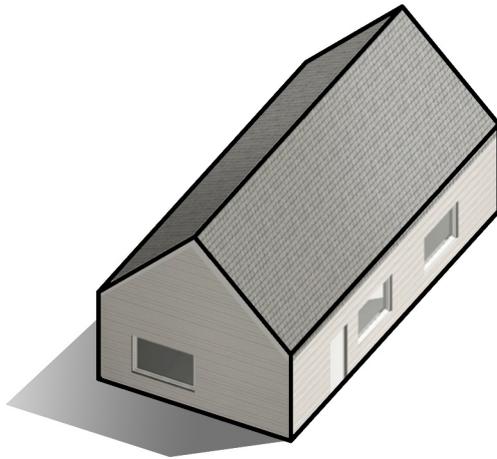


COBIM

Common BIM Requirements
2012

v 1.0



Series 8

Use of models for visualization

Foreword

The publication series “Common BIM Requirements 2012” is the result of a broad-based development project entitled *COBIM*. The need for these requirements arises from the rapidly growing use of building information modeling in the construction industry. During all phases of a construction project, the parties to the project have a need to define more precisely than before what is being modeled and how the modeling is done. “Common BIM Requirements 2012” is based on the previous instructions of the owner organizations and the user experiences derived from them, along with the thorough experience the writers of the instructions possess on model-based operations.

The parties to the project are:

Funding providers: Aitta Oy, Larkas & Laine Architects Ltd, buildingSMART Finland, City of Espoo Technical and Environment Services, Future CAD Oy, City of Helsinki Housing Production Office, City of Helsinki Premises Centre, University of Helsinki, Helsingin Yliopistokiinteistöt Oy, HUS Kiinteistöt Oy, HUS Premises Centre, ISS Palvelut Oy, City of Kuopio Premises Centre, Lemminkäinen Talo Oy, Micro Aided Design Ltd. (M.A.D.), NCC companies, Sebicon Oy, Senate Properties, Skanska Oy, SRV Group Plc, Sweco PM Oy, City of Tampere, City of Vantaa Premises Centre, Ministry of the Environment.

Written by: Finnmap Consulting Oy, Gravicon Oy, Olof Granlund Oy, Lemminkäinen Talo Oy, NCC companies, Pöyry CM Oy, Skanska Oyj/VTT Technical Research Centre of Finland, Solibri, Inc., SRV Rakennus Oy, Tietoa Finland Oy.

Management: The Building Information Foundation RTS.

The requirements were approved by an executive group consisting of members from the project parties. The executive group acted as committee TK 320 of the Building Information Foundation RTS, and as such, participated actively in developing the content of the requirements and asking for comments from the members of the executive group and from interest groups.

Parties to the © COBIM project.

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1 Main Objectives of Building Information Modeling

Property and construction modeling aims to support a design and construction lifecycle process that is of high quality, efficient, safe and in compliance with sustainable development. Building information models are utilized throughout the building's lifecycle, starting from initial design and continuing even during use and facility management (FM) after the construction project has concluded.

Building information models enable the following, for example:

- Provision of support for investment decisions by comparing the functionality, scope and costs of the design solutions.
- Energy, environment and lifecycle analyses for the purpose of comparing solutions, design and objectives of facility management follow-up.
- Design visualization and analysis of construction feasibility.
- Enhancement of quality-assurance and data exchange and making the design process more effective.
- Utilization of building project data during building operations and facility management activities.

To make modeling successful, project-specific priorities and objectives must be set for models and model utilization. Project-specific requirements should be defined and documented on the basis of the objectives and general requirements set in this publication series.

General objectives of building information modeling include, for example, the following:

- To provide support for the project's decision-making processes.
- To have the parties commit to the project objectives by means of using the building information model.
- To visualize design solutions.
- To assist in design and the coordination of designs
- To increase and secure the quality of the building process and the final product.
- To make the processes during construction more effective.
- To improve safety during construction and throughout the building's lifecycle.
- To support the cost and lifecycle analyses of the project.
- To support the transfer of project data into data management during operation.

“Common BIM Requirements 2012” covers targets for new construction and renovation, as well as the use and facility management of buildings. The minimum requirements for modeling and the information content of models are included in the modeling requirements. The minimum requirements are intended to be observed in all construction projects wherein the use of these requirements is advantageous. Besides the minimum requirements, additional requirements can be presented on a case-specific basis. Modeling requirements and content must be presented in all design contracts in a binding and consistent manner.

The publication series “Common BIM Requirements 2012” consists of the following documents:

1. General part
2. Modeling of the Starting Situation
3. Architectural Design
4. MEP Design
5. Structural Design
6. Quality Assurance
7. Quantity Take-off
8. Use of Models for Visualization
9. Use of Models in MEP Analyses
10. Energy Analysis
11. Management of a BIM Project
12. Use of Models in Facility Management
13. Use of Models in Construction
14. Use of Models in Building Supervision

In addition to the requirements of individual fields, each party to a building information modeling project must be acquainted at a minimum with the “General Part” (Series 1) and the principles of Quality Assurance (Series 6). The person in charge of the project or the project's data management must have comprehensive command of the principles of building information modeling requirements.

2 General

Building Information Modeling (BIM) and visualization are used for analyzing and comparing different design solutions. In addition to the investment costs and functionality, the lifecycle costs and environmental impact are also usually included in the assessment whenever possible, because their comparison using simulations is one of the principal benefits of integrated BIM. The scope of tasks will be defined in the design tenders and agreements.

2.1 Technical Illustrations and Visualizations

Visualization can be divided into two main forms. The first is a traditional, often photo-realistic visualization, which presents the designer's view of the project and its design solutions. Quality requirements for such images are often very high, and at best it is difficult to distinguish from photographs.



*Photo-realistic illustration for the marketing of the project.
Aitio Business Park / NCC Property Development Oy, Arkkitehtitoimisto Hannu Jaakkola Oy, image: Tietoa Visualisointi.*

The other form of visualization is a technical illustration. It serves as the communication tool between the design team, client, project management and construction site. The presentation requirements for technical illustrations are different compared to photo-realistic visualizations, for example, colors often represent different systems and building parts instead of the actual materials. In both of these cases, the visualization may be in a form of a video or a model with the ability to walkaround in real-time on your computer screen. Viewing and quality assurance software are commonly used for the technical studies, and the ability to move around the model in real-time is a basic feature of these applications.

Whenever it is necessary to distinguish between these two forms, the terms **technical illustration** and **visualization** are used in this document. The first refers to the technical presentation of the designs and the latter to the traditional rendered photometric visualizations.

2.2 The Many Applications of Visualization

Visualization by means of BIMs supports the work of the designers and project management, improving the communication between the design team, project parties and end-users of the facilities. The principal benefits of visualization include quality optimization, more convenient comparison of alternatives, increased interaction between different parties, and support of the real estate development and marketing process.

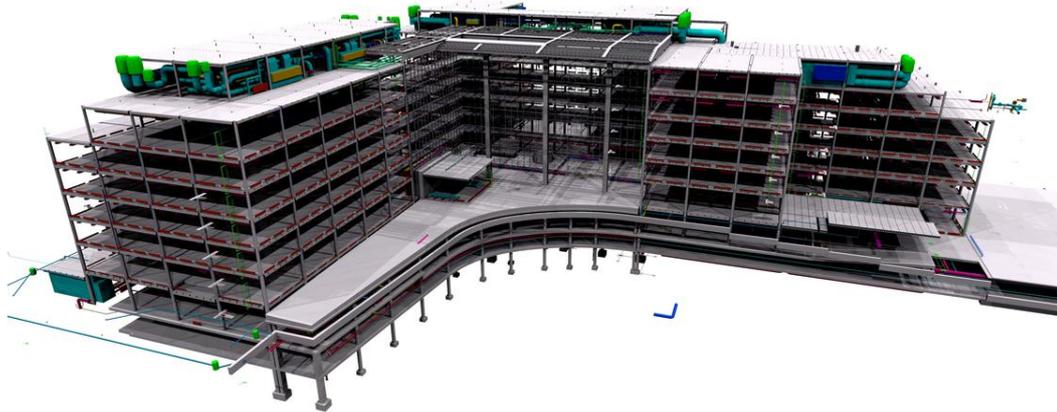


Illustration created by the HVAC designer presenting the structural and building services models. Tapiola Insurance Company HQ, image and HVAC model by Granlund Oy, structural model by Finnmap Consulting Oy.

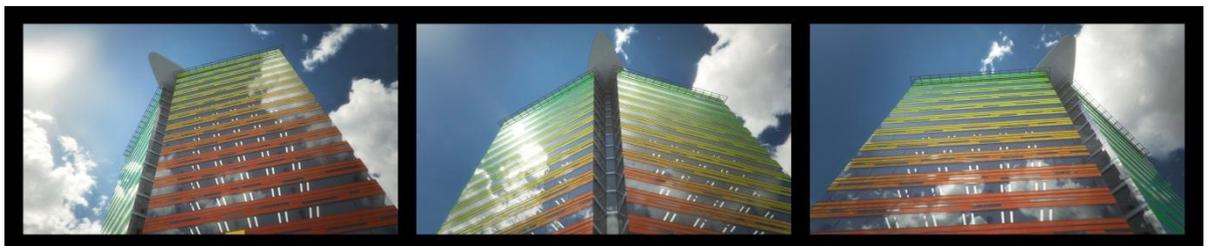
The BIM is utilized throughout the course of the project according to the information requirements of the Client's investment process. In particular, the BIMs are used during the design of alternatives and early design stages for the purpose of comparing the investment and lifecycle costs and functional properties.

As technical capabilities and know-how improve, the use of modeling simulations and visualizations will be increased and extend to various stages of the project process. Traditionally, visualization has been considered to be in the architect's territory, but as BIM-based design has spread rapidly to other areas of design, other disciplines have begun to produce technical illustrations and even visualizations from their own models.

These visualization guidelines also provide a brief description of the visualization of certain HVAC-related information generated by condition analysis and simulation tools. For the most part, however, they have been described in Series 9 of the BIM requirements, "Using Models in MEP Analyses."

3 The Objectives of Visualizations

3.1 Visualization of Design Alternatives



Screenshots from a video which has been created for marketing purposes.

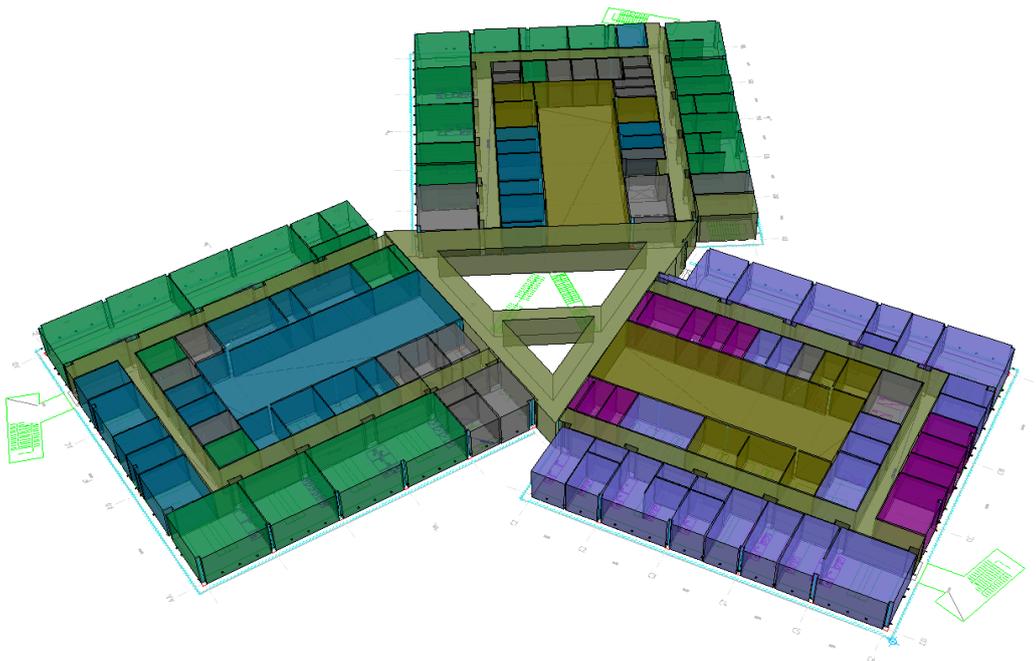
Avia Tower / Insurance Company Pension Fennia, Arkkitehdit Davidsson Tarkela Oy, image: Tietoa Visualisointi.

The fast, illustrative and interactive visualization and analyses enabled by BIM provide support for communication and decision-making. Visualization produces clearer and more intuitive information, and provides additional information on the existing site conditions.

The quality factors of the built environment can be illustrated using BIMs and visualizations generated on the basis of them, concerning, among others, land use and regional planning projects and complexes formed by multiple buildings, such as university campuses. In addition to the project team and end-users, the visualization may also serve the needs of external stakeholders, such as the public authorities. If there is high demand for visualizations, separate communication and visualization consulting may be included in the project team.

3.2 Assessment of Design Solution Efficiency

Area, volume and efficiency reports can be generated from the Spatial BIM. This information can be compared against the corresponding key figures of reference buildings and the objectives of the room program. The required reports can be generated using the reporting features of the BIM authoring software. Efficiency can be studied visually with a variety of diagrams and three-dimensional space models, which serve both the designers and the users together with other involved parties.



A three-dimensional spatial model, where various functions are illustrated with different colors. Micromedicum / Senate Properties, Arkkitehtuuritoimisto Heikkinen-Komonen Oy, image: Gravicon Oy.

3.3 Understanding the Content Solutions of the Design

The BIM can be used for the visual examination of alternative design solutions, either directly using the Spatial, Preliminary Building Element or Building Element BIM or with the help of visual simulations generated on the basis of the above using separate visualization software. The functionality of different design alternatives can also be examined in a virtual environment at different stages of the design process.

3.4 Support for Directing and Overseeing the Design

On the basis of the comparison of alternative design solutions, quantitative and qualitative assessment of the design solution can be performed. Visualization thus

provides support for both directing (principal design task) and overseeing (project management task) the design process alike.



Visualization of the architectural design to be used in marketing and authority processes. Merikartano / S-Asunnot Oy, Arkkitehtitoimisto Stefan Ahlman Arkitektbyrå Oy, image: Tietoa Visualisointi.

3.5 Setting and Managing Requirements

Models can be used for visualizing the requirements by using, for example, type, module or reference solutions. For instance, models can be used for assessing and simulating the following:

- Use and interconnections of spaces
- Accessibility
- Lighting
- Compliance with requirements
- Safety (fire safety, escape routes, coverage of surveillance cameras)
- Investment costs
- Lifecycle costs and environmental impact
- Indoor climate conditions
- Air flows (computational fluid dynamics)

The use of models in the management of the general quality requirements set for construction projects aims specifically at:

- Management and assessment of scope and quantity information
- Management and assessment of energy consumption
- Management and assessment of the functionality of spaces

The selection of the solution and the appropriate medium is affected by the media competence and habits of the project team and the clients, as well as the nature of the problem or design case at hand. Different forms of media (paper document, 2D/3D/4D digital BIM, virtual environments, augmented reality) provide different ways of presenting required information. The decision on the selection of the medium most suitable for the purpose will be made by the project manager.

It is essential that all material used for visualization is based on an up-to-date model.

4 Illustrations and Visualizations

BIM-based design always generates some level of three-dimensional material. The information content required for visualization cannot be predefined on a general level but must be decided upon on a project-specific basis. The visualization of the design

solution with a BIM, as well as the utilization of the information contained in the BIM, provide the information required for decision-making.

The required number and quality of visualizations at different stages of the project must be defined in the call for tender and, if required, specified further before signing the design agreements. Visual still images and simulations are suitable when a high quality level is required for the visualization of information.



Screenshots from a video that has been created for marketing purposes of a shopping mall. Hämeenlinnakeskus / NCC, Arkkitehtiyöhuone APRT Oy, image: Tietoa Visualisointi.

4.1 Use of BIM in Visualization

Design software is constantly evolving, and today it is possible to produce reasonably high-quality visualizations directly from design models. In practice, the designer's own way of working will determine how easily the visualizations can be done. However, there are differences between applications particularly in managing materials and lighting. Typically, the end result is complemented and edited in a photo editing software.



Visualization generated directly from the BIM. The vegetation and some additional images are added in a photo manipulation software to illustrate the environment.

Kuopion Helmisimpukka / Skanska, Arkkitehtitoimisto Huvila Oy.

The BIMs from each party must primarily meet the requirements set for the specific disciplines (Series 3-5). If the needs of visualization and general requirements are in conflict, the discipline specific requirements are given higher priority.

Currently, visualizations are usually based on the original model generated by the architect or the structural or HVAC designer. The Design BIM normally requires additional work in order to prepare high-quality visualizations, but it is well-suited for further processing. IFC-based data transfer involves significant limitations at its current development, but also a number of new opportunities already at this stage.

Visualization software support the dynamic nature of the design process when examining design alternatives. It is possible, for example, to lock applied lighting, material, and color settings. This makes the production of visualization images more efficient, even if the geometry of the model changes during the design process.

4.2 Technical Illustrations

Usage of BIM allows for study of the design in three dimensional form. Visible information can be controlled by adjusting the visibility of the various components of design disciplines.



An example of a technical illustration. The section of the combined BIM shows location of building services systems in relation to the structures. The colors and surface materials are purely symbolic and serve the technical reviewing of the design. Helsinki Music Centre, LPR-Arkitehdit Oy, Insinööritoimisto Mikko Vahanen Oy, Granlund Oy, Insinööritoimisto Lausamo Oy, image: Gravicon oy.

Providing color codes for different building parts should be used in modeling. Viewing and quality assurance software identify the data type, shape and location of the modeling elements in addition to modeling discipline. Each element should have a component property by which the component can be distinguished. This information will be transmitted in the IFC file. The colors shown by viewing and quality assurance software are based on this information.

Guideline

In practice, the color definition is such that modeling should be carried out by using the proper tools for each building part. For example, walls are modeled with the wall tool, slabs with the slab tool etc. Software specific modeling components can be given more specific information; you might be able to define a wall as load-bearing or non-bearing with a property that is transferred to IFC format.

In viewing and quality assurance software the elements from the Architectural BIM can be visually identified mainly on the basis of their shape, and are typically rendered in grayish or pale color of various shades. Building services and structural designer models are presented with strong and recognizable colors for illustrative purposes. All colors are symbolic and are determined consistently by the element.

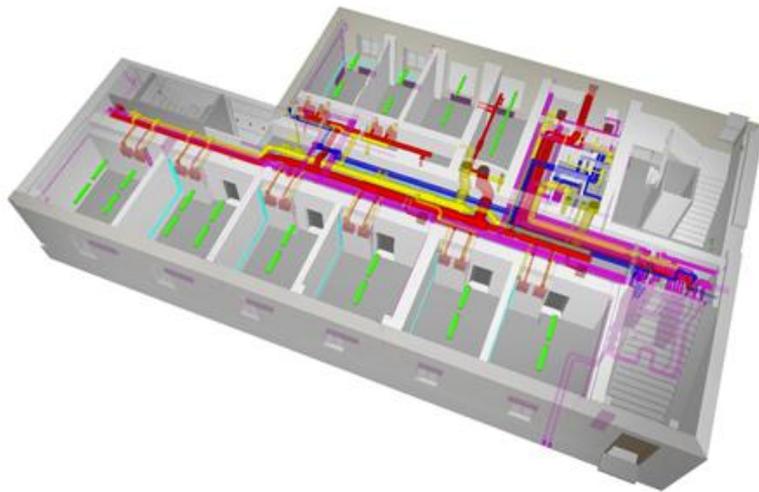
The color codes for each building services system has been defined in the Series 4, "MEP Design." The Structural BIM color codes for each building element group are shown in the table below.

Building Element	Color	
Wall	Turquoise	
Slab	Turquoise, dark	
Column	Red	
Opening	Violet, light (Opacity 40%)	
Beam	Purple, light	
Railing	Blue, light	
Roof	Violet, light	
Stairs	Turquoise, light	
General Object	Aquamarine, light	
Sheeting	Violet, dark	
Pile	Aquamarine, dark	
Foundation	Aquamarine	
Structural Sub-Components	Purple	

An example showing the colors used for structural elements by the viewing and quality assurance software.

Examples of visualization documents and models that can be generated by the designer may include:

- Perspective renderings (3D still images); rough mass models, photographic visualizations containing materials and shadows
- Urban landscape studies, relation to the environment (scope, precision level)
- Linking the model with photographs of the environment
- Facade studies
- Lighting studies on the indoor and outdoor space; entrance, main facilities, building passageways
- Animations or live-3D presentations depicting the main points of the design solution
- 3D sample space studies
- 4D animations for schedule assessment
- Documents supporting production control, for example the illustration of material types using color codes
- Illustration and 3D-sections from the BIM that help the installation work at site



HVAC systems stand out clearly because of the different colors in a combined BIM.

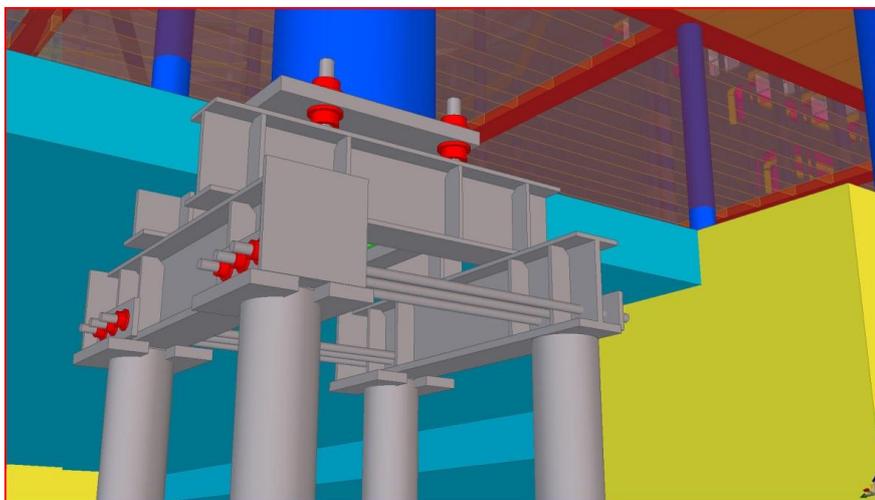


Illustration of three-dimensional structural details

4.3 Visualization

BIMs are primary technical documents. Use of BIMs for visualization should be evaluated for each project. The information content of BIM is determined by the accuracy needs of modeling, which does not always correspond to the needs of a realistic visualization. For example, if the BIM is used in simulations, plaster decorative forms are irrelevant. The essential elements for the visualization are often not necessarily for other purposes of the BIM. Instead, they might add unwanted complexity to the model. The sections of the building and building elements needed for aesthetic visualizations should be defined and selected case-by-case.



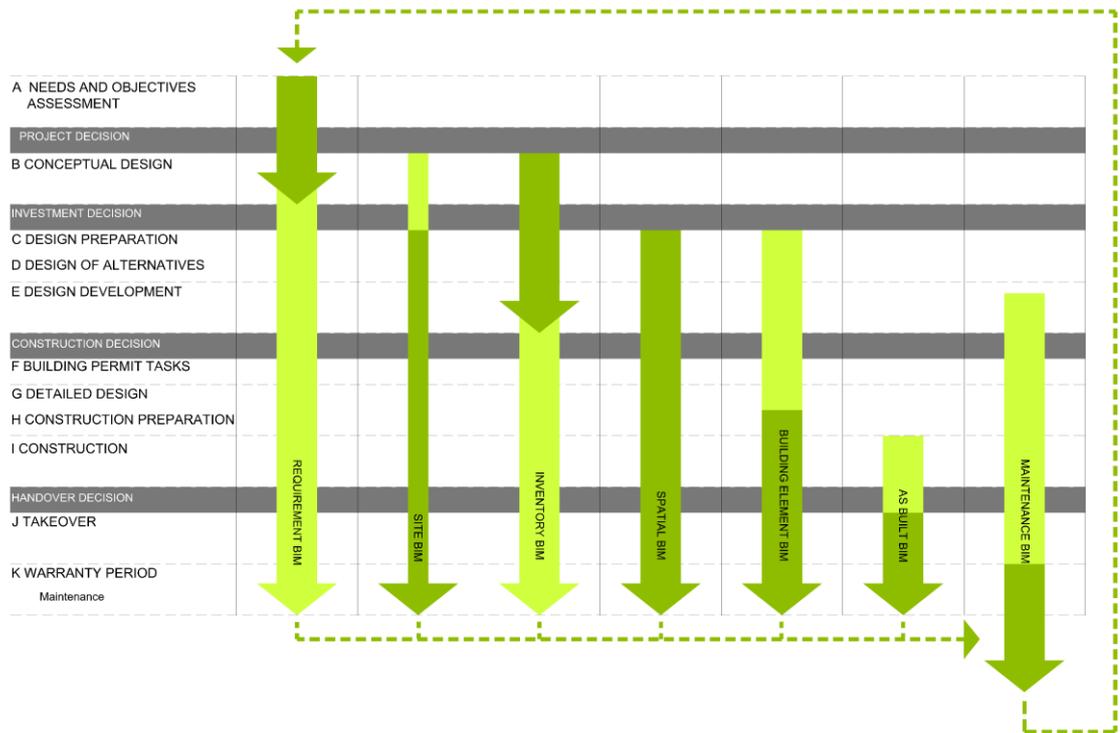
An example of an aesthetic visualization. Materials, lighting and atmosphere have been tried to make the scene as realistic as possible. The image is used to illustrate the outcome of the Concert Hall space. Helsinki Music Centre, LPR-Arkitehdit Oy.

Aesthetic visualizations are needed in the early stages of the project to define the objectives for the architecture and subsequently in marketing and presentations as they become more specific. The aim is to produce a realistic picture of the outcome of the project. Keeping the data model realistic is not necessary if photo-realistic visualization is not needed at each stage of the project.

On project basis, it is possible to decide that, in parallel to the working BIM, a separate visualization model is created for presentations and marketing materials. If the model is solely for visualization purposes, it does not necessarily have any other information than the shape, colors and texture. Use of BIM in visualizations is, however, recommendable.

5 Visualization at Different Modeling Stages

Visualization needs are always project-specific, and therefore there are no similar general requirements as for example, with an Architectural BIM. However, visualization is an essential part of communication and decision-making process in all projects. The three-dimensional nature of BIM itself is already a rich graphical design tool, and it is legitimate to take advantage of the models for various illustrative and visualization purposes.



The use of BIM in different phases of a project

The table below shows examples of different visualization tasks that support decision-making at different stages of the project. While this list is by no means exhaustive, and alternatively shows functions not necessary for all projects, the list gives both the Client and the designers a general indication of how visualizations can be used in the project and beyond. The project parties should also remember that because of the BIM-based design tools, visualizations are no longer the exclusive obligation of architects. Similarly, structural or technical building designers may be required to visualize the structural solutions, details, systems and simulations with three-dimensional models and images.

	Decision Point			Phase									
	Project Decision	Investment Decision	Construction Decision	Needs and objectives assessment	Schematic design	Design of alternatives	Design development	Building permit	Detailed design	Construction preparation	Construction	Handover/Takeover	Maintenance
Technical Illustrations													
Room Program	x	x	x	x									
Spatial Requirements	x			x									
User Diagrams	x	x	x	x		x							
Functional Diagrams	x	x	x	x									
Area Diagrams	x	x	x	x	x								
Shade Studies	x	x											
Energy Analysis		x	x			x	x	x	x				x
Lighting Analysis			x				x						
Design Visualizations	x	x	x		x	x	x	x	x				x
Model Collaboration			x			x	x	x	x	x	x		
Clash Detection						x	x	x	x	x	x		
Sections							x						
Details							x						
Utilization of BIM-based images at Site							x						
Site schedule and logistics management							x						
Location Diagram								x	x				x
Maintenance Guides													x
Visualizations													
Competition Renderings	x												
Alternative Room Layouts	x	x	x										
Visualizations ordered by the Client	x	x	x										
Exterior and Interior Renderings	x	x	x										
Facades			x										
Isometric Images													
Site Mass Models		x	x										
Lighting Visualizations			x										
Interior Design Studies													
Furniture Layouts													