OCCUPANT BEHAVIOUR: HOW DO WE DEFINE OCCUPANT?

White paper report

By Sophie Chisholm

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Overview

This paper was put together following the CBx breakfast event in October 2014, to summarise the open discussion around the influence of occupant behaviour on the operational energy performance of buildings, various tools and techniques to engage occupants in minimising their energy consumption, and the drivers and barriers for widespread and permanent change through an organisation.

With special thanks to our fantastic panel of experts; Benjamin Kott of EnergyDeck, Nicola Combe of Hive active heating, Euan Burns of Carillion and Richard Francis of The Monomoy Company.

Company information

SFMI

www.acclaro-advisory.com/sfmi/

sfmi@acclaro-advisory.com

WHO IS THE OCCUPANT?

OCCUPANT BEHAVIOUR: HOW DO WE DEFINE OCCUPANT?

Occupant behaviour is a key issue for building design optimization, energy diagnosis, performance evaluation, and building energy simulation. Its significant contribution to the operational energy consumption has been acknowledged and illustrated in the UK since the PROBE studies were performed back in the 1990's. Yet detailed knowledge of the influences of occupant behaviour remains insufficient both in building systems design and energy retrofit, leading to limited understanding and over-simplification. Existing studies on occupant behaviour, mainly from the perspective of sociology, lack in-depth, quantitative analysis.

Large buildings such as shopping centres and multi-tenanted offices often have highly complex environments coordinated by a Building Management

> ***"Occupant behaviour' is a catch-all phrase to cover any building type with any set of occupants. In reality, the 'occupant' has many different meanings."***

System (BMS) and customised controls. The building is inhabited by a number of groups that may have very different core business aims and ambitions and there is often a building and / or facilities manager resident on site that looks after the day-to-day running of the asset. In this case, it is the building manager and the contracted maintenance engineers that have a significant influence over the energy consumption of the building meaning that they are, to all intents and purposes, the 'occupants'.

In smaller, less complex buildings such as single retail buildings and small offices, the engineer operates very differently as they are commonly not resident. In these cases the engineer spends less time understanding the site and the inhabitants have a much bigger impact on the energy consumption. In these cases, the inhabitants are the true occupants in the phrase 'occupant behaviour' and they see their impact much more visibly.

Domestic buildings are generally of similar size to small single retail or small offices and are much less

> ***"As tenants change and businesses evolve, the M&E contract is rarely amended in tandem."***

likely to involve complex technologies and plant equipment. The energy consumption profiles are also different from commercial buildings with 60% of the energy consumed as heat. With no involvement from building managers, the inhabitants of a home have complete influence over the total energy consumption of their building; however research shows on average they spend a total of 10 minutes per year looking at their bills.

The UK population is rapidly ageing with 50% over 50 years of age by 2020. By 2031, a third of households will be headed by someone over the age of 65. However, 20% of adults struggle with basic numeracy and literacy, meaning that topics such as how kWh consumption relates to energy bills or how to set a temperature at a certain time are very difficult concepts to grasp for many.

COMPLEX STAKEHOLDER MAPS

A large, complex building will be party to a number of stakeholders including building manager(s), facilities manager(s), tenants(s), landlord(s) and their various contractors. Where the building is part of a larger portfolio, the stakeholder map can become substantial, creating a real barrier to change and development. As activities in the building transform, control change notes are rarely issued to the engineer.

Where notes are supplied, these can take many months to effect.

An occupant behaviour change programme in these typologies must be developed to include all building inhabitants in order to be a success; the challenge is to motivate the disparate groups to act in the same ways.

> ***"Occupant behaviour change programmes are misunderstood as activities to be undertaken over a set time period after which the board expect to see a measure of the success of the intervention."***

Occupant behaviour programmes must be informed by data and, in general, building data can be sporadic and of poor quality. Each stakeholder collects what is necessary for their reporting processes; the landlord will hold the asset information, the building manager typically records charges and meter readings, tenants may have their own meters and facilities managers have the working knowledge of the systems and set points. These information siloes lead to a fundamental lack of understanding of the building, a lack of shared incentives and a lack of trust. Moreover, it is impossible to design a retrofit or to generate a business case for an intervention without robust information.

Esfandiar Burman, an EngD candidate at the UCL Energy Institute has been working on a methodology to apportion the performance gap into the 'procurement gap' and the 'operational gap' by using the International Performance Measurement and Verification Protocol (IPMVP) as a basis. Dynamic thermal models of case study buildings are produced using the National Calculation Methodology (NCM) data intended (those data which were used in design-stage compliance calculations) and using the data verified post-completion within the same NCM methodology. The difference in resulting energy consumption between these models represents the procurement gap. The difference between the procurement gap figures and the total operational energy consumption is characterised as the operational gap, which is governed primarily by a building's 'occupants'. More details on this work can be found in the resources section of this paper.

OCCUPANT BEHAVIOUR PROGRAMMES

Euan Burns, Chief Engineer at Carillion Services has worked with a vast array of building types and ages over his career and has found it extremely difficult to gain any momentum with either operational efficiency or energy efficiency initiatives. In order to effect permanent change, any programme must reach maturity, driving through gateways to become embedded as part of the culture of the organisation. Achievements are also difficult to maintain; if they do not become 'business as usual', it will tend to failure.

Behaviour change is notoriously difficult to capture and prove meaning that results are easily lost even when utilising verification tools such as the International Performance Measurement and Verification Protocol (IPMVP). This is particularly true for the soft interventions, which make it impossible to accurately apportion the effects. In order to develop a programme that will remain embedded, it must be bound to the core business; how they want to operate effectively and efficiently for the long term, whether this is benchmarked by revenue, hours of availability, patients treated, customers served or otherwise. Objectives and drivers will differ across the stakeholders in the building and each will have a different measure of value; this may be asset or rental value for the occupier, efficiency of energy and operations for the building manager, or productivity for corporate tenants. The challenge is to work with all of

these drivers in order to implement a successful programme.

THE DOMESTIC SECTOR

Extensive research has been carried out in the domestic sector on individual occupants and how they interact with controls. As part of her doctorate research, Nicola Combe supported Zack Gill in monitoring the heat, electricity and water usage for over one year in 26 eco homes in early occupation in Clay Fields, Elmswell, Suffolk. Although the case studies were all code level 3 buildings, a huge variation was observed in the energy performance.

Energy consumption and heating are quite difficult concepts for many people to relate to. With an average annual heating bill of £690, this significant outlay is controlled by the occupant using a thermostat; the one place that people interact with their energy consumption in their own homes. Residents at Clay Fields were asked to set two times using their programmable thermostats while results were observed; two thirds of the people surveyed were unable to complete the task due to usability issues and five people wanted to stop the testing upon receiving the instructions which they found to be bewildering. Many older users of these devices might also have dexterity and visual impairments to overcome; the challenge is to develop a product that can meet these needs.

> ***"Extensive user interviews generated a detailed understanding of needs and concerns from noises on buttons to control overrides to literacy levels in technology."***

> ***"Upon commissioning, it may be prudent to programme settings for energy efficiency and allow them to be amended upwards guided by inhabitants' comments."***

Thermostat manufacturers make claims about their products saving energy by allowing users to programme a schedule, but users struggle with this task, meaning that the potential energy savings are almost never realised. It is important that design engineers specify equipment with the user of the controls in mind; a system may have high energy efficiency credentials but these will never be realised without effective control. This is also true for commercial buildings where the issue is further complicated by the question of who has control over the systems.

Nicola now works for British Gas Connected Homes on products such as The Hive Active Heating which allows the occupant to control their heating via their smart phone. Connected Homes are developing a range of innovative, simple-to-use products and services designed to help occupants synchronise their homes with their life.

The design of Hive is party to an on-going product development cycle; Connected Homes try to implement an agile work stream which is a little more difficult when working with hardware as it generally takes around 2 years to implement changes. Consumer testing begins at paper design stage and a wide range of issues are picked up from semantics on the instructions to how to set schedules on the device.

One of the major learning outcomes from the exercise was that users are not comfortable with the idea of full automation; occupant behaviour change is a journey, it is not a single event. In response, the Hive send their users contextual information via the application such as information about the weather and nudges when the device recognises they are out. Once people are engaged, they begin to wonder how much they could

save by switching off while they were out or if it's possible to set-back on a room-by-room basis.

During her research on default schedules, Nicola found that occupants were using less hot water in the evening than anticipated and this allowed British Gas to decrease the default evening time setting across their devices. In the commercial sector, set points and time settings are common issues that arise both in complaints to facilities managers and in post occupancy evaluation. In these cases, inhabitants are quick to alert someone if they are feeling too cold or if a light switches off too quickly but are less likely to notice if a light stays on for twenty minutes after they leave a room. Equally, if inhabitants are too warm, they are likely to try to regulate the temperature with clothes or opening windows before they complain.

PROCUREMENT AND CONTRACT

In large, complex environments the resident engineer is part of the sensors mechanism and is able to make real-time changes to the building. However, in many cases, there is a lack of empowerment of these stewards and they are bogged down in the day-to-day responses to thermal comfort complaints or alarms.

Maintenance engineers have an important role to play in small office and retail spaces in guiding occupants and providing settings that work for their business activities. Mechanical and electrical maintenance contracts have become commoditised; based on numbers of visits and length of time allowed and often the contract is not serviced by the same engineer each visit. This prohibits a deep understanding of the systems and the clients' needs and creating a disjoint between the occupants – who have a much larger impact on energy consumption in this environment – and their 'stewards'.

Engineers and occupants need to share a mission in order to be empowered to act and this involves having better knowledge and agreement about intentions and aims. Commissioning M&E contracts on a value-add

> ***"Whether design-side or maintenance, engineers have stewardship over the energy consumption in the built environment."***

basis would help to overcome these problems and empower engineers to reclaim stewardship of the energy consumption of their buildings. Additionally, more training is needed for engineers around the buildings and systems they are driving, the identification of occupants' core business aims and the communication of how to make their building work for them.

FULL DISCLOSURE: THE RISE OF THE NON-EXPERTS

The 2012 British Council for Offices, 'Change for the Good' report illustrated energy efficiency as an unequivocal driver of obsolescence. For most companies outside the manufacturing sector energy costs represent a very small percentage of net outgoings meaning that engagement with energy efficiency happens mostly as Corporate Social Responsibility or reporting levels.

In Germany, where operational energy disclosure is used in place of Energy Performance Certificates (EPCs) in the rental market, one case study saw the energy consumption of a building fall by 25% within a year with no interventions other than accountability; the landlords obliged their tenants to begin reporting.

OCCUPANT BEHAVIOUR: HOW DO WE DEFINE OCCUPANT?

The strongest correlations are shown around systems such as energy star that better reflect the actual performance of buildings. Occupiers are able to learn more and more about the buildings they inhabit as new technology is brought to market and existing technologies become commercially viable. As this becomes the norm, value differentials will cease to be driven by existing certification standards and will instead be driven by real, operational data. This gives occupiers the power to begin benchmarking a variety of attributes and use the information at rent reviews.

Increased access to data allows them to begin to apportion consumption to occupants vs. building fabric and systems, helping to determine whether the building is an asset to the occupier organisation and the prevalence of short term leases gives the occupants more power than ever to prompt upgrades using that information.

This rise of the non-experts could give way to disclosure as never before; occupiers could make all of this data public allowing the development of a system whereby not just prospective tenants, but also the general public, could read reviews on buildings and landlords; details on energy efficiency, maintenance, landlords and even staff sickness records and well-being. The smart occupier already asks to view bills as part of due diligence; increasingly they may ask to see data on CO_2 levels, medical complaints and physical complaints.

Equally, landlords will want to ensure that their tenants are not effecting the asset value of their property by disclosing high energy consumption that is occupier-generated. The Bank of America Tower, advertised to be one of the most efficient and ecologically friendly buildings in the world, made the headlines in 2013 when it was reported to be using much more energy than anticipated. When tenant energy begins to be linked to the asset value of a property, landlords are much more likely to engage readily with the energy consumption of their tenants and may even begin to screen prospective tenants on that basis.

TECHNOLOGY

While smart systems and large amounts of kit can add unmanageable complexity to buildings, technology certainly has a large part to play in reducing occupant-induced energy use. As any effective behaviour change programme involves occupant buy-in to become business as usual, products such as the Hive in the domestic sector are fundamental to educating occupants and bringing them on the journey.

> ***"Studies that include multiple sectors and counties have shown that there is a value differential between a sustainable asset and a non-sustainable asset."***

Building Robotics has developed a piece of software called 'Comfy' that crowd sources the optimum temperature in any given space by gathering votes from occupants on how hot or cold they are. This sort of technology has the potential to relieve facilities managers of their most commonly received complaint and empower them to work on the energy consumption in a more holistic way.

Energy Deck have developed a web based platform that enables owners and occupiers to run their buildings more efficiently through stakeholder engagement and automated analytics. By capturing data and sending the analytics to the relevant people, data can be acted upon to deliver more efficient buildings. The Energy Deck database has the functionality to capture all data points from across complex stakeholder maps generated in larger commercial buildings overcoming the problem of siloed data.

CONCLUSION

This paper has discussed the need to accurately define the 'occupant(s)' in a building before developing a behaviour change programme. Learning outcomes from both the domestic and the non-domestic sectors have highlighted that a programme should not be viewed as a temporary intervention but more like a journey towards business as usual. Useful evidence for commercial application can be drawn from the detailed market research performed in the domestic sector and new software coming to market should be utilised to free up potential energy stewards 'on the ground'.

More attention needs to be paid to procuring value-add M&E contracts with more training given to engineers. Default schedules can also be pivotal in the energy consumption of a building and specifications should look towards set-up for energy efficiency and being amended in response to occupant complaints.

The trend towards increased information in the hands of occupants and the potential consequences of that exposure will likely lead to better engagement in energy consumption from both landlords and tenants. Although there is potential to view this as a risk to asset value or company reputation, there are huge possibilities for the development of robust, tailored benchmarks for industry in the exercise and therefore disclosure should be embraced, not feared.

RESOURCES

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3. Burman E, et al., 2014., "Towards measurement and verification of energy performance under the framework of the European directive for energy performance of buildings"., Available from: http://dx.doi.org/10.1016/j.energy.2014.05.102