

# Augmented Reality as a Tool Supporting Design and Decision-Making Process in Landscape Architecture

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## Extended Abstract

Within the framework of the project *Application of digital spatial models in landscape protection and shaping*<sup>1</sup> some experiments were carried out to examine the potential of the AR technology use for the needs of architecture as well landscaping. As a background for creating proper guidelines to conduct research, the author had examined a number of real world implementations of technology to identify the actual drawbacks of applied solutions<sup>2</sup>. The research experiment was done in two variants corresponding to two different systems. The first was based on the generally accessible Layar system; the description as well as results of this experiment has been disregarded in this abstract. The other experiment, which is shortly described below, examined the author's pioneer solutions.

## 1 The MLBE V4 Experiment – The Aim of the Research

The objectives of the task were as follows:

- to create an AR tool free from the inconveniences of the already existing and examined solutions, which significantly affect the effectiveness of their application;
- to examine the limitations and difficulties that are entailed by implementation of an undertaking consisting in placing a virtual model of the designed object in its proposed location with the use of the AR technology;
- to interview a group of professionals from the field of architecture as well as non-professionals – in the form of public consultations on the potential investment project – on the question of reception and usefulness of such technology supporting the design and decision-making processes;

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<sup>1</sup> The research has been financed by the National Science Centre within the framework of individual research and scientific project NCN 2001/01/N/HS2/02295: *Application of digital spatial models in landscape protection and shaping*, the project executor: Jacek Konopacki.

<sup>2</sup> Research has been made on basis of articles, visits on site as well individual interviews with researchers responsible for implementation of their own developed methods. 1. AR VTT system cooperation with Arkval Arkkitechdit OY, implementation site: Raseborg, Helsinki, research carried out by team of prof. Woodward, software used; MapStudio and the AROnsite VTT package. 2. Urban Augmented Realty, carried by NAI Rotterdam supervised by Marlies Den Hartogh, 3. The HIT Lab NZ Christchurch New Zealand, AR technology implementation by team of Prof. Gun Lee.

- a side objective would also be to popularise the technology among designers by offering them the opportunity to learn about the tool's potential during the experiments and workshops.

The experiment held in Cracow, has been possible to be carried in cooperation with Prof. Gun Lee from HitLab NZ University of Canterbury who is the co-creator of the application operating in the Android system and at the same time the person responsible for the software part. System has been designed to meet the expectations of professionals in landscape planning and management. Main goal was to eliminate the deficiencies of the currently existing AR systems destined for visualisation of virtual objects in their planned location. Resulting system is a pioneer solution of this type. The results of the experiments gives satisfactory conclusions that can help to create efficient commercial solutions to support decision-making and project management in the field of landscape architecture.

*The characteristic features of the MLBE V4 application which are of key importance for the usefulness of the AR technology in supporting design and decision-making processes in landscape architecture and urban design:*

Four available ways of visualising the virtual object in its proposed real context:

1. The traditional method, the object is visualised as an overlay in the foreground.
2. Visualisation of the object together with virtual equivalents of real objects. This type of visualisation allows simulations of the designed object screened by real accompanying objects. Virtualised accompanying objects are represented in the form of opaque simplified spatial forms.
3. Visualisation of the object with virtual semi-transparent equivalents of real objects. This method is a modification of the one described above in the aspect of the accompanying objects display. Such semi-transparent spatial forms facilitate precise calibration of the model for persons with poorer spatial imagination.
4. Visualisation of the object in the form that represents its true impact, if in fact constructed at the site. Methods B and C – described above – allowed screening of the designed object by virtual equivalents of the objects actually existing in the real surroundings. In the case of the fourth method, these objects are not visible on the screen of the mobile device. They act like a mask and thus allow viewing the designed form screened by the simulated actual accompanying objects. This innovative method allows an exceptionally intuitive perception of the designed object by simulating precisely the real impact of the object in the existing spatial context.

Freely chosen by end user from two methods of the user location with key importance for the precision of locating the virtual object in its real context:

- The classic method using the satellite signal, offering satisfactory results as regards the precision of object location. Should not to be used in terms of professional decision making analysis. More to be useful in open landscape, as well as a tool to support public participation processes. Apparent (simulated) location.
- The author's method of fake location offering the possibility of very precise setting of virtual objects in their real surroundings. The application simulates the precise geographic coordinates of the pre-set location disregarding the satellite signal. The accu-

racy of this method oscillates within the range of a dozen or so centimetres, which is absolutely sufficient for professional use even in case of analysing impact of newly designed objects in street scape scale.

*Survey evaluating the usefulness of the proposed MLBE V4 system as a tool supporting decision-making and assessment processes in landscape*

The experimental in situ use of the application was combined with a survey and observation of the users. The respondents answered 9 questions to evaluate the AR technology usefulness; in the scale from 1 to 5, where 1 was a negative evaluation 3 – neutral, and 5 – the most positive, three questions where answer was Yes/NO. Last question number 12, was an open type asking about pointing out main drawbacks of proposed system. For purposes of the abstract, it has been chosen only those questions and answers expressing main goal of applying such AR system in field of professional practice of landscape designers, urban planners as well architects.

- *Is the fact that the new virtual object is screened by the existing buildings helpful in perceiving the real context of the proposed structure?*  
The users of the application evaluated this function as highly useful. The average evaluation was 4.52, where 60 % was grade 4, and the remaining 40 % grade 5.
- *Are the predefined locations from which the object may be viewed useful?*  
The experiment participants evaluated the opportunity of viewing the object from a predefined location for obtaining precise setting of the virtual object in the real context as useful. The average grade was 4.24, where 20 % was the neutral grade 3, 45 % – grade 4, and 35 % of the respondents evaluated this function as very useful and gave it 5.
- *How do you evaluate the usefulness of this technology as a tool supporting the procedures of public consultations in spatial issues?*  
The respondents evaluated the tool as highly useful for application in the procedures of public consultations. The average grade was 4.76, where 10 % evaluated it as neutral (3), 5 % as positive (4) and the remaining 85 % as highly useful (5).
- *How do you evaluate the usefulness of this technology as a tool supporting design – selection of form or scale?*  
The respondents evaluated the tool as fairly useful as a tool supporting the design process. The average grade was 3.45, where 5 % evaluated it as having little usefulness (2), 5 % as neutral (3), 25 % as positive (4) and the remaining 45 % as highly useful (5).
- *How do you evaluate the usefulness of this technology as a tool supporting the process of deciding upon location of an investment project?*  
The surveyed participants evaluated the solution as useful if applied to support the decision-making process on the location of the investment project. The average grade was 4.52, where 60 % of the respondents described it as useful (4), and the remaining 40 % as highly useful (5).
- *How do you evaluate the usefulness of this technology as a tool supporting the visual assessment – the height of the development?*  
This aspect of the tool usefulness was highly appreciated. The average grade was 4.76, which is the same result as in the case of the question on using it as a tool supporting the procedures of public consultations. The distribution of the answers was as follows:

30 % of the respondents evaluated it as useful (4), and the remaining 70 % as highly useful (5).

The open question, “*What are the problems in the reception of this kind of visualisation?*”, was answered in the same way by the majority of respondents. Most of them pointed out to the same deficiencies of the system.

- As far as the equipment was concerned, the respondents pointed out to the aspect of convenience of the used devices. It was emphasised that for professional use definitely 8-inch tablets or bigger should be used, cause it will provide more detail, real impact to be easier to perceive proportionally to the size of the screen. The reflections of the sunlight appearing on the screens of the devices were also considered a bit of a problem.
- As far as the augmented technology was concerned, the use of satellite signal for location of the virtual objects was considered a problem. It was pointed out that the accuracy resulting from the specific character of the system was not adequate. Some of the respondents (5 %) thought it was a nuisance that the virtual object was floating against the background of the picture recorded by the camera of the device.

## Summary

The experiments carried out confirmed that the proposed solution is useful and the AR technology should be implemented in a larger scale in the aforementioned fields. During the in situ research with the use of the MLBE V4 application it was observed on numerous occasions that the participants were discussing the matters of the object spatial form and its location proving in this way that using such type of tools support perception of the investment project in its real planned context is highly desirable. The tool was used in the way it was expected to be. The author’s proposed solutions allow focusing the users’ attention on the methods of effective landscape composition taking into account the existing spatial context. It allows visual assessment from freely selected and dynamically changing locations, which may be done by an unlimited number of users.

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# AUGMENTED REALITY

## See Evaluate Decide

### LANDSCAPE PLANNING URBANISM

Research by Jacek Konopacki conducted in 2013 - survey evaluating the usefulness of the proposed MLBE V4 system developed as experimental tool supporting decision-making and assessment processes in architecture and spatial planning



GPS

Method using the satellite signal, offering satisfactory results as regards the precision of object location in open landscape

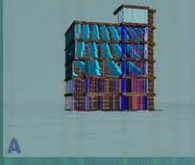
OR

Simulated location. Method of apparent location offering the possibility of very precise setting of virtual objects in their real surroundings. The application simulates the precise geographic coordinates of the given location. When placed on the pre-programmed point, its real coordinates are taken from the georeferenced internet data along the satellite signal. The accuracy of this method provides within the range of 10 centimetres to 30 centimetres, which is absolutely sufficient for objects of urban development scale.

SIMULATED LOCATION

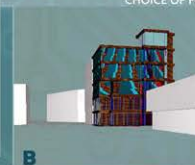
#### CHOICE OF FOUR VISUALIZATION MODES

**A**



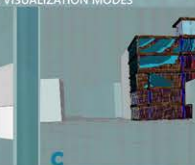
The object is visualized as an overlay in the foreground.

**B**



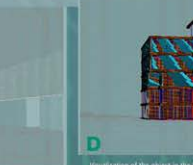
Visualization of the object together with virtual equivalents of real objects. This type of visualization allows immersion of the designed object screened by real accompanying objects. Virtualized accompanying objects are represented in the form of simple, simplified 3D forms.

**C**





Visualization of the object with virtual semi-transparent equivalents of real objects. This method is a modification of the one described above in the aspect of the accompanying objects display. Such semi-transparent spatial forms facilitate precise calculation of the model for persons with poorer spatial imagination.

**D**



Visualization of the object in the form that represents its impact. It is in fact concerned at the site. Methods B and C allowed screening of the designed object by virtual equivalents of the objects actually existing in the real surroundings. In the case of the fourth method, these objects are not visible on the screen of the mobile device. They are taken into account when viewing the designed form screened by the simulated actual accompanying objects. This innovation allows for an especially intuitive perception of the designed object by simulating primarily the real impact of the object in the existing spatial context.



#### THE EXPERIMENT MLBE V4 + SURVEY

The experimental in situ use of the application was combined with a survey and observation of the users. The experiment participants were asked 12 questions, including 11 questions of the closed type, which were related to the evaluation of the AR technology usefulness for certain specified tasks connected with landscape shaping and protection. Answering the first eight closed questions, the respondents evaluated the AR technology usefulness in the scale from 1 to 5, where 1 was a negative evaluation, 3 - neutral, and 5 - the most positive. 2 rounds, 80 people (age 24-65) participated in the event, and they were representatives of the academic circles (CUT Faculty of Architecture, Faculty of Civil Engineering and Faculty of Physics), students doing courses of architecture or architecture-related, representatives of architectural studios and potential stakeholders, i.e. passers-by.


**It is the fact that the new virtual object is screened by the existing buildings helpful in perceiving the real context of the proposed structure?**

The users of the application evaluated this function as highly useful. The average evaluation was 4.52, where 69% was grade 4, and the rest, only 40% grade 5.




**Are the preferred locations from which the object may be viewed useful?**

The experiment participants evaluated the opportunity of viewing the object from a preferred location for obtaining precise setting of the virtual object in the real context as useful. The average grade was 4.24, while 70% was the result: grade 3, 40% grade 4, and 33% of the respondents evaluated this function as very useful and gave it 5.




**How do you evaluate the usefulness of this technology as a tool supporting the procedure of public consultations in spatial issues?**

The respondents evaluated this tool as highly useful for application in the procedure of public consultations. The average grade was 4.76, where 10% evaluated it as neutral (3), 2% as positive (4) and the remaining 88% as highly useful (5).




**How do you evaluate the usefulness of this technology as a tool supporting the design - selection of form or scale?**

The respondents evaluated the tool as fairly useful for application in the design process. The average grade was 4.10, where 3% evaluated it as having low usefulness (2), 32% as neutral (3), 22% as positive (4) and the remaining 63% as highly useful (5).




**How do you evaluate the usefulness of this technology as a tool supporting the process of deciding upon location of an investment project?**

The surveyed participants evaluated the application as useful if applied to support the decision-making process on the location of the investment project. The average grade was 4.52, where 80% of the respondents declared it as useful (4), and the remaining 40% as highly useful (5).



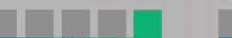
**How do you evaluate the usefulness of this technology as a tool supporting the visual assessment - the height of the development?**

This aspect of the tool usefulness was highly appreciated. The average grade was 4.75, which is the same result as in the case of the question on using it as a tool supporting the procedure of public consultations. The distribution of the answers was as follows: 30% of the respondents evaluated it as useful (4), and the remaining 70% as highly useful (5).



**Do you think that using AR technology in the design and decision-making processes may influence positively the landscape quality?**

90% of the respondents answered in the affirmative about the proposed technology, which demonstrates a high potential of the tool as regards the question of improving the quality of the project landscape.



**Do you think that using AR may influence positively the quality of public consultations?**

100% of the surveyed persons declared a positive opinion on the proposed application as the augmented reality technology as a tool supporting the public consultation. Expressing such opinion by all the respondents suggests with a high degree of probability that such implementation is expected and may positively affect the quality of the public consultations on the questions of landscape planning, protection and management.



**Do you think that application of such technology may have positive influence on the general public as regards spatial evaluation?**

80% of the respondents considered implementation of the AR technology useful for the purpose of raising public awareness as regards shaping and management of space.



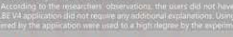
**Do you think that application of such technology may have positive influence on the general public as regards spatial evaluation?**

The open question: what are the problems in the reception of this kind of visualization? was answered in the same way by the majority of respondents. Most of them pointed out the same deficiencies of the system.

All forms the experiment was concerned, the respondents pointed out as the aspect of convenience of the used device. The 3- and 8- inch tablets, which were used in the experiment, were considered rather inconvenient and it was emphasized that for professional use definitely 10-inch tablets or bigger should be used. The size of the display unit is of key importance for its use. The influence of the angle of pointing on the screen of the device was also considered a lot of a concern.

As far as the augmented technology was concerned, the use of satellite signal for location of the virtual object was considered a problem. It was pointed out that the accuracy resulting from the specific character of the system was not adequate. Some of the respondents (2%) thought it was a nuisance that the virtual object was floating against the background of the picture recorded by the camera of the device.

According to the researchers' observations, the users did not have any difficulties using the device. The proposed software solutions and graphics, as well as functional layout of the AR V4 application did not require any additional explanation. Using the proposed system was described as intuitive and it was well received by the users. It was noticed that the application offered by the application was used to a high degree by the experiment participants.



Special thanks for prof. Gun Lee, from HUIA@NZ University of Canterbury for consultation on research as well help in development of the MLBE V4 android app.

Research/graphics : Jacek Konopacki, landscape architect | Cracow University of Technology, Faculty of Architecture, Institute of Landscape Architecture, Poland

Fig. 1: Poster describing main goals of MLBE4V Experiment; Author: Jacek Konopacki