ANTICIPATING THE IMPACTS OF URBAN DESIGN PROJECTS STARTING FROM THE PEDESTRIANS' EXPERIENCE

Barbara E.A. Piga [1], Valerio Signorelli [1], Eugenio Morello [1]

Abstract

The paper presents a four years study, developed by a university research laboratory, that deals with the anticipation of outputs of urban transformations. The main aim of the conducted investigation was to explore the ability of different tools to anticipate specific impacts of urban design projects in an interdisciplinary way. In particular, the general themes investigated concerned visual appearance (composition) and environmental conditions, i.e. shadowing condition, using simulations. In addition a specific point of view was used: how is it possible to anticipate the outputs of a design project from a perceptual point of view?
The research was conducted both in theoretical and experimental terms. For this reason a specific case study was analyzed. The required characteristic for the choice were: dimension and complexity (big urban project), importance for the city (centrality), implementation in a short time (project under construction). Besides studying the performance of the urban design project as a whole, we simulated it in order to clarify its output from an experiential point of view. To depict the perceptual impacts we used different typologies of simulations and we compared the possibilities and effectiveness of each one. Since this specific point of view was one of our main interests, a great attention was devoted to the tools that allow a dynamic description of the urban environment. Moreover, we were not focusing our attention on the functionality of the architectural projects alone, but on their cumulative effects on the urban environment. For this reason, we studied the output of the project starting from its local physical context (walking towards the project) and at the urban level (looking from a distance: changes in the skyline).
The use of a great number of different kind of simulations were experimented on the case study according to their proper characteristics. Since each one has its own limits and vantages, a combined use has been shown to be preferable for a more comprehensive understanding. In order to check the effective usefulness of the tools in a definitive way, we present a survey that allows to compare the real output of the urban project, which is almost completed, and the simulated one. The comparison gives an important feedback about the real capacity of the tool, helps to improve the entire approach and contributes to complete the theoretical framework. This will be the basis for future work on simulation, but it will also be an occasion to demonstrate the potentiality of this approach in depicting some relevant outputs. This could

[1] Laboratorio di Simulazione Urbana «Fausto Curti», Department of Architecture and Planning, Politecnico di Milano, Milano, Italy – eugenio.morello@polimi.it

improve the process of negotiation between public and private stakeholders, collaborating to the delivery of better public spaces.

1. Laboratorio di Simulazione urbana 'Fausto Curti' framework

This paper illustrates the results of the main researches activities developed by the *Laboratorio di Simulazione Urbana 'Fausto Curti'* (LabSimUrb) of the *Politecnico di Milano*. The research laboratory was founded at the beginning of 2007 by prof. *Fausto Curti* and prof. *Peter Bosselmann* with a threefold mission: to innovate, to experiment and to communicate. Using innovative methods of investigation and simulation to be integrated to more traditional methods of analysis, design and evaluation. Verifying through experimentation the outcomes of design alternatives in order to facilitate the understanding and to show the consequences of planning decisions. Effectively communicating the results of urban changes in order to facilitate the confrontation between planners, policy makers, developers and citizens (Laboratorio di Simulazione Urbana "Fausto Curti", 2011).

The research about Urban Design themes is conducted through the use of different kinds of simulations in order to predict some relevant outcomes, especially about perceptual and environmental impacts of new constructions. The first four years of the laboratory activities were devoted to set up the research methodology and to verify the proposed approach. In order to do this, we focused on a specific case-study area, the *Garibaldi-Repubblica* redevelopment project in Milan. The urban planning framework of the case study, and the first stage of the work, was presented at the ACSP/AESOP Joint Congress in 2007 (Arcidiacono et al., 2007), and in other several papers.

All the research works have been elaborated in collaboration with students from Architecture and Urban Planning, and part of the outputs presented here, are indebted to the theses that were developed at the laboratory on the ongoing research themes..

2. Perceptual and Environmental Simulation

The laboratory works both with conceptual (abstract) and perceptual (lifelike) simulations. The main interest is directed to the anticipation and the understanding, thorough simulation, of urban transformations and their effects on the experience of the city users. This is intended as a result of the correlation between the physical city structure with the generated dynamic conditions (visuals, shadowing, temperature and so on). In this sense, simulations are used as a basis for depicting in a realistic way the foreseen urban condition, and as a stimulus to which every user can react subjectively. From a perceptual point of view this means that we deal with photorealistic simulations that can guarantee an analogous interaction between the user and the simulation itself. As reported in the doctoral thesis of Barbara Piga (2010), each typology of simulation can address a different kind of interaction that can replicate, with a variable degree of equivalence, the actual one. From this point of view a tool that is able to describe the urban condition in a dynamic way, and that

can guarantee a certain degree of freedom of navigation and sense of immersion is the one that can better fit the real fruition of the environment; indeed, the urban experience takes place in time and space and our physical involvement gives us the sense of place. Despite this, each medium can help focusing on specific aspects of the described context, so that in our opinion it would be inappropriate to claim that one type is better than another. A video can well represent a walk in a street, while a panoramic image forces us to stop and focus on a specific point of view, exactly as we do when we live a city going from one place to another or we stop for looking around. Nevertheless, in both cases we are looking through the authors' eyes; this can be a benefit, because it allows to consider some important aspects of the urban projects, but at the same time it can be a relevant limit because the user cannot personally choose where to look at, and sometimes can even consider this as a lack of transparency: there is always the possibility that something is voluntarily hided. The same medium used in an interactive navigation can solve this problem, but cannot assure that all the representative points of view of the project are caught. Another modality of interaction can instead give the possibility to navigate the same place in different conditions, e.g. seasons or daytimes, or comparing project alternatives, and this can significantly enhance the comprehension. As it was shortly shown, it is important to understand what each tool can tell us. To better understand the proper ability of different mediums we tested different typologies of simulation on the same case study and we compared their potentialities and limits in depicting the urban condition from a perceptual point of view . In general, and if possible, a combined approach is preferable, and can increase the possibility that different (and related) ranges of implications are grasped.

Since the final goal is to enhance and to support the urban design process in all its phases, from the creative process to the evaluation one passing through public participation, it is important to understand in which way this approach can be a valuable framework and which are the more appropriate tools for the different needs. For this reason we tested the approach on the different design phases. In the first period of the laboratory activities we worked on the Garibaldi-Repubblica project in Milan; in this case the study was directed to analyze the use of perceptual simulation as a support for evaluation. After this phase we moved on, and we tested the same approach for developing guidelines to guide urban transformations. This experimentation was carried forward with the collaboration of students who developed their master design theses on the topic (Bulgheroni et al 2012) . The experimentation on some case studies helped us to focus on specific needs and always lead us to develop scientific methods to answer to specific purposes or demands.

This year we started to apply the approach for the design phase. In fact, a new master class linked to our laboratory activities started this March. For instance, students are asked to develop their design ideas starting from the perceptual point of view and with the support of different typologies of simulation, especially those that encourage them to think about the environmental and the urban experience as a coherent dynamic system. Another research branch at the laboratory deals with the theme of information and public participation. In this direction we started to develop a tool, the 'Tavolo Luminoso' with two colleagues, Laura Cibien and Francesco Secchi, and

its theoretical applicability on the topic of public participation became Laura Cibien's MSc thesis.

The work of the laboratory is now focusing on the previous mentioned different topics, as well as the research of new simulation tools that can support the improvement of the final outputs of urban design projects, both from the side of the designers and the decision-makers involved in the process.

3. Building an approach for urban simulation

The Garibaldi-Repubblica case study was chosen because of the following aspects: its strategic location for the city, indeed one of the last vacant and very accessible areas, close to the city center; the large amount of volumes involved in the urban transformation, because the total buildable floor area is over 330,000 sqm and the land utilization ratio is approximately 1sqm/sqm; the number of different stakeholders involved, such as several architecture offices, real estate developers, the public administration and the citizens, especially those already living in the area and who have reacted against the intervention. As it was already presented in other occasions (see the references above and the bibliography), we used different typologies of simulation in combination, in order to reach a more effective comprehension of the design outcomes. We started with traditional analysis, such as historical analysis, morphology, land use, infrastructure and green structure and then we move to perceptual and environmental studies. As a matter of fact one of the aims of the laboratory is to develop an integrated approach that can lead to consider how different aspects of the environment act together and which is their mutual influence. Sometimes the best solution is a compromise between several factors, that is the one that enables a positive balance between all the issues. For this reason we tend to work at least with environmental and perceptual impacts of projects, especially vision and hearing.

We started using simple tools, e.g. photomontage on single images, and then we moved on to more elaborated solutions that can better depict the design project effects in dynamic terms. To do that we used photomontages in sequences, renders, videos, Virtual and Augmented Reality. Having a photorealistic scale model at hand, the quickest solution for a first navigation in the transformed urban environment is to guide a micro-camera (Figure 1) within the model and look at the transformation from a subjective point of view (Figure 2). With a micro-car, developed by BetaNit for and in collaboration with our laboratory (Prati et al 2009), the area was explored and some representative point of views were individuated. The tool is really useful because it enables to travel through a large area in a relative short time, correlating the urban physical structure to the specific vistas of a pedestrian. At the same time it presents some limits, i.e. the height of the point view is fixed and proportional to the dimension of the camera and the scale of the model; in our case the model was in 1:500 scale, and this implicated that the point of view was six meters high, which produces a distortion compared to the 1,70 m assumed as the average height of a person. Nevertheless, the tool was appropriate to study the area in a quick way, and it

favored the collaboration and discussion on the projects among the colleagues. To study the individuated paths we used at first a sequence of photomontages, which was quite effective in depicting the future condition. Having a digital model of the area (Figure 3) it is not so complicated or time-spending to elaborate accurate images where the urban project is overlapped to the existing condition (Figure 4). Compared to the video from the scale model this solution enables to describe the vitality and the detailed richness of the area, even if it is related to the existing condition in a simple sequence of still events. To overcome this limit we decided to study, with a bachelor of science thesis (Secchi 2009), the applicability of movies techniques for urban design purposes. The output (Figure 5) of the superimposition of a video render of the project on the video of the actual condition, shows great potential of communication. The immediacy of reading the effects on the current situation and its strong recall of the real experience makes it a useful tool, not only for the evaluation phase, but also in the process of public information or participation, where the actors involved often do not have the technical skills to read and translate correctly what is represented in a map into the real outcomes that affect the daily life of the urban environment. The video produced was also presented in the Corriere della Sera, one of our major national newspapers, and this is emblematic of the communicative capability of this kind of approach.

Anyway, this kind of medium allows a fruition that is limited to a pre-selection of vistas. To overcome this limitation we decided to do a step further and to start to use simulation that could allow an interactive navigation. We started using pannable vrlm (Virtual Reality Modeling Language) panoramic images and then we moved on using game engine software for urban design purposes. Starting from the digital model we had, we created a virtual interactive simulation of the Garibaldi-Repubblica project and its surrounding.

In parallel to that step we started studying some environmental impacts on the area. The first step in this direction was the shadows analysis, that was approach as a laboratory research activity, and then was deepened with the MSc thesis of the author (Signorelli 2009). In this case too, we tested different typologies of simulation tool, both analogical and digital. We worked in combination with conceptual and perceptual simulations to figure out their effectiveness for the evaluation of urban comfort and energy efficiency, highlighting the potential and critical issues in relation to different stages of the processes of urban transformation. We worked with both a 1:1,000 scale model and a 1:500 scale model to study the shadow path generated by the intervention on the public space and on the facades of the building context; we did the same with the digital model and other simulation software. The results obtained were compared to evaluate the accuracy of the different tools used.
Vrlm permits to visualize interactively a panoramic image, developing a path composed by a series of these images. Nevertheless these types of simulations do not take in account the dynamic aspects of the urban environment and the interactivity is not so enhanced, if compared to the previous simulation tools presented. For this reason we decided to move on and use a game engine software. These products, commonly used for developing videogames, are increasingly used also in various

disciplines not closely related to a playful attitude (e.g. simulations in a hazardous situation that cannot be reproduced in a real environment without risk for users, such as in nuclear power plants or for virtual fire evacuation drills, improve the sightseeing of archeology sites and to develop virtual museums, and military simulators to recruitment and training). This has been made possible for different reasons: the increase of ease of use, the more realistic renders of the graphics engines, the improved interoperability among the software, the possibility to customize their components, and the affordability of the products.

Game engine are complex software systems characterized by different features. The most common components are a render engine for 2-D or 3-D graphics, a physical engine, a collision calculator and some frameworks (libraries) used for sound, animation and artificial intelligence. The level of detail reached by these products is extremely high, both in visual and physical simulations. Thanks to this software it is possible to provide a virtual environment, in which the user can roam freely, enriched with various dynamic elements and other components that give the possibility to the user to interact in real time with the simulation. By way of summary, the Game Engine permits not only to provide a static visual simulation of the urban environment but, acting on its components, it allows to include in the virtual environment the dynamic aspects of the urban fabric (e.g. simulating the alternation between night and day, and seasons, visualize the traffic flow and insert the various sound events etc.).

Nowadays there are manifold products, each one with specific characteristics, strengths and weaknesses. We choose to use Unity3D because it presents a user-interface similar to many commonly used software for tridimensional modeling; it allows us to import sound and readymade digital models, complete with textures, materials and animations in various formats; it includes an internal tool for recreating vegetation. Furthermore, it allows us to manage and change the point of view of the camera and finally permits a high customization, thanks to the ability to use different types of programming languages (C #, boo, javascript).

After we have inserted the digital model of the Garibaldi-Repubblica project and its surrounding in the game engine, we enriched the simulation adding the vegetation, using a software that permits to change dynamically the model of the tree used, according to the seasons and to the growing period; the animation of the public and private transport that will be refined using a multi-agent software to provide a more realistic simulation; some sound sources recorded in the real urban environment (but we have to point out that to date the game engine does not provide a physical based simulation of the acoustic environment); the various project proposals provided by stakeholders; and finally the sun, which can be moved in real time to see the shadows' impact of new urban projects on themselves and on the existing context.
As we said, the software permits to the users to walk interactively into a dynamic virtual environment, changing in real time the project proposals to understand their impact on the existent urban environment. For this reason we started to use this software also in a course held by our research group in order to compare the various

projects proposed by the students. This approach allow them to verify the perceptual outcome of their design process and it encourage them to think at the urban transformation in dynamics terms.

The capabilities of these instruments need more insights. The possibility to provide quantitative and qualitative information layers, in a virtual interactive environment is worthy of being investigated. Despite this, the product still has a weak user interface, which was developed for videogames and constitutes a hindrance in the usability of the product for a large part of users.

The game engine chosen was also used to develop the 'Tavolo Luminoso' tool (Figure 5), which was intended as an occasion to merge different topics and mediums together. The tool uses a physical scale model in combination with digital interactive simulation. In fact, on the base of the table an interactive visualization of the ground is projected in real-time. Using Augmented Reality it is possible to link the physical volumes to their relative digital ones, and it is possible to project on the table surface a simulation of the base with a simulation on it, i.e. the projected building shadows or other environmental conditions such as the wind condition (represented as particles that flow in the area).

Figure 1. Micro-car

Figure 2. Micro-car and subjective view

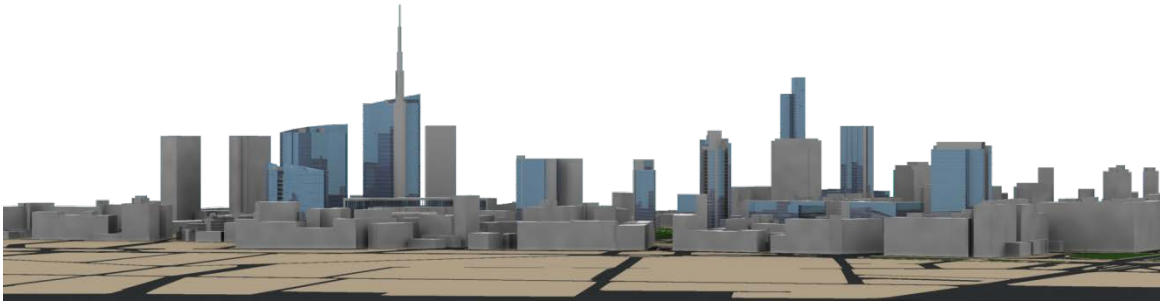

Figure 3. Digital Model

Figure 4. Photo-montage (via della Liberazione)

Figure 5. Frames from the video-montage

Figure 5. Tavolo Luminoso

4. Conclusion

A comparison between the simulation (photo and video montages) we produced and the real output of construction is now under development. Nowadays, the Garibaldi-Repubblica transformation is almost completed, and some considerations about the validity of the work done is possible. The first phase of comparison (Figure 6), demonstrates the general validity of the approach and also allows to highlight some limitations. Part of the gap between the simulated environment and the real condition is due to the fact that the projects have changed from the first (approved) hypothesis we have modeled. Especially, few buildings are in reality higher than it was defined with the first project approval. In general, the last solution is taller than the previous one. In some cases also the shape of the project has changed. This should lead to consider if, with a complex project like this one is, the planning tools and the required documents are enough for the municipality to direct the overall urban transformation and to verify the cumulative changes that occur during the process. In this respect, it is also particularly interesting to notice that it is quite common that the visualizations presented by the developers represent the project itself rather than the project in relation to its local or urban surrounding, while it emerges quite clearly that this kind of transformation, with high-rise buildings, has an impact on the entire city. As a matter of fact, considering as an example just the visual aspects, it is

immediately evident that the transformation will change the skyline of Milan (Figure 7) and some views from the street level.

Even if the simulated project and the built one are not exactly the same, it is quite evident from the comparison that the simulated views depict in an efficient way the urban condition. Moreover, the best comparison is the onsite one. Even if the building site is not completely concluded it is already possible to say that the general impression we had from simulation is comparable to the real one. Nevertheless, a further examination, especially after the conclusion of the building site, is necessary to completely evaluate strengths and weaknesses of the method. This review will also drive the development of our research on the topic. The quality of the render we superimposed to the photo of the actual condition is not that high, we just modeled simplified volumes and we treated their textures merely featuring solid and transparent materials: is this enough or this will imply a distortion that will be misleading for the evaluation process? Another aspect to be considered regards the vitality of the area. Obviously in photo e video montages we grab the situation of the existing condition. Even if it is quite difficult to anticipate correctly this aspect, which is due to many factors, it is anyway important to study which is the rate of bias introduced by this. Also other elements, such as the importance of the soundscape, will be investigated. This ongoing research will help to better figure out the limits of the approach and to identify which of these can be overcome.

Parallel to this, we are developing another study that analyzes the simulation of completed urban projects, produced by the developers, in comparison with photos of the realization taken from the same point of view. This research will give not only the possibility to highlight the gap between simulation and reality, but also to identify a trend in the professional production of this kind of products. Having this analysis at hand the final goal is to quantify the typology and magnitude of an eventual distortion. This will give the opportunity to reflect on the role that this kind of mediums, widely used, have on decision-making processes.

Figure 6. Comparison between simulation and realization


Figure 7. Existing and simulated condition

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