

## Quality Control in Visualization Processes

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**Abstract.** Computer visualizations of planned built environment and infrastructures are increasingly used as a basis for democratic decisions when the impact of the projects is of wide-ranging interests and influence.

It is of great importance for the democratic process that all aspects of the material in a project can be trusted as a basis for discussion and decisions among politicians and citizens.

This paper describes the objective aspects of the quality of data in the information basis for 3D visualizations and it calculates the precision that can be achieved by the known methods of 3D-CAD visualization. Furthermore, the paper suggests a model that can secure sufficient quality in future visualization work processes by accumulating documentation for both the factual basic data and information that carry the aim and meaning of the message and make this information accessible through the visualization.

**Keywords:** 3Dvisualization, process model, quality control

The Danish report “Vurdering af Visualiseringsmetoder”, (Evaluation of Visualization Methods) describes how it is possible to organize quality control of 3D visualizations. The report states that it is recommendable to establish process standards for production and communication of visualizations and it suggests a certification of consultants and companies that work in this area.

The background for the report is several cases, where inexact or ambiguous 3D visualizations of planned constructions have been part of a basis for decisions in public hearings, democratic processes, or important parts of public discussions. In the Danish press attention has been drawn to examples where the discrepancy between the written documentation, traditional plans, sections and the belonging 3D visualization has been so serious that the impression of misinformation has dominated the debate in the press and in the public.

### Introduction

Architects have used Multi Media long before the term became connected to IT. The new media are used overall in the design process supplying the traditional media.

For centuries the profession has produced visualisations directed to the outside world: juries of competitions, decisions makers, head officers and further out towards a broader public via the press and the media. Historically professionals, artists, illustrators have produced these depictions, e.g. the watercolour specialist o. 1900. Parallel to them are 3D visualizations often produced by specific trained IT-skilled persons.

Gidding and Horne point out that “*Architects have generally been diffident about such visualizations, because they are works of professional illustrators. There is a feeling, that the thin lines were produced by architects for the benefit of their peers and for themselves whereas realistic impressions have a wider appeal. They open architectural design to public discussion as the accessibility of these depictions enables everybody to have an opinion.*” Some architects do not feel that the public have any interests in the working process, while more enlightened architects try to involve their clients in the process and give them ownership to the design. (Gidding and Horne p93)

There has always been a public curiosity for the images of the future. No matter if they are illustrations of actual constructions (a new airport) or at far and fictive situations (Blade Runner City)

The interest is based on the fact that visualizations depict the special relation between art and science where architecture is played out.

Gidding and Horne explain in "Artists' impressions in Architectural Design" architectural visualizations as "a synthesis between the objective and subjective. The architect understands the properties of a proposed design in combination with the essential idea, and using it in its representation...The visualization uses the technical precision and formality, in the elements of the building and tell simultaneously a story through atmosphere that bring out the more emotive qualities" (Gidding and Horne p113)

When Serlio in o. 1500 produced his perspectives over town visions, they showed a new organization of space and represented a cultural expression for the scientific competences in society concerning anthropocentric philosophy, the organization of the universe, optical construction of the anatomy of the eye.

Our fascination for computer-generated visualizations is driven by the same excitement by artistic use and interpretation of science. Very clear expressed in the consummation of movies and 'the making of' computer generated universes, Matrix, Terminator where the scientific development is the driving force. The genetic or climatic disturbances are brought to life through movies such as The Perfect Storm and Jurassic Park and we are combining mediated realism and fiction in new ways. Images from NASA Mars Explorer are gliding together with the Science Fiction movie Expedition to Mars without clear distinction.

It is thought-provoking that the 3D visualization programs used to visualize architecture were "born and brought up" in the film industry and in the entertainment business before it became tools in design processes. This fact suggests that there is a need for developing a new language for images that can handle the new relation between quantifiable geometry, topology and localization subjective content in relation to feelings, experience, and atmosphere.

### **Development Tendencies in relation to Visualization**

Architects have traditionally preferred to show informal sketches produced in the early design process containing abstract and conceptual information with a view to communicate values and visions. The sketches express to all a clear relationship to the stage of development of the project but mainly architects are trained in depicting the message.

The public demand for further details and realism has grown because technology makes it possible to document the environmental consequences following urban growth and mass construction. Realistic images could give an overview to complexity. While architects are concerned with ideas and values, the public primarily want documentation for the impact of the project – reflecting that architecture belongs to both art and science. Architectural communication is traditionally clearly separated in different canals, but in photorealistic CAD-rendering it seems that documentation and illustration are mixed in ways that might cause 'noise'. The apparent realism might express some documentation without any basis in reality.

The demand for visualizations is growing because we are constructing more than ever and in scale beyond the pyramids. The visual impact of the individual project is growing combined with demands from developers and builders to secure the best display for the huge investments. Architecture becomes signals in the urban infrastructure with reference to Venturi. The amount of investments pressures

architects to express the marketability with methods similar to marketing. There is established legislation concerning advertisement, consumer information, marketing, and sale. Visualization services have to be covered by similar rules and standards.

### **New Design Processes**

The internal changes in the design process are influenced by the new organisations of the construction industry combined with digital technology. The background information is available as digital maps, plans, regulations together with infrastructural standard for formats and exchange, enabling a coherent digital working process. The technical platform for preparing photo realistic rendering direct on the desktop is present as well.

The structure of the design teams is changing. From the central leading role as holistic ‘artist’ architects are now becoming members of more hybrid network organizations, where the leading role in the design process not is evident, in an integrated team of designers and consultants. The new form of collaboration force the architect to formulate professional intentions and methods more explicit than in a traditional design process, where intentions and values could be kept in an ‘intuitive format’.

The network-based teamwork demands a formalized working process where intentions can be expressed explicit from an early stage. An important component in the internal communication is that ideas, aims, and intentions are visible for everybody. Parallel to the design process, visualization has become teamwork, where several professions have a role in the processing of information: land surveyor, photographer, model maker, rendering expert, environmental consultant. All parts of the chain are dependent of the quality of the data, which is processed, and they all have a need for documentation of their own data processing.

It points to the need for standards and formats for expressing different types of communication and target groups, standards for quality and precision of different products, how documentation of product and process can be embedded in the product.

### **The report ”Evaluations of Visualization Methods”**

According to the report the aim of 3D Visualisation is to give the receiver the possibility to evaluate new projects, but it will always be a debatable matter. The report introduces the scientific circumstances in methods, techniques, tools, and data used in 3D Visualization. The investigation is then extended to describe and discuss the more subjective conditions in choice of point of view, angle, detailing, and render technique in relation to the receiver’s reading and interpretation of the message.

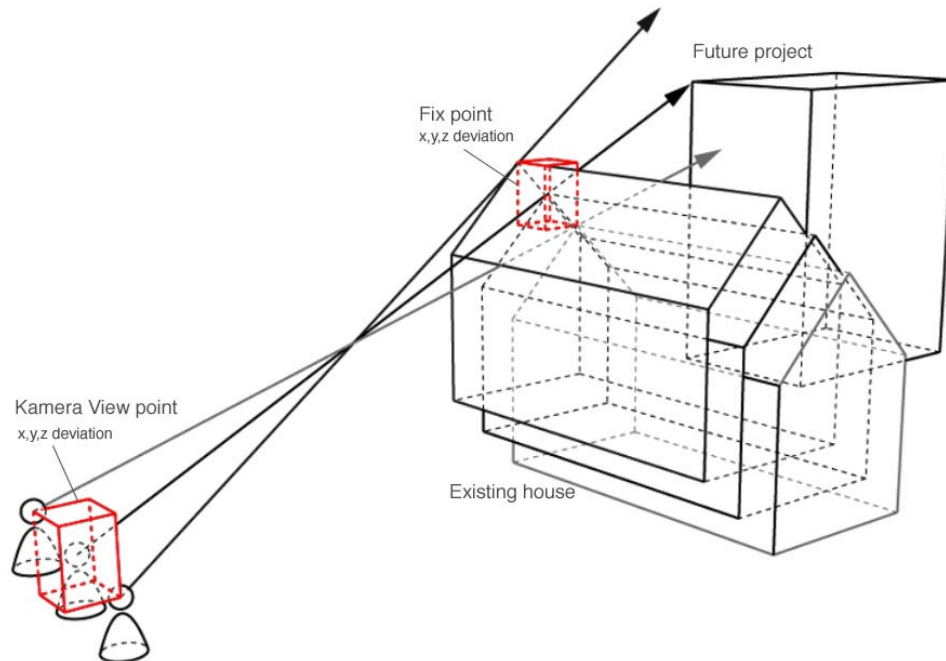
Ole Thyssen explains that *“The success of the image depends on the effect on the receiver. Therefore, it is important to the sender to know his receiver and his desires. That is where we meet the pragmatism of communication, which has been explored in the Rhetoric Tradition since the Antique. The aim is not only to distinguish between true or false but to affect a public in a specific interest.”* (Thyssen 2003, p 182).

Architectural communication is ‘designed’ in relation to context of the receiver to convince or inform different receivers most efficiently in their specific situation. The objectivity has many graduations in this kind of communication where a balanced relation between sender and receiver can be obtained if the sender explicitly expresses his objectives included in the message. The persuasive or rhetoric element in architectural visualization has to be explained explicitly and supply the communication to form a basis for evaluation.

### Geometric conditions are measurable

The report primarily describes conditions relating to the most used technique, Photo Match, where photos and rendering from CAD-models are mixed together mixing reality and fiction. Physical mock-ups, analogue models, and pure 3D-models are mentioned in short and their geometrical accuracy can be validated by the same method as presented in the report.

Photo Match is a technique, where a physical and a virtual camera are coordinated and the corresponding photo from the physical camera over layers the perspective generated from a 3D-model. To secure a perfect match between the physical world and the 3D-model, the most used technique is to match representation of fix points in the photo with coordinates in digital maps of the context where the 3D-model is integrated. The position of the physical camera can through this process be calculated with increasingly accuracy. The sources to inaccuracy are found in the relations between the physical world's Cartesian system and the 3 spatial systems: the camera, the 3D-map and the 3D-CAD model.



*Figur 1. In this example it is investigated if a coming building can be seen from a certain point of view or not. In the diagram the deviation is illustrated in the positioning of the camera, a fix point on an existing building and a planned project.*

The definition of the uncertainty is illustrated in the report through diagrammatic examples. Two typical types of commercial 3D-map products are available with separate price and quality used to decide the position of physical objects such as camera, fix points, and other relevant objects in the physical context. The most expensive and accurate method is traditional land survey. This product can position of any point be determined inside 2,2,3 cm in x,y,z. Much cheaper and accessible are commercial digital maps produces by terrestrial ortho photo where points typically are defined inside 10,10,15 cm in urban areas. The examples in the report are calculated with these two qualities of maps.

In this example the distance from camera to the fix point is assessed at 100 meters and the distance from the fix point to the project at 300 meters. By using simple

geometry it is possible to calculate the uncertainty of the visibility of the project in relation to the different maps. The deviation is 20 cm when using the traditional and expensive map and 100 cm with the commercial product compared to the exact height. In this example the 20 cm deviation will result in uncertainty inside 2 pixels while the 100 cm deviation will result in blurry situation inside 9 pixels if the deviation is translated into pixels in a photo match between 5 mega pixels (2560x1920) digital photo taken with a 'normal' (56 degrees) lens and a CAD-model. These relatively small deviations suggest that it is possible to create a photo match with an appropriate accuracy. It is important that the accuracy can be calculated and documented and price estimated according to the need for quality in the communication.

### Point of view and possible interpretation

A description of quality in visualization processes has to be done in another way, when ambiguity is dominating the receiver's understanding of the message. The situation is evident because the sender in his choice of viewpoint and angle has chosen that part of the context that he finds most interesting (or wants to hide). If the sender is aware of this purpose, this information must be added to the visualization in connection to the factual information as camera position, lens and time. The receiver gets an expanded ability to read and understand why the image is produced.

The report does no attempt to build any rules for 'correct choice' of lens or 'best position' of view. The manipulative possibilities in the choice of focal distance and camera position are discussed in details. The conclusion is that legally it is difficult and artistically it is precarious to establish rules and standards for these choices. The recommendation is to explain the aim of the choice.

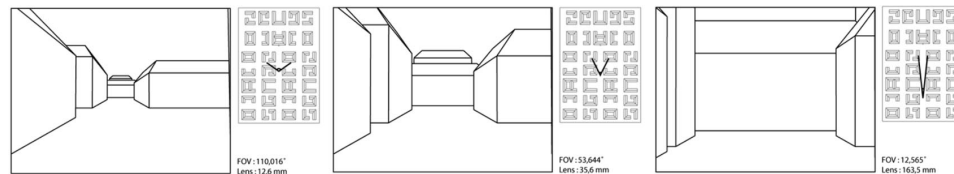


Figure 2. Various lenses and distances

The attitude to Quality Security is based on the pragmatism that the more detailed the sender can document the information and send it to the receiver, the higher quality in the process. Aims and values have to be explained explicitly. The attitude dominates the recommendations as regards types of visualizations, rendering quality, level of detailing, printing quality etc. Another general recommendation is that visualizations have to be done with different degrees of abstractions in parallel images to support decision-makers as well as a wider public to focus on isolated aspects of information, and from the same viewpoint get a holistic experience. It is important that the parallel illustrations are supplied with comments, which explain the intentions in the different abstractions. The press will with this extended information have a better basis for covering a specific project.

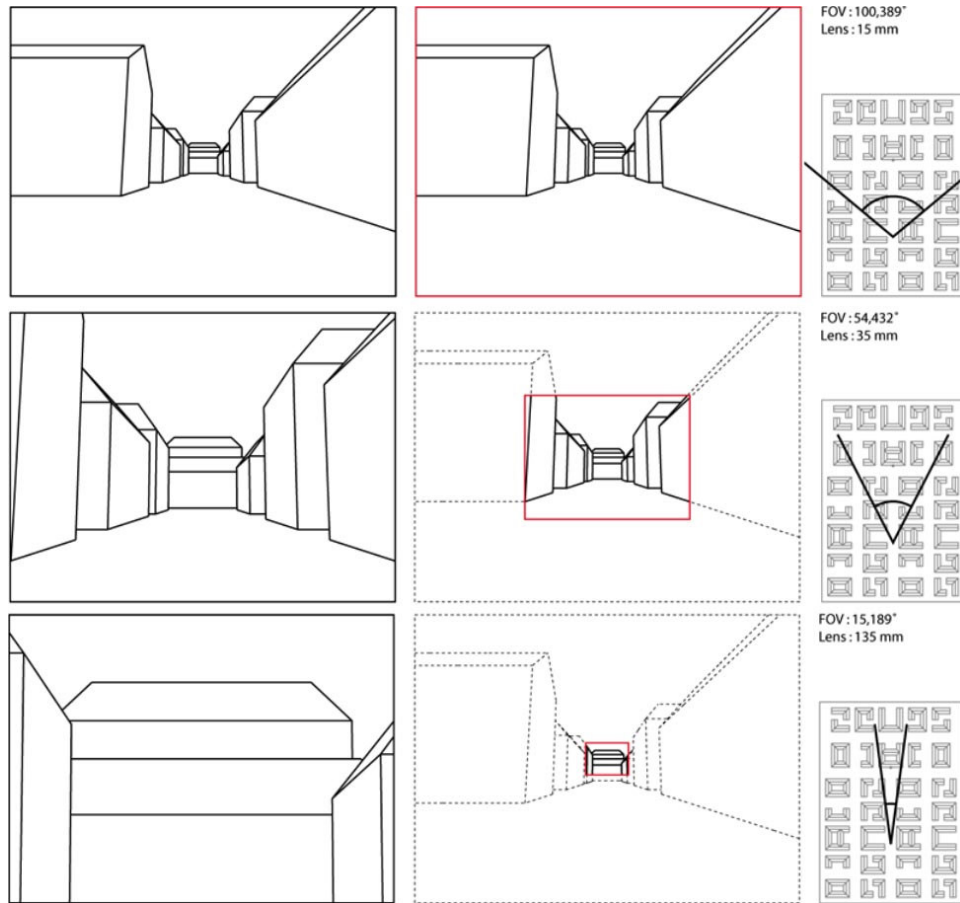


Figure 3: Various lenses with fixed view point

In general the report concludes that visualisations can be done in many levels of visual abstractions and in many levels of precisions, as long as the intention and accuracy of the visualization is clearly stated. This can be achieved by watermarking or attaching metadata regarding precision and intention to the visualisation. In this way the architects higher focus on the communication purpose increases the receiver's possibility of decoding the visualization, and thereby placing visualizations as reliable representations suitable for use in democratic processes.

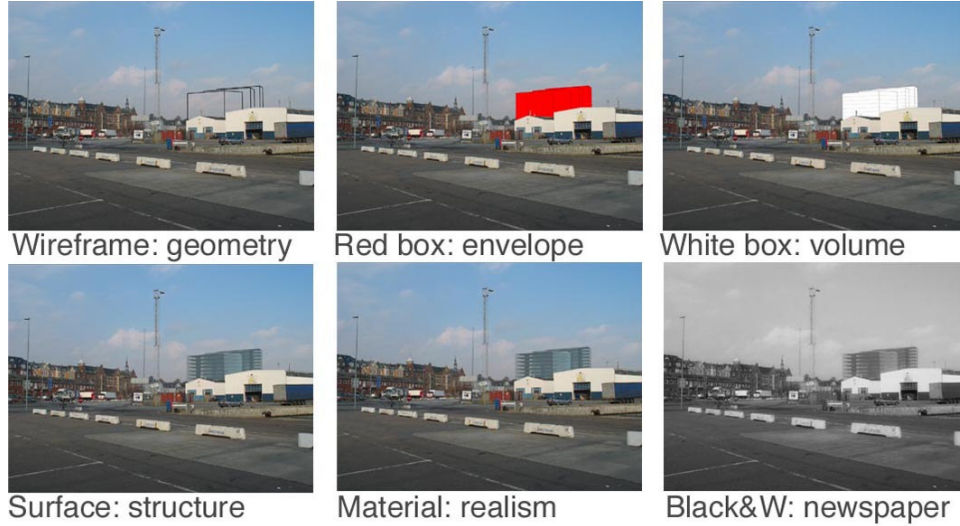


Figure 4: Examples of different abstractions and renderings bringing various information to different target groups

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