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Buildings don't use energy: people do

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Reducing energy use in buildings is a critical component of meeting carbon reduction commitments. There are several ways of accomplishing this goal, each of which emphasizes actions by a different set of stakeholders. This article argues that building users play a critical but poorly understood and often overlooked role in the built environment. In the face of climate change, the article finds purely architectural solutions, such as those proposed by the Architecture 2030 Challenge, to be necessary but not sufficient to achieve climate change mitigation targets. To fully address the task ahead, it argues that architects need to develop their professional expertise to improve buildings *and* seek ways of integrating user involvement in building performance. Moreover, from a professional standpoint, this paper suggests it may be wise for architects to claim a leadership role in this area before another group of building professionals does.

Keywords: Building users; climate change; education; professions; responsibility

INTRODUCTION

Reducing energy use in buildings is a critical component of meeting carbon reduction commitments. There are several ways of accomplishing this goal, each of which emphasizes actions by a different set of stakeholders. Much of the work in this area follows a physical, technical and economic model of the built environment (Lutzenhiser, 1993). In this scenario, architects, engineers and efficiency advocates are the major players, making technical improvements to existing buildings and designing new ones to higher standards. More recently, the European Union's energy performance of buildings directive asserts that reducing energy consumption is affected by not just how buildings are designed, but also how they are built, commissioned and used. This performance-based approach adds owners, operators and developers to the list of constituent groups. Energy use in buildings is also considered a social problem rather than a technological one (NRC, 1980; Stern and Aronson, 1984). How societies are motivated to use or conserve energy has been a topic addressed sporadically by social scientists for more than a century (Rosa *et al.*, 1988). From this perspective, it can be argued that reducing energy use in buildings requires changes in the entire fabric of society, not just changing the shape and nature of buildings.

Although there are diverse approaches to changing how energy is used in buildings, the power of architectural solutions and professional leadership has been recently reinvigorated by passive solar architect Edward Mazria. In his 'Architecture 2030 Challenge', Mazria reconfigured the usual energy consumption sectors used in the US Department of Energy's statistics to create a 'buildings' sector. This new sector combines the annual energy required to operate residential, commercial and industrial buildings in the US along with the embodied energy of industry-produced building materials like carpet, tile, glass and concrete. This analysis exposes buildings as the largest single energy-consuming and greenhouse gas (GHG)-emitting sector – 48% in the US, 'even greater' elsewhere – and it argues that architects and other members of the building community are therefore *the* key to stabilizing emissions (Architecture 2030, 2008). The 2030 Challenge asks the global architecture and building community to adopt energy performance targets that can be accomplished through design, on-site renewable generation and up to 20% renewable power purchase. The targets are:

- All new buildings, developments and major renovations shall be designed to meet a fossil fuel, GHG-emitting, energy consumption performance standard of 60% of the regional (or country) average for that building type.
- At a minimum, an equal amount of existing building area shall be renovated annually to meet a fossil fuel, GHG-emitting, energy consumption performance standard of 60% of the regional (or country) average for that building type.
- The fossil fuel reduction standard for all new buildings and major renovations shall be increased to:
  - 70% in 2015
  - 80% in 2020
  - 90% in 2025
  - carbon-neutral in 2030 (using no fossil fuel GHG-emitting energy to operate) (Architecture 2030, 2010a).

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The 2030 Challenge has inspired recent legislation in the US and has been adopted by firms and individuals in 54 countries (Architecture 2030, 2010b). In the face of climate change, architectural solutions like those proposed by the 2030 Challenge are necessary. But are they sufficient?

This article augments the 2030 Challenge's physical and technical approach by considering architecture's social and environmental responsibility from a system of professions standpoint (Abbott, 1988). This perspective conceptualizes work practices as a kind of ecosystem, where professional groups compete to perform different sets of socially accepted tasks. To fully address the carbon reduction task ahead, the article argues that architects need to develop their professional expertise *and* seek ways of integrating user involvement in building performance.

The article begins with a discussion of trends and expectations in building use, with a focus on the importance of building use relative to design. The second section develops the notion of how well people understand the use they make of the built environment. The third proposes that this understanding could be improved through an environmental educational programme that includes literacy on building performance. The final section argues that building professionals – particularly architects – could (and maybe even *should*) accept greater responsibility for teaching this kind of understanding to the public.

BUILDING USE: TRENDS AND EXPECTATIONS

Most designers are familiar with the concept that building use matters, but this aspect is generally considered to be a lower-order concern compared to the design intent. This section shows how social expectations and consumption patterns of building users can defeat the most careful design.

Since the 1970s, the US economy has become more efficient in its use of resources. Better use of resources is not in itself a sustainable path, however, as it is possible to use ever greater levels of resources in relatively more efficient and 'green' ways. For example, a large new house may use energy efficiently and be constructed with healthy materials, but it will often consume more energy and resources than a smaller 'inefficient' home. The general trend in American building has been to consume more and more energy and resources in the name of making life better. In 1970, two thirds of new homeowners kept cool without central air-conditioning; today, central air-conditioning is a standard feature in 90% of new homes, even in temperate climates. In the past three decades, the size of the average new American home has climbed 57%, to say nothing of the proliferation of two- and three-car garages (Janda, 2007). Over the last 40 years, efficiency gains have been outpaced by increases in the size, number, features and use of energy-consuming equipment. This supersizing of expectations has led some energy efficiency advocates to recommend policy targets based on consumption levels rather than efficiency (Harris *et al.*, 2006). As Andrew Rudin pointed out in his analysis of 45 years of US energy consumption, 'When we were less efficient we used less energy' (Rudin, 2000, p8331).

In addition to the size of a home, the way that it is used matters if carbon reductions are the goal. Figure 1 shows a Zero Energy Home (ZEH) development called 'Premier Gardens' near Sacramento, CA (USA). Although these are designed to be 'zero energy' houses, their size,

Figure 1 | Bird's eye view of Premier Gardens (Keesee, 2005)

shape and spatial arrangement are typical of many new developments.

Interestingly, as Figure 2 illustrates, the electricity use distribution in Premier Gardens is also typical. Figure 2 demonstrates that the photovoltaic arrays and energy efficiency measures are effective: there is an across the board decrease in bills in the ZEH development compared to a neighbouring development of similar design, called 'Cresleigh Rosewood'. However, the distribution of electricity use across the studied homes has not changed: electricity use patterns in the ZEH development exactly mimic those of their neighbours, rather than reflecting the near 'zero energy' design intent.

If building use matters, how much does it matter? Designers may already be used to thinking of the role of the occupant as part of the picture of energy use. Figure 3 shows one conceptual view of this relationship. In this view, occupant behaviour is an important part of the socio-technical system that influences a building's energy use, along with the building envelope, plug loads from appliances, and micro-generation opportunities. The exact proportion of occupant influence is variable. This particular graphic suggests that occupants are responsible for about one quarter of the problem with some probable influence over plug loads as well. Other research has shown that while approximately half of the energy used in the home depends on the characteristics of a house and its equipment, residents and their behaviour influence the rest (Schipper *et al.*, 1989). Differences in individual behaviour can produce large variations (>300%) in energy consumption, even when controlling for differences in housing, appliances, heating ventilation and air-conditioning systems and family size (Socolow, 1978). Given the wide range of possible patterns of energy consumption, opportunities exist to improve energy efficiency through different types of behavioural strategies. In fact, behavioural changes pave the way to more sources of the energy savings than are available through architectural and technical strategies alone (Shama, 1983). For example, heating a well-insulated house to 19°C will use less energy than heating the same house to 21°C. Recent research indicates that national implementations of 17 different behavioural actions could save 20% of US household emissions (Dietz *et al.*, 2009).

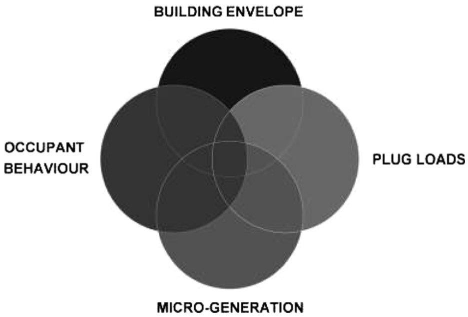

Figure 3 | Influences on building energy use (Killip, 2009)

However, the role of people in energy use can be seen as being even more influential. Figure 4 shows another view, suggesting that buildings don't use energy, people do. Figure 4 describes personal actions as accounting for approximately half of energy consumption across all sectors, while institutional (or 'non-personal') choices account for the other half. Seen this way, people and groups are responsible, one way or another, for all energy

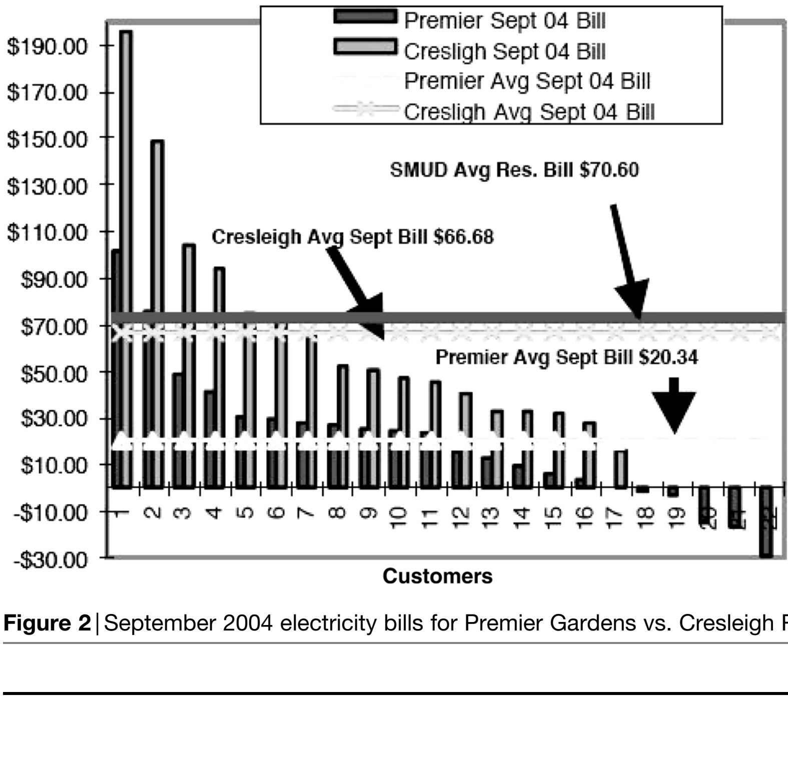

Figure 2 | September 2004 electricity bills for Premier Gardens vs. Cresleigh Rosewood (Keesee, 2005)

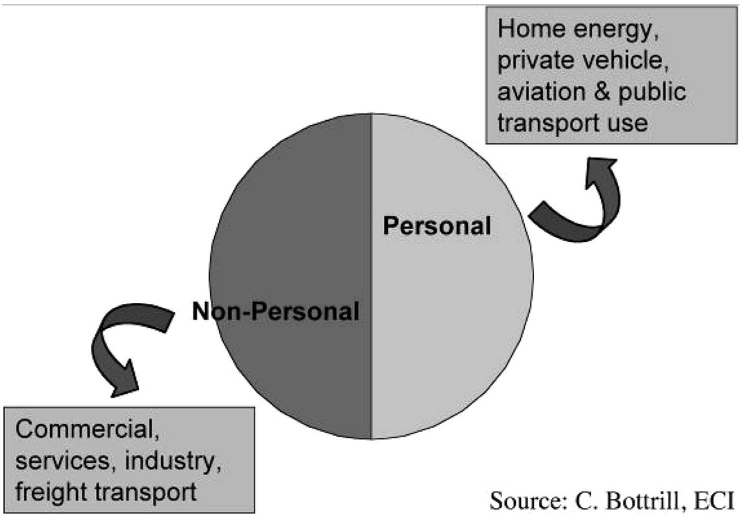

Figure 4 | Role of personal action in energy consumption

use. Buildings and technologies may enable or constrain the energy implications of these choices, but the choices themselves are fundamentally important.

USE AND MISUSE OF BUILDINGS

So how do people choose to use buildings? There are a wide array of theories about how individuals decide to use their homes (see e.g. Wilson and Dowlatabadi, 2007). Some of these theories are based on an information deficit model, which assumes that more and better information will result in better usage patterns. Others assume that usage is grounded in habits, practices and norms, which may shift over time but result from a combination of social expectations and cultural factors that are not easily redrawn (Shove, 2003).

In the spheres of policy and the energy research community, the information deficit model tends to dominate. Its weight leads to what Owens and Driffill call the ‘persistent emphasis in policy discourse on awareness-raising and education’ (Owens and Driffill, 2008, p4413). Awareness-raising and education are the main tools used to overcome the information deficit and ‘correct’ people’s behaviours. However, there are many different information ‘gaps’ to be filled, some of which are more tractable than others.

In most homes, attempts to understand energy use has been aptly compared to shopping at a grocery store without any prices on individual items and receiving a bill at the end of a month’s worth of purchases (Kempton and Montgomery, 1982). In the absence of specific information, residents asked to reduce their consumption have a hard time estimating the costs and benefits of their actions. Research conducted in different contexts over the past 25 years shows that providing feedback on resource use can help bridge this information gap and reduce consumption. Savings have been shown in the region of 5–15% for direct feedback and 0–10% for indirect feedback (Darby, 2006). Forms of direct feedback include real-time meters and associated monitors, whether web-based or free-standing; indirect feedback is information (e.g. a bill) that is not immediate and has been processed in some way before reaching its intended audience.

Although the feedback approach is useful, there are other factors that influence people’s energy use that may not be affected by this mechanism. This section of the article takes its name from a recent seminar called ‘How People Use and Misuse Buildings’ held by the UK Technology Strategy Board and the UK Economic and Social Research Council. The background brief for this seminar argued that insight into people’s behaviour is needed ‘because occupants behave in more complex ways than designers account for; they open windows, leave doors open, generate body heat, keep tropical fish tanks and install plasma TV screens’ (TSB/ESRC, 2008). The language of the brief and the title of the seminar are telling. It suggests that people’s energy-using behaviour may be idiosyncratic rather than reasoned and predictable. Further, the brief asks for insight into ‘what technologies and innovations in our buildings are allowing and encouraging users to be more environmentally sustainable in buildings’. By doing so, it suggests that behaviour may be driven not just by the presence or absence of information, but may be connected in some way to the technologies and innovations themselves. Will feedback on a plasma screen or fish tank result in changed behaviour? Does opening windows count as building ‘misuse’? Space prohibits a lengthier examination of the socio-technical systems and sociology of energy literature, but suffice it to say that these fields do not expect that more information will necessarily deliver either greater understanding or better behaviour.

Another important component in the puzzle of understanding energy use is the low level of existing knowledge about energy issues. The information deficit model assumes that people are cognitively prepared to participate in energy decisions. However, a survey by the National Environmental Education and Training Foundation showed that only 12% of the general US population can *pass* a basic energy quiz (RoperASW, 2002). Energy and environment form part of the curriculum in many countries, but not in all countries and not yet at adequate levels. A recent review of environmental education programmes around the world found that although environmental education is growing, energy and energy efficiency are under-represented in national and international programmes (Harrigan and Curley, 2010). Seen in this context, the idea of relying primarily on energy feedback to deliver changes in behaviour seems rather peculiar.

BUILDINGS AS PEDAGOGY

While efforts dedicated to improving feedback are important, this section suggests that to truly improve public understanding of the built environment, education about building performance needs to go beyond energy meters and monitors. Recent research on smart metering and householder engagement agrees that feedback alone is not enough to interest occupants (Darby, 2010). If the goal was to prepare people to accept more responsibility for their role in the built environment, education should be much more comprehensive, integrated, hands-on and iterative.

Such education could start in school. Although few students will ever become practising design professionals, all students use buildings and will continue to do so throughout their lives. Many students will own their own homes; others will rent apartments. Outside their homes, virtually all students will interact with other commercial and institutional building types in the course of their work, whether they become architects, doctors, teachers or zoologists. Although many of us spend 90% of our time indoors, few among us understand how buildings actually work, let alone their full effects on our health, psyche and the natural environment.

Although there may not be much conscious understanding of these issues, we do learn from our surroundings. David Orr, for instance, uses the phrase 'architecture as pedagogy' to describe the belief that we learn *from* buildings, not just in them. Many of today's educational buildings, Orr argues, teach students that locality is unimportant, energy can be squandered, and disconnectedness is normal (Orr, 1997). Yet, these lessons are usually tacit rather than explicit, and few people other than architects are ever taught to read the language of the built environment. As a result, the general population tends to treat buildings as static objects rather than dynamic systems. Developing a higher level of building literacy reifies the lessons absorbed from existing buildings and, concurrently, provides a basis for understanding the need for change.

There are a number of efforts underway to integrate sustainability into the design curriculum (Wright, 2003; Architecture 2030, 2009). While efforts to improve the education of future design professionals are necessary, the question an environmentalist might ask is: are they sufficient? Although the shape and nature of future design expertise is important, the reality is that architects, engineers and other design professionals represent a very small percentage of the total population. Based on US census data, for instance, the number of employees providing all architectural and engineering services is only two-thirds of 1% of employed persons in the civilian workforce (US Census Bureau, 1997). If building designers are learning more about sustainability, is there anything that the rest of us should learn about building design?

Some would argue that there is nothing wrong with the state of architectural education in the US, and that the problem lies instead with its citizenry. Architectural historian Sarah Goldhagen suggests that the quality of US buildings would be improved if architecture, rather than art classes, were a staple subject in secondary schools (Goldhagen, 2001). Goldhagen's proposal is aimed at improving the aesthetic quality of civic architecture, but her point that students have a lot to learn from the built environment is well-taken. If sustainability as well as aesthetics is considered, opportunities for integrating education and the built environment broaden far beyond stand-alone architecture courses. Architect Robert Kobet (2003) suggests that secondary school facilities should be designed to function as an extension of the curriculum. For example, operable shading devices that demonstrate solar geometry could provide a stimulating environment for teaching maths, physics and the sciences. School grounds that include gardens could provide participatory learning opportunities (as well as physical inputs) to school cafeterias, culinary classes and biology courses. Clearly, there are many ways to use the built environment that could enhance learning. Could this enhanced learning also result in better, more sustainable buildings?

If one subscribes to the premise that the built environment in the US could benefit by concurrently improving both the architectural and ecological literacy of its citizens, what should building users learn about buildings, and how should they learn it? The remainder of this article explores the question of which professional groups might accept responsibility for educating the public about building performance.

BUILDING PROFESSIONS, EDUCATION AND SOCIAL RESPONSIBILITY

Professions have been characterized as organized bodies of experts who apply specific knowledge to particular cases. Common structural earmarks of the professions include formal training, entry by examination, and a code of ethics or behaviour. Although some professions such as medicine and law have medieval or ancient roots, most of those recognizable today developed during the 19th century. The first systematic studies of professions were written in the early part of the 20th century, and the subsequent literature developed functionalist, structuralist and authoritarian interpretations for their existence.

Abbott (1988) provides an alternative theory that views professions as an interactive system based on work. Each profession is linked (neither permanently nor absolutely) to a set of tasks considered to be its jurisdiction. Professions compete within the system and develop interdependently, based in part upon their ability to perform (and defend) the tasks within their jurisdiction. Central to work practice is what Abbott calls a 'jurisdiction' – a group of tasks over which a profession claims exclusive social and cultural control.

Growth in knowledge is one of the ways that social forces external to the professions can create a 'new' legitimate set of problems and with it an opportunity for a new professional jurisdiction, and perhaps a new profession as well (Abbott, 1988, pp177–211). Consider, for example, the US Green Building Council's successful use of the 'LEED-Accredited Professional' examination. More than 77,000 building professionals from across all areas of practice have become LEED-Accredited since the programme was launched in 2001 (GCBI, 2009). The WBCSD (2009) suggests that a new 'system integrator' profession is needed to develop the workforce capacity to save energy. The UK is training domestic energy assessors to draw up Energy Performance Certificates (Banks, 2008), while the Australian government is vigorously supporting the development of a new profession of in-home energy advisors (Berry, 2009). A week-long panel on workforce training at the 2010 American Council for an Energy-Efficient Economy Summer Study on Buildings indicated that efforts in this area are underway in numerous countries (ACEEE, 2010).

There has definitely been a growth in knowledge and public concern around the 'problem' of climate change and energy use in buildings. In the UK, for example, the target in 2006 was a 60% reduction in carbon emissions by 2050, but in 2008 the target increased to 80% (Adam, 2008). As part of these reduction schemes, all new homes in the UK are mandated to be zero carbon by 2016. In response to these challenges, the architecture and engineering professions are starting to lay claim to various forms of 'sustainable', 'low carbon' or even 'zero carbon' goals. New programmes are forming wholly or partially around this concept (e.g. Northwestern Engineering, 2009), and existing programmes are seeking ways to adapt.

Despite these efforts, no one is accepting responsibility for the education of the 99.3% of the population who use buildings. A previous article (Janda, 2004) argued that the same hands-on diagnostic teaching methods developed to make building performance meaningful to architecture students can be used to teach building literacy to students in other disciplines. A multi-year, US Department of Education-funded programme using real buildings as living laboratories trained faculty and students in about a third of the accredited architecture schools in these methods (AoC, 2005). The necessary expertise exists within the field of architecture, even if it is not evenly distributed. However, the field itself is understandably oriented towards educating future professionals rather than the general public.

Another option might be a new profession, based around teaching people how to use buildings in less consumptive ways. This may sound far-fetched, but it might look something like the field of public health. Indeed, public health has historically addressed the relationship between sanitation and housing (Rosen *et al*., 1993); hence developing an educational effort within this field might have some traction. Articles considering the intersection of the built environment, public health and climate change have already been written (Younger *et al*., 2008), as have articles on a curriculum connecting the built environment and public health (Botchwey *et al*., 2009). What a new profession centred in the health tradition might lose, however, is the richness and diversity of building solutions that a more user-focused architectural education could deliver.

CONCLUSIONS

This article argued that building users play a critical but poorly understood and often overlooked role in the built environment. In the face of climate change, the article finds purely architectural solutions, such as those proposed by the Architecture 2030 Challenge, to be necessary but not sufficient. With climate reduction targets set at 80% of the 1990 levels, designers need to work with users to deliver comprehensive energy reductions. Preparing the public for this interactive role is a job in itself. To fully address the task ahead, the article suggested that either an existing professional group should adapt its jurisdiction to include public education on building literacy, or a new professional group should arise to claim this role. Some architects have the skills and experience to take on this challenge, but the field as a whole would need to develop professional expertise and seek ways of integrating user involvement in building performance to fully succeed.

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