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Research design for the study of Passivhaus modernisation processes and technologies: The RENORD project

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SUMMARY

This paper reports on the objectives and research methods chosen for the RENORD research programme, being conducted at 5 European research institutions. Partner institutions have been developing the themes and methods since early 2009, while the official start of the programme at the coordinating institution HiO started in Spring, 2010.

KEYWORDS

Modernisation, renovation, energy efficiency, Passivhaus, existing building stock

INTRODUCTION

All buildings, also candidates for Passivhaus modernisation, are in a progressive state of decay due to diverse physico-chemical processes and time. (Benjamin, 2008). Table 1 provides a sketch of what the factors are that through experience affect decay and the various capacities and roles of the different stakeholders. One factor or strategy outside the table that sometimes affects decay is a change to the brief to change how decay is viewed and dealt with. (Cramer and Breitling, 2007).

Table 1. Human factors affecting the decay of buildings.

Subject	technical knowledge	Practices/ cultural traditions	Design/ strategies	Regulations	Industry standards	Technologies Materials, etc
Construction industry	partial but ltd. informed	partial, Expert on practices	informed	partial and informed	partial and informed	partial and informed on installation
Users	partial, informed, subject of service, vital	partial, expert on societal practices	informed, often impartial	impartial and lacks information	impartial and uninformed	impartial and uninformed
Owners	partial, informed	partial, informed often expert	partial, uninformed	partial, informed	partial, informed	often Impartial, informed
Professionals	partial but ltd. informed	partial but ltd. informed, safety	partial and expert	partial, informed	partial, informed	partial, informed, race with time
Society in general	impartial, Lacks information	change and negotiation, informed	impartial (?) non-expert but vital	partial, participant in legislation	often impartial, uninformed disinterested?	often impartial, uninformed, disinterested?

Apparently, there is already here a high degree of complexity, disagreement, and lacunæ in the knowledge bases for the study of Passivhaus modernisations. Further, research is limited in time, budget, and its use of disciplines, so that the RENORD project has chosen to focus on understanding the physical structure, the construction process, and the design-related issues concerned with the achievement of the Passivhaus standard for modernisations. Thus, an anthropological view of the construction process is coupled with the technical view of the

buildings in the service of understanding how and why projects get built, how decisions are made; what affects tradition, normal practices, technological innovation, and market penetration have on the design/construction process; and what might be useful strategies and approaches for studying passivhaus modernisations. The final product of the RENORD project will be two-fold: A document co-authored with industry partners that will detail best practices processes, technologies, and design/engineering strategies and designs for the Passivhaus modernisation of existing structures in Norden, and enhanced research capacity within Norden on the research subject. The RENORD research group on Passivhaus modernisation in Norden is made up of the Tampere University of Technology (Tampere), Arkitektskolen Aarhus (Aarhus), the Swedish Environmental Research Institute, located in Stockholm (IVL), University College in Oslo, and Lang Consulting/IG Passivhaus Österreich (Vienna).

ENERGY AND COMPLEXITY OF MODERNISATIONS

It is the emerging perception that many buildings, even relatively new ones, are wasteful of energy, that many of these buildings are now seen as decayed or in need of modernisation. The RENORD partners contend that such buildings not simply be demolished, but rather that their preservation through the best practices of Passivhaus type modernisation contributes to both energetic and resource sustainability efforts, but also broader societal goals such as historic preservation, retention of urban wholeness, preservation of the feeling of *home* (Cramer and Breitling, 2007; Benjamin, 1996), and the preservation of historically significant aesthetics and building techniques. (See Table 1)

Further, the decision and construction processes involved in modernising a building to the Passivhaus standard are involved and run the gamut from the practical experience of preservation tradespersons and architects/engineers acquainted with surveying to the latest techniques of stakeholder participation, life-cycle analysis, and the incorporation of Building Information Modelling together with centrally controlled Building Automation Systems. (Wikipedia, 2010).

THE RESEARCH OBJECTS AND THE RESEARCH APPROACH

The RENORD research effort needs to study a physical object, as well as a process, and indeed, and viewed in different ways by different stakeholders. RENORD has chosen to look at these projects as case studies from an interdisciplinary viewpoint. (Groat and Wang, 2001; Amaratunga et al, 2002; Huutoniemi et al, 2010). See Fig. 1 for a simplistic model of the study object and Fig. 2 for a preliminary model of innovative project processes. This method shows a way forward to understanding the object and the process of building as different stakeholders view it, and thus has the ability to benefit from triangulation concerning the 'reality' of the performance of the construction processes and the building itself. Further, stakeholders bring up issues concerning the building and its use that often go unnoticed by architects/engineers or owners. Finally, by looking at the whole building and its process of becoming, one can begin to see how different elements, processes, materials, stakeholders, and time itself interact to make the finished building. All this goes toward making a so-called *abstract real-world historico-ethnographic model* (Clarke, 1972), based on an *architectural fact* (Guidoni, 1978). With such models, if built with care by using the same parameters and measurement criteria, one can begin to compare the case studies to both standards of interest (such as the Passivhaus standard), and to other buildings of the same type, other building types, or similar buildings but in other countries or climate zones. By such comparison, RENORD plans to look for generalities of how the modernisation process works, how well it functions to achieve the goals of the brief, how well the building functions energetically, and

where might improvements be made in terms of design processes and strategies, the use of materials, components, and equipment, and with regards to the design/construction process itself. RENORD will further use the case study method of model construction and comparative analyses to develop a general understanding of the modernised structures and their associated processes by developing in series *theses*, *antitheses*, and *syntheses* about the research objects. The construction of this series will further the holistic and inclusive understanding of the Passivhaus modernisations in time and space as dynamic processes, which should thus allow the group to compose the user guidelines on Passivhaus modernisation together with the several industry partners in the five different countries.

The techniques used to develop these theses, antitheses, and syntheses are as follows:

1. Literature reviews and content analyses of sources focused on the fields of Passivhaus design/construction, Passivhaus modernisations, construction and process innovation, energy efficiency for buildings, and historical conservation/restoration of buildings.
2. Traditional discussion and correspondence between PhD students and their advisors and colleagues.
3. Ethnographic type interviews with industry partners within the construction industry.
4. Document analysis of drawings and specifications of case study objects, from the industry partners.
5. Seminars and colloquia involving both industry partners and research partners for the presentation and criticism of these themes.
6. Finally, traditional editorial meetings to draft and edit the final document user guide to building modernisation.

Fundamental to such syntheses is a critical and interdisciplinary view of what knowledge is relevant, how the knowledge should be stored and communicated, how this information should be obtained, and the criteria for reliable sources.

The above will be summarised in research protocols. Further, specific types of comparison will be explicitly defined, based on agreed-upon definitions of wholeness, coherence, relevance, and falsifiability. Finally, a common set of research questions will be defined, in addition to the questions used by individual research institutions, in the form of: How is energy used by the existing building, what types of energy are used, what is the level of improvement of the energy efficiency, what techniques contributed which portion to the efficiency gains? From the answers to these questions, patterns, generalities, and exceptional cases will be sought out to explicate some ideas or concepts concerning the building and its modernisation process, which will then go to help in constructing a first thesis for each case study, and which can be further built upon to develop theses for a general concept of the Passivhaus modernisation process.

DELIMITATION AND DISCUSSION OF RESEARCH THEMES

HiO, Tampere, Aarhus, and IVL began a series of seminars and networked collaboration on the theme of Passivhaus modernisation of large, urban structures in 2008. In 2009, after meetings at international conferences, Guenter Lang of Lang Consulting in Vienna joined our collaborative network.

At present, research partners are involved in the following activities:

1. Developing an overview of the general existing situation for the existing stock in their own country, for the industry partners concerned, and especially with regard to buildings that will or are undergoing modernisation to the Passivhaus standard.

2. Defining concepts and architectural/engineering strategies for modernisation.
3. Selecting and documenting likely case studies.
4. Conducting initial interviews with industry partners, including professional design/engineering consultants and construction firms.
5. The conduct of major, public conferences on Passivhaus modernisations, at Aarhus the SuRe 2010 Sustainable Renovation Conference in March, 2010.
6. Planning for further international seminars between the research partners to take place during the balance of 2010.
7. Content analysis of prior research on Passivhaus modernisation and methods of study of the subject. (for example, Cf. Benjamin, 2008).

DISCUSSION

The RENORD research programme is now performing the meta-analysis of prior research on the theme of Passivhaus modernisations. The literature (Erhorn, 2005; Baker, 2009; Highfield, 2000, Burton, 2001; and many others), on Passivhaus renovations and early interviews seem to suggest the following themes: Understanding the existing structure, (Watt, 2007), the construction of the building envelope, achieving cost-efficiency with high levels of energy efficiency and aesthetic quality, developing coordinated and innovative processes within the construction sector to achieve both high quality and meet user needs, the development of innovative products and design/construction processes, and how to overcome the inertia against innovation and non-traditional payback period calculation in the construction industry. (See references list).

Based on these apparent challenges, and through discussions between the research partners and between the research partners and the industry partners, it appears that three themes or interest foci are developing for the research programme:

1. The renovation of large, urban housing blocks from the 20th Century to the Passivhaus standard. (Aarhus, Stockholm, and Tampere)
2. The renovation of the building envelope of large, urban buildings, to the Passivhaus standard, from a holistic perspective. (Oslo).
3. The cost-effective modernisation of large, urban buildings, taking into account detailed studies of the technical components and their affect on user satisfaction. (Tampere).

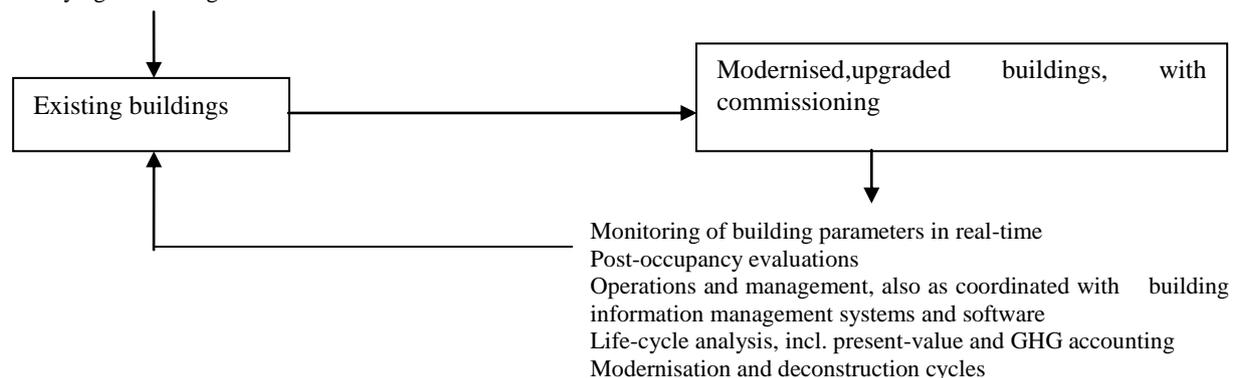
Aarhus has started their investigation of buildings with two projects: The first, an overall documentation project of existing and future energy efficiency renovation projects in Denmark by research assistant Karen Hansen, and the second, Sustainable Building Transformation by PhD student Terri Peters, a study of modernist housing blocks in Denmark from the 20th Century. The second project looks at blocks from between 1945 and 1970, as examples of material culture that require care and understanding, and which seeks to propose ways that such housing can achieve improved architectural quality.

The Oslo research team is coordinating international research communications and resource acquisition, while also starting the early stages of research on the overall building envelope. The PhD candidate Xavier Dequaire is doing research on Passivhaus renovations of schools in the greater Oslo region, as an example of how renovation deals with the built envelope, especially with regards to older buildings of more or less historical value, in congested urban sites. Such buildings present a myriad of challenges ranging from the aesthetic to the technical, and on to how to best deal with the design/construction process. This team is

starting this effort off by performing initial interviews with industry partners who thus help us to focus on specific buildings as case studies. Once the case study objects are selected from the present initial list of candidates, we will begin with more detailed analyses of project documents, drawings, photographs, more interviews, attendance at project meetings, and site visits.

Model of the existing building and the upgrading/modernisation process

Innovative techniques for quality assessment, quality control, team interaction from tradesperson to owner
 Future-proofing of buildings, flexibility and user responsiveness
 Passivhaus standard, Industry standards & gov. regulations
 Integration of renewable energies and low-carbon technologies
 Energy efficiency of buildings
 Conservation, modernisation, and renovation practice and knowledge
 Documentation and surveying of buildings



Documentation of the modernised, upgraded building

Figure 1. Modelling the interaction of factors affecting a Passivhaus building modernisation project.

CONCLUSIONS

The modernisation of the existing stock to the Passivhaus standard, or using Passivhaus components, is apparently a vital aspect of European, and indeed developed country, efforts to mitigate and adapt to Global Climate Change. (UNECE, 2010). Research in Norden on this subject is thus

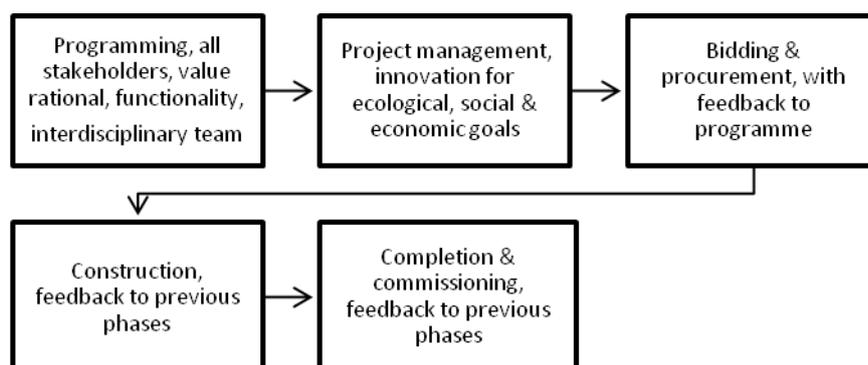


Fig. 2. A model of the innovative building construction process

timely, important, and interesting as a scientific pursuit because it is of value to society at this point in history and there are still disagreements and an apparent lack of knowledge and practical know-how concerning how to best achieve this standard in the region. This paper lays out the beginnings of a methodological discussion for research and thus invites comment and criticism on this research programme.

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