ABSTRACT: How can preindustrial architecture inspire sustainable thinking in postindustrial architectural design? How can we learn from experience and how can social, economic and environmental conditions give perspectives and guide a knowledge based evolution of basic experience towards modern industrialized building processes? Identification of sustainable parameters related to change in society, to building technique and to comfort are illustrated through two Danish building types, which are different in time, but similar in function. One representing evolution and experience based countryside fisherman’s house built around year 1700; and second a frontrunner suburban family house built year 2008. The analysis involves architectural, technical and comfort matters and will state the levels of design, social conditions, sustainable and energy efficient parameters. Results will show lessons learned in perspective of future building stock and to which level buildings are expected to operate to actual demands of zero energy performance and better indoor comfort.

1 FRAME OF UNDERSTANDING

To understand and analyze two selected houses of Danish building culture over a lifespan of 300 years may seems a bit theoretical, but an ongoing research subject in Denmark has addressed the theme to explore sustainability at Danish architectural heritage. In this relation we have set up a frame of how to define sustainability right from the quote of Our Common Future (Brundtland 1987). Responsible use of resources seen from the point of view as basic natural resources and cultural behavior is looked upon from three defined analytical aspects: 1. Social, cultural - how life is organized at a certain time and how culture is expressed through a physical house form and how use of house is organized. 2. Environmental - how context, landscape, topography, settlement, climate are interfering shape, organization, choice of material and technique, necessity of daylight, temperature, air quality, which means quality of indoor climate. 3. Economical - how use of material and immaterial resources, energy and transportation influence the level of time based ecological footprint, and how value of these resources are related to time. The possibility to compare values from the two mentioned time frames are theoretical, but comparisons has been done in order to understand how to differentiate our understanding of sustainability regarding the built vernacular and nowadays architecture. Another important aspect for modern architecture is of course the political decisions taken by the EU regarding future energy use in buildings in order to proceed towards a performance of a nearly zero-energy level (EU2010).

2 PRESENTATIONS OF TWO CASES

2.1 Fisherman’s house, Agger – built around 1700

This vernacular building is a dwelling for a fisherman’s family working outdoor and indoor, originally situated at the harsh climate at Agger at the west coast of Jutland (Ørum-Nielsen 1988). The original house can now be found at Open Air Museum, Lyngby (Engkvist 1947) (Fig. 1).

The house has narrow gables to the west/east, long sides to the south/north. Construction is high plate in wood (Mikkelsen 2005), detached roof with simple additions. Local work forces are presumed to have built the dwelling, walls half timbered, so-called backpacker additions towards north and south. At stables the pillar construction is filled of simple stones. Floors on ground are earth or stone directly at site. Structure lifted app. 15 cm from the ground. Heat comes from a mass oven also used for cooking and baking, daylight for kitchen comes from a smoke hole in the roof. Main living room is central situated and surrounded by alcoves and storage rooms (Fig. 1). Windows to south allows sun energy
to come directly inside the living room, furnished in a way that men could sit at the bench facing north and having direct light at the table, while women could run to and from kitchen in the free space of the living room.

2.2 Suburban house from Vejle - built 2008

This dwelling for a family working far away from the house is situated at the outskirt of Vejle (Fig.3) in a milder climate at the east coast of Jutland. The house is designed as a suburban dwelling (Bjerg 2014). It has a compact form with its long side facing south, constructed as a Passive House (PHS 2012), lying in a small community of passive houses built as experimental houses regarding (Isover a. 2010) investigations of energy efficiency under Danish conditions. The house is constructed of high performing industrial elements and has high performing ventilation as heat regulation of the indoor climate. All living rooms have windows, but the glass ratio is intensified to the south. The climate screen is highly insulated. Huge windows to the south have partly a geometric sunscreen, partly a dynamic sunscreen to regulate the incoming energy from sun. Main living room is central placed and in close contact with kitchen (Fig. 2). All rooms including sleeping rooms have same living temperature and surround the central living room for family life.
3 COMPARATIVE ANALYZE

3.1 Chosen parameters

Comparing the vernacular fisherman’s house with the nowadays suburban house it is chosen to focus on social and cultural aspects, the main climate screen for the living area of the two houses regarding construction and comfort regarding daylight and energy.

3.2 Social and cultural aspects

The vernacular house is functioning for a larger family of more generations – men working at fishing, household, farming and all what is related. Woman is taking care of the home, all food and many children sometimes co-working with the men. Family’s action radius is close to home, every function based on local working and trade, living a simple life based on local natural resources and as sustainable as possible.

The suburban house is based on society’s segregated way of living. A nuclear family, wife and husband is working away from house and two children attending school and free activities. One or two cars are needed for transportation of the very busy family, always on the drive. Transportation and use of resources, bought at the supermarket once a week, is the standard picture. All parts of consumption mean high environmental pressure on nature compared to the vernacular family life.

3.3 Climate screen construction

Half timbering represent a common and solid 1700 vernacular construction made as a wooden framework elaborated of elements, assembled on ground piece by piece to a whole wall by the local carpenter (Kuhn 2014).

It is either built on site or disassembled and brought to the building site in single pieces and reassembled and raised as whole walls and stabilized when connected. The tables are often made of wickerwork and reinforced by clay, which again in several processes are cladded from inside and outside. The last layers of clay are even reinforced with farmyards manure to make the material flexible to the wood and establish a strong surface (Fig. 4). The last working process is lime paint. This process is done ones a year in springtime to keep the surface tight, clean and tight. Every material in the construction can absorb humidity from inside and return humidity again. Under changing circumstances the house can easily be altered by adding new elements to the existing structure which gives a high rate of flexibility.

Figure 3. Vejle house, South façade (Vestergaard).

Figure 4. Principle for half timbering (Vestergaard).
Nowadays 2008 building components are constructed of well insulated elements built up by wooden framework (Fig. 5) at a small production place. Structure has minimal cold bridges and is thought as a unity as a holistic system (Vestergaard 2012) customized for the single house. House is designed by computer, manufactured by modern production and assembled on site. Building time is short. Structure of components is layered and has an outer ventilated construction which in case is meant for disassembly: rain protection layer can be altered in future if wished – without affecting the fundamental structure.

3.4 Comfort, daylight and energy

The vernacular house - the balance regarding indoor climate is extremely related to the structure, the choice of materials as wood, larch and wickerwork and clay: from outside the structure is protected from rain by a lime layer surface and from inside the materials are characterized by their hygroscopic abilities - flexibility in absorbing and releasing vapor. Simple draft through the fireplace guaranties a constant stream of fresh air through the building envelope and by that an indoor climate with reduced humidity in the living rooms (Fig. 6). Furthermore surrounding small cold rooms as alcoves, guest room and scullery are serving as a climatic buffer zone protecting against the rough west and north wind. Additionally the ceiling creates an acclimatized space under roof. This means that the only façade regarding living room to outdoor climate is a small part of south facade which gives daylight and sun energy to the inside space.

The suburban house is a certified Passive House with minimal use of energy for heating and ventilation. Window ratio in total is simulated to give maximal passive energy towards south, overheating is prevented by static and dynamic sun shading (Fig. 7). The top windows are not protected and allow the healthy sunbeams to reach living room at this Nordic building site: it is proved that Scandinavian population needs this exposure for sun for optimal health.
DISCUSSION

Discussing sustainability in vernacular and contemporary architecture is relative: over the timespan human beings have always believed in progress and improvement. But we can also see now, that our fascination of progress blinded our enthusiasm through the 50ties - 70ties, where a number of 100.000 different materials were developed without any particular knowledge of healthy substances and also modern buildings with sick constructions of glass and exposed cold bridges causing energy loss and bad indoor climate was not bothered about: the fascination took over, and the human belief in progress wouldn’t take and end! – Now we pay the bill, it has come to a point where knowledge based rethinking of all our actions has to be highly considered in relation to pressure on basic nature understanding.

Realizing that we as human beings must respect the unwritten laws of nature has brought us to act with more respect: related to designing architecture the principles from the Kyoto triangle is relevant: first design with passive principles related to use of materials, use of structures and quality of space, these elements are used in both houses: The vernacular house is built with no more resources than needed, the 2008 house is designed to keep the resource use at a low level.

It is now very relevant to look upon the simple qualities from the preindustrial period to find the basic parameters for a more appropriate evolution of our activities at many levels. And architecture plays an extremely important role as manager of both resources and comfort.

The two houses, both the vernacular and the suburban, show an optimized geometric form, which is compact and sufficient related to time and technology to protect the dwelling in symbiosis with climate: The vernacular house has the declined roof, slim building body and a long building volume dividing space for humans and space for animals, although united in a symbiotic way. The suburban house is more compact and economical. The climate screen is more complex in order to fulfill a higher demand on comfort, higher comfort also through a high temperature at the inside of the climate screen and openings that allows healthy exposure for sunlight essential for the nowadays human being, who are spending 95% of time indoor.

Both houses are exposed to south to maximize the incoming energy – in other words daylight and energy plays a huge role in both houses (Fig.8). The vernacular house demands a fireplace and firewood – which belonged to the daily worry and work to keep the fire going – particles had a huge inconvenience and health threat at that time. U-value of the outer wall in relation to living room is calculated to app. 0.9 W/m2K. The suburban house climate screen is calculated to U-value 0.096 W/m2K (Isover b. 2010), which means very low energy consumption, which is gained from the incoming sun and modest ventilation and a heat exchanger. Indoor climate is optimized.

Both houses make use of alcoves and additional rooms to the living room as regulators of temperature: in the vernacular house alcoves can be closed and play a role somehow like a very thick insulated climate screen. In the suburban house the sleeping rooms volume are calculated to regulate the overload of heat from sun energy in the living room.

Construction of climate screen and choice of materials are optimized regarding the technological development: The vernacular house apply a solid construction of timber, clay, withe and lime. Lime is protecting the wall from rain and humidity from outside, and all construction materials works hydroscopic towards the interior and plays a role to regulate the humidity regarding different temperatures. The indoor temperature varies substantially summer and winter, day and night and demands flexibility in clothing. The suburban house has an outer water rejection screen and interior exposed materials are to a curtain level hydroscopic. This is a minor demand because of higher and more even indoor temperatures around 20 – 22 Celsius degrees both summer and winter.

Both houses are built of healthy materials: The vernacular house as a result of experience gathered through generations. The suburban house because of innovations after Brundtland has given us these important perspectives.

Both houses are constructed of building systems built up of flexible and changeable components characterized by possibilities for disassembly of the materials with minimal waste. Even the waste in form of component for landfill is at a minimum, and both systems are thought in circular systems (McDonough 2002) without environmental pressure on the globe.

Figure 8. Suburban house living room.
Daylight is maximized to the south and the sunbeam distributes right through the top windows. (Bjerg Architecture)
5 CONCLUSIONS

Although it seems a bit odd to compare two houses built 300 years from each other the comparative analyses focus on important lessons learned, which can be valuable to be aware of in our need to reach a more sustainable architecture:

- moderate use of resources characterizes both houses, from the simple but efficient, vernacular craftsman technology to the high tech, industrialized technology
- optimized form and orientation of windows to the south brings energy and healthy daylight deep into the houses
- the two ways of insulation bring new focus at the vernacular structure, which could be elaborated in new buildings
- both houses are using an extended understanding of the climate screen for additional storing in the saddlebags or alcoves for regulating temperature
- building system are in both examples adaptable for change, with very little effort the houses can be extended and changed adding building elements to the building system
- both houses economize the use of energy related to time conditions, evolution has broad new and optimized technological systems to control indoor climate
- in both houses the climate screen has been made of local renewable materials with low environmental pressure, and can easily be made by local fabrication in order to minimize transportation.

These conclusions line up fundamental sustainable principles, which is important to learn from if we should bring the CO2 emission from the building sector down. Parallel to this conclusions we are reminded how important our choices concerning resources and maintaining are in the old house: this special design parameter which could avoid many disasters, when choosing or inventing new sustainable components nowadays could be interesting to bring into future buildings.

Comparative analyses methodology can open our mind for simple and plain ways of handling the building of houses. By the specific choice of the two cases we have shown how many parameters are alike although houses are built 300 years apart, our houses have a sleeping knowledge imbedded. Although the analyses is only built on the comparison of two in this case selected houses, and adding that the result in this case is not significant, the analysis has broad inspiration for further studies and research. Vernacular craftsman techniques can inspired to new products and components made in an industrial technique.

REFERENCES


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