The effects of decision-making on urban form

A tool for supporting planning processes

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Introduction

In wide area planning, collaboration and participation are nowadays a common approach to the creation of a land or urban design [1,2]. Thus, planning involves different kinds of professionals, usually coming from different disciplines and, in particular, speaking different languages.

GIS technologies are generally used as support to investigate planning and decision making questions, but knowledge process is often limited by the lack of users' ability in reading output data. Thus, the improvement of information sharing among many users is one of main tasks of Information and Communication Technologies (ICT) [3,4]. This is commonly achieved through the use of visual tools which allow users to understand data through intuitive perception.

For this reason, the ongoing research described in this paper is investigating a modelling system to combine visual tools with GIS technologies, in order to create a shared common language which could be able to really support wide area planning processes.

Proposed tool & method

This study focuses on the creation of a modelling system [5] to be used during focus groups, workshops and meetings which works with McNeel's "Rhinoceros" software, its free plug-in "Grasshopper" and other scripts in Visual Basic language [6]. To use shapefiles, or generally databases, this tool works together with Microsoft Excel and support large sized databases.

The here proposed modeling system wants to improve the cognitive process through an interactive framework, which combines different data in a complex structure of relations and connections. Each data has assigned a spatial behaviour, which can be described by mathematical formulas of different nature. Furthermore, each element of drawing can be connected to others and produce an attractive or repulsive

influence on them. In order to provide awareness on the spatial effect of planning choices, all functions among data within the model can be modified and set by users as decision makers, professionals and experts. Users can decide the influence among infrastructures, services and functions on different scales, as well as the suitability of a specific feature or the weights of each connections among data.
Since this tool is based on parametric and generative features [7], the spatial behaviour of data is represented by volumes and shapes that changes their form in a three-dimensional environment. This tool can produce 3D shapes directly from databases maintaining all their properties. Users can modify the values of specific issues and see in real time the effects on urban shapes. The system can provide different kinds of output as 3D models, 3D diagrams or dynamic maps, but it can also be used to represent a large amount of thematic views, both spatial and non-spatial as suitability, density or real estate values through different visualization techniques.
Planners and, more generally, decision makers can directly evaluate their large scale choices as effects on small scale areas, improving their perception and knowledge on urban dynamics.
This tool can be used to simulate and pre-figure “What if?” questions but, at the moment, it does not support time dimension. While simulation models generally provides a spatial output for each temporal step, it offers a vision of future outcomes but not their temporal sequence. However, this lack showed to be an opportunity for limiting misunderstanding because users do not use it as a “crystal ball” but, as it might be, as an instrument for work and evaluate choices. Then, the temporal horizon depends on the area and projects in which future is just the end state of a common shared perspective.
Differently from typical land use simulator, this system can work directly on the real land or urban shape, thus eliminating the questions concerning the sub-division of areas in parcels, the approximation of distances and the orthogonalization of shapes.

The application on a case study

This method has been used to study an urban area. The research concerns the planning of brownfields localized on the metropolitan border of Turin (Italy). It involves the study of many aspects as well as transport system infrastructures and land use.
The relations among data and their spatial behaviour are defined by mathematical curves. To set these curves, the study here described uses three kinds of input. The first is normative and defines areas which can not be built, protected zones or, more generally, the limits and constraints to specific functions. The second input is based on a survey compiled by different kind of experts: the survey results are compared with thematic literature and local trends of growth measured on other parts of Turin area [7,8,9]. Finally, transport simulation provides data on environmental pollution, offering a map of healthiness. These inputs allow to build in Rhino a general growth model able to reproduce local behavior and pre-figure different spatial solutions for the area (fig. 1).

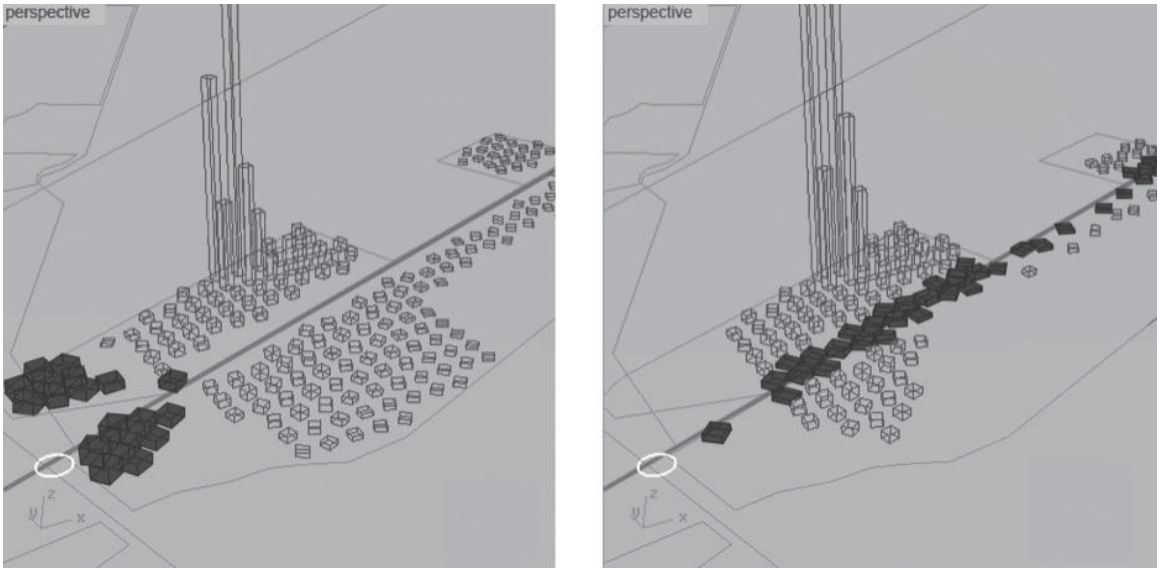

Figure 1: Figures above represent the same area with two different values on the attractive power of the central main road. In the first image, the white circle, which represents an underground station, has more attractive power than in the second picture, where the central road privileges the car system. Location choices for both residential (light gray boxes) and commercial (dark gray boxes) buildings changes with transport system modification.

The attractive or repulsive action of spatial axis (generally represented by the path of railways, highways, main and local roads, subways and rivers) or points (as subway and railway stations) on urban functions are used to calculate several issues. For example, the relations between public transport system and suitability on residential buildings or their maximum acceptable distance from facilities.

Results and conclusions

The application of this modeling system to a real case study provided a lot of positive responses. Firstly, the tool has been used to evaluate a number of scenarios proposed by real actors. This first application on a planning issue showed the effectiveness of this tool, which generated a functional localization very similar to the one proposed by city's architects. The comparison between the simulation output and the experts' design showed an important similarity, proving that the tool can provide a reliable support to planning, generating urban functions that fit with real requirements. The tool marked also a lack of infrastructures in the starting plan of analyzed area, thus providing useful recommendations. This application suggested also a further use at smaller scales for generating urban shapes, however this remains an opportunity for future studies.

Finally, this ongoing research has been applied for discussing with few actors some projects on area. The tool showed its utility in interactively feeding discussions on planning choices. It allowed to visualize the effects of different choices, calibrate the model with local behaviour and, in particular, it procured a shared basis for the agreement among actors.

In front of many opportunities, some questions remain to be solved. Each project needs to follow specific local dynamics, thus the curves defining the spatial behaviour of data must be set and calibrated each time. Furthermore, since users have different knowledge, also the typology of visualization technique must be set to adequately reach different actors.

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References

[1] **Van den Brink, A. et al.** (2007), Geo-visualization for participatory spatial planning in Europe: imaging the future. Wageningen Academic Publishers, Mansholt publication series vol.3, Wageningen

[2] **MacEachren, A.M. et al.** (2004), Geovisualization for knowledge construction and decision-support. Computer Graphics & Applications, Vol.24, n.1, p.13-17

[3] **Andrienko, G. et al.** (2007), Geovisual analytics for spatial decision support: Setting the research agenda. International Journal of Geographical Information Science, 21(8), pp. 839-857

[4] **Batty, M.** (2007), Planning support system: progress, predictions, and spectaculations on the shape of things to come. CASA, working paper series, n. 122, 09/2007, UCL, London

[5] **Lami, I.M., Masala E., Pensa S.** (2011), Multiple Criteria Decision Analysis and visualization of spatial data: an application to a Corridor 24 section. MCDA'73 proceedings, in press

[6] **Payne, A., Issa R.** (2009), The Grasshopper Primer, second edition, http://www.liftarchitects.com/storage/research/Grasshopper%20Primer_Second%20Edition_090323.pdf (accessed 04-20-2011)

[7] **Marietta, C.** (2008) Metronord, forme urbane emergenti nel territorio tra Borgaro, Settimo e Torino, coordinamento scientifico F. Corsico, R. Roscelli (Ed.), Celid, Torino

[8] **Bravi, M.** (2006) Processi di trasformazione urbana e mercato abitativo: il caso della città di Torino (Italia). ACE - Arquitectura, Ciudad y Entorno, vol.1, n.2, octubre 2006

[9] **Città di Torino,** (2010) Piano urbano della Mobilità Sostenibile (PUMS). Città di Torino, Divisione infrastrutture e Mobilità, planning report, Maggio 2010