e-FoC

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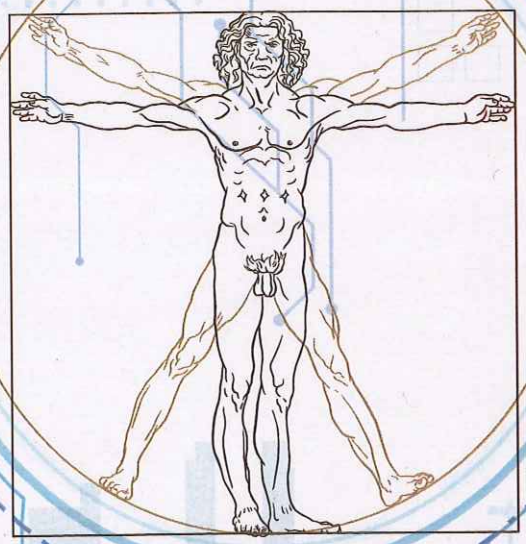
UNIVERSITY OF BELGRADE - FACULTY OF GEOGRAPHY

THE e-FUTURE OF CITIES

BETWEEN TEMPTATIONS OF EXPONENTIAL TECHNOLOGY GROWTH AND THE CONCEPT OF HUMAN CITY

EDITOR:
BORISLAV STOJKOV



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TRANSFORMATION OF THE URBAN MORPHOLOGY UNDER THE INFLUENCE OF THE NEW TECHNOLOGIES

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Abstract. The relationship between static elements (buildings, roads, open spaces) and dynamic activities (movements or stay) has always been an important part of an investigation in urbanism in an attempt to improve urban environments. This study explores new digital methods of the urban morphology and diverse behavioral human patterns in contrast with a traditional method of city-scale empirical analysis of users' engagement. Today, there are a lot of possibilities that the rapid development of new technologies give and with data that are precise and real-time it could facilitate the process of spatial analyses or decision making and could involve more participants. This work aims to explore correlations between human dynamics and the characteristics of urban places: What role does information networks and structures play in the construction of a modern city? What can we learn about cities via the data flows generated by their everyday activities? Can we develop tools to visualize this data to help us improve urban design and management? How can we integrate a dynamic representation of information in buildings and urban spaces? How different are the traditional methods of studying urban forms than modern ones? These questions will be analyzed through the case study - the bicycle system in the city of Barcelona. The results show that new methods still use simple mapping of the traditional urban morphology, but they are upgrading visualization a lot with precise data of the dynamical movements that make it more interactive.

Keywords: urban morphology; new technologies; visualization; urban planning

1. INTRODUCTION

Cities are becoming increasingly dense, complex and diverse, but still functioning mostly by physical urban infrastructure and services. In the new age of informatics, cities are becoming social networks embedded in space with a huge source for databases of urban information flows. Utopian and radical architects in the 1960s predicted that cities in the future would not only be made of physical material but also defined by bits and flows of information. Their vision has new meaning today where networks rule over many of the city's functions, changing our sense of time and space. The new urban landscape is predicated not only with physical architecture but also with invisible informatics flows that create sentient and reactive environments (Habitar, 2010). "Urban environments are one of contemporary society's largest "databases", daily generating volumes of information that require new methods of analysis and understanding" (De Vicente, 2008).

Two important movements are shaping today's world: urbanization and the spread of information technologies. The human population continues to expand rapidly, and cities are the epicentre of this growth. As the world's urban population grows, the systems and infrastructure that support city life are becoming more complex. Today's world is infused with digital infrastructure creating a parallel information environment. This information environment has initiated a new era of big data, generating

quantities of information so large that traditional techniques of collecting, manipulating, and representing data are no longer adequate.

2. URBAN MORPHOLOGY

Urban morphology examines the structure, diversity, and genesis of urban form. Urban morphology is a broad field of knowledge and an interdisciplinary framework of theoretical and methodological approaches. A common focus of different morphological approaches is the physical environment and urban form as a complex element and a phenomenon that must be viewed from various aspects (Kropf, 2009).

Urban morphology in the early 20th century was dealing primarily with comparative analysis of spontaneously and planned settlements to make recommendations for urban planning with a need to revive the positive visual qualities of traditional urban spaces. Among the first founders of the morphological studies were Otto Schlüter, Camillo Sitte, Josef Stübben and Pierre Lavedan.

Contemporary morphological discourse has been developing since the 1960s to the present and it is linked to the historical period of postmodernism, within the three morphological schools - British, French and Italian. Postmodern theory re-integrates issues and themes of place, body and meaning, that is, introduces socio-psychological aspects into architectural-urban concepts. According to Ana Niković (2013), who researched a connection between urban morphology and urban planning in her doctoral thesis, the work of English morphologists, especially Conzen, makes the greatest contribution to the analysis of plans and complex urban forms and is an important basis for contemporary morphological approaches that deal with the planning practice. Conzen's morphogenetic method is largely based on historical and cartographic analyses and distinguishes three complex elements - the street system, the plot scheme, and the building scheme. For Conzen, the urban form is a visual experience and as such a source of knowledge about social activities and processes. The Italian morphological tradition is more focused on typology as the basis for the analysis of urban form: buildings and no built space make an urban form which is the result of numerous activities and can be classified into types through which can show the essence of their different character (Niković, 2013).

Contemporary urban morphology observes the physical structure of the traditional city and the rules and regularities between the complex processes - primarily economic, social and political and the form of the city as a result of those processes. Today, the traditional city is the subject of morphological analysis in the context of its comparative analysis against the modern and contemporary city.

For the theories of urban morphology of particular importance where Gestalt principles in Rudolph Arnheim's work (Niković, 2013). As Niković pointed out, the Gestalt Principles influenced the theories of Kevin Lynch and the figure-field technique of Colin Rou, which he applies in the analysis of the urban structure of cities. The figure-field technique through the means of drawing, examines whether there is a spatial structure in the urban project. Through this method of analysis, the spaces of modern architecture and urbanism are criticized based on the means of morphological language without interfering with its ideological background. The figure-ground analysis introduces a key research question about the relationship between built mass and open space. This method was developed for parallel analysis of the traditional and modern city, to show completely different approaches to the design of open or built space.

Figure 1. A technique figure - background.

According to Rowe and Koetter, 1984

It can be concluded that the typology of the constructed structure, construction method, and grouping method, as well as the geometry, dimensions, and parameters of construction that can be expressed quantitatively, are crucial for the realization of the technical and functional requirements. But the criteria for evaluating the shape of a city correspond not only to its technical-functional but also with its spatial-experiential and visual-perceptual characteristics.

2.1. Urban morphology and the process of planning

More recent studies highlight the importance of practical application of urban morphology in the process of planning. However, this field still has not found an adequate place and full application in planning practice. The reconstruction and protection of existing ones, as well as the production of new urban forms, should be based on the knowledge and understanding of the existing built environment, its inherent forms, and their past development. Although the starting point of urban design does involve some aspects of urban morphology, still it is not used adequately in the process of urban planning (Whitehand 2001, 2013).

According to Niković, the main problems of the integration of morphological research into the design and planning practice are the difficulty of generalization, which would serve as the basis for forming a common methodological framework. One of the causes of this problem is the great international diversity, both in urban morphological research in different countries and different design and planning procedures. Besides, urban morphology is characterized by an interdisciplinary framework, where it emerges as a unique field that brings together theorists and professionals from the disciplines of geography, history, architectural design and urban planning (Niković, 2013).

McCormack advocates that knowledge in the field of urban morphology must be linked to the techniques of urban conservation, urban sprawl, and urban renewal and it does not apply solely to existing urban tissue of a traditional city. According to McCormack, for the successful integration of morphological research into the design and planning practice, it depends on how this tool is presented, where attractive appearance and integrated graphical analysis play an important role (McCormack, 2013). He emphasizes that the effectiveness of establishing communication is increased through the application of an effective graphic presentation that most directly conveys the idea of physical form. He implies the necessity of a three-dimensional reading of urban form that enables the analysis of urban structure through movement, which is a method of spatial syntax, with which urban morphologists are often associated.

As one of the problems of the relation between theory and practice, Nasser notes the orientation of urban morphology to the historical analysis, especially in the period after the 1960s as a reaction to the modernist approach (Nasser, 2013). Therefore, an important obstacle to the application of urban morphology in the design and planning of new urban tissue is a view of professionals - architects and urban planners - who link it to historical analysis and an orientation toward revitalizing existing tissue by introducing the qualities of a traditional city. This type of analysis seems to consider out of date, not applicable to today's digital reality. But that is exactly where the potential of urban morphology in future lies!

As an extremely important form of translating morphological language into widely understood codes and a mediator in establishing the relation between research and practice, Kropf emphasizes an illustration that, to him, conveys better information than text. The timely introduction of urban morphological analyses, in the analytical phase, enables the proper characterization of the area, which enables projections of long-term growth of the physical form of the settlement.

Consequently, the main question is how urban morphology can provide a repertoire of concepts for design and planning in a contemporary context, what types of interventions are appropriate, and how urban design can form a new field of research for urban morphological analyzes? (Kropf, 2011).

3. NEW TECHNOLOGIES AND VISUALIZATION

Visualization tools represent the information of dynamic citizen's activity and help us to understand how they use urban spaces. It shows the relationship between networks and the use of the specific architectural form such as squares or streets. Question is how can we use the data visualization and information design to understand the processes taken from contemporary cities and manage better with them? The aim is to “visualize the data flows generated by our everyday activities in the city to show previously invisible urban processes” (Girardin, 2008). Girardin also suggests to go “beyond mapping the emerging patterns of these new urban data and explore analysis techniques” such as user interaction, to understand real meaning and potentials of “the digital cities of the future”.

According to Friedman (2008), the “main goal of data visualization is to communicate information clearly and effectively through graphical means.” On the other hand, the visualization should not only communicate clearly but stimulate viewer engagement and attention. The visualization of information reveals to us some phenomenon and can be used to describe the process showing relationships between scientific research and space-making. They “tell us stories about how, what, and why things are happening” (Manning, 2012). Visualization must be so designed and shaped to provide a clear way of consideration of certain physical phenomena. Furthermore, “in reaching a wider audience there is a trade-off between making it as simple as possible for any user to be able to participate and knowing exactly who it is.” (Macintosh, 2004). Visualization is showing relationships between data and space. This approach aims at revealing new evidence that can lead us to understand how we link digital information with physical space and to develop a spatial-temporal data analysis tool to investigate the use of the spatial features. Visualization can be defined as communication techniques and transmitting messages through images. Information visualizations, especially those utilizing web-based platforms, are becoming an increasingly common medium for exchanging ideas. This emergent class of tools

enabling web-based, interactive platforms for visualizing data should be considered by urban planners and designers as an opportunity to create new modes of communicating information.

Information technology and computer systems are increasingly designed to support everyday routines and advance user experience in multiple ways (Chatterjee and Price, 2009). Novel computer systems can be also intentionally designed to influence how users think and behave. According to Stibe and Larson (2016), theories of persuasion (O`Keefe, 2009) and social influence (Cacioppo, et al, 1985) provide various strategies for the developers of such systems to facilitate desired effects on the user. According to social sciences (Bandura, 1986), any well-designed environment can become a strong influencer of what people think and do. There is an endlessly dynamic interaction between a person, a particular behavior, and an environment in which that behavior is performed. This initiative leverages this knowledge to engineer persuasive environments and intervention for altering human behavior on individual and societal levels.

Environmental, personal, and behavioral factors are locked into triadic reciprocal determinism, meaning that all three are strongly interconnected and continuously reshaping each other. Thus, environmental design, including persuasive urban systems, has a strong influence on human behavior and attitude. In other words, quite often it is merely sufficient to improve urban spaces to help people become healthier and to create sustainable communities. This is a very powerful vision as it encompasses the transformation of human behavior and urban environments at scale.

3.1. New technologies and the process of planning

Faced with such a huge amount of data, the interpretation of data relevant for decision-making becomes a key challenge that planners will be faced with in the future. The development of algorithms that can filter such massive and diverse data, to figure out what are the patterns, and how the reality could be understood and explained is a complex problem and a challenge of urban planners nowadays. Infrastructure and systems that were previously invisible are now revealed through digital information.

Providing up-to-date data is essential for identifying and understanding the behavior of the users – such as their movement, the effects they have in the built environment, etc. These data can help us define priorities and steer decisions related to development in the right direction. Acquiring these data is the area where IT smart solutions are widely applicable. (Brković M. and Sretović V., 2012). The decision-making process in urban planning is outdated and it is mostly a top-down process, with community participation only in its late stages. Furthermore, many design decisions are subjective, rather than based on quantifiable performance and data. Urban simulation and artificial intelligence techniques have become more accessible. However, until now these techniques have not been integrated into the urban decision-making process. Current tools for urban planning do not allow both expert and non-expert stakeholders to explore a range of complex scenarios rapidly with real-time feedback.

One of the important reasons for a long period of creating a plan is the lack of rapid-prototyping tools for both experts and non-experts to explore multiple scenarios collaboratively. Designing and planning with traditional tools, such as sketching on a zoning map or using CAD software or GIS, requires training, making it difficult to use these traditional tools in a public event. Today, many urban simulation tools are available, including traffic, solar, wind, thermal, and energy consumption. These

emerging urban simulation tools help us understand the impact of our decisions in a quantitative fashion. However, even for professionals, some urban simulation tools are not only difficult to learn but also consume an enormous amount of time and computational resources to run. Complex, urban scale simulations normally take hours or even days, which makes the design and collaboration process high-cost, inefficient, and non-intuitive. Most simulation tools only focus on a single aspect of the performance, whereas a city is a complex system. To understand it better, stakeholders need tools that address the internal trade-off between multiple dimensions of the city's performance.

4. THE CASE STUDY: VIZUALIZAR

This case study explores how big data can be useful in urban planning through a project of the city bicycle system researched at the international workshop in Madrid, in which the author participated. The project is focused on establishing the tools of analysis and processing of data that will reveal the "pulse of the city". The case study examines the importance and role of technologies in the environment in the context of urban morphology. It shows a multidisciplinary approach where technological development is connected to environmental protection. Consequently, the research is based on the knowledge of information technologies and urban studies.

The case study that is present here is part of the joint efforts: on one side, the enhancement of environmental quality, and on another, development of IT and introduction of smart systems in managing the spatial and urban affairs. They illustrate how a productive link between IT and managing environment can be established, and how taken together they affect planning, making it more responsive and "fast forward" practice.

The *Visualizar* project, directed by José Luis de Vicente and held at Medialab-Prado in Madrid, is conceived as an open and participatory research project around theory, tools, and strategies of information visualization. As it was explained on web site, *Data Visualization* is a transversal discipline which harnesses the immense power of visual communication in order to explain, in an understandable manner, the relationships of meaning, cause and dependency which can be found among the great abstract masses of information generated by scientific and social processes (Medialab-Prado, 2014). *Visualizar 2008* had title: *Database City* and focus was on data visualization applied to the city context. The project aimed to represent real data of the city. *Visualizar* program has the aim to explore the social, cultural and artistic implications of data and proposed methodologies to make them more understandable and open for participation and criticism. A great number of prototypes were developed during workshops that tell stories through data: from measuring atmospheric pollution in the streets of Madrid to the use of social webs in the planning process such as Twitter. (Medialab-Prado, 2008), so from design systems, branding to social media marketing.

The projects developed at *Visualizar'08* explored issues connected only to the city, from the investigation of the role of information networks of the structures play in the construction of a modern city, all the way to the making knowledge base about cities via the data flows generated by their every-day activity. The main goal was to create tools to visualize this data so it could help to improve the urban design.

The methodology of the workshop consisted of the published main theme, second phase was giving proposals from interested authors, then the jury made a detailed evaluation of the technical feasibility

of carrying out the proposals which correspond to the subject and after all that was public call for collaborators from all over the world to participate at the selected projects that would be developed there. During the workshop, various activities were parallel maintained such as talks and presentations from great experts in those fields. There were eight projects which were going to be developed physically and five paper that was presented. So, the workshop had two sides of contribution to the subject - one strict scientific and second, as an experiment developed by computer programs or with some other physical mechanism.

BCNoids was the project or interactive design by Barcelona Tech Ph.D. students and architects Enrique Soriano *and* Marina Rocarols. The success of Bicing in Barcelona as a complex system was recognized by them as a possibility for studying its impact on the city. As they proposed, the project aimed to trace the uses of 400 stations and 6,000 bicycles to extract patterns of diverse periodicity. Those flows served as a tool that could be read via mass data processing tools. Program vvvv[1] were used to analyse and interpret flows issuing the information data of biking use**.** With other programs, authors made geo-visualization that reveals the "pulse of the city." It was the idea of making invisible visible.

“The art of distilling and translating masses of data into meaningful images requires precision and analysis. To begin the process of formally visualizing something, you have to know two things—data and audience. We have to figure out *who* we want to reach with this information. Learning about your audience, who they are, what questions they are asking, what information directs their decisions—influences how you illustrate the story” (Manning, 2012).

Figure 2: Map of Bicing stops in Barcelona (Medialab-Prado, 2008)

The goal was to show human mobility patterns in urban areas using the data daily generated. That made an interactive interface to visualize the processed biking data. The long-term objective of the project was to create an instrument for the prediction of the number of available bikes in each station. The used data was the number of available bikes and holes in each station of the community bicycle program, called Bicing, in Barcelona, accessible through the Bicing website.

The public bicycle rental service was introduced into Barcelona in May 2007, and its gradual and successful implantation ever since has transformed the cityscape. With their displacements, users of this service generate information on their journeys, bicycles, and stations which are then compiled in

[1] Used tools: Web Ripper by Pau Rodriguez, VVVV: a multipurpose toolkit for visual programming and a Korg Nano Midi Controller.

the central computer of BSM, the body managing the service, which then searches for mechanisms to optimize responses to imbalances in the use of its network. The information published on www.bicing.cat filters the valuable origin-destination matrix of users, and only publishes the state of using Bicing`s stations around Barcelona, This information is downloaded and stored using a scraper hosted on an independent server. Then, this database is later made accessible on the Internet, and through specific requests, it visualizes the use patterns and behaviors of this service on an urban scale (Soriano et al, 2009).

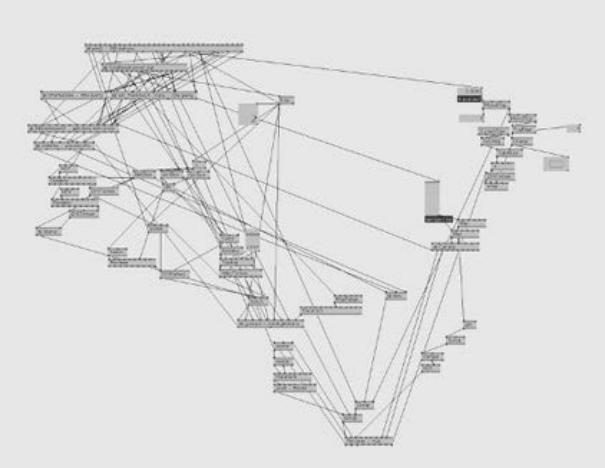

Figure 3: Data structure (Soriano, et al, 2009)

The Bicing webpage provides information on the service for users through Google Maps API. It shows a map of Barcelona covered with small markers indicating station positions and the number of available bicycles and free spaces for parking at each station. The data is inserted in the map using a JavaScript code with a chain of characters that contains a KML geospatial annotation document. To analyse the dynamics of the use of the stations, KML documents have been accumulated every five minutes, parsing it and storing in a MySQL database all the relevant information, such as the station name, localization, available bicycles and slots (Soriano, et al, 2009).

Figure 4: Map with showed active Bicing stops (http://vimeo.com/2352567)

The visualization tool is a web-based dynamic model that builds up the virtual space that the components generate, where through data some behavior patterns could be visible. The result of these data feed is a changing envelope, the layer above real ground model, a cloud, blurring virtual atmospheric architecture that has invaded from the activity of the citizens. It uses instruments that collect data of the existing public transportation bicycle to monitor a condition of empty or full slots.

Constant readings of these parameters are performed and data are collected from a large number of locations. These data are then delivered to the central server via the wireless network for further analysis and database storage. This real-time information about the number of slots is freely available on the interactive map accessible to virtually anyone with an internet connection or mobile phone. Primarily, it is intended to be visible and usable physically at every stop. Data are mainly used for monitoring bicycle traffic and if needed making the readjustments in traffic where traffic is jammed.

Visual information immediately shows outliers in the data, such as overall peaks at night when is some concert going on or spots where the distribution of bicycles during the daytime is overtaken. As with this example, flow diagrams are good for revealing some important information, from which we can easily conclude where touristic places are and the way we can predict places with empty slots. The important thing is that a message has to communicate clearly. The toolkit is a video that synthesis designed which facilitates the handling of large media environments with physical interfaces (real-time motion graphics) and audio-video that can interact with many users simultaneously.

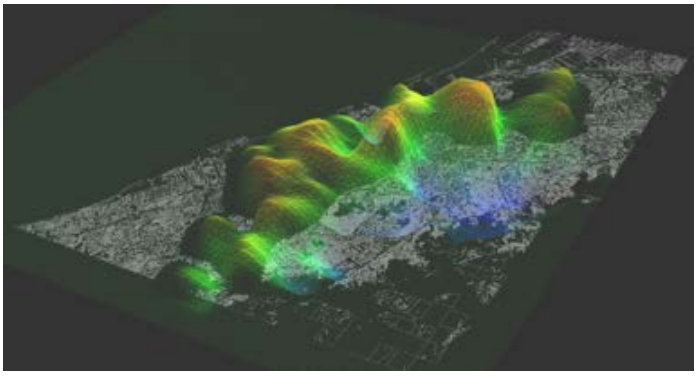

Figure 5: Dynamic map, pulsing envelope over the city (Soriano et al, 2009)

This project was developed in the framework of the Visualizar 08 Medialab- Prado Madrid workshop which set in place the optimum conditions for permeability between different disciplines. The result was a collaboration between various persons and the integration of the diverse tools they provided. Physicists and computer scientists materialized the ripper machine able to extract data and generate the database, while the city planning and design disciplines organized the overall data architecture and its visualization (Soriano et al, 2009).

The result of this workshop tried to highlight the importance of data structures in public decision-making and governance processes. What are the social benefits of fostering a culture of free, open data? The project purpose was a strategy for the construction and visualization of the urban digital skin, adding and remixing social media from users and conventional sources of information taken from the city. The active role of local users is by providing information, consume visualizations, or use the visualizations to make individual or collective decisions. The technology is simple and user-friendly.

This project can be used as a tool to identify the sources of bicycle slots. Thus, it can also be viewed as a form of participatory sensing. This crowd-sourced data help service to receive valuable data from public transport that can be used for the planning purposes and evaluation of the existing planning measures. The value of the system is that it requires immediate planning responses for solving problems in traffic. This system provides information about a specific location and it is updated

almost in real-time. It offers user-centric service – allows users to query specific data about bicycle location, while fosters two-way communication between citizens and municipality government. Finally, because of the faster and simpler use of the bicycle system, it helps in raising environmental awareness among the population.

The final result as the interface is data obtained and could be used as a set of emerging and promising tool that may become a standard part of bicycle systems, but also on a higher level for traffic engineers in planning.

5. CONCLUSION

The results from the case study of the bicycle system show that new methods still use simple mapping of the traditional urban morphology, but they are upgrading visualization a lot with precise data of the dynamical movements that make it more interactive. Visual representation is a powerful and effective way to impart information. It can help make complicated or tedious information – research, data, facts, statistics, demographics, history, weather patterns, traffic, growth, and more – relevant and easy to understand (Manning, 2012). The ultimate goal of the visual project is not only to connect with an audience but also to get some feedback from users so it can help to improve the functioning of the city. Presenting results from the workshop in this paper was significant because bicycle system represents just part of the city function and shows the great possibility to be implemented in other cities such as Belgrade or any bigger city in the world that has a similar urban problem such as, for example, density and poor public transport.

Data enable planners to base decisions about place-making on analysis and measurement using tools that allow them to better test and understand the implications of different decisions. This is the rise of the iterative city, one shaped by feedback loops that are constructed as planners rely on measurements of urban activity to inform their decisions, implement changes, and measure again to assess their impacts, which in turn serves as the basis for the next set of decisions. Such complexity necessitates tools that improve our ability to generate useful, accessible information from big data. Dynamic visualizations facilitate the extraction, interpretation, and dissemination of data, giving them great potential as communications tools for urban planners and designers. Such technologies enhance the planning process by connecting all parties. They also improve the ability to represent the city and planners should further explore the applications of dynamic visualizations as a contemporary medium for communication.

The most powerful tool of urban morphology is the understanding of urban change and evolution, the formation of a conceptual framework for design through transformation. However, there is a lack of broader awareness of the applicability of urban morphology not only in protecting the existing but also in designing the new. In accordance with the research of the practical application of urban morphological research, it can be concluded that morphological research can be included in the design and planning procedures in 1. initial, analytical phase – in the function of analysis of the existing situation, 2. the phase of generation of the solution in the design, that is, examining the possibilities of location in the planning - in the function of arriving at the optimal solution in the context of the given conditions and the terms of reference and 3. phases of formulating rules and restrictions for future development - in function of control of development (Niković, 2013).

Raising awareness about the need to use new technologies in combination with urban morphology, it is necessary to integrate them into the types of interventions and guidelines into the urban plans and projects, to provide public participation and education of citizens, local authorities and experts in the field of urban planning. Urban morphology plays a significant role as an instrument of linking architecture and planning concerning its multidisciplinary and multidimensional approach to urban form study, which enables the understanding of key qualitative properties. Aside from data gathering, the other important benefit arising from implementing smart solutions for monitoring environmental quality is the way they enhance public participation and environmental awareness of the general public – local population in particular (Bajić Brković, 2008).

Such smart technologies connected with traditional urban morphology can extensively contribute to urban planning and development on many levels, especially in the area of monitoring environmental parameters, thus extending the information base necessary for planning, and helping planers define priorities and steer developmental decisions in the right direction.

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