Visualisation as a Model. Overview on Communication Techniques in Transport and Urban Planning

TeMA

Journal of
Land Use, Mobility and Environment

This special issue collects a selection of peer-review papers presented at the 8th International Conference INPUT 2014 titled "Smart City: planning for energy, transportation and sustainability of urban systems", held on 4-6 June in Naples, Italy. The issue includes recent developments on the theme of relationship between innovation and city management and planning.

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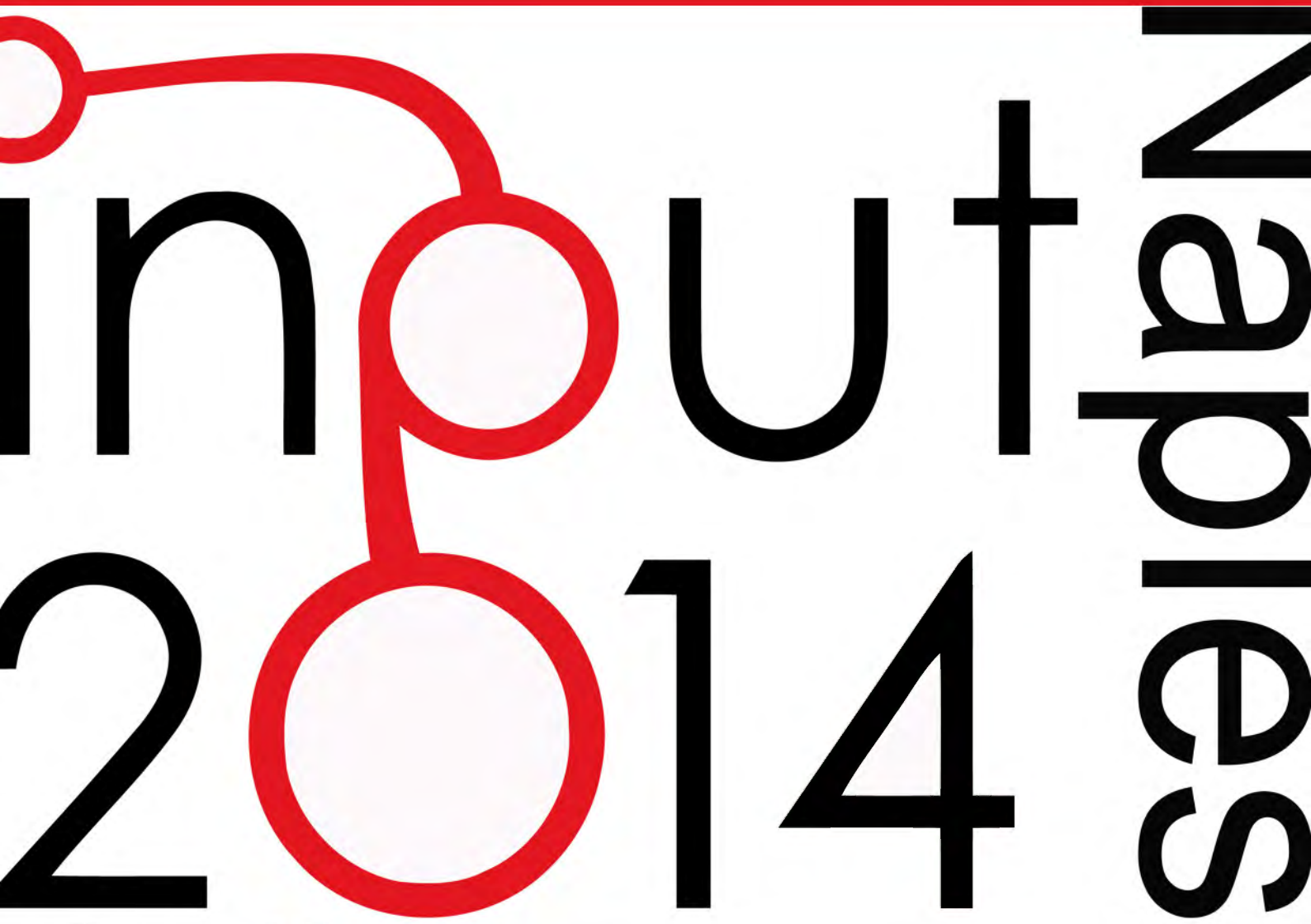

Smart City

planning for energy, transportation and sustainability of the urban system

Special issue, June 2014

print ISSN 1970-9889 e-ISSN 1970-9870
University of Naples Federico II

TeMA Journal of Land Use, Mobility and Environment

SMART CITY

PLANNING FOR ENERGY, TRANSPORTATION AND SUSTAINABILITY OF THE URBAN SYSTEM

Special Issue, June 2014

Published by
Laboratory of Land Use Mobility and Environment
DICEA - Department of Civil, Architectural and Environmental Engineering
University of Naples "Federico II"

TeMA is realised by CAB - Center for Libraries at “Federico II” University of Naples using Open Journal System

Editor-in-chief: Rocco Papa
print ISSN 1970-9889 | on line ISSN 1970-9870
Lycence: Cancelleria del Tribunale di Napoli, n° 6 of 29/01/2008

Editorial correspondence
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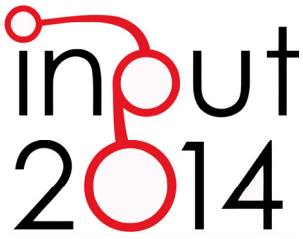

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EIGHTH INTERNATIONAL CONFERENCE INPUT 2014

SMART CITY. PLANNING FOR ENERGY, TRANSPORTATION AND SUSTAINABILITY OF THE URBAN SYSTEM

This special issue of TeMA collects the papers presented at the Eighth International Conference INPUT, 2014, titled "Smart City. Planning for energy, transportation and sustainability of the urban system" that takes place in Naples from 4 to 6 of June 2014.

INPUT (Innovation in Urban Planning and Territorial) consists of an informal group/network of academic researchers Italians and foreigners working in several areas related to urban and territorial planning. Starting from the first conference, held in Venice in 1999, INPUT has represented an opportunity to reflect on the use of Information and Communication Technologies (ICTs) as key planning support tools. The theme of the eighth conference focuses on one of the most topical debate of urban studies that combines , in a new perspective, researches concerning the relationship between innovation (technological, methodological, of process etc..) and the management of the changes of the city. The Smart City is also currently the most investigated subject by TeMA that with this number is intended to provide a broad overview of the research activities currently in place in Italy and a number of European countries. Naples, with its tradition of studies in this particular research field, represents the best place to review progress on what is being done and try to identify some structural elements of a planning approach.

Furthermore the conference has represented the ideal space of mind comparison and ideas exchanging about a number of topics like: planning support systems, models to geo-design, qualitative cognitive models and formal ontologies, smart mobility and urban transport, Visualization and spatial perception in urban planning innovative processes for urban regeneration, smart city and smart citizen, the Smart Energy Master project, urban entropy and evaluation in urban planning, etc..

The conference INPUT Naples 2014 were sent 84 papers, through a computerized procedure using the website www.input2014.it . The papers were subjected to a series of monitoring and control operations. The first fundamental phase saw the submission of the papers to reviewers. To enable a blind procedure the papers have been checked in advance, in order to eliminate any reference to the authors. The review was carried out on a form set up by the local scientific committee. The review forms received were sent to the authors who have adapted the papers, in a more or less extensive way, on the base of the received comments. At this point (third stage), the new version of the paper was subjected to control for to standardize the content to the layout required for the publication within TeMA. In parallel, the Local Scientific Committee, along with the Editorial Board of the magazine, has provided to the technical operation on the site TeMA (insertion of data for the indexing and insertion of pdf version of the papers). In the light of the time's shortness and of the high number of contributions the Local Scientific Committee decided to publish the papers by applying some simplifies compared with the normal procedures used by TeMA. Specifically:

- Each paper was equipped with cover, TeMA Editorial Advisory Board, INPUT Scientific Committee, introductory page of INPUT 2014 and summary;
- Summary and sorting of the papers are in alphabetical order, based on the surname of the first author;
- Each paper is indexed with own DOI codex which can be found in the electronic version on TeMA website (www.tema.unina.it). The codex is not present on the pdf version of the papers.

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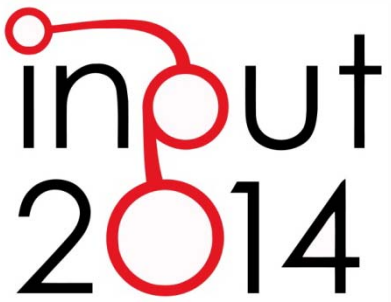

VISUALISATION AS A MODEL

OVERVIEW ON COMMUNICATION TECHNIQUES IN TRANSPORT AND URBAN PLANNING

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ABSTRACT

Information and Communication Technologies (ICT) changed the way planners present and operate with their projects. New visualisation tools have changed the ways projects and plans are presented and disseminated. However, the opportunities given by visualisation are not completely exploited in the professional practice. This is due to several bottlenecks which occur in the daily carrying out of activities.

The paper is organised in three sections. The first one explains how visualisation can be an added value to the planning practice if it is organised and designed as a framework of information; conceiving the visualisation as a model, data can be managed and represented in order to provide information at different levels of expertise, allowing city plans to be analysed and understood before their realisation. The second section resumes the changes caused by the introduction of ICT within the daily practice; a comparison between pre-digital and digital approaches highlights current opportunities for implementing the communication values of plans and projects. The third part illustrates some examples of innovative visualisations in the urban and transport planning practice, showing a number of uses of visualisation to fit different purposes. The paper concludes this insight formulating the necessity for integrating the studies on visualisation coming from different disciplines into a scientific method that can be proposed as a guideline in building the images of urban and transport plans. This would be particularly useful for obtaining a more scientific approach in the choices of representation and visualisation of urban aspects.

KEYWORDS

visualisation, urban models, ICT, representation.

1 INTRODUCTION

The use of technology in managing and processing different information has nowadays a strategic role in many fields of science. Latest Information and Communication Technologies (ICT) are increasing the possibilities to interact between users, to express and manipulate data, thus developing new perspectives and applications for experts.

ICT changed the way planners present and operate with their projects. In the last two decades, the daily practice framework has shifted from paper to computer screens, making visualisation a framework and technique for converting hand drawings into processed images. Nevertheless, visualisation is something more than a technical switching from manual to digital tools. Thanks to its visual properties which enable human intuition skills, visualisation can enhance the professional work in different ways. In particular, it can improve the process of knowledge building, thus making easier the communication between people.

However, the opportunities given by visualisation are not exploited in the daily professional practice. The reason is connected to several bottlenecks which range from personal skills in handling digital tools to the understanding of outcomes of these tools which are often not easily comprehensible (Couclelis 2005; Vonk, Geertman and Schot 2005; Geertman and Stillwell 2009). Furthermore, the use of visualisation is cross-disciplinary. This implies that the techniques related to its use are not defined by a systematic approach as it happens for other disciplines. In the transport and urban planning context, no common scientific standards have been defined in the visualisation field. Therefore, the building of images does not follow a pre-constituted scientific method, but it is often left to aesthetical preferences and personal choices.

This paper aims at bringing an overview on the use of new visual ICT within urban and transport planning contexts in order to analyse the relationships between the uses of visualisation and possible achievements in its application. It is organised in three sections.

The first one explains how visualisation can be an added value to the planning practice if it is organised and designed as a framework of information; conceiving the visualisation as a model, data can be managed and represented in order to provide information at different levels of expertise, allowing city plans to be analysed and understood before their realisation.

The second section resumes the changes caused by the introduction of ICT within the daily practice; a comparison between pre-digital and digital approaches highlights current opportunities for implementing the communication values of plans and projects.

The third part illustrates some examples of innovative visualisations in the urban and transport planning practice, showing a number of uses of visualisation to fit different planning purposes.

The paper concludes this insight formulating the necessity for integrating the studies on visualisation coming from different disciplines into a scientific method that can be proposed as a guideline in building the images concerning urban and transport plans. This would be particularly useful for obtaining a more scientific approach in the choices of representation and visualisation of urban aspects.

2 VISUALISATION AS A MODEL

Representation and visualisation are terms often used as synonymous, but a substantial difference exists between the two. To represent means to symbolise (Oxford dictionary) so that representation is a selection of the reality, which includes an intention and can be visually showed within a map or a shared system of signs. Meanwhile, visualisation is a term formed by the combination of the words action and visual: it is the action to make something visual. This gives to the visualisation the characteristic to communicate by visual language, which is recognised as a more intuitive and useful form of communication. In fact, it can enhance

the process of knowledge building by the illustration of the hidden relationships which occur between different objects (MacEachren, Cai and Hardisty 2003; Dodge 2005). Therefore, visualisation contains the representation, but it is something more. Visualisation allows the data exploration and makes visible the connections between different elements, so that it can be considered as a framework for selecting, filtering and organising data (Masala, 2014). In this sense, visualisation can be defined as a model. Therefore, visualisation becomes a way for conveying knowledge by means of a classification of entities, reading processes and components of visualisation.

2.1 THE MODEL FRAMEWORK

The flow of information within spatial studies is based on the translation from a reality, perceived as rich and complex, to a representation of reality, which results limited and simplified but useful to illustrate an idea. This passage is the result of a modeling work that uses the brain as a filter and generates unique interpretation of the reality. For instance, a group of different people standing in front of a beautiful landscape may experience and perceive diverse aspects of the same reality, highlighting the several semantic richness of a landscape. On the contrary, a model of the same landscape, as it can be a map or whatever representation of that reality with arbitrarily chosen elements and fixed codes, returns a unique interpretation.

To build a visualisation, conceived as a visual data model, some considerations can be done.

- Firstly, it is essential to identify “physical” or sensible entities that can be objectively determined. These entities are the elements which can be assumed as variables in the model. The relationships between these entities are the information to be analysed.
- Secondly, the process of visualisation assumes that the model builds a unique relationship between data and goal. Thus, the goal is considered a guideline throughout the construction of any component of this process and cannot be considered as a separated object.

After that, the model can be structured to reach a goal trough a chain of relationships connecting different entities (fig. 1). Three entities have been identified:

- the *medium*, or device, which is the physical object that supports the message. It can be referred to a map as well as to a wood mock-up or a software image;
- the *message*, intended as information, which is limited to what is physically and objectively observable and countable;
- the *knowledge*, a target achieved by users at the end of the reading process as a determinable object, strictly related to the success and effectiveness of the visualisation.

To connect these entities each other, three relations have been recognised:

- The *reading process*, which constitutes the relationship between the medium and the message, physically observable and countable. It is determined by the visual grammar, made of signs, colours, shapes and order, and it is affected by the capacity of the human eye to read and catch different images. The visual grammar is lowly susceptible to interpretation.
- The *communication* is referred to a higher level of reading, in which the message is converted into knowledge. It is the relationship between the objects of the message and the knowledge that the receiver is supposed to achieve. It is susceptible to interpretation.
- The *fruition* is referred to the capability of the receiver to use the new knowledge acquired through a visualisation process. It strongly depends on personal skills of the receiver in using what has been learnt during the pursuing of the objective. It is highly susceptible to interpretation.

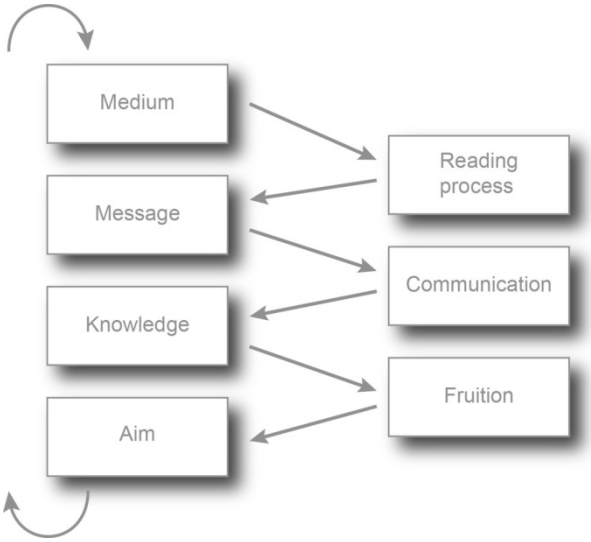

Fig. 1 Visualisation as a model: the structure of the model

However, in all cases, the process of knowledge deeply depends on two main elements: firstly, the personal skills of end-users of the visualisation and, secondly, the uniqueness of visual messages. Ambiguity on the representation, misleading information, cultural differences between actors are all factors which can affect the effectiveness of the visualisation and generate problems that can bring to a failed communication. For these reasons, the process of building a visualisation as a model requires a planned design which could organise the knowledge within a determined framework. Only through this designed framework, data can be managed to provide information at different users with different skills and backgrounds. Therefore, visualisation can be an effective support for implementing the urban and transport planning processes, allowing plans and projects to be explored before their accomplishment and evaluated by actors aware of their choices.

3 BRIEF OVERVIEW ON THE TRANSFORMATIONS INDUCED BY ICT

New Information and Communication Technologies (ICT) brought several changes on the methodologies and tools conceived for supporting the urban planners' practice. In the last two decades, all the aspects concerning the communication and acknowledgment of information have been strongly improved. The widespread use of websites and social networks has led to innovative possibilities to provide information for the general public. Meanwhile, important changes have occurred among the possibilities for the management of land use, of urban facilities, functions and morphology. In particular, ICT provide different devices for the planning and management of cities, offering instruments for modelling the cities (Batty 1976; Wegener 1994, 1995), for supporting planning and decision processes (Batty and Densham 1996; Geertman and Stillwell 2003, 2009; Klosterman and Pettit, 2005), or for structuring and evaluating the geo-graphical information within systematic frameworks (Malczewski 2006).

With regard to the past physical medium, ICT brought several innovations, which increased the number of applications and the accessibility to information. Table 1 resumes the main differences between traditional supports and digital tools for each part of the visualisation model.

For instance, an evident change is the acquired dynamism in rapidly modify the scale of a drawing or a map when needed it. This possibility may involve a greater manageability for the user and also provide the opportunity to represent different levels of detail at the same time. Furthermore, the use of a dynamic scale

in time makes possible the representation of multiple dimensions and the visualisation of non-static and evolutionary phenomena, like the maps of traffic and parking availability.

	TRADITIONAL SUPPORTS	DIGITAL TOOLS
MEDIUM	Fixed scale Limited space Handy use	Dynamic scale Unlimited space Visual use Easy links to other documents
Reading process	Fixed codes Deterministic	No standard Undetermined and subjective
MESSAGE	Unique	Plural
Communication	Static and objective Not interactive	Dynamic and subjective Interactive
KNOWLEDGE	Rigorous method Limited accessibility Low ambiguity	User based Highly accessible Possible ambiguity
Fruition/use	Restricted Conveyed	Possible ambiguity Open to new applications
PURPOSE	Unique	Plural

Tab. 1 Visualisation as a model: differences between traditional paper-based supports and digital tools

In addition, the process of reading information on traditional supports is characterised by fixed codes which result more rigorous and scientific, such as the graphic elaborations of colours and backgrounds in the tables of urban master plans. Thus, users who are familiar with these codes are enabled to receive a clear, objective and unambiguous reading. On the contrary, new ICT are not yet subject to fixed codes or standards. The choice of colours, shapes, patterns is often left to the personal preferences of the technician who builds the image, so that, sometimes, the reader may be led into error because misunderstanding a subjective interpretation of the modeller.

Moreover, the use of new ICT allows a multiplicity of messages to be generated through the same graphical visualisation. This feature enables the representation of larger amount of data and consequently a richer and more detailed description of the phenomena represented. In particular, interesting possibilities are given by the use of data coming from new types of dynamics platforms, which constantly generates large amount of records known as “Big Data”. Social networks as Facebook, Twitter, Instagram, Flickr or Foursquare, telephone companies and data from User Generated Content (UGC) represent the new frontier for the analysis and design of future cities. Therefore, the plurality of data is not only a better source for gathering information, but it represents also a way for obtaining important input from different parts of the urban society, improving the bottom-up approach within the urban planning. Thus, ICT offer the opportunity to increase the social inclusiveness and participation in the urban design process, allowing new possibilities for cities to become socially smarter.

Visualisation in urban planning context can enforce knowledge, allowing the final user to be guided in understanding and becoming conscious about facts and projects concerning the planning issues. The message is carried through a virtual communication, that is no more static and objective as the traditional support, but subjective and dynamic. Visualisations through ICT can have a greater visual impact than traditional supports, so to provide more opportunities to caught decision makers' mind. Therefore, through the interaction with the information, the user becomes an active subject in the process of knowledge. As a consequence, the point of view becomes plural and connected to the perspective of every user.

As a conclusion, it is evident that the increased flexibility enables the possibility to produce more appealing and attractive visualisations, thus enhancing the capacity of communication of messages.

To be successful and provide a high level of knowledge to the final user, the construction of a visual support for decision makers with new ICT is strictly linked to the expertise of final audience. In fact, visualisation should be based on its users. Therefore, knowing the public is fundamental to resize the visualisation on audience's culture and level of experience. This is also essential to make the transmission the most efficient possible to avoid the problems of communication typical of traditional supports .

With regards to the process of fruition, intended as the use of knowledge for the achievement of the purpose, conventional supports are characterised by limited space and less flexibility than tools given by new technologies. For example, a traditional map is usually made only for one purpose limiting consequently its fruition, while new digital instruments can have a variety of purposes that extend their applicability.

In conclusion, the introduction of digital tools has increased the accessibility to information and the opportunities for implementing the communication values of plans and projects. Nevertheless, analysing the daily use of tools in planning practice shows that technicians and experts in spatial studies make a limited use of technologies. Therefore, more awareness is needed in the use of new ICT so that more opportunities can be properly exploited.

4 EXAMPLES OF USE OF VISUALISATION IN URBAN AND TRANSPORT PLANNING

To visualise the city, a process of selection and filtering of reality is needed. Therefore, a model of the city itself should be created. According to this concept, the city may be divided into three layers, by three different point of view in which urban planners take into account the complex urban fabric: the first level of the city, "*urbs*", regards the structural and physical aspect, representing buildings disposition, transport localisation, within technology network and energy resources. The second interpretation level of the city, is called "*civitas*" and comprehends the functional social and economic aspects, like the social and economic behaviour of the people living there, throughout their work place, the majors activities in town, public service lifestyle, ethnic groups and their different living places, and so on. The third and last point of view, looks at the city as a cultural aggregate, the "*polis*", expressed in its governance, in its ability to be renewed and bearing its quality of life.

As in the previous chapters visualisation has been discussed as a model for the organisation of data and information, in urban and transport planning the visualisation of a model may assume a threefold utility throughout different functions (Occelli and Rabino 2006):

- *communicating to other people* (visually expressing ideas)
- *operating policies* (evaluating projects with simulation)
- *learning problems* (showing the city dynamics and structure, points of strength and weakness).

These functions allow different levels of knowledge to be achieved by users. As discussed by MacEachren *et al.* (2003), the purpose of the visualisation can strongly affect the possibilities of knowledge building for actors involved in the planning processes. In the case visualisation aims at communicating with other people, users can just attend a presentation of data. In the second case, visualisation can support planners in operating policies by means of analysis and evaluations, providing useful information to understand the dynamics of a spatial system such as a city or a region. However, only in the case visualisation aims at learning problems, users can really achieve awareness of the city inner structure and take conscious decisions. Through the exploration of the information, users can reach a high level of knowledge about spatial issues and form a personal consciousness on questions to be solved. Then, a successful visualisation

provides a support to the planners' job and helps users in visually acquiring knowledge, understanding different dynamics and strategies.

In approaching visualisation, two important issues has to be addressed: one regarding the use of the model, related to its final aim, and the other regarding the choice of the visualisation method, related to what is meant to be showed. Therefore, a matrix can be combined between city layers (urbs, civitas and polis) and visualisation purposes (presentation, analysis and exploration) (tab. 2).

	URBS	CIVITAS	POLIS
PRESENTATION	• Rendering • 3D morphological models		
ANALYSIS		• Dynamic maps • Tools for filtering GIS data	
EXPLORATION			• Semantic models • nD interactive visualisations

Tab. 2 Matrix between city layers and visualisation purposes

Analysing the physical object, that is the city as "urbs", even if ICT allow new possibilities, there are not so many innovations about information included in the model. 3D construction and maquettes are not too different from a 3d representation such as the mock-up built using CAD software (Fig.2).

Fig. 2 Physical city:3d visualisation of Milan

In this case, the visualisation operates just as a form of communication to other people, limiting its purpose to present data.

However, the difference is substantial when handling the mock-up. The classic three-dimensional maquette can be touched, moved and rotated by hands, but it is strictly connected to the physical presence. At the same time, a digital maquette can be anywhere and visualised worldwide, without needing to be in a particular physical place. It can be scaled in and out allowing free use of its form, but it can not be touched yet (gloves for virtual reality explorations have not reached yet the expected sensibility for users).

If visualisation is used to analyse the functional aspects of the city (the so called "civitas"), traditional supports present more difficulties. At this level, the information technologies can provide the maximum of support for creating visualisation models of the city. This is due to the complexity of data and the large amount of elements to be represented, which are better managed if using a calculator. For example, the

analysis of specific aspects, such as the social behaviour or data streams, is better represented if the scale and the image are dynamic (Fig. 3).

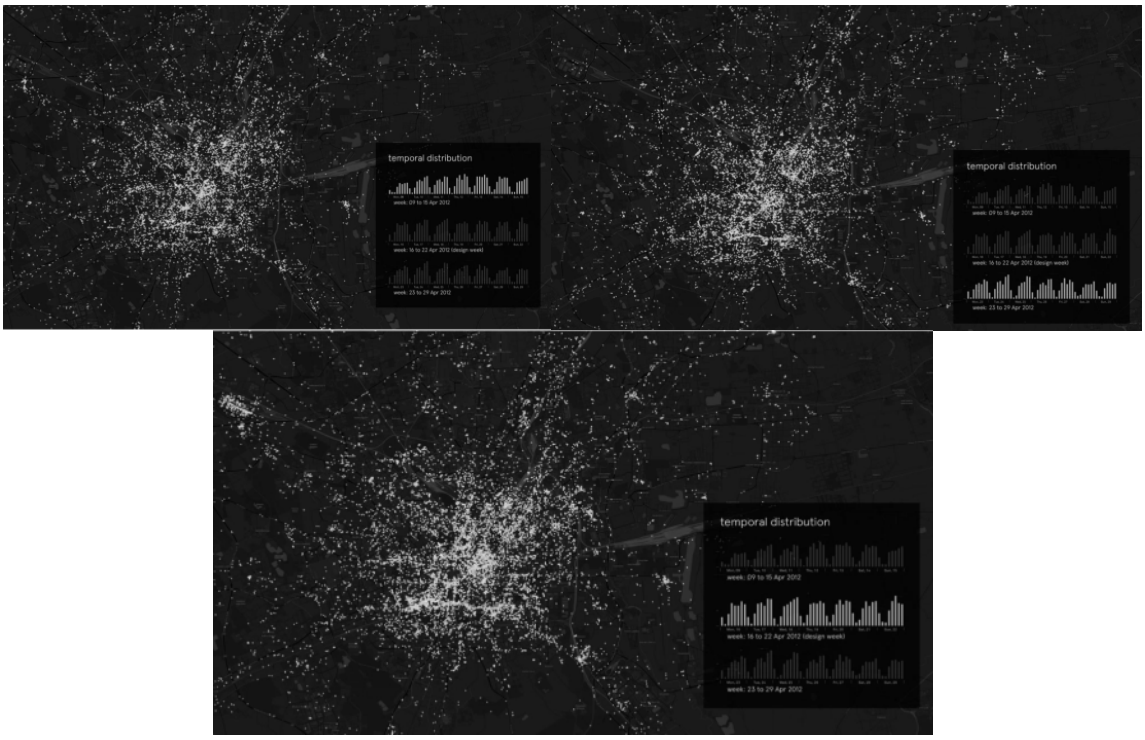

Fig. 3 Socio-economics city(maps of tweets in Milan during design week)

In this example, the use of "Big Data", or data coming from user generated content (UGC) technologies can provide deep insights within the cities, which cannot be seen in other ways. The comparison with classic tools is practically non-existent. This kind of city model is an innovation which is possible only through a complex management of very large data base.

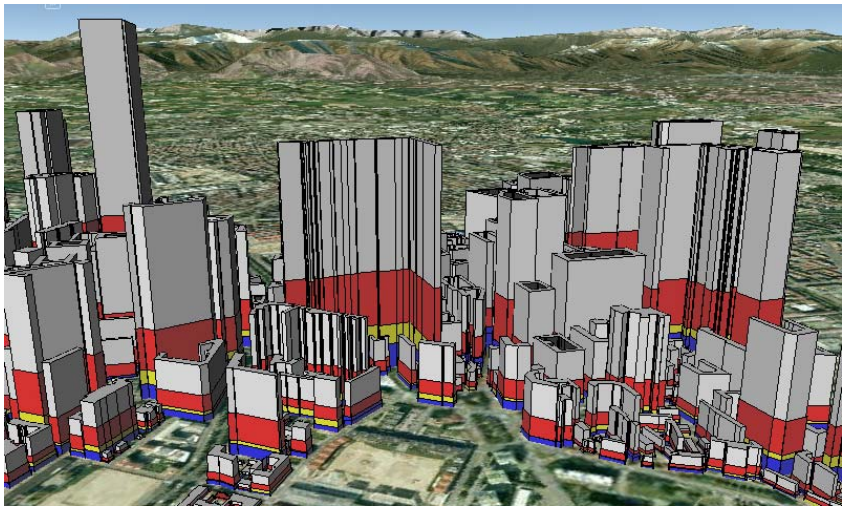

Fig. 4 Datascape for the exploration of form and function within the existing city

At the third level, the city is conceived in its ability to create a proper strategy for its own development. It is the polis, the brain of the city. In this case, visualisation can offer many advantages in creating shared

visions and providing an imagery for producing common perspectives among citizens, stakeholders and policy-makers (fig. 4).

Datascapes, as well as other geo-referenced diagrams, generate information on the behaviour of the urban spaces, providing important information on the dynamics occurring within the city. This sort of images can provide leading guidelines for the construction of new visions and policies of the city, explaining which are the key elements that most affect its behaviour.

Visualisation can thus be used in different ways on the basis of pre-fixed purposes. Depending on the urban layer which has to be renewed, visualisation can assume different form and be adapted to satisfy specific tasks.

5 CONCLUSIONS

This paper introduces elements for investigating the potential of the use of visualisation within urban and transport planning. Analysing the different possible applications, it suggests the visualisation as a model to organise the process of knowledge of spatial systems. The paper proposes a method for conceiving the visual support as a framework for leading analysis, evaluations, communication, discussions and decision-making within planning processes. Nevertheless, this insights formulates the necessity for integrating the studies on visualisation in order to obtain a more scientific approach in the choices of representation and visualisation of urban aspects so to best fit the opportunities given by the use of ICT tools within the planning practice.

Additional developments from this work, that would require a more complex and deep investigation, are expected to be carried out within an International group of work, capable to link different competences and expertise such as: informatics, designers, city planners and urban engineers, who might increase knowledge and awareness on the use of visualisation within the planning practice.

ACKNOWLEDGMENTS

Contributions to this paper are as follows: G. Rabino, conception of the paper, overall guidance of the research; E. Masala and S. Pensa, theoretical insights on visualisation and operational supervision of the research; D. Adamo, S. Baccinelli, U. Del Gobbo, D. Gibin, analysis of visualisation methods.

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IMAGES SOURCES

Fig. 1: Authors' image.

Fig. 2: Rainer Schmidt Landschaftsarchitekten, 2010.

Fig. 3: GiorgiaLupi, 2012. https://giorgialupi.net/2012/07/01/design-week-tweets/.

Fig. 4: Stefano Pensa's image: Pensa, S. (2013). InViTo - Geovisualizzazione interattiva a supporto dei processi di decisione territoriale. PhD thesis. Torino: Politecnico di Torino.

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