COLOUR IN URBAN SPATIAL SIMULATION AND EVALUATION
SELECTED ASPECTS OF USE, VISUALIZATION AND EVALUATION OF COLOUR IN URBAN SPACE
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Abstract
The impact of colour on human perception of space is a known fact. Spatial simulation and evaluation without the consideration of colour would be rather simplified, as evaluation and reactions to viewed environments are very much conditioned by the observed colour combinations. As one reaction to this challenge in the last decades we witness the development of various models in colorimetry that try to predict the appearance of colours. These predominantly mathematical tasks however still tell us too little on how to proceed when we need to specify, evaluate or communicate about complex colour scenes in real space with stress on appearance and perceived colour. The question concerns both simulation and evaluation using a variety of tools, as well as the mapping and analysis of existing environments. Such tools are subject of this EAEA conference, and it is in this context that this contribution aims to put forward some of the challenges that we are still facing in hope, that we may work towards common procedures or solutions. Focus is on both visual and instrumental working methods with the aim to contribute to bridging the gap between theory and practical application, ideas, imagination and reality.

Architects are involved not only in designing buildings but in creating spaces with certain perceived qualities and atmosphere. A holistic approach is desired, in which colour plays a crucial role. We experience colour as an integral part of the visual world, together with form, structure, surface texture, cesia (gloss, transparency, etc.), light and illumination. There is a mutual interdependence of colour and other environmental qualities, and we are still facing the problem of predicting the concrete effects of colour in environmental design. Visualization in this context has its obvious significance.

Colour specification
In teaching, as in practical colour design, the question remains which methods, tools and materials should be used for colour specification, evaluation of choices, colour communication and visualization. When should we use standardized or non-standardized colour papers and when computer rendered colours for visualizations and communication of the intended ideas and images. The choice is much conditioned by needs of colour specification.

A simple comparative study of visual and instrumental measurements for exterior colour assessment (Urland, 1993) has shown, that the Munsell system and sample chips of paint producers (Synthesa and Syntalux) corresponded more closely to colorimetric instrumental measurements done with a Minolta CR 200 portable colorimeter. Measurements using the NCS showed more significant differences, in line with the fact that this system is more apt for phenomenological analyses.

For the storage, interchange and manipulation of digital images there are device-dependent colour spaces such as CMYK, RGB on one hand, and device-independent colour spaces such as CIE XYZ or CIELAB, which are considered less suitable for the manipulation of images. These systems, however, tell us little about the appearance of colours. Full and unambiguous specification of colour appearance requires not only a colorimetric specification of the image, but also the knowledge of the
state of visual adaptation of the observer controlled by the viewing environment and image state (Woolfe and Spauling). Such information allows unambiguous communication of the intended colour appearance and image interpretation. Eastman Kodak Company reports on having developed two colour encodings – the Reference Input Medium Metric (RIMM RGB) and Reference Output Medium Metric (ROMM RGB) to support this performance.

New tools try to give a hand in using standardized systems in computer colour design – the NCS palette is for some time available in a CD version.

Teaching applied colour to architects
In our teaching, we in some cases leave the choice of computer or traditional elaboration to students, in other cases – especially those connected with 3D models production, we insist on the traditional approach. In subjects in which treating the principles of forming urban spaces are discussed (i.e. urban composition), we have in the recent years introduced colour to be used in the models representing the proposals. The spaces of street and piazzas are thus completed in form and colour choices for the main planes. The purpose is to make students aware of using colour conceptually with a clear purpose, idea, contextual links, and thus avoid its haphazard and merely accidental or intuitive application. (Figures No.1, 2).

Students also have the possibility to learn applied colour science on an advanced level. The focus in this case is on a coloristic analysis of a given urban environment as a basis for its evaluation and objective improvement by means of quantifying the limits and regulations / standards of appropriate colour use. (Figure 3). The tool used in this task is the human eye. Colour measurements are done visually and the NCS system is used for colour specification as well as for the studies of the relationships between colours and the various phenomena.

The basis for working with colour in the context of urban space is the understanding of its nature, effects and perception, its specification and reproduction when using the variety of relevant available tools. We know from our experiences, that so far, there are no common rules for colour specification.

Environmental colour design and research challenges
The series of traditional as well as sophisticated tools available today do allow colour manipulation, but the accurate prediction of real world colour appearance often does not work. (Oberascher, 1997)
Evaluation, description and prediction of real world colour appearance in environmental design is still a challenge. We realize this when looking into all the conditioning factors of the process and the influencing phenomena. In the following, I will point out some main concerns.

**Predicting real world colour appearance - predicting the change of colours** between the choices at the stage of the project and the finished architecture or urban space. An important part is image analysis. Studies focus on interior conditions or exteriors. Research in this field has, so far, been following two ways – one is laboratory testing, the other work in real space or with full-scale models. Laboratory situations are connected to higher or lower degrees of simplification. Let us look at some examples. Already in the 70s and 80s of the past century a lot has been published on this topic in Sweden by L. Sivik and A. Hard. They stress the importance of experimental research and research in real environments, for which laboratory results have very limited application. The total appearance concept by Hutchings, although aimed at food industry, gives a good framework applicable also in architectural and urban colour environments. The Environmental Assessment approach suggested by Kenneth H. Craik in 1971 offers according to today's specialists a good conceptual and methodological framework for a systematic investigation of the problem of assessment and prediction of real world colour appearance. M. Billger in her recent project on simulation of light and colour in buildings sees the main goal in making virtual reality applications usable for the planning of light and colour in order to solve problems connected to difficulties in visualizing and comprehending colour appearance. Little is known and published on colour appearance in real rooms compared to virtual rooms, as comparative studies have focused on different aspects, mainly the functional and ergonomic studies and on visualization of architecture regarding spaciousness. M. Billger's project focuses on solving problems in the design process that has to do with the difficulty to visualize and comprehend the way light and colour will appear, i.e. Virtual Reality from the perspective of factors that affect the appearance of colour surfaces – such as illumination, colour combinations, textures.

**Colour choices evaluation, preferences**
On the basis of a research study on our responses to exterior environmental or urban colour design (Ureland, 1993), it is interesting to note, that
- subjects were more concordant in positive response comments than in the negative ones
- the the semantic variables used spontaneously in the judgements of the subjects were related to colour by 29%, composition by 22%, other aspects (as tradition, practical meaning) by 15%, emotional aspect by 12%, colour-form relation by 10.5%, overall impression by 7.5% and form by 4%.

This evaluation study of complex realistic urban colour schemes (Figure 4) worked with slides projection of the situations to the subjects and subsequent specification of the colours in a standardized colour system visually.

A recent study on evaluation of exterior colours of buildings with effects of colours of the foreground buildings by Takuzo Inagaki had for its goal to determine how evaluation of the exterior colour of buildings was influenced by the colours of adjacent buildings. The system used was Munsell and situations were simulated in scale models of five buildings. L. Oberascher emphasizes the importance of full-scale studies because of the difficulties of predicting colour appearance in completed architectural space. The problem becomes even more difficult in
urban space, where full-scale modelling is out of question. The simulations of colour and light we can make today with existing software is still of insufficient quality – there is need to improve the reliability of these simulations, i.e. know how well they agree with human experience of the real colour space.

**Colour perception phenomena**

The perception of surface colours and illumination studied on pictorial images (Da Pos, Urland, 1994) has shown, that the general illumination appears diffuse if the background colours are little chromatic and their nuances are close to each other (Figure 5). The illumination appears clear when the background is more chromatic and the nuances are quite different. Two sides (facades) of an object lying in different planes appear of the same colour, one lighted and one in shadow, if their hue is the same and their nuances lie either over equal whiteness or equal saturation lines. The two sides on the object appear differently coloured in the other cases. It has also been shown, that the two kinds of perceived general illumination do not affect the appearance of one vs. two surface colours.

Area effect studies connected to colour shifts would like to reduce the error between the colour sample and its application in the real situations. In this case colours were specified in the Munsell system and situations were simulated on a colour panel produced with the help of a computer and printer.

Most recent studies focus on the concept of inherent and perceived colour. Previous research has not addressed difficulties of choosing façade colours using colour samples – a common practice. The questions posed in a recent focused study (K. Fridell Anter, 2000) dealing with the complexity of perceived colours of facades seen under varying natural circumstances concern the possibility to survey and map out what colours people perceive on facades observed under different conditions, the variations of perceived colour of a façade with changing observation conditions and the perceived colour difference from the colour corresponding to the specification of the sample used for selection.

Colour specification was in the Natural Colour System, NCS. In this case, observations were done in situ in real urban settings and the results show tendencies of perceived colour to vary with viewing conditions, but these were found always smaller than the differences between perceived and inherent colour, which show variation patterns for both hue and nuance. Inherent colour was measured by comparison with colour samples placed directly on the façade surface. A combination of several methods for determination of perceived colour and comparison of perceived and inherent colour were developed and used. Dr. Anter gives the example of perceived colour always having less blackness than inherent colour. The variation patterns are for practical use in exterior colour design.
The current development moves towards taking more factors into consideration. Colour should not be reduced to surfaces, as it is “perceived within parameters of space and time, material and form, light and surface, as well as movement, action, specific characteristics and state of mind of the people using them” (Oberascher, 2001). The colour image of an urban space is to be considered as a constant flux of permanently changing and overlapping scenes, themselves a result of compound effects of various factors. With the project “Luminos 3” - the colour labyrinth, Oberascher constructed a mobile and interactive installation offering a unique opportunity to develop and explore new colour design concepts in the context of space, movement and time.

**Simulation vs reality**

A common present-day practice is, that companies offer colour consulting – using computer graphics as a tool of simulation, to produce colour alternatives of projects though of single buildings only. Mostly there is no consideration of appearance phenomena. In the endless amounts of colour combination possibilities, there is need to work conceptually, considering spaces as a whole with maximum respect to all the involved phenomena.

**Conclusions**

Simulation of light and colour in virtual environments are on one hand limited by our insufficient knowledge about how humans perceive spatial colour phenomena, and on the other hand by technical problems of creating realistic colour images at a high enough speed.

We need to work on obtaining more reliable data on prediction of colour appearance in reality in order to understand better how responses to simulations predict impressions of the real world. Such information is essential for sound practice and creation of better quality environments.

**References**


