Evaluation in 3D endoscopic simulation – application in architectural studios

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INTRODUCTION

Simulation techniques are nowadays commonly spread in CAAD applications. They are so popular, that even notion of SAAD (Simulation Aided Architectural Design) is used.

Practical implementation of simulation techniques is present almost everywhere in our lives. All of us had a possibility of watching on TV, how Russians are going to pick up their atomic submarine “Kursk” from a sea-bottom. It is very tragic but significant example. People convinced themselves, that it is much cheaper to analyze any “virtual environment”, than to experiment with reality. Especially, when cost this “tampering” is extremely expensive. That is why some light and

Fig 1: Three different shots taken from a design of the office-building. Their purpose is presentation for potential hirers of office-area. Late stage of design, but changes are still possible.

scenography simulation are prepared by computers. From the same reasons filmic special effects are produced (sink of Titanic…). There are also obvious medical applications, where endoscopic surgery replaced invading methods, while simulation of human body help students to learn anatomy. Forensic medicine try to identify faces of murders or body remains.

Last, but not least - simulation is utilized in architectural design, where it's range of use is very wide – from form modelling through light simulation and material application to visualization, animation etc.

All examples mentioned above derive from different environments, but that proves, that a notion "3D environmental simulation" is strong rooted in contemporary world.

From the other side architectural endoscopy and simulation is quite well investigated by scientists and, as being very up-to-date, it is still

researched. Some scientist try to define different ways of application of endoscopic simulation– from stills to film and video (Martens). Some try to develop understanding endoscopy and its division between optical and digital (Stellingwerff, Philip Thiel).There were attempts of technical description of hardware and its configuration (Petri Siitonen, Ilkka Alavalkama). Some research were made on urban planning and teaching applications (W. Thomas, Jere Maula). As a scientific field simulation is permanently spreading and transforming.

OUR THESIS

We observed, that the main reason, why people use endoscopic simulations in architecture (and in other disciplines) is better evaluation of some potential diseases, mistakes or ideas.

As a result of notion “endoscopy” (a scope of science which looks into normally inaccessible) we made one obvious assumption, that accessibility of estimated environment is very poor.

FOCUSING

Paper will focus on digital endoscopy for some reasons. First is the most important – there is no optical endoscopy laboratory at Warsaw Department of Architecture, so it is difficult to achieve and compare results. After all we are convinced, that scale-models will only support digital ones in the future. We realize, that conjunction of optical and digital is inevitable, optimal solution for experiments, but while the first remain a domain of professionals, the second is almost already present at our homes.

ANALYSIS 1

Hypothesis – evaluation is present at different stages of design and serves for it’s quality.

Some aspects of design connected with 3D simulation are separated from a whole spectrum:

“External” evaluation. We called in this way interaction between customers and designers. All the time architects should consider

opinion of his client. So “external” means here “out of office”. Presentation for non-professionals, but deep involved. It is important at this point to present as good and realistic image as possible.

“Internal” evaluation. It may be a discussion between designers or comparison of different variants. These simulations needn’t have to be so exact. They are to express some ideas, not to present exact visions. At this point technology of Open GL and any real time preview appears to fit best. Level of detail is usually low, but the most important is accuracy of the idea. Designers’ PC should have fast graphic accelerator to help efficiently.

“Environmental” evaluation. As example can serve a collage, which presents how design fits into real. Two directions can be distinguished here: eye-level position and birds’ eye view. The second simulation is far more difficult due to special snaps, which have to be taken from a plane or any high enough place. Both methods must consider accuracy of light simulation, so that cast shadow of the “real” and “virtual” worlds are in the same direction… Both of them have to take into account color-palette from “real and virtual”. It happens, that perfectly made and joined picture appears to be “artificial” due to color palette.

Sun-shadow simulation. From a curio transformed to serious part of documentation. It is verified as a document by the Department of Architecture. There are plenty of presentation techniques – from the simplest planar graphs through a perspective view till animated sun-study. The most important is to choose the right method, which will help in evaluation, not garble a meaning.

Conclusion. Evaluation at mentioned stages of design is possible to overcome (to avoid…), but surely it would cause the design to be out of context and reality. Famous polish poetess Wislawa Szymborska wrote “we know about ourselves only this, what we were tested.” Once architecture offers no possibility of test during creation, the final effect can be surprising and – usually disappointing.

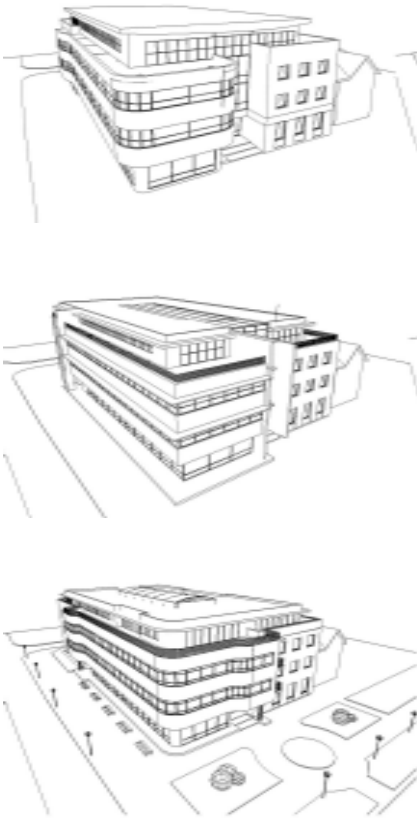
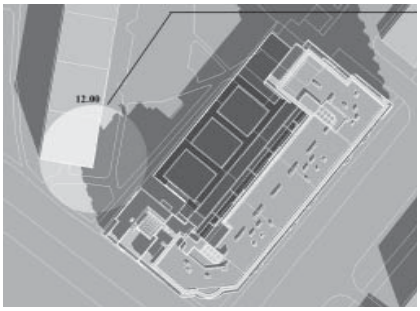


Fig 2: Three different shots taken at the early stage of design of the office-building. Their purpose is verification of some aesthetical points of view. No glitter and glare – only pure geometry for professional use.



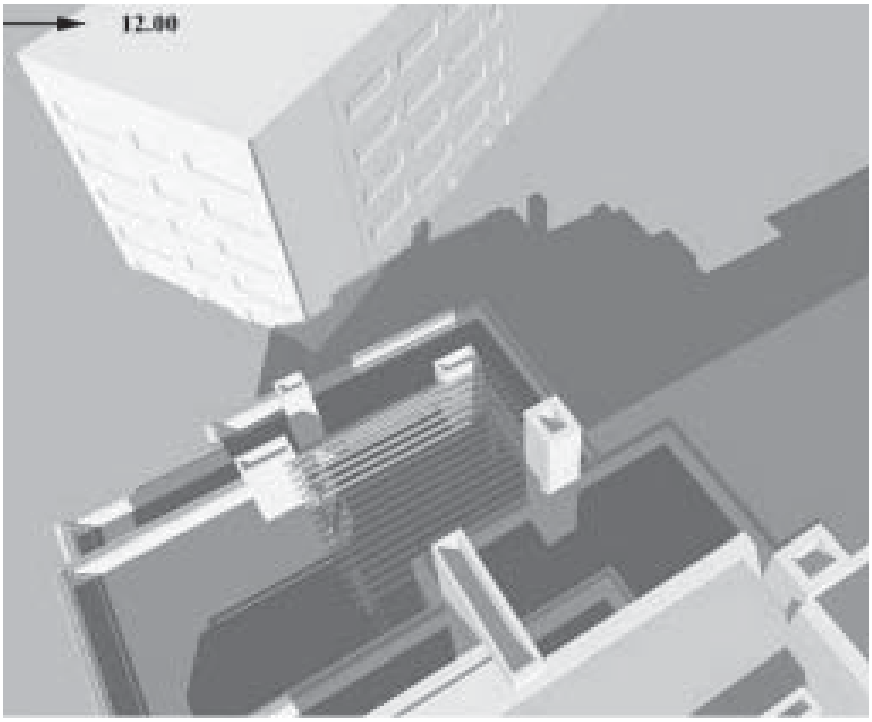


Fig 3: above- vector sun-shading at noon, 21 March; Right- the same time and geometry, but precised in a perspective view. Evaluation of shade is very intuitive and reliable here. There is also animated and – simplified version.

ANALYSIS 2

Hypothesis – the way of evaluation in architecture changed from "inner method" which took place in our mind, to "outer" one, which is strongly affected by our senses.

To verify this, we must realize, which digital endoscopic methods can be used for a presentation of interiors or any other "normally inaccessible" spaces. We have to answer the question : What role play our senses and how they influence human thinking about presented design? Let us point out some methods.

Sequence of images. (turn back to Figure1.) Still frames give to the spectator the widest margin for the imagination. The question, how model would look like from the unrevealed side always remains… That is why we classified this method as "inner" evaluation – it takes

Fig 4: From the left: cross section + perspective; horizontal section rendered with a central convergence point; non-isometric cross-section. All of these representations shows “inaccessible” places in different ways, with a distortion, which will never appear in a real life… A striking difference between these pictures and a movie is presented in digital version of this paper, where medium is not an obstruction.

place mostly in our mind. Our senses give here only the first clue, and a holistic model is to be build in our mind.

Visualized cross-section or plan. (Figure 4.) These ways of presenting are very specific for a digital endoscopy. Scale models have to be prepared, or constructed from a very beginning to achieve a section. Digital simulation allows “slicing” of existing model without disassembling it. User must only specify a cross-plane. Information, which is achieved, is completely unique and impossible in reality, and it shows clear and exact point of view.

Rendered animation. Depending on the quality it may be very impressive method, but the most important is for us the mechanism of perception. Very exact view and frame control could be both – an advantage and a restriction. From one side spectator is given a

finished, compiled vision of a building, but from the other side – he has no possibility of choice. He is led by the hand. His only possibility of interference is to turn off the animation or pause it. But “hidden” places will remain uncovered and left to his fancy. In this case human mind has very narrow area for contriving.

Interactive walk-through. Writing about this technique is like trying to describe to the blind-man a beauty of a sunset. It is beyond the “capacity” of a medium like paper… It must be brought out, that this method leaves the least for human imagination. Wherever you wish to turn round – just push your mouse… This method is a first step towards “virtual reality”. Almost objective valuation of presented object is possible, but because of lack of insinuations, our mind has nothing to “add”. It is only collecting and processing desired frames. That is why this method can be called as “external” or “outer”.

Conclusion. As it was shown, different techniques of simulation engage our senses and mind to different extent. It seems to be proved, that the more advanced and complex technology is being used for the presentation, the less engaged is our imagination and mind and the more involved are our senses (Figure 5.).Because evaluation is strictly connected with a way of presentation, and presentations become more and more attractive, we could imply, that also the way of evaluation changed from “inner” to “outer”.

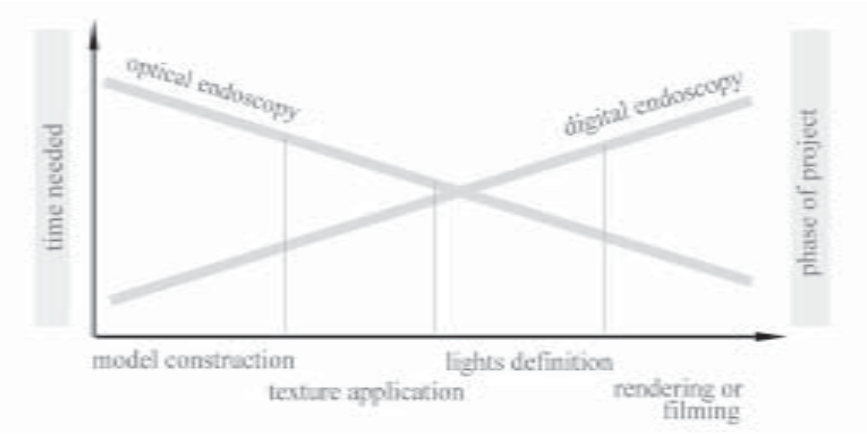


Fig 5: Interdependence of data, which absorbs mind/senses and the way of presentation.

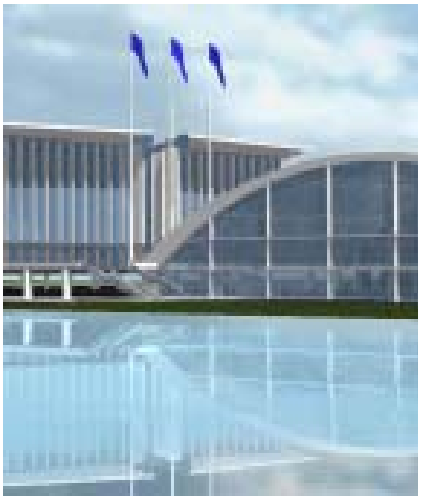


Fig 6: From the left: complex light simulation, water-reflection, special effects. All these effects could be easily imitated in an optical endoscopic laboratory, but what precision and cost would have been engaged?!

ANALYSIS 3

Hypothesis – effective ness of evaluation increases with effective ness of environmental simulation. It is different in optical and digital way of working.

At the beginning we will find out a few reference planes, which together comprise effectiveness of animation:

Light simulation. While a scale model requires a great precision, this effort quickly turns back in time spared on computing lights. There is no computing at all! We can put as many lights as we want and some complex shadows will not prolong a time of computing. It is real advantage of “non-digital” method. On the other hand special lights (neons, projectors) are extremely hard to obtain at a scale model.

Complex effects simulation (mirror, fog, water, etc.) Reasoning is the same as in light-simulation. They are hard to “assemble”, but their “computing-complexity” takes no time in a scale-model. On the opposite side – it is so easy to define a material as a mirror, but than hours and hours are needed to obtain a rendered picture…

Fig 7: dimensions of Amsterdam's Ring of Canals can be properly estimated only compared with a human body. Town Hall at Veere (Netherlands) and Olavinlinna Castle (Finland) – without a "real – artificial" background it would be impossible to recognize a fiction! Precision and material accuracy of these scale-models is perfect for endoscopic use, but they were also immensely expensive and time-consuming.

Material, texture, roughness, opacity simulation. Easier using digital method because of a scale factor! Let's imagine a "real" tree diminished 200 times! 3D-model of tree will never perfectly imitate a real one with its rustle of leaves, slightly moved on the wind, but we cannot construct scale-models 1:1. Despite all limitations, possibilities of texturing can be appreciated by playing some games with contemporary graphic accelerators…

Detailed geometry simulation. Digital method is undoubtedly much easier. Every car, tree, brick, stone or human must be cut, polished, trimmed. It is very time-consuming and requires special tools. After all digital copy is costless, and a real one – doubles the price.

Nevertheless some spectacular scale-models were constructed and serve as a tourist attraction and a proof, that it is still very difficult to compare “direct” and “indirect” impressions while intercourse with architecture. A full “immersion” can be felt in a place called “Mini Europe” in Brussels, where scale-models (1:25) from all over European Union are presented.

After realizing some factors influencing effectiveness of animation , its time for conclusions.

In the digital way we can evaluate simplified environment from the very beginning, but once complexity increases – effectiveness dramatically goes down. Strangely enough - in a “optical endoscopy” a hard work must be done prior to admiring affects and evaluating, but once it is done, all kinds of special lights and effects can be added without decreasing a speed of “treatment”. It is presented on the diagram below.

To sum up: the effectiveness of digital endoscopy is higher at the beginning of work (as it consumes less time). Optical endoscopy seems to be more efficient at the end of the work, or once it’s complexity increases.

A simple proof for conclusions above. We created two short animations presented below (Figure 9.) as exemplary stills – an abstract “patio” and a one-family house. There was no possibility of comparing results to a scale-model, but some easy predictable thoughts came up.

First animation is geometrically very simple, but it is very demanding for a PC due to many lights and reflections. Constructing geometry, placing lights and materials took a while, but rendering of 1 minute long movie (15 frames per second) took more than 25 hours.

The second frame shows relatively complex geometry, but lightened very simple. A whole process of creating 3D-model took plenty of time, but instead the same length of movie rendered in about 8 hours.

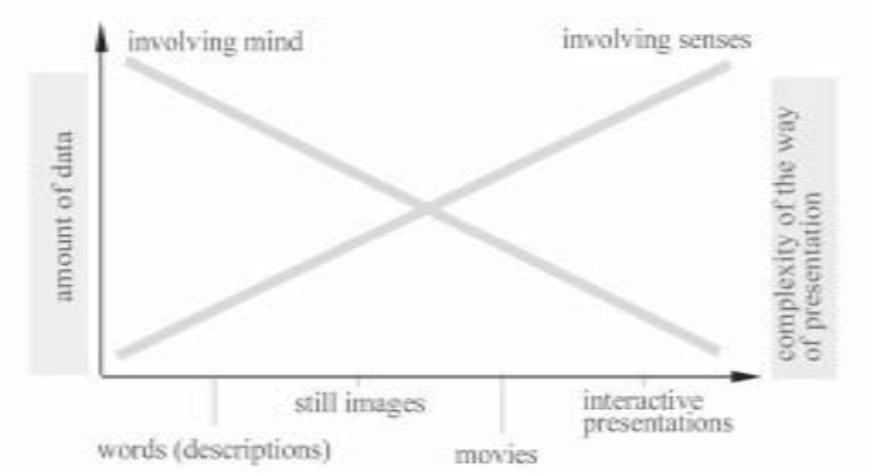


Fig 8: Diagram of endoscopy's effectiveness.

In the first case – it would have been more efficient to construct a scale-model, once we had realized complexity of task. In the second case digital endoscopy was an optimal solution, because of short geometry preparation and moderate length rendering.

CONCLUSIONS FOR TODAY.

3D digital endoscopic simulation is already easy-affordable and it means for architects better design evaluation in any sense.

We analyzed three aspects of environmental simulation: effectiveness of evaluation, it's interdependence with effectiveness of simulation , change in the way of presentation and evaluation (considering previous point) from "inner" to "outer" and we checked out, whether and how simulation is present at different stages of design.

As a result we can state, that environmental simulation changes the way of design in some aspects, such as work organization, psychology of design or design methodology. That is a proof for Mc Luhan words "We become what we own [...] We shape our tools, but soon our tools will shape us."

Fig 9: Still frames of mentioned movies. Left: simple geometry + complex lights/ texturing. Right: complex geometry + simple lights. A model from the up in much more time-consuming and it pays to construct its „optical“ equivalent. to compare results recommended a digital version of this paper.

CONCLUSIONS FOR THE FUTURE

We are convinced , that application of 3D environmental simulation will broaden. There are two directions of it's future expansion:

"Real" application – scientific researches, testing of prototypes and other new areas will demand improved hardware. This direction will follow Moore's "rule", which says, that computers' internal "speed" and "capacity" will double every 18 months. Graphic accelerators will follow the same rule. They will enable very soon rendering of complex scenes in a real time mode. It is possible even today, but still is too slow for everyday-use.

Finding new areas of use is so fascinating, that Michio Kaku even wrote a book on it. A reasonable "forecast" is that simulation will be present everywhere, because of growing costs of "real" experiments. Perhaps future "virtual libraries" will contain a "simulation of crane-work" and "building-site environment". After joining them together and setting some variables a simulation of a whole building-site will be possible…

"Virtual" application - reinventing the way of using software. This second direction will be far more important, as it will change not only the way of evaluation (narrow use), but also a way of communication in two aspects : designer –customer and human-computer. This will be a beginning of new interface. Voice–controlled designing, as if standing in the middle of a building-site… It recalls some 3D games, but instead will be very useful.

Endoscopy is a first step to a virtual environment of the future work…

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