Indoor climate and thermal comfort in a long term perspective: Burmeister's house in Visby, Sweden, c. 1650-1900

Abstract

This article discusses how a Swedish wooden burgher house, Burmeister's house from the mid-1600s, over the course of 250 years was adapted to satisfy ever-changing expectations on thermal comfort. The investigation is based on the climatic conditions of the Nordic Region where the issue of thermal comfort is crucial when attempting to understand the development of the indoor environment. The text is an interpretation of how spatiality, heating, and interior décor and furnishing operated and affected the inhabitants' experiences of indoor climate and thermal comfort. The results show that Burmeister's house followed a general pattern of improvement, especially when it comes to innovations in heating. Burmeister's house ceased to be a dwelling when it was restored and turned into a historic house museum. Rather than revealing its history, restorations carried out in the twentieth century worked to conceal or remove most of the building's more recent history. As a consequence, the house has become more difficult to use since it cannot any longer be efficiently heated.

Key words

Northern Europe, early modern, wooden burgher house, indoor environment, thermal comfort, heating technologies, climate change

Introduction

How indoor climate affects comfort in dwellings is an often-overlooked aspect in studies of material culture of the past. In fact, in northern Europe the improvement of thermal comfort has been crucial to the development of dwellings. Focusing on one building and its 250 years of history as a dwelling, this study aims to show how different generations of inhabitants reacted to the indoor climate, and what their strategies were when improving it.

Indoor climate is usually defined as an interrelation between the form and fabric of the building and the current climate, temperatures, relative humidity, solar radiation and wind direction (cf. Hawkes 1996). Previous to the late nineteenth century when central heating and ventilation developed rapidly, knowledge on how to dress warm, to secure thermal insulation, to regulate temperatures and repeatedly consider new energy solutions were crucial in order to survive harsh winters and weather extremes. Environmental control also worked together with social practices and hierarchies, which is particularly shown in the intimate connection between status and comfort. Thermal comfort was a question of having access to appropriate material resources; heat sources of different kinds and the fuel necessary to heat them. Consequently, we believe a key factor in understanding architecture from a historical climate perspective is through indoor climate and its relation to thermal comfort and use.

The main objective of this paper is to raise the question how embodied materialities of thermal comfort in *one* single dwelling may relate to cultural and climate change in a larger context. This topic will be discussed further on by looking closer at different energy

solutions in a wider framework, embracing among other things the effect of the Little Ice Age and contemporary social practices.

Our case in point is Burmeister's house, a wooden burgher house from the mid-17th century, located in central Visby on the Swedish island Gotland in the Baltic Sea. The building is considered as one of the most well preserved log buildings from the period in Sweden and has been highlighted in previous research in Sweden, especially in the 1940s when the last major renovation took place (cf. Svahnström 1942; 1947). However, this is the first time Burmeister's house is analyzed from a pronounced climate and comfort perspective, and the results made available for an international audience.

For several reasons it is not possible any longer to heat the building the way it was heated in the seventeenth, or the nineteenth century, for that matter. Today the building is partially heated with electrical heaters from the 1970s. Most of the building is not heated at all. Consequently preserved stoves and fireplaces are today purely decorative. The absence of working heating sources also makes it difficult to interpret how the heat may have affected past experiences of thermal comfort. We are therefore not proposing only a detailed study of heating technologies as objects of evidence, but an exploration of a range of interacting components in the building that may subsidize our interpretations, such as spatial organization, interior design and furnishing.

Methodologically speaking, our approach is about detecting various elements and uses of Burmeister's house. How have generations of inhabitants gone about when making this house more comfortable to stay in? Depending on the character of the source material, we are primarily analyzing two historical periods, namely the early 18th century and the second

half of the 19th century. The building itself and associated archival information act as a kind of "laboratory" in which we can test and tune various methodological inputs. Consequently, this work should be seen as a first approach to the intersection of climate history, architecture and thermal comfort in a Swedish early modern context.

Our hope is that this article can serve as a starting point for future discussions on how to broaden building historical studies and make them more relevant to building conservation where the question of heating often is a crucial problem. We are convinced that climate issues, including indoors, should be given a more prominent role because of the changes contemporary society is going through with global warming and an increased concern for climate change.

Methods for investigating historical indoor climate

Buildings, even very old ones, have often been adapted to better suit the changing needs of their users, and Burmeister's house is no exception. Heat sources are replaced, windows and doors better insulated, paneling is added to the walls, and so forth. Hence, the characteristics of indoor climate depend on a complex fusion of interacting variables that must be taken into account. This view is inspired, among others, by theories formulated by Dean Hawkes, Jane McDonald and Koen Steemers (2002; also Bowler & Brimblecombe 2000; Hawkes 2012) who launched the concept 'selective design' as a way of understanding buildings as a system of interrelated elements, as well as an adaptive approach to thermal comfort (Nicol et al 2012). This reasoning is based on people's cultural preferences and recurrent needs to resolve the issue of weather protection and thermal

comfort. In order to adapt to different weather and climate situations, the inhabitants often moved between various locations in the house to ensure best possible comfort. Experiences of comfort also have social connotations based on contemporaneous norms of society (e.g. Crowley 2001; Shove 2003). This is particularly evident in stratified households where access to resources and comfort were determined by the inhabitant's social position within the house unit, suggesting buildings do not contain *one* climate or *one* experience of comfort.

While contemporaneous analyses of indoor climate have the possibility of using living people and environments as study objects (cf. Brager & Dear 1998), our reconstruction of a building's climate history draws attention to a range of diverse sources, which requires various methodological entries. Since we primarily are interested in questions concerning human strategies to create comfortable thermal environments in the past rather than achieving objective facts on temperatures, the methodological approaches derived from buildings archaeology and history seems suitable. In our case this is made possible primarily through the Burmeister's house (its construction, spatial disposition and traces of heat sources) and secondly through surviving archival records.

Traces of alterations, additions and refurnishing from different époques help us to understand the inhabitant's response to their living environment. Consequently, it is very important to identify any transformation in the building, due to the fact that even small changes may affect the basis for a given indoor climate and perception of comfort. Our methodological proposal for detecting the relative chronology of traces on a micro level is therefore a detailed buildings archaeological analysis (cf. Morris 2000; Schuller 2002; Eriksdotter 2005).

The dilemma of investigating buildings with various alterations is of course the risk that essential parts of the building's older climate history have been removed. Even though Burmeister's house, for example, has essentially functioned as a museum for more than hundred years with the purpose of exposing interior sceneries from the 17th century, it is hard for visitors today to fully perceive environmental settings and endeavors of thermal comfort from this period. The majority of heating sources have been removed, sold, even lent out and finally replaced with other types, which partly complicate the interpretations. In such cases archival materials are of enormous value (cf. Legnér 2011; Legnér & Geijer 2012). Documents such as inventories, accounts, diaries and historic images of different kinds often have the ability to give unique details about internal climates or occlude missing links (cf. Cassar & Taylor 2004; Legnér 2012).

Historical descriptions of Burmeister's house are quite scarce, but inventories drawn up in 1723 and 1852 offer helpful insights about spatial functions and furnishings, which are no longer discernible or have been removed over the centuries. Although the inventory from 1723 has been used in earlier building historical investigations and greatly contributes to a better understanding of the early history of the house (cf. Svahnström 1942; 1947), our objective requires an amplified discussion in which the climate aspect is made more visible. Consequently this study should be seen as a re-reading of some of the most important historical sources from a climate point of view and merged with supplementary building archaeological observations. To support our interpretations, we also use earlier building historical research concerning the building type that Burmeister's house represents.

Fig 1

The wooden burgher house of 17th century Sweden

Building with logs has a long tradition in parts of Europe where there has been an abundance of wood. Until the end of the 19th century mansions as well as prominent burgher houses in Sweden were also frequently built in wood. Although building always involves local practices and varieties, it is possible to detect numerous resemblances in both construction and layout throughout Northern Europe in the 1600s. Several aspects are relevant to address in order to clarify whether Burmeister's house is an uncharacteristic wooden burgher house or follows a traditional early modern pattern.

Northern European burgher houses in wood are generally characterized by their multi-functional uses and numerous floors (Lundberg 1935: 281). The Swedish counterparts, commonly known as storage houses with a loft, are similar even if they are of simpler design (Lundberg 1935: 297). Each floor had at least two rooms without any interconnection, which meant that the entrance to the upper level consisted of an exterior stairway, located in the back of the house (Lundberg 1978: 24). The rooms on the second floor were mainly used for storing varying merchandises and had initially no heating systems, although they were often converted into magnificent banquet halls when necessary (Lundberg 1935: 297). Indeed, the heat coming from the open fireplace on the bottom floor helped to create a dry environment in the upper storages (cf. Almevik 2012: 152). The upper rooms were also commonly used as guestrooms and could therefore be left unused for a long time (Hidemark 2006: 44). The bottom floor functioned as a combined dwelling,

workshop, and office, and accommodated normally also a small shop along the street (Lundberg 1978: 131-133).

From the 17th century onwards, the most overall floor plan design in rural as well as urban Sweden was undoubtedly the "parstugan" meaning that two identical dwelling rooms or "stugor" are bonded on each side of a passageway or entrance hall (cf. Lundberg 1935; 1978; Erixon 1947; Hidemark 2006). This plan permeated also the storage houses mentioned above. The passageways mainly functioned as links between different spatial regions, thus separating the dwelling area from more representational or public spaces. The parlor, or "stuga" as it was called in Swedish houses ("stube" in German) which usually occupied one side of the passageway on the ground floor, initially functioned as a dwelling room with kitchen. According to continental influences, the cooking area was later detached and placed in a separate room (Erixon 1947: 302; Almevik 2012: 152), leaving the "stuga" to social and daily activities.

The interiors of well-off burgher houses from this period were often insulated with richly painted panels and fixed furnishing, and we can also see an initial abundance of movable furniture (Lundberg 1978: 87). The heating of wooden dwellings are rarely addressed in Swedish literature (e.g. Erixon 1937) although the early modern period is a time when heating sources and the thermal outcomes developed dramatically. The hearth in the "stuga" is mainly spoken of as an open fireplace used for lighting, cooking, baking and washing. However, when the kitchen moved to a more central place adjacent to the passageway, the function of the fire place in the "stuga" changed and became exclusively for spatial heating (cf. Troels-Lund 1914). The tile stoves, which produced a smoke-free, constant and warm radiant heat, were used in this period and also much earlier in German

speaking areas (Atzbach 2012: 269). For a long time they were exclusively mounted in upper-class dwellings (cf. Brewer 2000; Crowley 2001; Nyström & Sundin 2001). Cast iron ovens, i.e. basically closed boxes standing on four legs, were related to tile stoves and were used both in urban and rural settings throughout central and northern Europe (Hansson 2012: 264). However, it seems that the iron ovens were much more commonly spread in Denmark and Norway than in Sweden during the 16-17th century (Troels-Lund 1914: 224; Eriksdotter 2013b). The great advantage in comparison to an open fireplace was fire safety, having easier control of the temperature and cleaner air. A disadvantage was that it provided no light at all.

To briefly summarize, the early modern wooden burgher houses were often designed as storage houses with lofts, which initially housed a variety of functions corresponding to the needs of the owners. However, over time the buildings transformed into more refined dwellings with an increased number of separate bedrooms and specific chambers for servants (Erixon 1947: 303). The alteration meant an increased demand for thermal comfort. Since the tile stove once fired could heat a room up to 24 hours (cf. Atzbach 2012: 269), it represented an important technical innovation and a key factor in the maintenance of this new interior lifestyle.

Fig. 2

Visby in the 17th century and the emergence of Burmeister's house

Visby, which experienced its heyday during the Middle Ages, is generally depicted as a city in a poor state with ruined buildings and few inhabitants in the 1600s (e.g. Rosman 1930; Gardell 1986). One reason for this stagnation was the wars between Sweden and Denmark, which depleted Gotland. Sweden obtained the whole island in connection with the peace treaty in Brömsebro 1645, but the island continued to be fought over until 1679. The deprived situation continued mainly due to the island being leased out (Svahnström 1968: 10-13). In its endeavor to revive the island's long-stagnant trade and economy in the mid-17th century, the Swedish government encouraged foreign merchants, in particular Germans, to settle in Visby by decreasing their toll taxes (Rosman 1930: 142-143).

Even if several merchant and burgher houses from the 1600s were erected along medieval central streets such as *Strandgatan*, the buildings differed greatly from the medieval hanseatic warehouses in stone with their high gables facing the harbor and the sea (e.g. Westholm 2000). The 17th century houses were mainly built in wood or partly half-timbered with the long side facing the street (cf. Troels-Lund 1914: 134-136). The shift in dwelling design from gable-fronted stone houses to the wooden burgher house may have many explanations. The changes took place during a dynamic period when Visby was not only changing nationality to Swedish, but European society in its entirety was undergoing several social transformations affecting the housing culture (cf. Rosén 2004). Urban dwellings, for example, became more public and received greater representative importance, both as private households and as part of commerce relations. It is in this context that the emergence of Burmeister's house should be understood.

The German-born Hans Burmeister came to Visby in 1647, acting as a merchant representative for a Lübeck trading company (Svahnström 1942: 41). He soon became one

of Visby's main importers of commodities, receiving goods from his own ships arriving in Visby each spring. In the beginning of the 1650s, he became owner of a vacant lot located at the crossing of *Strandgatan* and *Donners plats*, where he built a two story house in log technique as a combination of storage, shop and dwelling, comparable to the storage houses with lofts which have been described above. Initially the house functioned more as a storage and selling point for his goods since it did not have any heating sources. Burmeister's accounts of imported goods reveal that he traded with a variety of things such as food, spices, wine, tobacco, textiles and weapons which explain the need of extensive storage spaces (Svahnström 1942: 43-44). According to Svahnström the first private residence consisted of a modest one-room construction, located in the back of the main building, similar to many contemporaneous burgher houses in Lübeck during this period (e.g. Hübler, 1968). However, after Burmeister married Karin Jensdotter who belonged to one of Gotland's richest families, extensive alterations took place in the house; a work that went on for more than a decade. In 1654 Burmeister was registered as a household tax payer, which indicates that the basic interior setting of the house was finished by that time (Svahnström 1942: 42). Judging by various inscriptions in ceilings and fireplaces, it seems that the former storage compartments in the bottom floor were transformed into a domestic area to begin with a separate "stuga" and a kitchen. Later, in the 1660s, the upper floor was partly refurbished into an exclusive hall, which has been preserved. The northern part was nonetheless kept as a store- or guestroom or a place for summer lodging since it still did not contain any heating sources. Around 1670, the old dwelling in the back of the main house was expanded and turned into an office and adjoining hall for receiving customers.

When Hans Burmeister died in 1681, he had not only accomplished a successful career as a merchant, but also as an alderman, custodian and notary in court. Consequently, his prominent position in Visby was expressed materially in his residence at *Strandgatan* as well. Wall paintings and open fire places with stone decorations are examples of exclusive attributes which can be compared with contemporaneous upper-class houses in Visby such as the *Gamla Residenset* (the Governor's Old Residence), erected in 1649-51 by the Swedish Governor Åke Hansson Ulfsparre (Svahnström 1942: 26;.

As a foreign merchant's house in Visby, the Burmeister house enclosed what can be interpreted as a typical Northern European architectural fusion of its time. The influences from the Swedish mainland is clear, for instance the log technique and the central-passage floor plan which we have touched on earlier, while the spatial separation of the "stuga" and the kitchen as well as the use of iron stoves probably reveals Burmeister's connection to his homeland, or the fact that the island once was Danish (e.g. Engqvist 1976; Krongaard Kristensen 2004).

Fig 3

Fig 4

Traces of indoor climate and thermal comfort in the 1720s

In previous sections we have tried to illustrate the building historical background that will explain the initial appearance of Burmeister's house in Visby. We have established that the house was erected as a storage house with a loft, which was a frequent type of timber

construction throughout Northern Europe, particularly in Sweden during the early modern period. However, rather quickly the house turned into a more clearly defined residential building with a central "stuga" and hall on the first; a spatial transformation that we can observe in many urban environments in this period, although other types of layouts were operating parallel (e.g. Girouard 2000).

The following section consists of an analysis of how Burmeister's house functioned from an indoor climate perspective. Our discussion involves three themes: spatiality, heating and interior décor and furnishing. The aim is to try to understand how these features operated and affected the inhabitant's experiences of indoor climate and thermal comfort.

The reason why we choose to set the scenario around 1720 is due to the date of the earlier mentioned inventory from 1723, which is the first known description of Burmeister's house. However, the analysis should, according to the earlier mentioned Swedish historian, Gunnar Svahnström (1942), also be applicable to the late 1600s when the house started to function as a combined dwelling, shop and storage. In 1720 the household consisted of five people: Alderman Mårten Burmeister, his wife and three servants. Just twenty years earlier the household had been somewhat larger with seven members, probably because of children at home.[1]

Spatiality

The spatial structure of a house is intimately related to its heating resources. This is especially manifested in buildings before the central heating was introduced when rooms were left unheated for transits, storage or summer use, or heated with the purpose to spend

some time in. As we have seen in previous section, the layout of the Burmeister house was originally erected as a central-passage type house flanked by two major storage rooms without any heating sources. However, this structure was early remodeled when the passage was divided into two minor entrance halls due to the construction of an intermediate chimney; i.e. the original heating design of the house. The entrance halls lead to a ”stuga”, shop and kitchen. Similar spatial divisions were applied to the annex located west to the main house where an entrance hall preceded an office and a minor representative hall. On the second floor the visitor would arrive in an entrance hall before getting access to the great hall and chambers. The entrance hall can be defined as preparatory spaces for distinct social units such as domestic, business, economical and representational areas (cf. Troels-Lund 1914: 27). Yet, from a climate perspective their purpose was perhaps of even greater importance as sluices with doors between the rooms decreasing drafts. As such the entrance halls had a significant role for controlling the indoor climate and comfort in the inner rooms.

Fig 5

Climate awareness is not only possible to detect horizontally through the interconnection of spatial units. When it comes to the relation between the “stuga” and the great hall, which is located on top of each other, their internal spatiality has, climatically speaking, primarily been working vertically. The thermal input from the “stuga” on the bottom floor has benefited the great hall through air movement transporting warmer air upwards through the

wooden ceiling and the chimney. Because the great hall has only been used on special occasions and therefore not warmed-up daily, heat rising from the first floor has been the primary source of heat here. This energy solution has probably also been in use since the start for a better dry storing when the second floor may have functioned exclusively as storage space (cf. Crowley 2001: 54).

Orientation is often an overlooked aspect for understanding indoor environments. It is no coincidence that the two major spaces in the house; the "stuga" and the great hall, are facing south. The augmented volumes demanded thermal compensation in order to maintain habitability and comfort according to contemporaneous social standards. Hence, the southern orientation provides the rooms with essential light and warmth, necessary to balance the extensive volumes even if heating sources are the main providers. The two mentioned rooms in the Burmeister's house are actually measuring 38 respectively 54 sqm^2 which is a great deal more than Burmeister's anterior residence which according to Svahnström's reconstruction only measured 16 sqm^2. An interesting dissimilarity between the two rooms is that the "stuga", according to the inventory from 1723, has had shutters for the windows and the great hall not. The reason, except for protection from burglars, is most probably the daily use of the "stuga" which required a more continuous insulation than the great hall that was only in use occasionally.

Heating

Heating sources are for natural reasons indispensable in order to inhabit a house in Northern Europe, which is also evident in the Burmeister's house. As soon as the house began to be used as dwelling, heat sources were installed. The interpretation of the heating

systems in the house is quite complex. The majority of them have been changed which is clearly visible from traces of older foundations in the floor. Unfortunately, the material traces do not reveal what kind of heating sources that have been in use. However, from the inventory made in 1723 it is possible to merge these two different sources and reconstruct the spatial location of different types which, as we will see, have had various impacts on the indoor climate. During early 18th century, the former inhabitants have operated two different kinds of heat sources; open fire places and iron stoves, depending on the function and status of the rooms.

While the open fire places were primarily destined for representational areas which were only populated on special events, the iron stoves were installed in rooms used on a daily basis. Consequently, the open fireplaces were located in the great hall on the second floor (and still stands there) and a minor representative hall in the western wing. Since the sides were decorated with various ornaments and figures made of a special stone called "Burgsvikssten", they were considered as a symbol of status and only frequented in houses for upper classes. Still, the function of the open fireplaces was not only to provide heating, but also to illuminate the room, thus exposing the stone décor as well as the painted walls (cf. Söderström 2009). Both fireplaces have had, according to the inventory, dampers, which kept the heat inside the room better when the fireplace was not in use.

Fig 6

As a contrast, the iron stoves (Swe. *vindugnar)* which during this period were placed in the "stuga", the office and in a smaller chamber on the second floor did not offer light, but rather quick heating of the air volume of a room. In addition, these stoves were energy saving heating sources which were suitable for rooms that were used often. This is probably one reason for having an iron stove in the "stuga" which supposedly was the most frequent place in the house. Without doubt the large amount of windows with views in three directions recompensed for the lack of light. The iron stoves could also easily be moved. One case in point is the information given in the 1723 inventory, which mentions that the iron stove in one chamber was temporarily on loan.

Fig. 7

The only rooms in Burmeister's house with no heating sources during this period were two chambers on the second floor. It seems that they still functioned as storage places or used as summer lodgings as mentioned earlier. Even if both rooms benefited warmth from the main chimney in the kitchen below and at times from the adjacent hall, it was never sufficient to heat the rooms for all-year-around dwelling.

Interior décor and furnishing

In Burmeister's house we find several material expressions that can provide us with additional information about how indoor climate affected thermal comfort. In this section

we look closer at the relation between panels, paintings and furnishing, i.e. elements that traditionally are interpreted from a stylistic or a status point of view.

Today almost all rooms in the Burmeister's house have panels or inner boards, but in the early 18th century house this was a luxury and according to the inventory of 1723 only installed in the "stuga", the great hall on the second floor and the adjacent chamber. It is generally known that inner boards were decorating walls of rooms associated with status and rank. However, it must have been quite a different experience in comfort in comparison to other rooms where walls not were paneled and thus more susceptible to draft through air leakage. Insulated rooms allowed for longer stays and as a consequence new ways of using them. The inner boards were also painted with various 17th century sceneries, which were a symbol of status as it gave the impression of exclusive tapestries. The preserved paintings in the "stuga" are concentrated to square fields in the walls. Hence, lack of paintings might indicate that there has been some kind of wooden insulation in the sockets along the floor as well as the corner parts of the room (cf. Troels-Lund 1914: 206).

Another observation made by Svahnström involves the placing of fixed furniture in the "stuga" due to the absence of paintings (1942: 60-61). It is a four-poster bed that likely has been positioned in the northeast corner like an alcove, close to one of the entrances and the iron stove. It is likely that the placement of the bed took advantage of the warmth from the heating source. The furnishing in the "stuga" is very different from the one in the great hall, which according to the inventory only was equipped with one oak table, a circumstance that undoubtedly reflects the occasional use of the upper room.

Living in the Northern Europe allowed the former owners of Burmeister house to make necessary adjustments according to climate and environment. We have seen how conscious energy choices in terms of spatiality, heating and interior design several times interacted to achieve a sense of comfort. However, the building also accommodates examples when comfort was sacrificed for the maintenance of certain symbols of status in rooms such as the great hall. Most striking about this early historical phase of the house is how the residents used only one room, the "stuga" for living in. This room was the best insulated and most heated in the house. As we shall see in the following text, later interventions meant that more rooms would be occupied, and thus more heat sources and other measures would become necessary.

Subsequent changes affecting indoor climate and comfort

What measures were taken to improve the thermal comfort in Burmeister's house? Whereas the seventeenth- and eighteenth-century history of the building has been thoroughly recorded in previous investigations, life in the house of the nineteenth-century is much less known. As mentioned earlier, much of the interior of this time period have been removed. In order to understand the chronology of actions taken to improve the comfort in the house, we have to rely on drawings, paintings and photographs of the building together with written accounts. The Burmeister's house is fortunately one of the most frequently depicted buildings in nineteenth-century Visby. There are also some interior photos from the late nineteenth century, as well as a couple of plans produced around the turn-of-the-century.

Finally, we can also make use of an inventory compiled in 1852 when the last member of the Burmeister family on Gotland died.

Although no radical modifications had been made to the house since the 1723 inventory, several alterations have abetted to transform the indoor climate. One exterior measure decreasing drafts in the building was for example the yellow-painted paneling, which was added already in the early nineteenth century (Hansson 2002-03). It was still used as a combined dwelling and workshop/retail. Furthermore, windows were enlarged letting more light in. This alteration probably had to do with the great hall beginning to be used as living quarters and not just for festive occasions or for storing. An additional room to the north, functioning as quarters for one or two servants, was furnished on the upper floor in the late eighteenth century and heated with a tile stove, which considerably improved the thermal comfort in this part of the building. In 1790 the household was headed by a merchant widow and comprised a total of seven people, i.e. a family of five and two servants. Twenty years later, the number of occupants was still seven: the master of the household Johan Brobäck, his wife Johanna Fredrika (born Burmeister), her mother, a son and a daughter and two maids.[2]

Fig 8

After Johanna Fredrika Burmeister's death in 1852, an inventory was made of the family's collected belongings. In this inventory not only Burmeister's house was included but also another property, which should have been furnished. The inventory gives proof of the

affluence, which a mid-nineteenth century burgher family could boast in Visby. Furniture was no longer kept to a minimum and was moveable. In the two houses there were no less than forty-eight chairs, three cupboards, two chests of drawers, three couches, fourteen tables of varying size, and four single beds with ample bedclothes. There were also a large number of light sources, most of them moveable lamps or candelabra. One of them was probably a kerosene table lamp. When open fires increasingly were replaced with tile stoves or iron ovens, they were in general coupled with kerosene lamps supplying light, which the new heat sources did not offer. Kerosene lamps were still uncommon and expensive in Sweden of 1852, showing that Johanna Fredrika made use of contemporary improvements in the lighting technology (Garnert 1993).

Judging by pictorial evidences from 1845 and 1862, curtains were used at least in the southern windows on both floors. These curtains served to regulate incoming light and heat from the sun, but could (except for providing some privacy) also decrease draught and heat loss from the room in winter. There are also hooks left on the inside of the window frames indicating that secondary glazing has been used. In wintertime a second sash was probably used in all windows for better insulation. However, sunlight and draft should have been difficult to control since a thick ivy plant covered all of the south façade, efficiently putting the shutters out of use. Between 1845 and 1900 the ivy plant was evidently allowed to grow quite freely. By the end of the century even the ever-growing plant had covered the windows. It should have cooled the indoor climate considerably. The plant was not removed until frost killed it during the cold winters of the 1940-41.

Fig. 9

The house was extensively modified in the late 19th and early 20th centuries. This work began in the mid-1880s when architect Emil Viktor Langlet gave the building a partially new exterior appearance by replacing the tiled roof with zinc plating. After these changes attempts were made to restore the house to a more original appearance, first by the new owner Colonel Gustaf Björlin. In 1895 he began reconstructing the seventeenth-century building in the spirit of late nineteenth century style restoration (Kruse 1907). Björlin's vision was to transform the building into a historic house museum. It was probably at this time a new chimney was raised in the northwestern part of the house. The exterior paneling was taken away, and the large windows of the hall were each given two posts. We know that wallpapers had been used in the nineteenth century (Kruse 1907), since they were taken down during this restoration, leaving only some fragments, which are still visible today. Less sensitive to the history of the house was Björlin when he took down walls and floorboards to create a large paneled dining room on the bottom floor, north of the "stuga". This room was probably not used every day but only in weekends or for celebrations. Although the paneled walls and roof, it was not properly heated (it had an open fireplace) and towards the northern garden a double door with windows was put in, making the room chillier.

The "stuga" was at this time still used as the main living room. The fireplace had had to give way for a large, late nineteenth century tile stove, which managed to keep the occupants comfortable in accordance to contemporary aspirations of thermal comfort. The

floor was recurrently carpeted for better insulation against the drafts from the cellar (Kruse 1907). Most of the furniture (a sofa, a table and a couple of armchairs) seems to have been placed in the southwestern part of the room, where the daylight was optimal. This corner also gave the family some distance to the lively shopping street *Strandgatan* on the eastern side of the house. The fireplace in the hall on the upper floor had been converted into a tile stove, giving this large space a more even climate than a large open fireplace could ever do. Contemporaneous photos of the hall also show that the room has been furnished for everyday activities. The trend of the time was also to open up representational areas for more common use (cf. Troels-Lund 1914: 205).

Fig. 10

After a few years Björlin got tired of the restoration and sold the house. In 1905 it was purchased by the city as the result of a campaign for the preservation of the house. An extensive restoration work was begun anew and was finished in 1907. The fireplace present in the "stuga" today was put there in 1906. Additional evidence of the building's more recent climate history, highlighted in this chapter, was erased in order to give preference to an archaic, seemingly untouched guise. However, by using other sources than the building itself we have tried to show how smaller, subsequent alterations and refurnishing affected the indoor climate and, hence the sense of thermal comfort.

Burmeister's house in a climate and cultural context

So far our attention has chiefly been focused on the local context, i.e. the relation between an estimation of the historical climate indoors and the embodied materialities of comfort in a single building study. However, our survey has at the same time exposed various features that Burmeister's house has in common with coexisting wooden burgher houses. Without doubt, the dwelling followed a general scheme of technical developments and stylistic tendencies linked to a contemporaneous urban middle/upper class and its social practices.

As Burmeister's house is located in the northern Europe it is close at hand to interpret several features as climate awareness in order to create as habitable and comfortable indoor environments as possible. By putting the climate issue in focus we somewhat challenge conventional understandings of the rise of individual and other societal changes during the early modern period.

One of the most surprising discoveries during our investigation was, indeed, the recurrent changes of heating systems that took place rather early in Burmeister's house, already during the 17th and 18th centuries. Only one room, the hall, still has retained its original heating source, although it was temporarily modified in the late 19th century. We interpret these constant adjustments as the inhabitants' response to the environmental conditions and desire to optimize their sense of comfort. Recurrent changes of heating are characteristic for regions such as Northern Germany, Denmark and Eastern Sweden. Similar phenomena have also been found in different settings close-by on the Swedish mainland, for example at Skokloster castle (cf. Andrén 1948), Karlberg castle (O:son Nordberg 1945) and Stockholm castle during the 17th century (cf. Troels-Lund 1914).

Additionally, we need to see choices and flexibilities of warm-up in the light of the climate change that that the inhabitants most probably experienced in the early modern period. Northern Europe underwent a cooling period called the Little Ice Age, i.e. the 1500s until the late 19th century with a noticeable peak during most of the 17th century (Fagan 2000; Mann et al 2009). Scientific analyses show that all seasons in the Northern Europe went through a cooling, resulting in wetter summers and longer and more severe winters (cf. Brázdil *et al.* 2010; Pfister 2010). In 1695-98, for example, the Baltic region experienced a recurrent period of harsh winters which resulted in recurrent crop failures, starvation, deceases and increased mortality (cf. Lilja 2008). But the Little Ice Age was not necessarily a period in permanent crisis but rather a time of flexibility, experimentation and transition (Eriksdotter 2013a).

Hence, climatic reasons may have caused architectural transformations associated with heating, spatiality and interior design, even if they were not essential to life. The development and use of various heating sources can, for example, be seen as the result of endeavors to produce more energy efficient systems. The less wood-consuming iron stoves and later tile stoves represented in this respect a major improvement in thermal comfort since they were able to generate constant warmth over a longer time. Tile stoves became more common in the upper strands of Swedish society in the late eighteenth century (Sherman 2007), but did not enter the homes of common people until a century later when a domestic production of tile stoves was developed in Sweden (Cramér 1991). As we have discussed earlier, the Burmeister family had resources to equip the house with the latest heating installations, and hereby also had the possibility to follow the increased demands for thermal comfort.

At the same time as new heating systems were developed in the 1600s, the spatial structures in upper class buildings changed when spacious central multifunctional spaces were abandoned for sets of smaller intimate rooms (cf. Crowley 2001; Girouard 2000). The spatial alterations are commonly connected to changing social practices such as privacy, individuality and exclusion. But the modifications also had several obvious climatological benefits. The problem with heating a larger amount of rooms was solved by constructing more chimneys, and smaller rooms were easier to warm up (e.g. Rosén 2004). In Burmeister's house we can clearly see how spatial divisions worked according to different functions. A spatial system with a number of rooms preceded by entrance halls permitted the inhabitants to shut off rooms not in use, and to furnish rooms according to specific uses. The "stuga", for example, which was the most frequently used room, was decorated to meet daily thermal requirements, in contrast to the rarely used hall where symbols of status were given precedence over comfort. As a prolongation, the idea of the inefficient, fuel extensive open fire in the great hall as something ceremonial or "relational" speaks to comfort as something more than physical; as a contrast to the iron stove in the "stuga" that simply warms (e.g. Eriksdotter 2013b).

Later on, in the late 1700s, installments of heating in the servant's quarters can be seen as a way of sustaining a social stratification within the household as well as permitting higher standards of comfort among the subaltern. The installments should be seen as an echo of a more wide-spread use of tile stoves among all social groups due to reduced production costs. As a consequence, the upper-class introduced new objects of comfort signaling their supremacy, such as more elaborated textiles, furniture and interior design.

Although we at present cannot say with certainty whether or not the discussed architectural changes should be connected to the effects of a global weather phenomena such as the Little Ice Age, we can ascertain that Burmeister's house contains several variables that can first be fully understood when we look at the building from a wider climate and comfort context with all the alterations and technical innovations that occurred between 1650 and 1900.

Conclusions

The single most important reason why the Burmeister's house has been preserved until our days is that it has remained useful; otherwise it would not have been possible to maintain and improve it. In this sense, turning the house into a museum has not been solely a benefit for its preservation. In order for the house to remain in service it should be possible to heat at least parts of it efficiently in wintertime.

The main point of our analysis, however, has been to show the potential of studying one building over a longer time period. Burmeister's house opens up for a deeper understanding of changing perceptions of habitability and comfort in a wider context. Restorations carried out in the twentieth century have obscured the improvements of indoor climate made between 1720 and 1900. Although the 16-1700s represents the climax of the cooling period, and the late 1800s embodies the ending, we can observe a gradual increased desire for comfort, which probably should be associated with contemporaneous technical advances within the heating sector as well as changing social practices. Nevertheless, the persistent use of open fire places in some of the rooms also show that thermal comfort

partly was perceived as something secondary, assigning ceremonial and relational functions of the fire in first place. Further on, the technical development in Burmeister's house was abruptly broken when the house was converted into a museum and a reversion of the comfort occurred to meet modern belief of early modern standards.

From an architectural point of view, climate history has a great knowledge value with its tentacles in various societal matters. Although we cannot fully recreate comfort sensations of the 1700 or 1800s, we noticed that applying a climate perspective on Burmeister's house exposed several environmental and social aspects, which have not been fully recognized previously. Our focus has mainly been on clarifying the historical indoor climate and comfort, showing there are alternative ways of exploring climate than the purely technical ones.

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Notes

1. Regional archives in Visby, County of Gotland, population register (*mantalslängd*) of the town Visby 1642-1820, registers for the years 1700 and 1720.

2. Regional archives in Visby, County of Gotland, population register (*mantalslängd*) of the town Visby 1642-1820, registers for the years 1790 and 1810.

3. Nobel, L. Letter to Gunnar Svahnström, Gotlands fornsal, 19 May, 1943.

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Gunhild Eriksdotter holds a PhD in medieval archaeology (2005 at Lund University, Sweden). Eriksdotter received a prize for meritorious doctoral thesis by the Royal Art Academy of Sweden in 2006 and has a long experience performing building archaeological investigations and teaching in Sweden, Italy, Tanzania and Colombia. At present she is working as a free-lance researcher within the fields of archaeology, conservation and cultural heritage management.

Mattias Legnér

Figure **Captions**

Fig 1. The exterior of Burmeister's house as it appears today. Photo by Gunhild Eriksdotter 2012.

Fig. 2. A classical floor plan with two rooms, i.e. a kitchen and a "stuga", bonded on each side of an entrance way (From Erixon 1947).

Fig 3. The Baltic region and the island of Gotland with a detail over Visby and the location of Burmeister's house. Map by Niklas Martis 2012©.

Fig 4. Reconstruction of Burmeister's house in plan and section showing the oldest phase when the building mainly functioned as a warehouse (inspiration from Svahnström 1942). Drawing made by Sharon Pulvino 2014©

Fig 5. Reconstruction of the spatial organization of the two floors of Burmeister's house from the inventory of 1723 (inspiration from Svahnström 1942). The section shows also the vertical relation between the "stuga" and the main hall. Drawing made by Sharon Pulvino 2014©.

Fig 6. The open fire in the great hall, today the oldest remaining heating source in Burmeister's house (dated to 1662). The great hall as it looked in the 1890s, after Colonel Björlin's restoration work. Courtesy of Gotland Museum©.

Fig. 7. When the open fire place in the parlor was removed (traces are shown in the floor), a cast iron stove was put in its place. Photo by Gunhild Eriksdotter 2012.

Fig 8. The interior of the "stuga" c. 1900. In 1906 the tile stove was replaced with a 17th century fireplace. Courtesy of Gotland Museum©.

Fig 9. The great ivy covering the southern facade of Burmeister's house, after 1907. Courtesy of Gotland Museum©.

Fig 10. The fireplace in the great hall in 1890, which then was rebuilt and used as a tile stove. Compare with figure 6. Courtesy of Gotland Museum©.