SMART BUILDINGS AND PEOPLE

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INFORMATION

The term 'smart' is applied to a host of enabling technologies in modern buildings, the 'smart meter' being probably the most familiar. Examination of smart meter technology allows us to begin to understand interactions between people and technology applicable to both dwellings and commercial buildings.

The equivalent of domestic smart meters, meters that signal half hourly consumption data to the utility company, have existed for many years in commercial buildings. If equipped with an in-home display (IHD) or commercial equivalent, the building occupiers can also access the data. However, in both cases the term 'smart meter' is a misnomer, as the meter merely conveys information. It is up to the occupier to do something smart with that information.

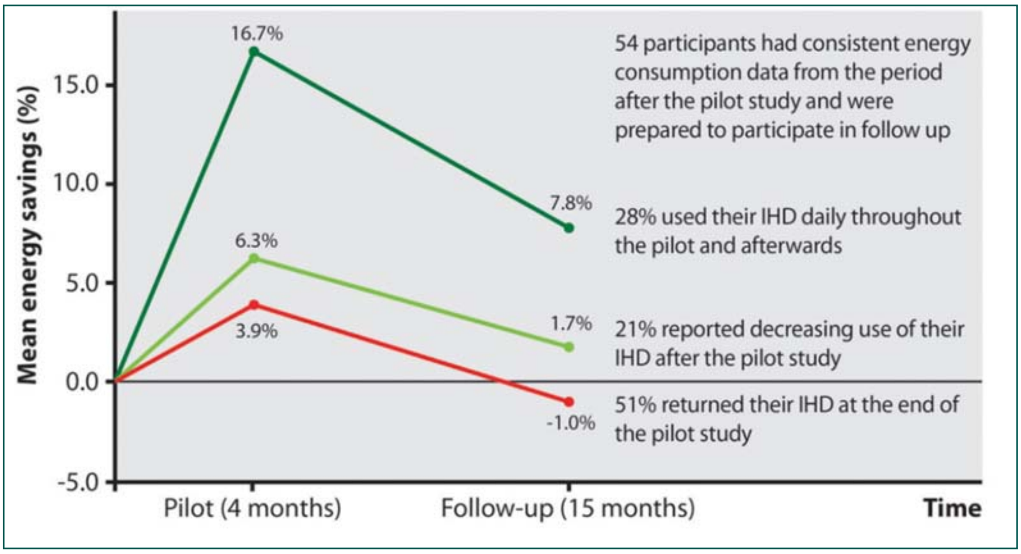
The presentation of data alone is of little value without context. Stevenson and Leaman (2010) said: "It is not enough to presume that the information from 'smart metering' will encourage people to reduce their energy consumption any more than a car speedometer will reduce speeding." A car speedometer provides information, but the driver must have knowledge of the speed limit in order to correctly interpret that information. Without significantly improved energy numeracy amongst the populace it is unlikely that the smart meter will deliver its full energy savings potential.

In-home displays (IHDs) need to present information in context in order to be useful. A PV generation monitor (right) can be easily calibrated against the size of array to present contextualised information. It is impossibly complex to calibrate an in-home display (left) against all the variety in UK households.

ENGAGEMENT

Van Dam, Bakker & Van Hal (2010) found that novelty appears to play a significant role in savings in short term trials of in-home displays. Revisiting households that had previously participated in a pilot study they found that the initial savings had generally not been maintained. Moreover, the lapse rate was more or less consistent regardless of how well the participants had engaged with their in-home display during and after the pilot study.

The study shows a lapse towards prior behaviour over time, but was unable to corroborate the hypothesis that the magnitude of energy savings achieved correlates to level of interaction with the in-home display. It is clear that, if we are to make the most of the opportunity of smart metering,

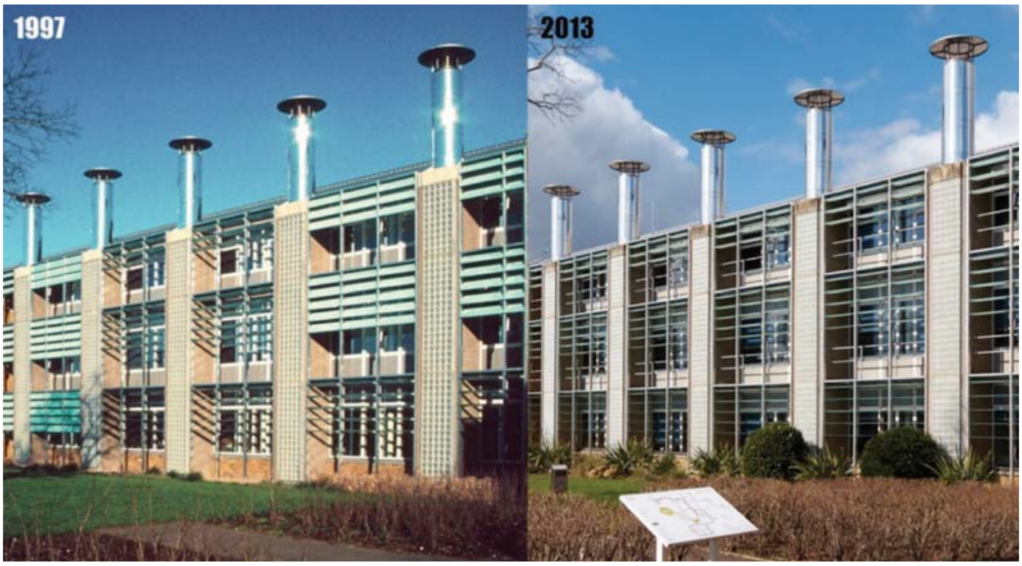


Results of a study by Van Dam et al (2010) suggest that energy savings achieved in pilot studies of in-home displays may be transitory regardless of the level of engagement by homeowners.

we need to understand better people's interpretation of, and response to, energy information and tailor it to their needs in both domestic and commercial situations.

CONTROL

It is not only in-home displays that need to be designed with attention to the human interface. The control systems in commercial buildings are complex, yet the design effort put into the user interfaces is poor. Bordass, Leaman & Bunn (2007) found that: "If user controls are ambiguous in intent, poorly labelled, or fail to show whether anything has changed when they are operated, then the systems that lie behind them are unlikely to operate effectively."



Completed in 1997 as an exemplar of energy efficiency, The BRE Environmental Building featured external shades which were designed to respond automatically to changing daylight and over-heating conditions. However, over time the state of the art control system became obsolete and the actuators progressively failed and were not replaced. Instead, simple manual blinds were installed to control glare and overheating. Today, the louvres remain static and the building's occupants rarely adjust the blinds, even when daylight levels fall, as the lighting controls compensate by bringing the lights on even in the middle of the day.

Ambiguous controls create confusion and can lead to users distrusting the system or simply ignoring subsequent useful information or control signals.

User interfaces need to be engaging, where possible intuitive, and make it easy for individuals to do the right thing, particularly given the increasing tendency to install complex controls in domestic situations, where the understanding of control functions is poor.

Further, if control systems do not provide building occupants with the functionality and convenience that they expect, they will take actions to override the control systems in order to achieve what they consider to be more favourable outcomes.

Thus, it is common in commercial buildings to find thermostatic controls being used as on/off switches and for daylight sensors to be covered with sticky tape to ensure that the electric lights remain on.

MANAGEMENT

Building structures are designed for long lifespans, whilst smart building technologies will fail or become obsolete several times during that span. As with any information technology system, it is essential that a clear upgrade path is available and is followed throughout the life of the building. All too often, building controls become obsolete, making subsequent repair prohibitively expensive and leading to the controls being abandoned.

Cohen, Ruyssevelt, Standeven, Bordass & Leaman (1998) wrote: "The myth of [building] intelligence is that it is 'fit and forget': buy it, and the electronics will do the rest. The actuality is that it is very much 'fit and manage'. Complex engineering and control systems tend to work best in an environment in which the occupier can resource a high level of facilities and engineering management. Problems start to occur where sophisticated technology is applied in a management-poor environment."

DESIGN

To deliver smart buildings that sustain their smartness requires more thorough design than is presently the norm. Greater interaction is needed between the building's users and designers, both at project inception, to articulate requirements clearly, and after handover, to tune the systems and gather feedback. There also needs to be a much more robust system for communicating design and performance goals throughout the chain from design through delivery to operation.

Waide, Ure, Karagianni, Birling & Bordass (2013) wrote: "Building Automation Technology often fails to deliver its potential because those specifying the system have limited understanding of how it will be operated." They go on to assert: "The best design can only come from a thorough understanding of operation." In order to be truly smart a building must be

People will use buildings in ways that can never be anticipated by the designers. A smart building must be flexible enough to accommodate the needs and desires of the users without forcing them into compromises, which will result in them ultimately overriding the systems.

designed to be 'user centric'. It needs to accommodate the habits, needs, desires and capabilities of those who will use and operate it.

PROCUREMENT

Mapping the typical, mass market construction process onto a systems engineering diagram indicates that there are gaps in the key areas for the design of smart buildings.

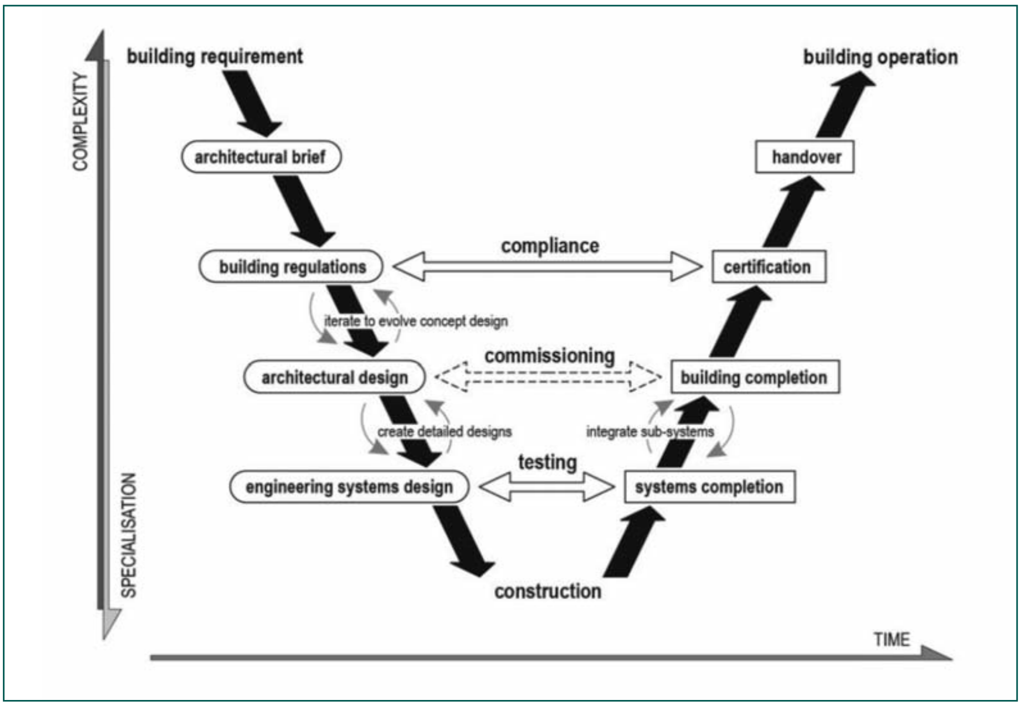
As an alternative one could propose a construction diagram, including confirmation of outcomes and feedback into subsequent designs, that may be capable of delivering genuinely smart and sustainable buildings.

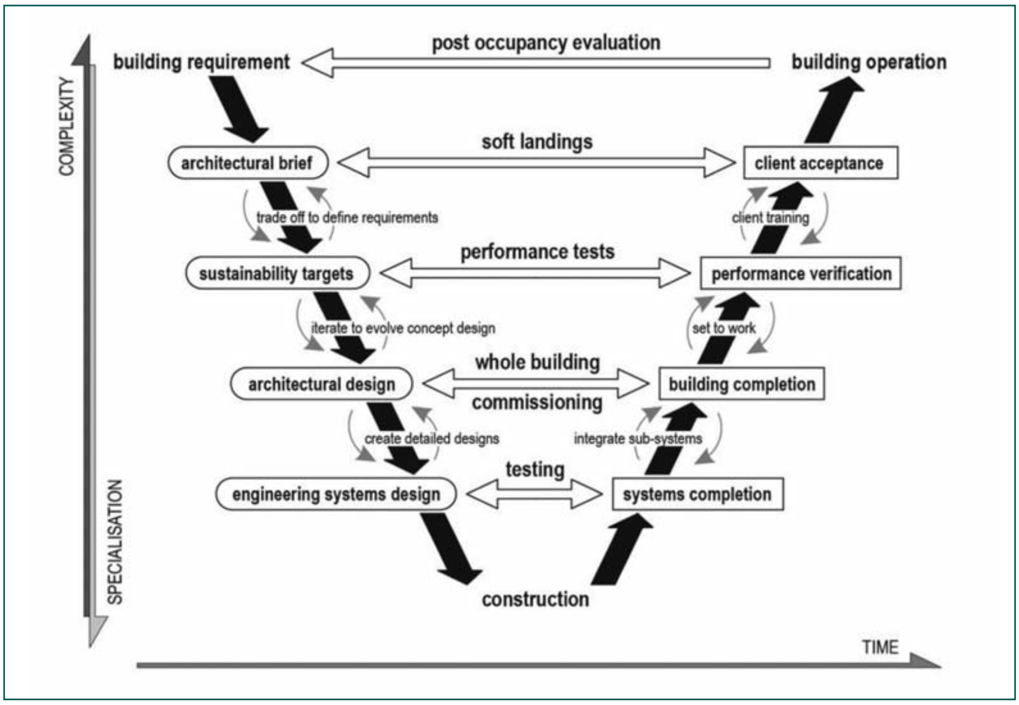
However, we need to acknowledge that the present methods of procurement in both the public and private sector do not allow the requisite interaction between users and system designers before and after the construction period. If we are to deliver smart and sustainable buildings we first need to address the shortcomings in the procurement process.

CONCLUSION

For a building to be smart, it must get the best from both its automated systems and from the intelligence and understanding of its occupants. It needs to be robust, cost-effective and not too complicated. Smart building design must account for the desires and capabilities of those who will use them.

This creates major challenges. Although there are exemplars, in typical UK construction scant attention is paid to human factors, to the design of the product, and to the creation of integrated systems. Shortcuts are taken in the installation, commissioning and handover. Provision of complete operating information and user training is rare. Systems designers do not learn from performance in use.





These challenges are not insuperable. However, they will need to be addressed if the benefits of smart buildings are to be realised. We need to improve skills and education amongst the designers, constructors and operators. We must put the users at the heart of smart building design and operation.

"A 'smart building' is one that doesn't make its occupants look stupid" *Adrian Leaman - The Useable Buildings Trust*

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