Buildings Don't Use Energy: People Do

KATHRYN B. JANDA

Environmental Change Institute, Oxford University, Oxford, United Kingdom

ABSTRACT: 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 paper 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 paper finds purely architectural solutions, such as those proposed by the 2030 Challenge, to be necessary but not sufficient. To fully address the task ahead, it argues that architects need to develop professional expertise and *seek ways of integrating user involvement in building performance. Moreover, a system of professions standpoint suggests it may be wise for architects to claim this role before another group of building professionals does.*
Keywords: Professions, climate change, building users, education, 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 [1]. 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 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 has also been considered as a social problem rather than a technological one [2, 3]. How societies are motivated to use or conserve energy has been a topic addressed sporadically by social scientists for more than a century [4]. From this perspective, reducing energy use in buildings requires changes in the entire fabric of society.

Although there are diverse approaches to changing how energy is used in buildings, the power of purely architectural solutions has been recently reinvigorated by passive solar architect Edward Mazria. Mazria reconfigured the usual energy consumption sectors used in the U.S. 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 U.S. 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 emitting sector—48% in the U.S., "even greater" elsewhere—and it argues that architects and other members of the building community are therefore *the* key to stabilizing emissions [5].

This paper considers architecture's social and environmental responsibility from a system of professions standpoint [6]. This perspective conceptualizes work practices as a kind of ecosystem, where professional groups compete to perform different sets of socially-accepted tasks. In the face of climate change, the paper finds architectural solutions, such as those proposed by Mazria, to be necessary but not sufficient. To fully address the task ahead, it argues that architects need to develop professional expertise *and* seek ways of integrating user involvement in building performance.

The paper begins with a discussion of trends and expectations in building use, with a focus on the importance of 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 program 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 & 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 U.S. 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 their cool without central air-conditioning; today, central A/C 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 2 and 3-car garages [7]. Over the last forty 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 [8]. As Andrew Rudin pointed out in his analysis of 45 years of U.S. energy consumption, "When we were less efficient we used less energy."[9, p. 8331]

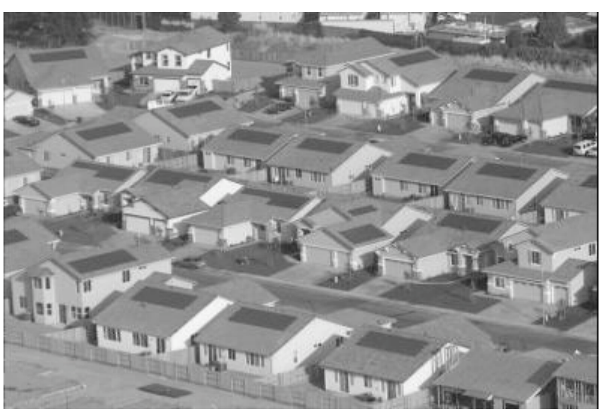

Figure 1: Bird's eye view of Premier Gardens [10].

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 development called "Premier Gardens" near Sacramento, CA (USA). Although these are designed to be "zero energy" houses, their size, 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 PV arrays and energy efficiency measures are effective: there is an across the board decrease in bills in the ZEH development compared to a neighboring development (Cresleigh Rosewood). However, the distribution of electricity use across the studied homes has not changed: the electricity use patterns in the ZEH development exactly mimic those of their neighbors, rather than reflecting the near "zero energy" design intent.

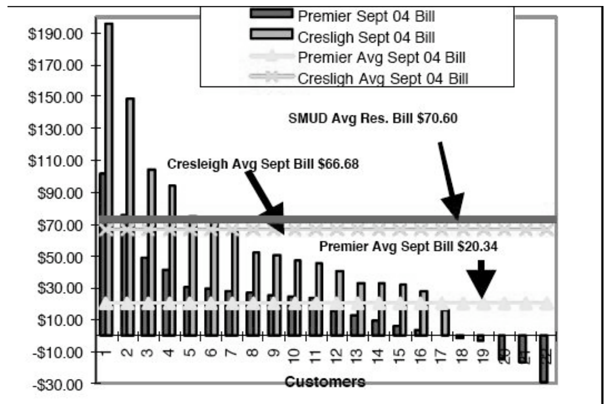

Figure 2: Sept. 2004 Electricity Bills for Premier Gardens vs. Cresleigh Rosewood [10].

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.

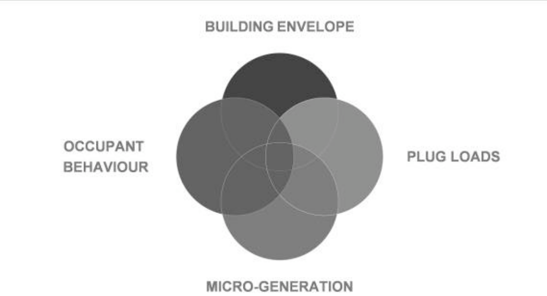

Figure 3: Influences on building energy use [11].

In this view, occupant behavior is an important part of the socio-technical system that influences a building's energy use. It looks to be about ¼ of the problem with some probable influence over plug loads as well. 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 behavior influence the rest [12]. Differences in individual behavior can produce large variations (>300%) in energy consumption, even when controlling for differences in housing, appliances, HVAC systems, and family size [13]. Given the wide range of possible patterns of energy consumption, opportunities exist to improve energy efficiency through different types of behavioral strategies. In fact, behavioral changes pave the way to more sources of energy savings than are available through architectural and technical strategies alone [14]. For example, heating a well-insulated house to 68°F will use less energy than heating the same house to 70°F.

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

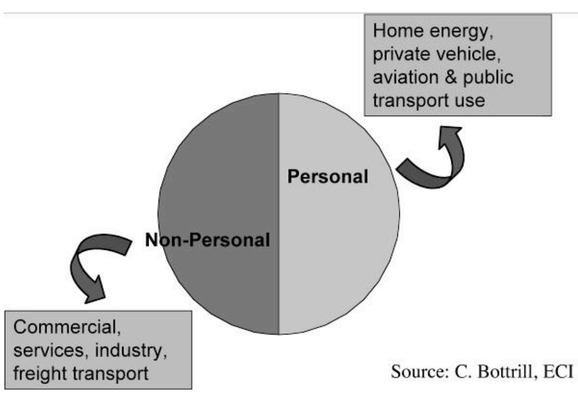

Figure 4: Role of Personal Action in Energy Consumption.

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 for example, 15]. Some of these theories are based upon 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 [16].

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." [17, p. 4413] Awareness-raising and education are the main tools used to overcome the information deficit and "correct" peoples behaviors. 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 [18]. 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 [19]. 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 paper 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 peoples behavior 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." [20] The language of the brief and the title of the seminar are telling. It suggests that people's energy using behavior 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 behavior 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 behavior? 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 more information to deliver greater understanding.

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 recent survey by the National Environmental Education and Training Foundation showed that only 12% of the general population can *pass* a basic energy quiz [21]. Seen in this context, the idea of relying primarily on energy feedback to deliver changes in behavior 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. 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 practicing 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 [22]. 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 [23, 24]. 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 U.S. census data, for instance, the number of employees providing all architectural and engineering services is only two thirds of one percent of the employed persons in the civilian workforce [25]. 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 U.S., and that the problem lies instead with its citizenry. Architectural historian Sarah Goldhagen suggests that the quality of U.S. buildings would be improved if architecture, rather than art classes, were a staple subject in secondary schools [26]. 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 [27] 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 math, 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 U.S. 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 paper 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 behavior. Although some professions such as medicine and law have medieval or ancient roots, most of those recognizable today developed during the nineteenth century. The first systematic studies of professions were written in the early part of the twentieth century, and the subsequent literature developed functionalist, structuralist, and authoritarian interpretations for their existence.

Abbott [6] provides an alternative theory which 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 [6 pp. 177-211]. 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 APs since the Professional Accreditation program was launched in 2001 [28].

There has definitely been 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% [29]. 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 programs are forming wholly or partially around this concept [e.g., 30], and existing programs 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 paper [31] 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, FIPSE-funded program using real buildings as living laboratories trained faculty and students in about a third of the accredited architecture schools in these methods [32]. The necessary expertise exists within the field of architecture, even if it is not evenly distributed. However, the field itself is understandably oriented toward 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 [33], so 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 [34], as have articles on a curriculum connecting the built environment and public health [35]. What a new profession centered 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 paper 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 paper finds purely architectural solutions, such as those proposed by the 2030 Challenge, to be necessary but not sufficient. With climate reduction targets set at 80% of 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 paper 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.

ACKNOWLEDGEMENTS. The author would like to thank the reviewers and editors for their comments and suggestions. This work has been informed by colleagues in the Society of Building Science Educators, and it is supported by the Demand Reduction Theme of the UK Energy Research Centre.

REFERENCES

1. Lutzenhiser, L., (1993). Social and Behavioral Aspects of Energy Use. *Annual Review of Energy and the Environment*, 18: p. 247-89.

2. Stern, P.C. and E. Aronson, eds, (1984). *Energy Use: The Human Dimension*. W.H. Freeman and Company: New York, NY.
3. NRC, (1980). *Energy Choices in a Democratic Society*. National Academy of Sciences: Washington, D.C.
4. Rosa, E.A., G.E. Machlis, and K.M. Keating, (1988). Energy and Society. *Annual Review of Sociology*, 14: p. 149-72.
5. Architecture 2030. *The Building Sector: A Hidden Culprit*. 2008 [cited 2008 Jan. 31, 2008]; Available from: http://www.architecture2030.org/current_situation/building_sector.html.
6. Abbott, A., (1988). *The System of Professions*. Chicago: University of Chicago Press.
7. Janda, K.B., (2007). Turning Solar Consumers Into Solar Citizens: Strategies For Wise Energy Use. In Proceedings of *Solar 2007*. Cleveland, OH: American Solar Energy Society.
8. Harris, J., et al., (2006). Don't Supersize Me! Toward a Policy of Consumption-Based Energy Efficiency. In Proceedings of *ACEEE Summer Study on Energy Efficiency in Buildings*. Asilomar, CA: American Council for an Energy-Efficient Economy.
9. Rudin, A., (2000). Why We Should Change Our Message and Goal from 'Use Energy Efficiently' to 'Use Less Energy'. In Proceedings of *ACEEE Summer Study on Energy Efficiency in Buildings*. Asilomar, CA: American Council for an Energy-Efficient Economy.
10. Keesee, M., (2005). Setting A New Standard - The Zero Energy Home Experience In California. In Proceedings of *Solar World Congress*. Orlando, FL: International Solar Energy Society.
11. Killip, G., (2009). *Presentation to Oxford MSc Master's Course*. Environmental Change Institute: University of Oxford.
12. Schipper, L., et al., (1989). Linking Lifestyles and Energy Use: A Matter of Time? *Annual Review of Energy*, 14: p. 273-320.
13. Socolow, R., (1978). *Saving Energy in the Home: Princeton's Experiments at Twin Rivers*. Cambridge: Ballinger.
14. Shama, A., (1983). Energy Conservation in US Buildings: Solving the High Potential/Low Adoption Paradox from a Behavioral Perspective. *Energy Policy*, 11(2): p. 148-167.
15. Wilson, C. and H. Dowlatabadi, (2007). Models of Decision Making and Residential Energy Use. *Annual Review of Environment and Resources*, 32: p. 169-203.
16. Shove, E., (2003). *Comfort, Cleanliness & Convenience*. Oxford, New York: Berg.
17. Owens, S. and L. Driffill, (2008). How to Change Attitudes and Behaviours in the Context of Energy. *Energy Policy*, 36: p. 4412-4418.
18. Kempton, W. and L. Montgomery, (1982). Folk Quantification of Energy. *Energy*, 7(10): p. 817-827.
19. Darby, S., (2006). *The Effectiveness of Feedback on Energy Consumption*. Environmental Change Institute: Oxford.
20. TSB/ESRC, (2008). *How People Use and Misuse Buildings*. Technology Strategy Board/Economic and Social Research Council: London, UK.
21. RoperASW, (2002). *Americans' Low "Energy IQ:" A Risk to Our Energy Future*. The National Environmental Education & Training Foundation: Washington, DC.
22. Orr, D., (1997). Architecture as Pedagogy II. *Conservation Biology*, 11(3): p. 597-600.
23. Architecture 2030. *The 2010 Imperative*. 2009 [cited 2009 Feb. 11, 2009]; Available from: http://www.architecture2030.org/2010_imperative/index.html.
24. Wright, J., (2003). Introducing sustainability into the architecture curriculum in the United States. *International Journal of Sustainability in Higher Education*, 4(2): p. 100-105.
25. U.S. Census Bureau. *DP-3. Profile of Selected Economic Characteristics*. 1997 [cited 2004 May]; Available from: http://factfinder.census.gov/servlet/QTTable?_bm=y&-geo_id=D&-qr_name=DEC_2000_SF3_U_DP3&-ds_name=D&-_lang=en.
26. Goldhagen, S. (2001) *Architecture: Boring Buildings*. The American Prospect Online 12.17.01, http://www.prospect.org/print/V12/22/goldhagen-s.html.
27. Kobet, R. (2003) *Empowering Learning Through Natural, Human, and Building Ecologies*. DesignShare.com January 2003, http://www.designshare.com/Research/Kobet/learning_ecology_2.htm.
28. GCBI. *Green Buidling Certification Institute*. 2009 [cited 2009 Feb. 11, 2009]; Available from: http://www.gbci.org/DisplayPage.aspx?CMSPageID=28.
29. Adam, D., (2008). *Global carbon reduction targets*, in *Guardian.co.uk*.
30. Northwestern Engineering. *Architectural Engineering and Design*. 2009 [cited 2009 Feb. 11, 2009]; Available from: http://www.civil.northwestern.edu/architecture/.
31. Janda, K.B., (2004). Beyond Architecture: Real Buildings, Real People. In Proceedings of *Solar 2004*. Portland, OR: American Solar Energy Society.
32. AoC, (2005). *Agents of Change: Building the Case* Fund for Improving Post-Secondary Education (FIPSE) Grant Database.
33. Rosen, G., E. Fee, and E.T. Morman, (1993). *A History of Public Health*. Baltimore, MD: Johns Hopkins University Press.
34. Younger, M., et al., (2008). The Built Environment, Climate Change, and Health: Opportunities for Co-Benefits. *American Journal of Preventive Medicine*, 35(5): p. 517-526.
35. Botchwey, N.D., et al., (2009). A Model Curriculum for a Course on the Built Environment and Public Health. *American Journal of Preventive Medicine*, 36(2S): p. S63-S71.