The EEPOCH Project – Multidisciplinarity in a Multiple Case Study
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1. The background and the present
The Swedish EEPOCH project spans over several fields and professionals to investigate how we can deal with preservation issues and energy issues in our built heritage in a balanced way. Energy efficiency has for many years been pointed out as a key action for reduction of greenhouse gases. “One of the initiatives of the Europe 2020 Strategy is the flagship resource-efficient Europe adopted by the Commission on 26 January 2011. This identifies energy efficiency as a major element in ensuring the sustainability of the use of energy resources.” according to The European Parliament and The Council (2012, p.2). This new Directive on Energy Efficiency came into force 4 December 2012 and the Member States have 18 months to transpose the Directive. In Sweden a referral on amendments of national laws, regulation, mandatory provisions and general advice in accordance with the new Directive has been sent to state authorities for processing.

One of the reasons for a new directive is that the Union is unlikely to achieve its energy efficiency target of 20% primary energy savings by 2020, and concomitant reduction of greenhouse gases, based on the current policy mix. All Member States shall set up measures in order to use energy more efficiently at all stages of the energy chain including total renovation of the national building stock in the residential and tertiary sector, in both public and private buildings, and nor the industry neither the existing built heritage are exempt. In the claim on urgent need for total renovations the Government shall act as model, according to the Directive, refurbishing 3% of their properties per year. This might be possible to achieve in Sweden but there are also other challenges inherent in the implementation like the obligation to procure products, services and buildings with high energy efficient performance; metering and billing information for consumers; the promotion of efficiency in heating and cooling; obligations on industry relating to energy audits and energy management systems and a common national framework for annual energy savings of 1.5% of energy sales.

The Swedish mandatory provisions [Boverket, 2012a, p.261] already treat new constructions and existing buildings as equivalent in terms of energy demands regardless of existing cultural and historic values when applying for building permit e.g. in alteration projects. The energy requirements may be waived by 20% [Boverket, 2012a, pp.267, 271] if there are special values but the demands are set so high that it is likely that very few buildings can manage to meet them, even if total renovation and refurbishment are carried out. This is true at least for the buildings studied so far in the multiple case study within EEPOCH and implies an impending danger. Historic values in our built heritage could be at peril in extensive refurbishments, but it could also mean that the potential for energy measures may not be realised depending on how building permits are being assessed.
There is also a Swedish law [Riksdagen\textsuperscript{2}, 2006a], and a regulation [Riksdagen, 2006b], and mandatory provisions [Boverket, 2012b] on energy declarations where buildings with cultural and historic values are not exempt. Cost efficient energy measures should be suggested to the real estate owner but it is optional to follow them or not. A national energy rating is also intended to be introduced in connection to the summary of the declaration.

Historically the energy issue has not had any major role within architectural conservation work while the buildings considered worth preserving have been the few ones with properties of outstanding values where any energy measures would have ruined these values. Today the mapping of built heritage shows another picture. The inventories made in the County of Halland, Sweden, in the 1990s had about 3000 buildings and included objects representing the social, technological and industrial development of society and all social classes. The accomplishment of these inventories was a result of the implementation of integrated conservation formulated in Sweden after signing of the Granada Convention [European Council, 1985] which was passed in the European Council in 1985. Heritage preservation was now connected to environmental and cultural survival. The member states committed to take action on legislation, public supervision, planning, education and research aiming on conservation, protection and maintenance of the built heritage. Within a few years a new view on built heritage and conservation was formulated. From a societal viewpoint caution of our built heritage permeated all sectors of society and was seen as an integrated part of the regular planning [Roberts-son, 2002]. The latest inventories in Halland completed in 2010 have mapped over 10 000 buildings and also sites, where the built environment with their surroundings as a whole, show significant historic values. The inventory is available for everybody online [Länsstyrelsen Halland\textsuperscript{3}].

In light of the new inventories on built heritage and the new legislation on energy efficiency it is clear that there will be difficulties with the safeguarding and in managing both preservation and energy efficiency in our built heritage. Conservation work and the work on energy efficiency have to be redeveloped or be codeveloped in concert with the new situation. Cooperation is needed to cover the multiple fields in practice and theory.

2. Built heritage and sustainable development

Economic, environmental and social sustainability are natural and uniting approaches in the necessary cooperation. Built environment is part of society’s development, and of people’s history and their experience of belonging to it. The social dimension is also crucial for building society and the inhabitants are a source of power and knowledge that should be utilized. While the authenticity is the dominant property decisive for a building’s historic value; time and the time layers should be seen as a tradition not to be broken, with a binding rather than dividing effect in the built environment’s historic fabric. The buildings should be the main source of knowledge for determining what measures to take. In this context the inventories and the cooperation among professionals are indispensable.

Long term sustainable management of cultural values presupposes change,
but avoiding loss of built cultural heritage and keeping the desirable diversity in our built environment demands cautious transformation. All buildings are expected to modify strongly varying local exterior climate to significantly more consistent interior climate for human use and wellbeing. Architecture must be used to be perceived as architecture. There must also be an economy for maintenance of existing buildings. From a resource and techno-economic perspective, invested time and money in the already existing environment, must be taken care of. This includes all built heritage, not only the officially protected monuments with outstanding values.

According to Donovan Rypkema (2007) “There can be no sustainable development without a central role for historic preservation”. Sustainable development is crucial for economic competitiveness and has more elements than just environmental responsibility. As an example Rypkema mentions that one million dollars spent in new construction generates 30.6 jobs, but the same million dollars in the rehabilitation of an historic building generates 35.4 jobs. Furthermore he claims that sustainability means stewardship. Maintaining original fabric and repairing historic buildings usually mean that money is spent locally and that the building’s embodied energy is used instead of destroyed, and simultaneously one is reducing waste generation, compared with new construction work, and also increasing recycling. Functional adaptability of historic buildings and adaptive reuse are typical features of maintaining and management of cultural heritage. All this is sustainable from economic, environmental, cultural and social views, and part of sustainable development.

3. The future - Vision for Sweden 2025

Boverket has instructions from the Government to promote good architecture and efficient design of the built environment. The Board has a great responsibility for the regulatory work but has also been commissioned to develop a vision for 2025 [Boverket, 2012c]. It is composed of four mega trends; a changed climate, a globalised, urbanised and digitalised world, and shows twelve views of Sweden’s future, and it is written in Swedish. In brief all construction in 2025 is done with a focus on people’s needs for quality of life, good health and good management of resources and energy, and adaptable for changing needs. Materials are recycled and architectonic, aesthetic and historic values are given at all construction work (p.5). The overall goals for policy within the field of architecture and design are that it should be given favourable conditions for development; aspects of quality and aesthetic aspects should not be subject to short-term economic considerations and the interest should be strengthened and broadened; and cultural, historic and aesthetic values in existing environments should be protected and enhanced (pp.43-44). Every year our building stock of dwellings increases only by one percent, so the buildings we mainly have to work with are the existing ones. The vision says that our cities will grow in density but with consideration and by a well thought out urban idea (p.39) of sustainability, diversity and mixed uses, and in collaboration with the residents. "Good planning takes time and needs to take time. The environment that we create will be part of our lives for a long time, and new buildings must for example fit in with the existing buildings and
structures. Mistakes are hard to correct when large investments in buildings and infrastructure have been made, and great values may be lost when changes are made in haste." (p.35). In 2025 a lifecycle perspective is emphasised and energy efficiency measures and alterations are made with great attention to good indoor environment and accessibility and to the buildings' and their environments' qualities and historic values. In this way interventions are minimized, the different values are taken advantage of and deficiencies are corrected (pp.55-56). “Architectural and aesthetic qualities and access to cultural values also affect people’s well-being positively.” (p.57).

"Creativity, diversity and artistic quality should inform society’s development. To reach the objectives the cultural policy should promote a vibrant cultural heritage which is preserved, used and developed." (p.52). In Sweden we have made ourselves known to protect our natural and cultural environments, but they also have great potential for development (p.6). Today tourism industry in Sweden has become one of our most important industris with a major export value, higher than the iron and steel industry, and almost as much as iron, steel and timber export together (p.72). When reading these selected parts of the Vision for Sweden 2025, the future undeniably looks bright for our existing built environment.

4. The Project
The basis for the research design in EEPOCH has been developed in a multiple case study where the combination of the architect’s, the energy expert’s and the antiquarian’s perspectives are essential, and hence the overall approach is multidisciplinary and extends across multiple fields. The objective is to formulate theoretical models with integrated balance of low energy use and preservation, which could be tested in practice, but also a model for cooperation between involved professions. Robert Yin's case study methodology [Yin, 2009] is followed to construct validity and reliability. The research is descriptive, exploratory and explanatory using different methods, and workshops being one of them, and is presented in a licentiate thesis [Norrström, 2011]. Six workshops, with in total 95 participants, have been carried out with themes and focus directed on the physical work on the restored buildings and on the working processes. Professionals from academy and practice attended and the outcome and their advice on the research have directed the project e.g. adding architectural values as a unit of analysis and to look into the legislation concerning built heritage.

Five units of analysis have been explored using seven methods of which the use of workshops has been decisive for development of the project as a whole. In brief a traditional λ-value method was used for calculating the energy balance and then compared with measured energy use and reference values for similar buildings. An IR camera was used to investigate the presence of moisture problems. Cultural and historic values was assessed in situ separately by an architect and an antiquarian of built heritage using Unnerbäcks guide (2002) and compared with archive material for triangulation. Architectural values and use values were assessed in situ by one architect using CABE’s Design Review (2006) to avoid arbitrary choice of qualities and values to as-
Management and teamwork were explored by making interviews with antiquarians, engineers and an architect engaged in the conservation work, and a systemic meeting aiming at understanding and insight was performed and tested at workshop no VI. Interviews were also carried out with administrators of building permits in the municipalities of Halland to understand the legislation, and Russel Bernard’s guide (2006) was used for interview methods. Beside literature studies a reference group and experts have been consulted for help with managing the different methods in use. The units are applied to the chosen buildings and to the teamwork and leadership carried out.

5. The objects
Three buildings restored within the Halland Model have been chosen. Tyreshill a private dwelling and Teatern and Fattighuset are public buildings and are all situated in the County of Halland in Sweden.

![Photo 1 and 2 show Fattighuset at the corner to the right and an interior from the ground floor](image1)

Key results for Fattighuset, built in stages from 1859 and on, are that the preservation issues were given foremost priority at the expense of indoor comfort and energy issues. The architectural value is high both in the context as a corner house at a square in Halmstad and for its expressive brick façades. A lift was installed at the restoration in 1996 and most parts of the building are accessible for disabled people. The structure and planning possesses universality, and the detailing is skillfully worked. The key figure for energy use is 204 kWh/m² and year using district heating and the CO2 emissions amounts to

![Photo 3 and 4 show Tyreshill on the sloping site and the porch at the front entrance](image2)
16.74 tons per year. There are moisture problems at thermal bridges.
Key results for Tyreshill, built in 1907, are that it is the least preserved building where usability, comfort, and energy issues were prioritized at the expense of the original authenticity and patina since the whole interior was in a bad state and had to be remade. Tyreshill still has a high value in its context being the oldest house in Rydö. It has a sloped court yard and thus is not accessible for disabled people. The building planning has good spatial relations and possesses adaptability. The key figure for energy use is 157 kWh/m² and year with no CO2 emissions due to the installed pellets boiler and there are no moisture problems.

Key results for Teatern, built 19013, are that it is a well preserved building with high authenticity and a moderate energy use. The function as a theatre is announced in the façade and it is dominating the square in Laholm, and a lift installed in the 1950s makes it accessible for all people. The structure and planning possesses specificity and the design is inclusive. The key figure for energy use is 122 kWh/m² and year with 20.53 tons of CO2 emissions per year due to the heating with a gas boiler and there are no moisture problems at thermal bridges. None of the objects would manage to meet the energy demands if restored today. The demands for energy use when applying for building permit for alteration is 80 kWh/m² and year for public buildings and 90 kWh/m² and year for dwellings and flats.

6. Some conclusions and continuation
The overall conclusion is that there are possible actions to take and to recommend. When reading the Vision for Sweden 2025 and thinking through the new regulation framework for energy and the objectives one can discern a gap and maybe a worrying inconsistency. One way to counter this may be better definitions of what counts as heritage and extended legislation e.g. protection of all buildings older than 50 years by demanding a parallel investigation of their historic and cultural values in connection with applying for building permit for alterations and when an energy declaration is carried out. Complementary vocational courses for antiquarians of built heritage on energy measures and their impact on buildings’ appearance and courses for energy experts, and also for administrators of building permits, on cultural and historic values, could increase the understanding and be a start for cooperation aiming at a view on the buildings as a totality.
Results from workshops and interviews indicate that connections and similarities between the different professions outweigh the differences when analysing the approaches and methods in this study and in the project as a whole. The ability to generalise but also to make estimations of a few facts, being aware of the general and universal perspective as well as the specific and individual, is present and used in all professions. The method of using a reference group, an expert group and the workshops have been essential to get an overview of all different aspects in the multiple fields and all involved professions. Multidisciplinarity has been possible to perform through this research design.

A lesson learned from Fattighuset is that the indoor climate must be in focus and adapted to human well being and the planned activities in the building. Ventilation and heating should be continuously measured and adjusted, and risk of moisture problems must be calculated and dealt with in all projects. Putting people first demands a good indoor environment and comfort. User participation in the planning process should also be part of the model. Bearing in mind that technology has a fairly short life cycle and new innovations are constantly being made in research and also appearing on the market it seems to be unwise to adjust a building totally to energy technology available at the present since a building’s life cycle spans over decades and often centuries. Measures taken today may result in loss of inalienable values and may also counteract possible measures available in the following ten years. Therefore a whole building audit taking both historic and architectural values and energy efficiency into account would be more appropriate for a building as part of the long-term strategy proposed in the Directive 2012/27/EU, Chapter II, Article 4 on Building renovation than e.g. a single energy audit. Multiple knowledge and professions are needed to implement a whole building inventory or audit.

The three objects in the multiple case study show three different positions on a scale where Fattighuset represents the preservation aspect; Tyreshill represents the energy aspect, and Teatern represents the combined and balanced aspect of energy measures and preservation. The investigation of these objects form a foundation for a possible overview of the other objects restored within the Halland Model. The next step is to place the other objects on this scale by going through them briefly and also determine what conservation measures and energy measures that may conflict with one another and which is appropriate in each case. This work will be carried out in cooperation with Heritage Halland and their antiquarians of built environment, and will form a base for a balanced model.

7. The balancing
Our existing built environment is valuable in many ways for living, working and for various businesses. In architecture and construction many features and perspectives must coexist and interact. An important question is if all our needs and interests can be met and balanced in our built heritage?

In balancing the physical we need to ask what resources and measures, and properties we are dealing with in alteration and conservation. A building can
be considered a physical system with different interacting parts; construction, water use, electricity, heating and hot water, ventilation, and cooling. The parts must be distributed in separate systems and controlled by the users. The control and regulation equipment should then have user friendly interfaces for adjustment of the system as a whole to the planned activities in the building. All parts should have the property of good functionality and the building should be accessible also for disabled people.

An existing building also consists of other parts like the documented values of its history and building technology, the patina and authenticity as well as historic values from societal, social and techno-historic perspectives. Furthermore, the experienced values of art and architecture, and the building’s place in the context, its identity, continuity of a tradition and its value as a symbol, and all these parts should be balanced to achieve a totality and be optimised. This is complicated but linear, and complicated only means that it all can be identified and problems solved. Dealing with a building as physical matter with all interacting parts is then complicated, linear and thus predictable. All this need system thinking for organising the issues evolving in alteration projects while system thinking is mechanic and is used for categorising to get an overview and for optimisation.

In balancing the process we need to know which experts and professions that are involved. An inventory of all parts when planning for a refurbishment, or restoration, requires different experts. These are; conservationists, construction engineers, energy experts, antiquarians of built environment, architects and urban planners, installation engineers and technicians. These professionals should communicate and collaborate with the owners and inhabitants who live or work in the buildings. The overall working model should be balanced and preferably be transparent with a horizontal organisation, learning from the Halland Model, and carried out with respect for the individuals in making use of their special skills and knowledge.

Physical material is measurable, possible to assess and to calculate. The immaterial is maybe more time consuming to assess, but the methods are based on both facts and estimations carried out by real people with different background and ways of interpretation. When people are part of a situation it usually turns from a complicated state into complexity, to non-linearity and new unpredicted situations. Dealing with a building as a process with all involved experts and users is then complex, non-linear and projective. Accordingly systemic thinking is a possible, maybe even a necessary methodology to use. Systemic thinking, as opposed to system thinking, is dynamic and puts man in focus, in a context with other people. It is used for understanding and insight, and making use of possibilities for managing the processes [Sarv 2013, Allen, 2000]. The use of abstractions and conceptualisations are present in both the system thinking and in the systemic thinking, and it is the mix or coexistence, and the cooperation that are the most important parts. Together with the multidisciplinary view spanning over several fields; the interdisciplinary knowledge sharing between the different professions, and transdisciplinary academic cooperation with practitioners it is possible that our interests can be balanced in our built cultural heritage.
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Notes
1 Boverket is the Swedish National Board of Housing, Building and Planning.
2 Riksdagen is the Swedish Parliament.
3 Länsstyrelsen Halland is the County Administrative Board in Halland.

References
Rypkema D., 2007, Sustainability, Smart Growth and Historic Preservation, article containing excerpts from a presentation, given at the Historic Districts Council Annual
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