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Exploring Comfort in the Home: Towards an Interdisciplinary Framework for Domestic Comfort

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Abstract

With increasing costs of energy and the need to cut CO_2 emissions, householders are actively encouraged to reduce their energy consumption. As the biggest uses of energy in the home are for space and water heating, research into comfort has predominately focused on the thermal environment. A wider perspective on comfort is provided by sociological practice-orientated research that seeks to understand how people create comfort at home and psychologically informed approaches relating to understanding the drivers for behavioural change. By gaining a multidisciplinary understanding of how and why occupants create comfort at home, opportunities to maximize energy demand reduction can potentially be identified. Findings from a study of householders and a review of the literature were used to create a framework that incorporates a three-tiered approach to understanding comfort in the home consisting of "comfort needs", "comfort preferences" and the highest level, "comfort aspirations".

Keywords: domestic comfort, energy consumption, interdisciplinary framework, user centred design

Background

The topic of comfort is dominated by research relating to thermal comfort, not least the work of Fanger (1970) who developed a thermal comfort model based on the heat transfer between people and their surroundings. Extensive research in this area has led to the standardisation of comfort conditions and technological advances in the energy efficient heating and cooling of buildings. The way people live and behave in their homes has an impact on energy consumption and this has led to a growing interest in perspectives from social and behavioural scientists (e.g. Prof Elizabeth Shove and Prof Tim Jackson) in order to better understand the impact of the occupants on the overall energy use of the home.

The value of bringing these varying perspectives together to maximise opportunities for energy demand reduction is increasingly recognised within energy policy (e.g. Owen, 2000; Chatterton, 2011). But at the ground level, there is still considerable opportunity to inform building energy research with insights from these 'softer' disciplines.

This paper offers a framework intended to act as a thinking tool to bring together different perspectives on comfort from engineering, social and psychological, and

arguably most importantly, the householder perspective. Developed from a user centred design perspective, the framework is intended to provide a bridge between technical and social disciplines (e.g. Haines, et al., 2012). It is hoped that, by taking this perspective, opportunities for multi and interdisciplinary research towards reducing energy demand whilst maintaining user comfort will be identified.

The meaning of comfort
Whilst not a comprehensive overview of the area, the following section introduces contrasting perspectives on comfort and energy saving in the home, to provide an illustration of how comfort is framed within the technical, social and psychological disciplines. A pragmatic overview of these sociological and psychological approaches to describing energy behaviour has recently been provided by Chatterton (2011).

The definition of comfort varies throughout the literature; the dictionary defines comfort as 'a state of physical ease or well-being' (Collins, 2003) while across the literature there is debate surrounding the meaning of comfort. Brager and de Dear (2003) describe comfort as 'the absence of pain'; this engineer's definition of the optimum comfort condition focuses on the physiological state of the body and the surrounding environment. ASHRAE defines thermal comfort is 'that condition of mind that expresses satisfaction with the thermal environment,' (ANSI/ASHRAE, 2010) whilst Parsons (2003), an ergonomist, describes comfort as 'a psychological phenomenon not directly related to the physical environment or physiological state'. For centuries the word 'comfort' was predominantly associated with moral and spiritual support during difficult times; it was during the eighteenth century that the meaning of comfort for Anglo-Americans became based upon 'physical comfort' described as a 'self-conscious satisfaction with the relationship between one's body and its immediate physical environment' (Crowley, 1999: pg 2). This form of physical comfort gave birth to a new material culture where there was a growing desire for items such as home furnishings to provide occupants with satisfaction from their surroundings. It was during the nineteenth century that the word comfort became related to environmental aspects and the physiological state.

In a search of scientific databases, Vink, et al., (2005a) found that most papers were published in the area of thermal comfort above other areas such as acoustic comfort, vibration/shock comfort and physical comfort. Although these areas of comfort, to an extent, stand alone from one another, they each strive to understand how individuals are affected by their surrounding environment and their interactions with objects. Vink, et al., (2005b) developed a comfort model consisting of eight elements both physiological and psychological in nature. These are: temperature/humidity; pressure/touch; posture/movement; noise; smell; visual input; history; and state. The eight elements are described as being interrelated however it is unknown whether they equally affect the experience of comfort.

Sociologists have sought to understand how energy is used in the home by using 'everyday practices' as a lens through which to structure understanding of reality. The theory of the co-evolution of comfort is put forward by sociologist Shove (2003) who explores the socio-technical components of comfort. Shove uses the term 'co-evolve' in order to explain the relation between both social and technical dimensions of comfort, however the interplay between both sides is emphasised. The theory explores three dimensions of co-evolution:

- *The relationship between specific technologies or material infrastructure and social practices or procedure.* This refers to the product, technology or material in question, for example a television, a central heating system or water supply.
- *The relationship between specific technologies or material infrastructure and socio-technical systems of collective conventions and meaning.* This describes the social meaning behind the action of practices and social influences that define particular 'social norms'. Norms are defined as a 'psychological phenomena, a construct that has widespread usage because it helps describe and explain human behaviour' (Cialdini and Trost, 1998: p1). Normative behaviour is that which has more commonalities with the social collective unit rather than individual behaviour.
- *The relationship between socio-technical systems of collective conventions and social practices and procedures.* Practices are defined as an action, or series of actions, carried out as part of completing a task; practices are normally closely linked to social norms. The term 'procedure' refers to the habits and routines of individuals; habits being 'behavioural tendencies' which are acquired in a similar process as skills (Ouellette and Wood, 1998: p2).

The theory of co-evolution can be applied, for example, to the everyday practice of bathing or showering. The *material infrastructure* in this case refers to the water supply; the *meaning* behind the practice refers to the feeling of freshness and improved hygiene; the *procedure* refers to the habit or routine of showering everyday (Shove, 2003). Scott, et al., (2009) collected data on participants' bathing practices. Participants were asked to challenge their current bathing practices and unveil the reasons behind their actions. They found complex motivations for bathing: assuming that people will save energy by reducing the flow rate of a shower may not actually lead to energy saving, as people may compensate by taking longer showers in order to achieve their wider goals for freshness, self-confidence and comfort.

Another key influence on energy policy has been models of behaviour change and decision making. Emerging from the discipline of psychology, where many well-established and widely accepted theories have been put forward, (e.g. Azjen, 1991), these have more recently been applied to energy demand reduction (e.g. Jackson, 2005) and operationalised within the Design for Sustainable Behaviour approach (Lilley, et al., 2005). From the perspective of comfort, these approaches emphasise the role of the individual's intrinsic motivations and rational choices in contrast to sociological perspectives where it is recognised that individual choices are constantly being shaped by the social context in which they take place (Shove, 2003).

Understanding comfort in the home – a field study
To support the literature, primary data were collected through a field study to understand how household occupants perceive comfort in their homes, and whether their practices drew comparisons with the literature. Interviews were conducted with household occupants and the following questions asked:
1. Within your home, what does comfort mean to you?
2. How do you create comfort in your home?
3. Other than thermal comfort, what other attributes do you associate with comfort?

The interviews were conducted alongside the CALEBRE project (Consumer Appealing Low Energy technologies for Building Retrofitting) which is a four year project funded by E.ON and RCUK that aims to find solutions to reduce domestic carbon emissions which are both achievable and acceptable to the user. The CALEBRE householder study focused on what home improvements the occupants had completed on their property and their motivation for doing so. This study was also interested in comfort and appearance in the home (see Haines, et al., 2010) and so the specific questions about comfort practices and comfort making fitted well within the wider interview. Twenty households were visited in the East Midlands area of the UK and thirty three participants (19 female and 14 male) were interviewed, with ages ranging between 15 to 80 years old (mean 48, SD 13.45). All the houses were owner occupied, solid wall dwellings as these hard to treat properties were the focus of the CALEBRE project (Vadodaria, et al., 2010).

The qualitative data from the interviews were coded and sorted. The comfort making themes identified are summarised in Table 1. This shows the extensive ways in which people reported comfort being created in the home; the numbers in brackets refer to the percentage of participants who discussed these particular areas. The main themes are discussed in further detail below.

Table 1. Emerging comfort themes from the householder study

Comfort-making category	Comfort-making elements
Thermal (79%)	- Room temperature (keeping warm, keeping cool, preferred temperature - Ventilation - Adapting clothing - Bathing
Surroundings (67%)	- Tidiness/cleanliness - Security (home security, familiarity) - Home aesthetics (décor and furnishings, space)
Physical comfort (33%)	- Sitting comfort - Changing clothing
Entertainment (33%)	- Watching television - Reading - Socialising - Time for hobbies / self
Food (27%	- Beverage (tea, coffee, hot chocolate, wine) - Food
State (18%)	- Peace and quiet - Stress free time
Visual (12%)	Light (artificial, natural)

Emerging Concepts from the Householders Study

Thermal comfort

Issues relating to thermal comfort were most frequently mentioned when participants were asked about how they created comfort in the home. The majority of the references to thermal comfort were in relation to keeping warm. Some participants, however, recognised the alternative practices to reaching a comfortable state when financially it is unaffordable:

> *"[Comfort means] being warm, or warm enough. But then you have constraints, if you haven't got a high income, you put on another sweater and wear a scarf around your neck rather than put the heating up. I keep the heating pretty low, it's about 17."* (Female, aged 70)

This type of behavioural adjustment refers to the changes an individual may make to address an uncomfortable thermal environment (Brager and de Dear, 1998). Nicol and Humphreys (1973) postulated the adaptive principle, when people act to restore their comfort when a change occurs that produces discomfort. Whilst putting on additional clothing is an adaptive behaviour which does not (directly) use energy, it is important to acknowledge that not all adaptive behaviour is necessarily energy saving. A total of 30% of participants referred to using a fireplace to create comfort in their homes and although a majority of times it was discussed in terms of its thermal qualities, participants also acknowledged its aesthetic value. One participant referred to a sensation of comfort they experience from their open fire:

> *"We've got an open fire in that far room, which I like. I know if I'm sitting in there, especially in the winter time having an open fire, it's not so much the heat, it's the feeling of it which is quite nice."* (Male, aged 51)

The sensation of comfort that the participant described was similar to the findings of Henning (2006) who interviewed Swedish participants in relation to thermal comfort in their homes and found individuals described how having a fire used all five senses and created an atmosphere of warmth and comfort. Bathing was also used as a way to increase thermal comfort:

> *"Warm baths they're nice, or hot baths should I say."* (Male, aged 50)

Surroundings

Another strong emerging concept from the study was the importance of the surroundings to the participants; for example:

> *"If there's too many jobs that need doing nearby, I can't be comfy."* (Male, aged 52)

Swan, et al., (2008) describe how individuals sort clutter to create an orderly and safe place unlike the world beyond the boundaries of their home. This, to some extent, explains why individuals may find it difficult to get comfortable in cluttered and untidy environments and require a certain level of organisation within their home. Clutter and untidiness can mean different things to different people; there is no standard of tidiness which will suit all and therefore makes it difficult to identify at what level clutter and untidiness impact on comfort.

The aesthetics of their home (e.g. decor, furnishings and space) was important in creating comfortable surroundings and a personalising living space, for example:

> *"I also want things to look nice and be solid and simple. I don't really like gadgets and flash things. And that to me makes me comfortable* (Male, aged 43)

Having a home which occupants regard as beautiful was frequently referred to as important in creating comfort. Participants expressed a need for a beautiful and personalised home in order to feel comfortable:

> *"[Comfort is] having a décor that you yourself enjoy, which is why I've enjoyed doing the bedrooms because they were not to my taste beforehand."* (Female, aged 70)

An additional concept relating to surroundings was security; this was discussed in two ways, in terms of familiarity and home security. One couple explained how they did not feel comfortable unless the house was secured; this was after a recent burglary, however they acknowledged securing the house was previously unrelated to their state of comfort:

> *"Comfort is based on security after what we went through which is very important. Hence the gate, hence the new front door, hence the neighbourhood watch, hence the burglar alarm and then comfort, to my mind is, it is the most amazing lovely, lovely home."* (Male, aged 63)

Other participants described how wrapping themselves in a blanket knitted by a loved one helped them feel comfort and security. This corresponds with the literature where familiarity is often pertained to comfort; Pennartz's study of occupants (1979, cited in Heijs and Stringer, 1987) led him to believe there were a number of factors which made a 'home', one of which was having a sense of familiarity with both the physical and social surroundings. The following quote shows a short dialogue between a younger participant and their parent:

> *"I like getting quilts and piling them on the sofa and just watching TV or a film or something."* (Female, aged 15)
> *"It's partly a security thing as well, you always have your grandma's quilts. My mum made [those] homemade quilts didn't she... you like to snuggle up in those don't you?"* (Female, aged 47)
> *"Yeah..."* (Female, aged 15)

<u>Physical comfort</u>
Physical comfort was mentioned by 33% of the participants, including the more traditional issues of seating comfort, for example:

> *"Comfort means feeling good when I'm sitting in a chair, able to put my feet up. The chair is right, [it] gives me the right kind of support"* (Female, aged 62)

Participants also talked about changing their clothes when they came in from work to make themselves comfortable.

<u>Entertainment</u>

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Whilst several people mentioned relaxing in front of the television or reading as a way of creating comfort, some participants found socialising made them feel comfortable in their home. When asked what made her feel comfortable, one participant listed the following:

"Warmth, light, space, entertaining." (Female, aged 51)

Another participant mentioned entertaining at home or going out:

"I think comfort might be having a nice meal with your friends, having options, being near to the town centre." (Male, aged 35)

Food
A number of participants (27%) mentioned that food was part of how they created comfort in their home. This was either as a beverage, usually a hot one such as tea, coffee or hot chocolate, or food, with participants referring to "comfort food."

State
A state can be described as a state of mind in which emotions are experienced; this is also referred to as an emotional experience. A state such as this cannot be observed unless the emotion is knowingly expressed to others. Studies have shown that an individual's state of mind can affect how they may perceive a product or environment. (Picard, 2000; Vink, et al., 2005b). One participant illustrated this with the following comment:

"Time as well, time to do stuff properly, or take your time to enjoy something is a comfort. It's a cross between comfort and luxury." (Male, aged 50)

Visual
Research in the area of visual comfort concentrates on the lighting, particularly in an occupational context. The presence of daylight in offices has been found to create a more comfortable environment which actually improves individuals' wellbeing and health, as sunlight consists of a balanced spectrum of colours, unlike artificial lighting (Edwards and Torcellini, 2002). Within the home, participants mentioned a preference for natural light and the use of lights to create a pleasant environment, for example:

"I think also with the painting as well, with the colour you paint, and lamps and the light can make it even warmer and more attractive and you create a warm impression." (Female, aged 31)

Development of a framework for domestic comfort
Clearly comfort making in the home is a complex issue and, whilst there may be elements that relate to the traditional components of thermal comfort, justifying its dominance in the literature, there are many other aspects that are important to people in their home. Some of these practices are energy intensive (hot baths, fires) whilst some are not (wearing extra clothing, creating a calm atmosphere, painting a wall a particular colour). If we are to encourage energy saving in the home without reducing comfort levels, then focusing on comfort practices that are low in energy use might allow people to reduce the energy-hungry practices without a significant loss of overall comfort. As comfort is a multidisciplinary research subject, providing a

framework to help bring together the various facets of comfort may encourage a more holistic approach to achieving low energy domestic comfort.

To make sense of this 'messy reality', inspiration was taken from Maslow's Hierarchy of Needs (1970), in which he sets out seven levels of needs; basic needs, safety needs, love/belongingness, esteem needs, cognitive needs, aesthetic needs and finally the need for self-actualization. It is not necessary to completely satisfy one level in order to move onto the next level; for example, an individual could have no access to regular food and water but could still have loving relationships with others. However, if the physiological and safety needs are not fulfilled in the longer term they are likely to take priority over higher needs (Maslow, 1954; Maslow, 1970). Maslow's motivational theory follows a goal-centred approach, so the needs for safety, esteem, etc, are goals achieved by an individual's behaviour. This runs parallel to Shove's (2003) framing of comfort as an achievement which requires an action or series of actions to reach.

It is proposed that the elements of comfort could follow a similar hierarchical structure to Maslow's hierarchy of needs. In taking this approach, the constant striving for comfort can be, to some extent, explained; Maslow describes how, when the needs of one level of the hierarchy are met, individuals then feel motivated to fulfil the needs of the next level; as a result the motivation to fulfil the needs of the first level is diminished. It seems this approach suggests that we are always striving for more, be it self-actualization or complete comfort. This is supported by a psychological phenomenon known as the hedonic treadmill which states 'good and bad events temporarily affect happiness, but people quickly adapt back to hedonic neutrality' (Diener, at al., 2009). It could be suggested that a similar adaptive behaviour is shown towards comfort; by considering comfort in its entirety, there are clearly some comfort elements such as physical comfort which, once satisfied, are likely to diminish quickly and leave individuals striving for the next comfort level. The hedonic treadmill phenomena can also relate to one specific aspect of comfort such as thermal, and could explain the escalation of energy consumption on space and water heating in the domestic environment. The thermal conditions at which the physiological needs of the body are satisfied do not run parallel to current average indoor temperatures. Although the body has its own physiological response to cold/hot temperatures such as sweating and shivering, often thermal comfort conditions are purposely set by occupants to avoid natural physiological reactions. Could it be that, once the temperature is at a level to avoid these reactions, occupants then strive towards reaching a temperature which is preferable (i.e. warmer in the winter) and do not try to adapt their behaviour such as wearing more or less clothing (Hajiran, 2006; Diener, et al., 2009)? The final level of Maslow's hierarchy of needs of self-actualisation (when an individual reaches their full potential) has a sense of completeness, in that all that could be achieved, has been achieved. In terms of comfort, is it possible to achieve a state where all lesser comfort levels are satisfied and one is fully comfortable?

Perhaps comfort in the home is to have an environment which allows for self-actualisation to occur? Heijs and Stringer's (1987) paper, in which they classified different forms of comfort that a dwelling can provide, identified two forms of comfort which could help occupants reach self-actualisation; these were facilitative comfort and personalisation comfort. Facilitative comfort refers to a dwelling where

occupants have the freedom to complete the task or hobbies they wish to; and as a result their home allows them to reach self-actualisation. Elements of facilitative comfort could be found throughout the results of our study, described as an occupant's ability to do what they want in their home, (i.e. entertainment, time for self). Personalisation comfort describes a home where occupants can personalise their surroundings to add their own identity to their environment and there were plenty of examples of this within the study findings; this can help individuals reach both esteem needs (by improving their image) and self-actualisation. Moving away from self-actualisation and towards achieving a full state of comfort, if a home can provide an individual with the freedom to do what they want, be it simply to relax or create time and space for leisure, it suggests an individual can reach a point of relative comfort, when they are not restricted. Further to this view, comfort is often paired with the phrases such as 'psychological wellbeing' or 'a pleasant harmonious state', but it is unclear what is really meant by these terms in the literature and how this state is achieved. A study on users' perception of bus travel (Stradling, et al., 2007) sheds some light on this. The study investigated bus users' likes and dislikes of bus travel in Edinburgh. One of the concepts which emerged from the research was that people desired to reach a 'switched off' state of mind, where the elements they disliked about travel (such as space invasion by others) were absent and they could achieve a tranquil state. The study drew upon the four emotion quadrant devised by Russell (2003) which illustrates the core affect, a 'neurophysiological state consciously accessible as the simplest raw feelings evident in moods and emotions' (Russell, 2003: pg 4). The core affect is depicted in Figure 1.
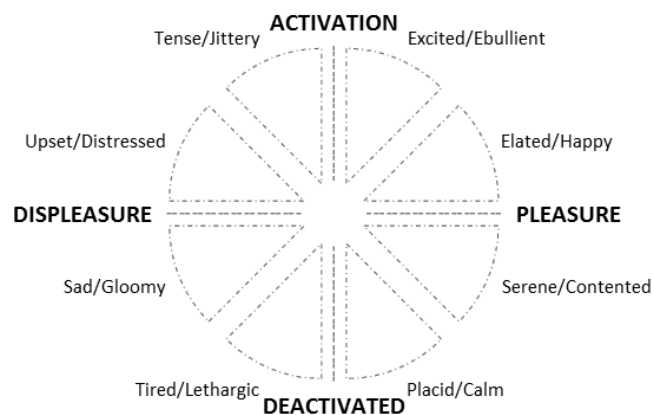

Figure 1: Core Affect (from Russell, 2003)

The state that respondents on the bus were reaching was a deactivated/pleasurable state, which is described as placid/calm and serene/contented. It is possible that this state of 'tranquillity' plays a role in reaching a fully comfortable state in the home environment.

Framework for Domestic Comfort
By considering the various comfort making practices reported in the householder study and the literature, an initial framework for domestic comfort was developed and is shown in Figure 2. It is proposed as a thinking tool, a catalyst to help us consider how these elements fit together at a practical level. As comfort is multidisciplinary, so is the framework, bringing together technical, social and psychological elements. At the boundaries of these are socio-technical and psycho-social considerations; these are

the truly interdisciplinary areas where the approaches from the two disciplines are integrated to construct a more comprehensive understanding (Repko, 2012, p19).
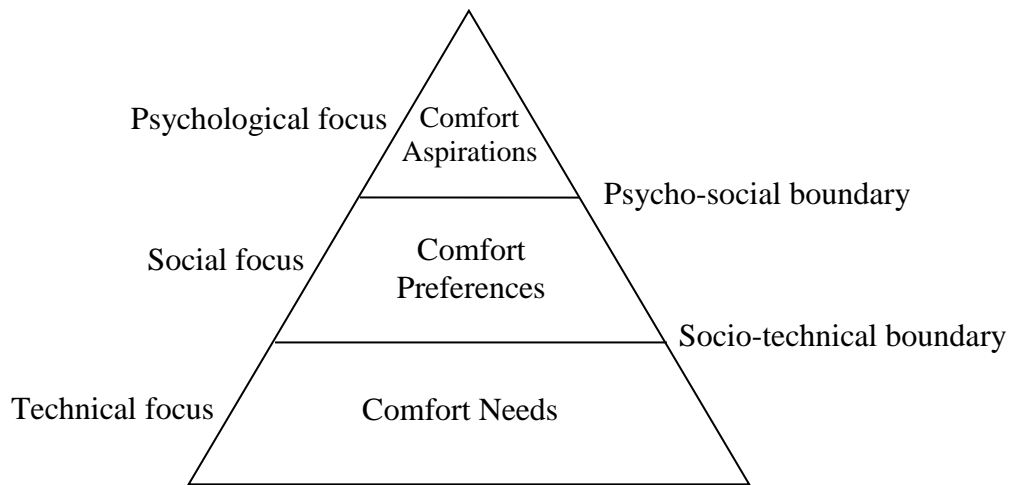

Psychological focus / Comfort Aspirations

Psycho-social boundary

Social focus / Comfort Preferences

Socio-technical boundary

Technical focus / Comfort Needs

Figure 2: Framework for domestic comfort

The framework has three key elements:
- **Comfort Needs**. These are the basic needs for keeping warm (or cool) and relate to the domains of engineering, where measured values of temperature, relative humidity, air speed etc can be considered. This could be viewed essentially as a technical element and ensures that a householder is able to achieve an adequate level of comfort for health.
- **Comfort Preferences**. These relate to the preferences that a householder has, in terms of preferred room temperature, preferred aesthetics or being able to take a hot bath when desired (not just to keep clean). This can be considered as essentially a social element of the framework, focusing on user requirements to allow for personalisation of the home. For households with working heating systems and some disposable income, this can generally be achieved, whereby they can choose how they create a comfortable home environment. Those in poverty (including fuel poverty) or with other constraints (for example, in rented property) may not be able achieve these preferences.
- **Comfort Aspirations**. The third element of the framework relates to aspirations, whether they be aspirations for the type of life a person wants to lead or what they would like their home to be like. This element focuses primarily on psychological aspects, with the aspirations never being fully achieved by the majority of householders. However, there were examples of aspirations being achieved on a small scale in the study: a roaring fire on a cold winter's day, surrounded by a happy family.

In creating this framework, it asks the question about whether comfort should be considered as solely hierarchical or whether comfort preferences and aspirations can be met in parallel with comfort needs. Whilst most would agree that it is important to ensure a home is warm (at the minimum, reaching a decent standard), it is also reasonable to offer a householder the ability to control their environment to achieve their preferences and to work towards their aspirations. The complexity of multiple occupants in a household obviously means that not all preferences will be the same,

however, as illustrated by many anecdotal accounts of fighting over the settings of the thermostat!

The next stage of the research will be to use the framework as a catalyst for discussion with building engineers to determine its value as a thinking tool. It will also be enhanced with additional data from an on-going study exploring comfort-making practices in the home.

Conclusions
There is a need to move from a multidisciplinary understanding of comfort to the generation of truly interdisciplinary knowledge. In order for the complex issue of energy demand reduction in the domestic housing stock to be tackled, there is a requirement for the disciplines to work together towards solutions that are effective, from a technical, social and psychological perspective. The direct implications of the thinking tool presented in this paper for building engineers, architects and others concerned with reducing domestic energy demand from a technical perspective are yet to be explored. A potential benefit may relate to the design of innovative and holistic approaches to reducing comfort 'take back' in domestic environments, which can amount to 15% of the theoretical energy savings. (Sanders and Phillipson, 2006). A common by-product of improving energy efficiency within the home, particularly for those who may currently be financially struggling to meet their basic comfort *needs*, is a marked increase in thermal comfort when the efficiency of the heating system is improved. This illustrates how householders may take the opportunity to meet their comfort *preferences* as well as comfort *needs* when provided with the means to do so. Indeed, there are already devices that help householders personalise their heating, through programmable controllers and thermostats, but these are not always easy to use and so *needs* and *preferences* may not be met in practice. The comfort framework presented here could lead to consideration of other ways to meet comfort preferences and indeed *aspirations* in the home when installing more efficient boilers or improved insulation. This will need consideration of what sort of service provision is needed to take such a holistic approach to comfort outside the world of academia. The introduction of smart zonal heating systems offer the opportunity to reduce energy demand reduction whilst still meeting the comfort preferences of householders. Maximising the savings from such systems may similarly benefit from a more holistic approach to delivering comfort within the home. Perhaps therefore part of the debate about the true value of this thinking tool to those with a technical focus should include consideration of new service models for delivering energy saving measures to householders, where the aesthetics of the home and the opportunities to create comfort using non-energy consuming measures are discussed with householders alongside the provision of technical solutions. By understanding the different interdisciplinary perspectives, it is hoped that each discipline can look wider than their own field for effective carbon reduction strategies.

Chappells and Shove (2005) describe comfort as a "highly negotiable socio-cultural construct" and conclude that society should be embarking on debate on the meaning of comfort and ways of life associated with it, rather than focusing solely on more efficient ways of maintaining current indoor temperatures. It is hoped that more efficient ways of maintaining acceptable indoor temperatures can be pursued in parallel (and integrated) with understanding of comfort making practices; this framework attempts to progress that discussion.

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