Building Information Modelling of Modern Historic Buildings

Case Study of HUT / Architectural Department by Alvar Aalto

Hannu Penttilä¹, Marko Rajala², Simo Freese³
¹,²Department of Architecture, Helsinki University of Technology, Finland, ³Architectural Office Freese Oy, Finland
http://arkit.tkk.fi/senaatti
¹hannu.penttila@hut.fi, ²marko.rajala@hut.fi, ³simo.freese@freese.fi

This paper reports a research study which evaluated the possibilities of building information modelling (BIM) within renovation of buildings of significant architectural, historic or cultural values. Renovation or restoration projects of historic buildings can be more demanding, challenging and complex than traditional renovation of for instance within housing. Objective of this research has been to transfer ICT (information and communication technology) and BIM research findings to historic design practice and true renovation project environments.

The concept of building information modelling BIM is a proposed integrative framework for all design and construction project information in digital form. BIM can currently be seen to be in a phase of pragmatic pilot projects in several countries. Nevertheless, BIM has not been tested that much in renovation projects yet, although the importance of renovation and restoration is remarkable within the total volume of western construction sectors.

One essential conclusion of this study is, that renovation design work should be started earlier in model-based design projects than in traditional renovation projects. More resources have also to be assigned to earlier design phases, if BIM is intended to be used extensively throughout the project.

Another finding is the new concept of an inventory model, which is proposed to be the container for all building inventory, survey and measurement data. Even more so, when significant historic, hence more demanding building renovation is concerned, because there are more needs for various kinds of surveys, accurate data gathering and analyzing queries concerning the project.

Keywords: BIM; building information modelling; design process; design methods; reconstruction; renovation.
Background

Basic concepts BIM and IFC
Building information modelling, BIM is a rather new and general concept of model-based building process, building related information and data management with digital tools (Eastman 2006). It is essential, that despite the geometrical 3D-model of the building – which is most often modelled with CAD-systems – the BIM-concept will cover even wider all the information concerning the building, its design and construction process and also the use and maintenance phases through out the whole life-cycle of the building.

The short history or the evolution of the BIM-concept consists of such topics as object oriented systems and parametrical modelling, often strongly related with CAD-software development. The concept design for fabrication is also essential within BIM, because the intention is to manage not only design, but also the actual construction process information such as building materials, time and money. Quite often BIM is, still somewhat misleadingly, understood to contain only geometric modelling of the building's shape and form, but the concept should be understood more comprehensively.

An essential acronym related to BIM is IFC (industrial foundation classes), which is a neutral data exchange standard developed to carry and deliver building related data between various software application within the AEC-sector (architecture, engineering and construction). Although IFC is a rather complex standard, a designer or a software user does not have to care about IFC's details, but he should regard it as a technical channel to deliver data between software applications.

BIM - from visions, strategies, research and pilots to practice
Since the late 1980’s design & construction field information technology research has concentrated on technology related development in defining new collaborative data exchange methods and standards such as IGES, PDES/STEP or the early Finnish Ratas. Pilot projects around BIM and IFC finally started to appear during the early 2000’s and currently the trend seems to be in publishing pragmatic guidelines and instructions for various design disciplines and project participants towards BIM-oriented activities, and finally to design and construction practice.

Despite various countries in Europe, Scandinavia and USA one of the recent concentrations of BIM-activities has been “the laboratory Finland”. A major facility manager of state owned buildings in Finland, Senaatti Properties, as well as the biggest construction companies, such as Skanska, YIT and NCC have recently announced that their near future strategies will be targeted towards BIM (Senate Properties 2006).
BIM does not mean just the technical applications or data exchange standards, but the essential meaning of it is, concerning the companies and especially project owners, that they have first to be committed to BIM-based visions. Then the organization has to assign resources plus a planned strategy to develop their own processes, collaborative working methods and information management following their visions.

Objectives of this study

Main objective of this study was to demonstrate how modern digital methods can be used in reconstruction design as well as in renovation projects, with special emphasis in BIM, which has been under active research and piloting efforts in Finland during the last years. Key questions concerning this study have been:

- What kind of additional value will modelling and BIM give to renovation and reconstruction?
- How does model-based renovation process differ from “traditional” renovation process?
- How should existing buildings with remarkable cultural, architectural and historic value, be modelled?
- How do building preservation aspects affect model based design?

The Finnish project owner, Senaatti Properties, has more than 11 000 existing buildings to be maintained all around Finland, and because they recently launched their BIM-strategy, they naturally want also to know what does their BIM-vision mean for their existing building stock.

The Architectural Department building of Helsinki University of Technology HUT by Alvar Aalto 1965, has been used as a case example to demonstrate the possibilities of model-based methods within renovation and restauration. We have considered the topic even more extensively, presenting alternative contemporary possibilities of digital information and communication technology as well.

State of the art of ICT in renovation and reconstruction

Design domain within renovation and restoration, and on the other hand modern digital information technology are two very different research domains with separate research traditions, and still these two domains will be combined in contemporary reconstruction projects.

A vast majority of ICT-related research, contemporary working process development and data exchange methods as well as the available software applications are clearly focusing on new buildings, whereas reconstruction design or new reconstruction related design methods have not been studied thoroughly yet. The overall meaning of renovation is still remarkable. For instance in Finland some 40 % of the total volume of the AEC-sector is currently renovation related.

Contemporary and integrated digital reconstruction process was evaluated in this study to find out the existing possibilities to use modern technologies. Various digital tools and methods are currently available for renovation and restoration purposes. For instance 2D drawings to document the building, inventory databases, geometric 3D-modelling, tacheometry-based measurements, 3D laser scanning and automatic locationing of images.

An important observation is, that even if technology-related issues seem to master the contemporary design process, it is still more important to define the objectives for the digital renovation project first:

- Why to perform model-based renovation?
- What are the goals, needs, objectives and requirements for digital renovation information management?
- What are the decisions and actions needed to achieve these goals?

The next phase will then be to organize skilful personal to do the renovation design work, and very often to also learn some new technology-related skills. Finally, the most important requirement is the ability
to combine the high-quality professionalism in renovation design with new digital methods.

Since digital renovation design is not yet widely implemented into project practices, design process development should be done with small and achievable development steps.

Even if there are some modern tools and methods available for renovation design, not all of them will necessarily support the design work, nor the transition towards model-based design – if that is the objective.

The graphical part of inventory data is very often currently stored in the format of digital drawings (2D). An inventory database of collected inventory information allows to store text, numerical information as well as also images in a well structured and

Figure 2
Web-based room cards in a Kioski-solution have been used to store the architectural inventory data of Alvar Aalto's Finlandia-house in Helsinki (Tmi Hilla Tarjanne 2004).

Figure 3
Integrating drawings with models. When digital drawings of the case building at HUT/architecture (Alvar Aalto 1965) were overlaid with new laser scanned data (2006), it was observed that the 2D-drawings from 1995 were actually not based on proper measurements, but they were just digital copies of the original hand-made drawings from the mid 1960's.

Figure 4
Laser-scanned data was used as the accurate measurement basis for a geometric 3D-model of the case-building which was done with AutoCAD.
searchable format. Even more complex hybrid solutions of databases integrated with drawings or models can be used.

The essential basis for contemporary renovation design is well-structured inventory data of an existing building, of its properties, and of its current and previous conditions.

Another important criteria for the inventory data is its reliability. It is far better to have less information with proper accuracy, than lots of just roughly correct data.

It was noticed in the project, that the inventory work has to be carried out by a skilful design professional, presumably by an architect, who has a good overall understanding of the inventory objectives and who also knows the final needs for the inventory work. It is useless to document lots of detailed data with precise accuracy, if the data can not be used later in the design and construction process.

**An inventory model**

Our observation is, that the information structure of renovation projects differ remarkably from the structures of new buildings. The models, which for instance were developed in Finnish ProIT-project (Penttilä 2005) do not necessarily fit for renovation purposes. Hence, a new schema for a renovation project structure was further developed, as well as the concept of an inventory model was introduced.
The definition of the proposed renovation inventory model would be:

All historic, survey, measurement etc. data, information [and even knowledge] about an existing building in an accessible and usable format.

The overall intention of the inventory model would be to support the renovation process: renovation design, actual on-site renovation work, as well as later facility maintenance activities of the buildings. Model-based renovation design as well as the inventory model has naturally to fit well with the financial decision making process of the renovation project owner.

It is essential to note, that in renovation projects the inventory model does not contain just geometrical data, but it has to be able to contain all the design project related information which is needed in the process, and by all project participants.

**Conclusions**

One of the most important observations from model based renovation is, that renovation design should be started earlier than in traditional processes, and more design resources (time & money) should also be assigned to early project phases.

Design work should be started before so-called project launching decisions, because otherwise the project owner would not get BIM-based validation, evaluation nor analysis information to support his project decision. Currently the designer selection is usually done after the project decision.

A few interesting criteria were found during this research project, namely aspects which can slow down or even hinder the adoption of model-based methods in renovation and restauration design. In renovation projects, following decelerating characteristics have been noticed:

- Model-based inventory is a tedious task to do, because usually the modelling principles have to be created first. There are not too many existing guidelines, models nor inventory mechanisms available for renovation yet.
- Each renovation project tends to be unique by its nature, hence categorization of buildings, projects or renovation methods is more difficult than it is in new building projects.
- Motivation for model-based renovation is crucially important. The project owner may not see – or does not want to see – the life-cycle long chain of design-construction-maintenance process.
- Resources for model-based renovation design are missing. If the project owner tends to select always the cheapest possible project solutions, he will obviously also miss the possibility to develop new and more effective model based methods.

**Acknowledgements**

The authors want to thank architects Auli Karjalainen and Kari Ristolainen from Senate Properties about their comments on the topic and the possibility to perform the study, as well as professor Tor-Ulf Weck from HUT about his valuable support during the work.
References


