single buildings and the district as a whole, including data and information on their energy requirements". The reported experience is connected to the importance of the representation of the collected data for their use, as was already highlighted in the first part of Urban Data. In the DIMMER project "different tools are considered to visualize data about public and private buildings (such as schools, university campuses or municipal buildings as well as residential) in different ways for different users/ stakeholders using Virtual and Augmented Reality (V&AR)". Such representation methodologies suggest the opportunity to develop, as mentioned in the chapter, "dashboard and a benchmarking tool".

Finally, it is essential to point out that innovations in the construction of the city of the future relies on the definition of possible futures. These futures can be interpreted as a cultural, political, decision-making and economic expressions. These futures need strong improvements in the design practice, especially facing the new digital technologies, in order to dominate the instruments and methods in a background characterized by a great abundance of data and information. The different approaches, the various case studies and visions included in this book aim at suggesting that it is fundamental to acquire cultural and technological skills and a set of values to properly design on the urban scale in the horizon of the digital age.

PART I

City and Future:
design issues of the digital era

1. CityFutures facing the shift in the energy paradigm: beyond sustainability

Lorenzo Matteoli

1.1. The City - the Highest Expression of our Culture

The city is:

- the most complex, necessary, diversified, dynamic, variable, ineffable and disconcerting of all the structures built by human kind;
- a living organism that responds to the hosted culture, reacting with an ambiguous time delay;
- the product of the inhabiting society and its expression too, a political statement and subject to political conditions, a technological challenge and a place of technological achievement;
- an object of constant design and planning, without any certainty of results;
- a cultural, political and financial action decision-centre that rules the Planet.

The real possibility to control the many operational and development modes of great metropolitan regions through planning and design has always been whimsical and arguable. Long decision-making processes and even longer implementation times, operational uncertainties, the number of executive competences and countless interactions defy any attempt of management and control procedures.

The concepts of *planning* and *design* referred to the city must deal with the peculiar conditions implied by the size and implementation time of the "urban item". The "endogenous" evolution dynamics of cities have always