



Perceptual simulation for urban design: its use for developing and sharing urban design guidelines

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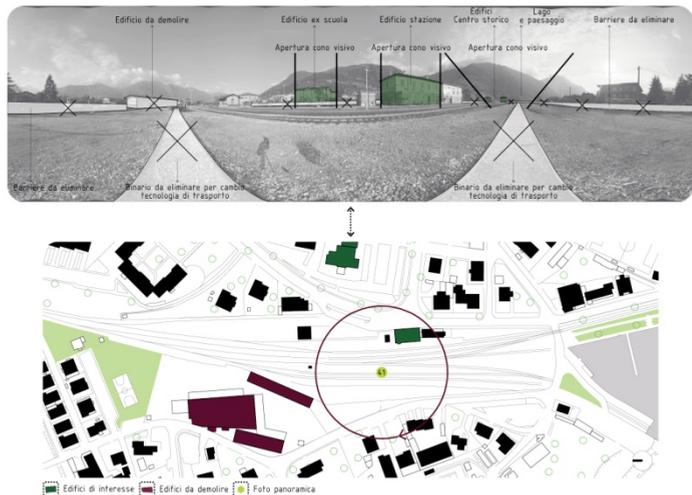
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Abstract Traditionally, graphic and written guidelines are provided on conceptual representations, like plans and sections, in order to highlight specific design tips. The exploration of our research refers to the representation of guidelines on perceptual and subjective images, in particular on photography, digital models and videos. The main goal is to make designers aware of the importance of the experience perceived in space, thus giving attention to dynamic aspects, which are so relevant to the sight while we approach architectural and urban objects in space.

A series of works concerning the use of analysis and guidelines on perceptual supports, implemented within our research team and together with students, are presented in this paper. The applications refer to punctual places within urban sites and to linear landscapes, such as a motorway, whereby the issue of velocity highly impacts on perception. Applications show that the use of graphic and written guidelines on perceptual images – beside traditional guidelines – enhances the attention of designers to the environment as is perceived by users, thus improving the overall quality of design. In fact, the use of perspective views becomes an effective way to drive conceptual design and verify design outcomes on visual simulations.

Hence, the combined use of traditional types of representation with photorealistic images contributes to generate a working basis, easily shareable, that can support the development of the design project and increase the understanding of its cumulate and dynamic output on the existing environment. Moreover, realistic simulations are more comprehensible by the wider public, and this helps communication, evaluation and participation.

Fig. 1 Guidelines on 360-degree panoramas (courtesy of Bulgheroni, Clauser, Ghisla)



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Introduction

Traditional representation techniques, like maps and sections, portray reality in a conceptual way, but the gap between their abstraction and the real experience they synthesize is not easily comprehensible by all the actors involved in the design and evaluation process. Reality is a complex system not reproducible in all its variable and dynamic aspects, but some simulation techniques can help to figure out the appearance of the built environment from a perceptual point of view. Indeed, an efficient simulation system should take into account different sensory aspects at the same time, such as sight, hear, touch and so on, and this is our long term research goal. So far we have concentrated our attention mainly on the visual sense, as this is normally the primary aspect involved in the perception of urban environment, at least on 'first-encounter reality', as Donald Appleyard noticed (1976).

Both the theoretical and experimental studies on the effectiveness of visual media in reproducing the urban environment from a perceptual point of view started at our laboratory at the beginning of 2007. The use of different techniques was firstly tested for simulating reality as it is (Piga et al, 2011a); secondly, we worked on the anticipation of urban transformation projects. In order to do this we augmented simulations with ongoing urban design projects; at the moment we are employing the same approach and test its usefulness for supporting the design phase of urban projects. This last advancement in our research, and especially the usefulness of perceptual simulation for developing urban design guidelines, is the main subject of the proposed contribution.

In particular, the work carried on by our research group on the implementation of archives of the urban space opens up a series of opportunities concerning the use of the collected information for design purposes. For instance, storing images and other sense-related information, allows to use that information not only as a design support, but as design tool as well. In fact, we argue that there is a lack of perceptual tools to support design and decision making.

In particular, in this paper a number of techniques and tools that make use of the 3-D or even immersive visual environment (photography or the 3-D model) is presented. The aim of the research is to establish a novel approach to design that allows and stimulate architects and planners to focus their attention on the perceptual outcomes of the proposed design projects. The final goal is to improve the overall quality of design and assist designers with a novel toolkit.

The use is twofold: firstly, to use photography and immersive environments (i.e. 360-degree panoramic pictures and digital models) as the support for design guidelines and tips to be used by the designer for analyzing the environment; secondly, to use the same type of support for simulation, namely for verifying design schemes and concepts directly on 3-D and immersive supports. In so doing, designers are enabled to understand the implications of their ideas in a more complex way, thus giving attention to what lay people are going to experience in the envisioned environment. Working according to this modality allows also evaluators of design to compare alternative design schemes on the same support. For instance, walking through a virtual environment or taking a snapshot of a digital model from the same point of view enables to make an effective comparative study of the perceptual implications of design.

Research context

The references to the use of panoramic photography for design purposes (guidelines and support for simulation) are not many. In fact, literature is not very rich in terms of presenting methodologies for providing design guidelines, with specific reference to perceptual simulation. We can mostly refer to techniques for perceptual analysis that make use of photorealistic support for defining design strategies. One of the fundamental references in this sense is 'The view from the road' by Donald Appleyard et al (1964). In this book a series of analyses on perspective views (reported as hand drawings) are presented, aiming at simulating snapshots along a path experienced during driving, thus considering velocity and the level of detail that travelers can perceive. A more recent work on the topic of design guidelines for designing motorways refers to

the Mecanoo Architecten study 'Vision on the road ways of the future from the perspective of the driver in the Delta metropolis of the Randstad' commissioned by the Rijkswaterstaat (Mecanoo Architecten, 2003). Even if not conceived as guidelines to support designers, the above presented references serve as good technical examples in order to consider photography and 3-D environments as a relevant feature for supporting design choices.

Methodology and applications

According to the aim of this work, we explore how traditional design guidelines can be implemented using photorealistic supports, in particular perceptual and subjective representations. Applications of the proposed techniques can be guidelines on different images as a design support to be delivered by public administrations to orient designers for urban projects or within design competition briefs. For instance, adding information on perceptual representations (pictures or digital models) enables to catch design tips such: how are we going to perceive the building or the space in general from a specific and relevant point of view? Will the project be visible or not from a certain location? What will be the overall perceptual quality of the transformation? Will we preserve the visual character of a precious environment, such an historical center or a natural site?

Hence, this type of visual guideline can be intended as input material for simulation, where the designer is asked to focus attention and test its intervention on relevant locations. This way of proceeding will inevitably change the weights in the concept design phase and drive decision making. Finally, simulations can be shown on identified relevant points of view, thus conducting to the verification phase. For instance, comparative studies among different design solutions can be conducted and evaluated. Hence, the cycle is closed: in fact, guidelines can be initially used to drive design and finally to support evaluation and decision making.

We can refer to different types of supports and techniques. Photorealistic images include sketches (hand drawing or photomontages) in perspective view, photography, videos and virtual environments (from digital modeling). Photography, in particular, offers a variety of types: the single picture, the sequence of pictures and panoramas (180 or 360-degree panoramic pictures).

Case studies

In past and current works carried out at the laboratory and together with students we investigated the use of photorealistic images (photography and modeling) for the analysis, the construction of design guidelines and the support as a design tool in simulations. In particular, studies on visual perceptual simulation for developing and sharing guidelines were applied to specific case-study areas. The diverse characteristics of different sites allow us to test the validity of the approach in depicting the urban experience in dynamic terms, which is one of the main distinctive aspects of our research approach in a broader sense. We applied the method both to urban contexts and to linear landscapes; in both cases the goal was to analyze the physical context from an experiential point of view and, according to the results, to develop guidelines that could integrate traditional urban planning delivered by the public administration. In both studies the focus was on the traveler experience: in the first case it was linked to pedestrian paths in the city, in the second one to car drivers along urban borders. This was the occasion to test the approach to different velocities, which, of course influence what can be perceived.

Guidelines can be given by municipalities or local authorities in order to verify the relevant points of view to be preserved or at least considered to evaluate the visual impact of design schemes. Moreover, building up a visual archive enables to monitor the transformations in time. The master's thesis by Paolo Bulgheroni, Marco Clauser and Marco Ghisla (2012) provides a methodology for guidelines to be visualized on 360-degree panoramas and sequences of pictures (see Fig. 1). The preliminary construction of a visual archive of Pisogne, a small town on the Iseo Lake, was the fundamental and time consuming part of the work. This archive was published as an online application to be used as the basis for visualizing relevant nodes and paths in town (see Fig. 2). On those pictures a series of information and guidelines were superimposed in order to

make those data, that otherwise would not be communicable on a plan, visible. On each 360-degree panoramic picture, a quantification of visible areas to be preserved (in green) and to be transformed (in red) was displayed with different levels of opacity depending on the relevance of the analyzed features. Afterwards, the degree of sensitivity and ‘intervenability’ (or transformability) of each point can be calculated. An insight on an urban transformation project aimed finally at testing the guidelines on pictures and revealing perceptual tips in order to block or preserve characteristic views. Alternative design solutions were compared through simulations superimposed on the panoramas, in order to provide an easy way to understand the impacts on the same visual support.



Fig. 2 Example of the structure of the interactive tool to navigate perceptual and conceptual analysis and guidelines developed for the city of Pisogne (courtesy of Bulgheroni, Clauser, Ghisla)

Drawing hatches on pictures was also used in their master’s thesis by Roberta Cassi and Sonia Tosetti (2011). The authors traced guidelines aiming at highlighting urban features that can interfere with the accessibility of urban spaces by people with disabilities (physical and visual impairments were considered) as showed in Fig. 3. Those guidelines were used as the basis for the analysis of an entire urban district and helped in defining urban design rules and a design strategy for a novel street design in that area.

In a similar way, the master’s thesis by Roberta Radaelli, Gessica Salerno and Valeria Villani (2011a, 2011b) was the occasion to test street photography taken at the height of kids’ eye view, in order to quantify the visual presence of the urban materials falling within their view, as opposed to adults. Quantifying the amount of visibility of different urban materials, make designers aware about the importance of considering the visual obstacles at low heights on open spaces (walls, parked cars).

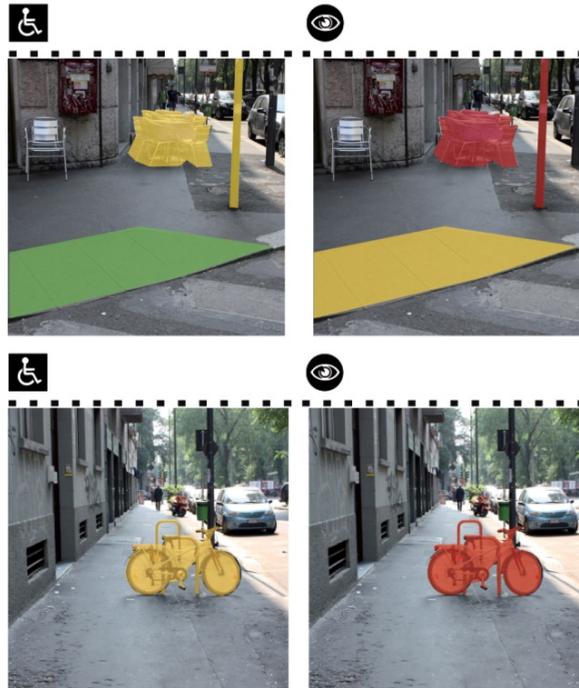


Fig. 3 Visual guidelines highlight how urban features interfere with disabilities, both physical (left side) and visual (right side); samples of the analysis carried on the streets of the university district (courtesy of Roberta Cassi and Sonia Tosetti)

Another study was conducted for identifying and communicating strategic guidelines for a public competition open to students and aiming at retrofitting an open space on campus that it is currently used as a parking space¹. In that case, as our laboratory was responsible for the setting up of the completion brief and we could test the use of photography and 360-degree panoramas as support information that integrates traditional representation of places as well strategies. For instance, the design guidelines identified by the perceptual analysis on the panoramas were reported on the written brief, on the plan, and visualized on a panoramic tour of the place (see Fig. 4). In so doing, the use of images in sequences, related to their geographic location, and navigable 360-degree panoramas, posed attention to relevant routes and nodes. Additionally, participants to the competition were asked to verify their design schemes on two views extracted from the digital model, which was included in the materials. This allowed to envision design alternatives from representative points of view and to compare their different experiential outputs, to be used as an evaluation criterion by the jury (see Fig. 5).

The same type of tasks is asked to the students of the ‘Architectural and Urban Simulation’ design seminar. Starting from a shared digital model of an urban district, students were asked to insert their design schemes into the virtual environment and run simulations using cameras located at the ground level, in order to give back the subjective experience inside the urban space. Once again, outcomes show that design choices by students are greatly conditioned by the perceptual approach to design.

¹ The design competition was entitled ‘Riquilificazione degli spazi aperti del Campus Bonardi’ and launched in the fall of 2012 within the sustainable campus initiative. A virtual gallery of the delivered projects was published on the sustainable campus website: <http://www.campus-sostenibile.polimi.it/en/web/guest/mostra>



Fig. 4 Guidelines provided for the design competition within the sustainable campus initiative. Above, two screenshots showing perceptual guidelines from one of the virtual tours; below, indications given on a plan.

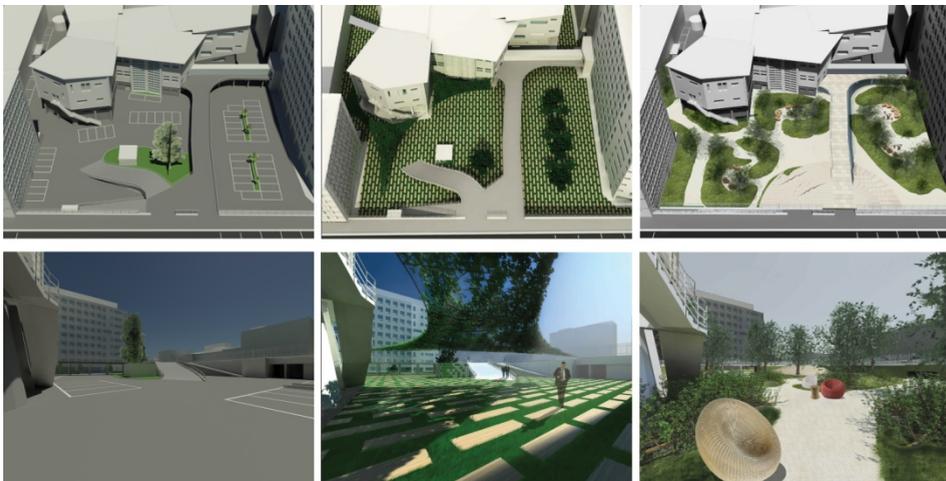


Fig. 5 The simulations produced by the students on the basis of the renders given by the competition (on the left column), (courtesy of Antonio Rinaldi, Jessica Moncada, Mery Brocca, Stefano De Crescenzo, Andrea Corbetta, Rebecca Broll)

Finally, the technique of video recording enables to carry on even more sophisticated analysis and represents the best way to get closer to the dynamic experience. This is the case of a visual study about the perception of linear landscapes, namely a motorway² (Piga et al, 2011b). Frames of a movie taken from the car driver perspective can be extracted and implemented with visual guidelines (refer to Fig. 6). In particular, guidelines were derived after a detailed analysis that includes the video recording of the trip from three views, i.e. the central view, and the two lateral views that can be perceived from the interior of the car. An application of eye-tracking enabled to identify those areas of vision where the traveler poses attention while driving.



Fig.6 Example of the study conducted on a linear infrastructure. Above, a frame of the video showing the multiple recording of the traveler's experience inside the car; the image on the top in the middle identifies the center of attention depicted through the eye-tracking technique; on the upper left side, the map with the localization. Below, three images of the resulting design guidelines on the same motorway, with hatches and written tips based on perceptual observations

Conclusions and future work

In conclusion, we argue that the direction of the proposed approach is crucial, and that the design process as a whole – from conception to evaluation – can benefit from this type of improvement. In fact, it can help to fill the gap between the urban layout, depicted by traditional forms of representation, and reality. In this way it can serve as an effective support for envisioning design alternatives and anticipate their experiential outputs, thus permitting the observer to subjectively interpret them, according to his/her interest and background.

² This work is part of the research named “New tools to analyze and manage the linear cultural landscape. Preservation and planning policies” - Progetto di ricerca “5 per mille junior”, Politecnico di Milano.

Future work has to address the issue of work time required in the production of the guidelines. In fact, most of the works presented in this paper are time consuming, not so much in terms of the production of the guidelines, but in terms of the provision of the support, such as photography or 360-degree panoramas. In some cases, think about municipalities or similar, the visual archive of images could be a preliminary work or something already available to local authorities. In that case the work would be very fast and straightforward.

Finally, a better insight on the potentialities of virtual environments to embed richer layers of information is for sure the next frontier of our research, and would allow to get even closer to the dynamic experience of a place.

References

- Appleyard, D. (1976). “*Understanding Professional Media. Issues, Theory, and a Research Agenda*”, Institute of Urban and Regional Development, Vol.2, No.150, 58-59.
- Appleyard, D., Lynch, K., Myer, J.R. (1964). *The View from the Road*, Cambridge MA: MIT Press.
- Bulgheroni, P., Clauser, M., Ghisla, M. (2012). *Percezione e progetto: sviluppo e sperimentazione di un metodo per un approccio percettivo alla progettazione urbana*, unpublished Master of Science in Architecture thesis, Politecnico di Milano.
- Cassi, R., Tosetti, S. (2011). *AccessAbility: Ripensare lo spazio urbano di Città Studi per un’utenza ampliata*, unpublished Master of Science in Architecture thesis, Politecnico di Milano.
- Mecanoo Architecten (2003). *Holland Avenue, Research Road Atlas; Holland Avenue, Design Road Atlas*, The Hague, Netherlands: Publ. Ministry of Transport, Public Works and Water Management.
- Piga, B.E.A., Signorelli, V., Morello, E. (2011a). *The experience of an academic simulation laboratory: The use of visual simulations for education and research*. In: Respecting Fragile Places: Proceedings of the 29th Conference on Education in Computer Aided Architectural Design in Europe . Ljubljana, 21-24/9/2011, Ljubljana: eCAADe and UNI Ljubljana, 734-741.
- Piga, B.E.A., Tangredi, C., Signorelli, V. (2011b). “*Investigating the traveler experience: the use of eye-tracking for urban design purposes*”, In: Envisioning Architecture: Proceeding of the 10th Conference of the European Architectural Envisioning Association, Delft, Netherlands, 14-17/09/2011, Delft: Delft Digital Press, 161-168.
- Radaelli, R., Salerno, G., Villani, V. (2011a). *Progettare la città con gli occhi dei bambini: proposta di un metodo di indagine attraverso la simulazione percettiva*, unpublished Master of Science in Architecture thesis, Politecnico di Milano.
- Radaelli, R., Salerno, G., Villani, V., Piga, B. E. A., Morello, E. (2011b). *Designing child-friendly urban environments: a proposal for a method of investigation based on visual simulation*. In: Envisioning Architecture: Proceeding of the 10th Conference of the European Architectural Envisioning Association, Delft, Netherlands, 14-17/09/2011, Delft: Delft Digital Press, 181-188.