DAILY LIFE, DIGITAL TECHNOLOGIES & ENERGY DEMAND.

Working paper collection.

Editors:
Rachel Macrorie,
Faye Wade.

Balance Network & Urban Institute


BALANCE
NETWORK
Urban
Institute
Shaping Future Cities

Table of Contents

Introduction

Rationale

The *'Daily life, digital technologies and energy demand'* networking activities sought to interrogate the changing rhythms, routines and relationships associated with the increasing adoption of digital technologies into domestic and work practices. Their aim was to better understand implications for the organisation of everyday life, patterns of energy demand, and personal wellbeing. The rationale for this resultant interdisciplinary working paper collection emerged from the juncture of several trends; increasingly flexible working practices (BIS, 2014), rising levels of home-working, growing investment in the digital technologies sector (Tech City and NESTA, 2016) and a concurrent surge in the use of digital devices for automating, monitoring and remotely managing domestic and work practices (Strengers, 2014). These trends are set against political drivers to dramatically reduce greenhouse gas emissions across residential and commercial sectors (e.g. UK Climate Change Act, 2008) and yet, they often lead to variable and unintended energy performance results (e.g. Gram-Hanssen *et al.,* 2004). Further, whilst digital technological are promulgated as enabling a more inclusive, convenient and manageable everyday life within and between homes and workspaces, mounting evidence points to their deployment exacerbating daily stresses and reinforcing socio-political divides (e.g. Hargreaves and Burgess, 2013; Kitchin, 2014).

Dominant research and policy approaches addressing the increasing energy-intensity of domestic life seek to achieve widespread diffusion of digital energy demand management technologies, and to optimise the design of software, hardware, and supporting infrastructures

(prioritising efficiency, control and inter-operability). People are commonly framed as rational individuals who will simply respond to information and economic incentives encouraging them to use these technologies and initiatives 'correctly' to; gain insight into how they perform their daily activities, better organise these routines to 'free up' family or personal time, save money on household energy bills, and lessen their household carbon footprint. This 'techno-rational' position often overlooks or purposely 'designs out' the complexity of home and work; embodied and routinised actions, intersecting and competing daily practices, interpersonal dynamics, and social conventions (Guy and Shove, 2000; Macrorie *et al.*, 2015). As such, there is a paucity of research examining the emergence of digital technologies in daily life, and their potentially transformative consequences for; 'work life balance', energy demand reduction, and personal wellbeing. This working paper collection begins to address this research gap.

Process & participation

The collection has been developed through a series of collaborative and interdisciplinary activities, which have included; a two-day workshop hosted by the Urban Institute (University of Sheffield, 26-27th November 2015); a series of four discursive webinars (February to April 2016); and a peer review process.

Production of this collection has involved partnerships between Early Career Researchers (ECRs) representing; the Balance Network (BN), the Practices, the Built Environment and Sustainability Network (PBES), the Dynamics of Energy, Mobility and Demand (DEMAND) Centre, the Urban Institute (University of Sheffield), TEDDINET, and British Environment Psychology Society. Whilst sometimes challenging, drawing on multiple disciplinary perspectives from; geography, sociology, anthropology, environmental history, psychology, product design, mathematics and the modelling of real world phenomena, led innovative questions to be asked, worldviews to be challenged, and unusual (and productive) collaborations to be formed, that will hopefully last beyond this series of activities.

Representatives from policy, industry and the voluntary sector who generously contributed their perspectives throughout the series of events have included; Ian Preston (Head of Household Energy Services, Centre for Sustainable Energy (CSE)), Dr. Nick Banks (Senior Development Manager, CSE), Matthew Lipson (Head of Consumer Insight, Energy Technologies Institute (ETI)), Jeremy Yapp (Deputy Director, BEAMA), and Pedro Guertler (Research Director, Association for the Conservation of Energy (ACE)). Their participation in the working party, insightful comments on the collaboratively produced articles, and/ or involvement in the Beyond Balance event panel session, provided welcome insights from 'outside the Academy'. Their contributions provided understanding of contemporary discourses, emerging industrial opportunities, and personally experienced challenges, associated with designing and implementing digital technology mediated interventions intended to enable a less energy-intensive society in the context of home and work.

Prof. Simon Marvin (Director of the Urban Institute and Professor of Geography, University of Sheffield), Dr. Tom Hargreaves (Lecturer in Environmental Science & Policy, University of East Anglia (UEA), Dr. Yolande Strengers (Co-Director Beyond Behaviour Change research programme in the Centre for Urban Research, RMIT University,

Melbourne), and Dr. Matt Watson (Senior Lecturer in Human Geography, University of Sheffield and DEMAND) provided welcome insights throughout the peer review process and/ or during the Beyond Balance panel session.

Research themes

The working paper collection provides multi-disciplinary thinking about the influence(s) digital technologies have on our everyday home and work experiences, household energy demand, and personal wellbeing; as well as how everyday life reciprocally shapes the design, implementation and governance of energy demand interventions. The papers are expansive in their consideration of time (past, present and future); how digital devices affect householders and their daily practices (in the organisation of daily tasks, addictions and dependencies, personal well-being and household dynamics); how householder routines and experiences are implicated in design processes (of digital technologies & infrastructures, sustainability interventions, and broader planning decisions); and the visible and invisible actors and agents involved in governing the work of digital technologies (designers, manufacturers, advertisers, installers, consumers; algorithms and standards).

With regard to time, **Skelton & Morosanu** combine historical and anthropological accounts to compare residential living in 17th and 21st Century Britain. In particular, they draw comparison between 17th Century urban craftspeople whose livelihoods centred around the home, and modern home-workers who draw on digital technologies to perform their work (e.g. phones, laptops and the internet). They suggest that widening the temporal scope, across which analysis of the rhythms of work and home life and their implications for wellbeing and sustainable resource demand takes place, can provide useful research and policy insights.
Continuing this contemplation of time, **Foulds & Morosanu** look to the future. Their paper focuses on the 'promises' made within the discourses from manufacturers and developers involved in the 'smart home' industry. They analyse a range of marketing materials to investigate the notion of 'busyness' and how digital technologies are often promoted for their ability to support and manage the performance and outcomes of daily routines, and ameliorate busy and stressful everyday lives.

Shifting analytical focus to the impact that digital devices have on the individuals using them **Buchanan, Robison & Whittle** apply a psychological perspective to interrogate the variously 'inclusive' or 'exclusive' features of digital technologies that differ in how they meet basic human needs of competence, autonomy and relatedness. This paper provides novel perspectives on technological acceptance (focusing on smart metering devices), how these technologies might benefit individuals' personal wellbeing and relationships. The authors highlight particular user needs that need to be considered when relying on digital 'smart metering' technologies as a means to reduce household energy demand.

In a related vein, **Morley & Robison** investigate the idea of technology addiction and dependence. They explore how different disciplinary perspectives acknowledge these ideas, drawing on clinical medical psychology, sociology, and popular psychology to present distinct thinking about technology addiction. They suggest that policy makers and intervention organisers should consider the wellbeing of individuals and broader populations, as well as implications for energy demand, when promoting the use of digital technologies throughout everyday life.

Who or what shapes digital technologies, and how this involvement in turn shapes user practices, with potentially broader socio-political and environmental implications, provides the focus of the final two working papers. **Wade & Nilstad Pettersen** investigate ideas of daily life that exist amongst different actors involved in designing and installing domestic heating controls. They draw on empirical data from Norwegian and British organisations (including energy utilities, manufacturers and installers) to explore how notions of household users are constructed, and how these ideas, in turn, shape the workings of digitally controlled heating technologies installed in homes.

These ideas around how smart devices are designed, operate and in turn influence society and the environment, are extended by **Macrorie, Kragh-Furbo & Morley** who explore the role of algorithms and software in shaping everyday life. Reviewing three empirical cases (learning thermostats, smart television, and assisted driving), they discuss how, despite frequently being invisible, algorithms enable automated functioning and capture and process numerous data points that are subsequently used for decision-making purposes, therefore having significant presence and power in the world. Consequently they contend that a social science research programme is urgently required to address this gap.

Research dissemination

The six working papers were presented and debated in a 45-minute panel session at the Balance Network *'Beyond Balance: how digital technologies are affecting our work, our homes and everything in between'* symposium (June 27th 2016, The Institution of Engineering and Technology (IET), London). The panel session was chaired by Dr. Rachel Macrorie with discussants including; Dr. Tom Hargreaves, Dr. Yolande Strengers and Dr. Matt Watson; and Dr. Nick Banks (ACE).

The working paper collection has been published online through the Balance Network. It is available to freely download at http://balancenetwork.bimserver2.com.

Rachel Macrorie
Urban Institute, University of Sheffield.

Faye Wade
Energy Institute, University College London.

Suggested citation for Working Papers:

e.g. Buchanan, K., Robison, R., and Whittle, C. (2016). Are you in or are you out? Considering inclusive and exclusive features of digital energy management technologies and wellbeing. In Macrorie, R. and Wade, F. (Eds.). Daily life, digital technologies and energy demand – A working paper collection: Sheffield, Cambridge: Urban Institute (University of Sheffield), Balance Network (Balance Network, Anglia Ruskin University).

Biographies

Editors

Rachel Macrorie
Rachel is a post-doctoral research associate at the Urban Institute, University of Sheffield. Her research is concerned with the governance of urban infrastructures, technological innovations, and resources (particularly energy and water), and their socio- political and environmental implications for everyday life. Her doctoral research appraised implementation of a UK building performance standard and, by developing a 'systems of practice' framework, considered its ability (or otherwise) to reduce the energy and carbon implications of the new-build housing market. Her current research interests include: experimentation in urban automation, and formal/ informal smart urbanism.

Faye Wade
Faye is a research associate at the UCL Energy Institute, UK. She recently completed a PhD, which applied ethnographic methods to investigate how central heating installation processes can shape the energy consumed through these systems in the home. She is currently working on a project combining social surveys with energy monitoring to provide insights into the needs of fuel poor customers and explore their participation in energy efficiency and demand side response in relation to smart metering solutions.

Authors

Kathryn Buchanan
Kathryn holds a PhD in psychology from Royal Holloway, University of London. She is currently a post-doctoral researcher at the University of Essex, working on a 4-year EPSRC funded DANCER project under the (Build)TEDDI umbrella. Here she is helping to develop and evaluate a technologically innovative system for reducing domestic energy consumption without compromising occupant comfort. Kathryn's key research interests lie in identifying factors that can be used to reduce carbon emissions and promote pro-environmental behaviours. In this context she has investigated: subjective wellbeing, contributions of the wider social political context, marketing appeals and digital feedback systems.

Chris Foulds
Chris is a Senior Research Fellow at the Global Sustainability Institute, Anglia Ruskin University. He is an interdisciplinary environmental social scientist with a keen interest in sustainable consumption and socio-technical change, particularly relating to energy demand, the built environment, and everyday and professional practices. Chris has published in a number of high-impact journals, including Nature Energy, Energy Policy, Building Research & Information, and Energy Efficiency. He is also a co-author of an interdisciplinary book intended for undergraduates, 'Building Futures: Managing energy in the built environment' (Routledge, 2016).

Mette Kragh-Furbo
Mette is a Senior Research Associate in the Dynamics of Energy, Mobility and Demand (DEMAND) Centre at Lancaster University. Her current research investigates the governance of energy demand in local smarter grids. This involves studying how the agency to govern demand is becoming distributed in new configurations across the network of actors, across material technologies and infrastructures of different forms and devices of knowledge management, data processing and data representation. Her doctoral research in the Lancaster Environment Centre focused on data practices within consumer genomics.

Janine Morley
Janine is a Senior Research Associate in the DEMAND Centre at Lancaster University. She is a sociologist who studies the relationships between social practices, infrastructures and resource-use. Her current research investigates the roles of digital devices and services in everyday life, the nature of "technologically-led" social change, and the implications for shifting patterns of energy demand. Her doctoral research explored how theories of practice can transform understandings of variation in household energy-use. Focusing on cooking, comfort and computing, it also showed how knowledge of variations can provide insight into how social practices have and may continue to change.

Roxana Morosanu
Roxana is a social anthropologist working at the intersection between the fields of social sciences of sustainability, digital anthropology, and the anthropology of Britain. She was awarded her PhD by Loughborough University in 2014. She is the author of An Ethnography of Household Energy Demand in the UK: Everyday Temporalities of Digital Media Usage (Palgrave Macmillan, forthcoming 2016) and she has published in peer-reviewed journals, such as The Cambridge Journal of Anthropology, International Journal of Cultural Studies, and Visual Communication. Currently, Roxana teaches ethnographic methods at Loughborough University and works as a researcher at Royal College of Art.

Ida Nilstad Pettersen
Ida is an Associate Professor at the Department of Product Design of the Norwegian University of Science and Technology (NTNU) in Trondheim, Norway. Her research is concerned with the role of design in fostering change in the everyday practices of citizens and professionals. Her current research interests include energy management and use in non-residential buildings, the transformation of public health and care services, and sustainable urban transitions.

Rosie Robison
Rosie is based at Anglia Ruskin University's Global Sustainability Institute. With a background in applied mathematics, she now works across the social and physical sciences. She is currently Principal Investigator of the EPSRC-funded Balance Network, supporting a network of academics around the themes of work-life balance in the digital age. She was also co-investigator on the EPSRC-funded Digital Epiphanies project, exploring the use of digital tools to support reflection and self-directed behaviour change. She also currently co-leads (with Chris Foulds) a project analysing monitoring data from iMeasure – a web-based tool which allows householders to track their long-term energy use.

Leona Skelton
Leona is an environmental historian of the British urban environment (1500-present), who has focused on the regulation of rivers, the development of sanitation and water-supply infrastructure and Nuisance Law. Her work attempts to deepen understanding of how dramatic environmental change has shaped cultural, economic and social lives and how communities have been able to shape environmental change from the bottom upwards in very different governance frameworks over five centuries. She has published *Sanitation in Urban Britain, 1560-1700* (London: Routledge) and is currently working on her second monograph, *Tyne after Tyne: An Environmental History of a River's Battle for Protection, 1530-2015* (Cambridge: White Horse Press, 2017). She is based at the University of Sheffield in the Department of Urban Studies and Planning where she works closely with the Sheffield Water Centre, Pennine Water Group and the EPSRC-funded TWENTY65 consortium.

Colin Whittle
Colin is based at the University of Sheffield's Department of Psychology. With research interests in the development of cities, smart grids, and energy management, Colin currently studies the role of citizens within smart cities and the acceptance of energy management technologies. In particular, he has explored the acceptance of Home Energy Management Systems and load shifting behaviours. As an environmental psychologist, his broader interests include the predictors and moderators of energy consumption and pro-environmental behaviours. In 2014, with four colleagues, he cofounded a network for environmental psychologists researching in Britain; see breps.org.uk or follow us @Br_EPS.

Academic reviewers

Tom Hargreaves
Tom is a lecturer in Environmental Science and Policy in the School of Environmental Sciences, and a member of the Science, Society and Sustainability (3S) research group, at University of East Anglia (UEA). His research focuses on how innovations to promote sustainability impact upon people's everyday lives. He is particularly interested in the inter-relationships between: the dynamics and evolution of social practices, how technologies are adopted and used in

everyday life, and the effects of attempts to govern everyday life to try and steer it in more sustainable directions.

Simon Marvin
Simon is Director of Urban Institute, at the University of Sheffield and Professor in the Department of Geography. He has internationally acclaimed expertise in constructing conceptual understanding and empirical evidence of the changing relations between socio-technical networks and urban and regional restructuring. His work is noted for the way it develops innovative, interdisciplinary perspectives to help open up and explore important new agendas for urban studies and infrastructural research. His most recent book publications include, a critical international assessment of smart cities, with Andres Luque-Ayala and Colin McFarlane, and the development of a socio-technical framing of urban retrofit practices, with Mike Hodson.

Matt Watson
Matt is a senior lecturer in Human Geography at the University of Sheffield. His research is concerned with understanding social change in relation to sustainability, through a focus on everyday life and the socio-technical systems that shape it and he focuses on issues relating to biodiversity, waste, food, mobility and energy. His work engages with geographical and sociological theories of practice, materiality and everyday life, as well as with science and technology studies, and literature on the structures and processes of governing.

Yolande Strengers
Yolande is a Vice Chancellor's Senior Research Fellow in the Centre for Urban Research at RMIT University, Melbourne, where she co-leads the Beyond Behaviour Change research programme. Her work is clustered around a series of applied research projects focused on smart technologies, energy demand and sustainability. Her past projects have investigated how new and old technologies such as telepresence, smart grids, smart meters, energy and water systems, air-conditioners and housing infrastructures are reshaping and shaped by the ways we live and work. She has published a monograph on 'Smart energy technologies in everyday life'.

Reviewers from policy and practice

Nick Banks
Centre for Sustainable Energy (CSE)
Nick is a Senior Development Manager at the Centre for Sustainable Energy (CSE). He completed his PhD in the Sociology of Energy Use with Oxford University's Environmental Change Institute in 1998. At CSE, he specialises in behavioural and attitudinal research but has also undertaken energy and environmental audits, carbon foot-printing of organisations, life cycle assessments, implementation of environmental management systems (ISO 14001), energy modelling and mapping projects, statistical analysis and general strategy and policy work.

Pedro Guertler
Association for the Conservation of Energy (ACE)
Pedro has a BSc in Environmental Policy with Economics from the London School of Economics and an MSc in Environmental Technology (specialising in Business and the Environment) from Imperial College. He has 13 years' experience of working in the field of energy policy, with particular expertise in energy efficiency and fuel poverty policy and programme design and evaluation. Pedro also has a deep understanding of the role of research in underpinning advocacy work, working very

closely with ACE's Campaigns Team and Chief Executive. Pedro is a Trustee of the Eaga Charitable Trust and UK ambassador for the European Council for an Energy Efficient Economy.

Matthew Lipson
Energy Systems Catapult
Matthew is Head of Consumer Insight at the Energy Systems Catapult, which seeks to bring the worlds of industry, academia and Government together in service of building consensus on the transition pathways to a future energy system and to accelerate the development of new technology-based products and services in the energy sector. As a social researcher, in his previous role at the Energy Technologies Institute, he gathered insights about what people need heat for and working across disciplines to develop technically feasible, commercially viable smart low carbon heat solutions. Prior to this role, working for the Department of Energy and Climate Change as a Senior Customer Insight Manager, he collated and analysed behavioural insights to help inform UK climate change policy (e.g. Green Deal, Smart Meters).

Ian Preston
Centre for Sustainable Energy (CSE)
Ian is Head of Household Energy Services at CSE, having joined in 2001. In his previous role as Senior Analyst, he researched fuel poverty, consumer behaviour, hard-to-treat housing issues and scheme evaluation. His particular skills include energy modelling, data collection, analysis and survey work. He has considerable knowledge of energy policy, and has been involved in the evaluation of a number of policies, including most recently CESP and the Energy Company Obligation, providing a working knowledge of the challenges facing householders and installers. He has managed several consumer behaviour projects including; a trial of the Energy Saving Trust's Market Segmentation Model; working with Consumer Focus to explore measures that might be supported under the Green Deal; Climate Change West, and several studies examining consumer tariff-switching behaviour.

Jeremy Yapp
BEAMA
Jeremy managed an independent retail business before joining the Australian Public Service as a Hansard editor in the Australian Parliament. He has worked as an orchestral musician, as production manager of an international music festival, and as a freelance editor and political researcher. He has experience of a number of policy areas in the UK Civil Service, including Department of Energy and Climate Change (DECC)'s Smart Metering Implementation Programme. He is currently on secondment from DECC to BEAMA (who represent the interests of a collection of trade associations in the energy and power industry), where he manages the Mandated Smart Metering Products Group, representing manufacturers of smart meters, communication hubs and consumer access devices.

Qualities of time:

A comparison of work-life balance in 17th and 21st century urban Britain.

SKELTON AND
MOROSANU

Abstract

Today, recent shifts in work-life balance characterised by the blurring of boundaries between home and work are largely regarded as a phenomenon facilitated by technological innovation and, as such, unprecedented. With their capacity to make home-based work activities ubiquitous, convenient and immediate, new digital technologies contribute to transforming ideas about work, domesticity and time itself. We are tempted to conceptualise the reconfigurations of everyday schedules, routines, and experiences of time that are articulated in the changing relationship between work and home as impossible without new and smart digital technologies. However, looking into seventeenth-century British homes demonstrates that such an integrated style of living and working was possible in the context of pre-modern, rudimentary technologies too. This article compares seventeenth-century domestic living to that being designed in the 'smart homes' agenda, analysing: work rhythms; domestic fuel consumption; and self-sufficiency. Understanding similarities as well as the differences across centuries, it is argued, can underpin the development of novel and comprehensive future approaches to energy efficiency and to time, as interconnected aspects of living.

Introduction

The media is currently flooded with exciting and inspiring information explaining how to convert our old, inefficient homes into 'smart homes'. Enabling technology to effectively programme, in order to optimize, our work-life balance, energy consumption and activity rhythms is perceived as revolutionary, innovative and futuristic. And it might be. But however inefficient housing was in the seventeenth century, there were many aspects of domestic life and work rhythms which were very 'smart' indeed, and far better in many respects than the housing, fuel consumption and work-life balance which developed subsequently with industrialisation (Thompson, 1967, pp.57-59). This article compares seventeenth-century domestic urban living to that being designed in our present and future 'smart' homes in order to argue that, despite the real, numerous and very important differences between seventeenth-century British homes and 'smart' homes, there were also some important and striking similarities too. We will focus on examples related to work-life balance, or the integration of work and non-work activities, and to domestic fuel consumption and practices of domestic self-sufficiency. The paper develops an interdisciplinary approach to this topic, by blending a historian's understanding of a distant period with an anthropologist's understanding of recent and current work and life rhythms.

Researching 'multiple scales' and 'short-term cycles', articulated by Frank Trentmann *et al.* (2009, p.4), as the

Leona Skelton[1] and
Roxana Morosanu[2].

[1] Urban Studies and Planning, University of Sheffield;
[2] Dept. of Sociology, Loughborough University/Royal College of Art.

'seasonal patterns and processes that unfold over generations as well as weeks and days' is undoubtedly important. However, this paper highlights in a much broader context the similarities linking work and life daily rhythms and self-sufficiency as experienced in seventeenth-century UK towns to those of the twenty-first century present and future. Following Dale Southerton's examination of the discontinuities between daily temporal rhythms in 1937 and 2000 (2009, pp. 49-63), this paper draws a comparison between two historical periods situated four centuries apart to explain the interconnectedness and entangled development of domestic and work life both before and after industrialisation, and advocates the benefits of such longer-term appreciation of continuities in daily life and work rhythms. While the substance of how people lived their lives differed substantially between these contrasting time periods, for example using wood and coal fuel instead of gas and electricity, this article focuses on how daily work and life rhythms were temporally and structurally organised, and the processes and systems through which daily lives functioned, rather than contrasting the details of social organisation, politics, culture and economics, which of course vary considerably between seventeenth-century and modern-day Britain.

Work and life daily rhythms

In seventeenth-century British towns, many people were engaged in a combination of domestic, industrial and agricultural activities in the same neighbourhoods, streets and even within the bounds of one property. Craftsmen's workshops were commonly situated above, below or behind their homes, to facilitate economic familial survival. Small agricultural outbuildings, such as pig sties, hen houses or stables, were common features of the areas of land behind houses, known as backlands, rigs or crofts (Palmer, 2004; Barnwell, 2004). Indeed, in Aberdeen, some people even shared their homes with their livestock (Still, 2002), and many smaller town centres still featured functioning tithe barns where agricultural produce was brought for valuation as people paid a tenth of their produce towards the upkeep of their parish church. For all of these people, regardless of socio-economic status or occupation, the concept of a very firm separation between work and life would have made little sense. Work not only took place in the same physical spaces as life, but life and work were also conceptualised in a far more fluid way, merely as aspects of an overarching and largely seamless daily experience of living. In 1596, for example, John Haithway, a tanner of Carlisle, died leaving a 'lime croke', 'bark', 'working and chipping knives' and a 'tanning vat' in the 'barkhouse' behind his dwelling house, suggesting that he conducted his work very close to his home (Carlisle Record Office, 1596; Clarkson, 1960). For men like John, there was no separate concept of a 'workplace'. For townswomen, their responsibilities within the 'domestic sphere' were set out in contemporary advice literature, such as the Puritan clergyman William Gouge's *Of Domestical Duties* (1622), as officially separate from those of the husband who operated much more in the public sphere. However, in practice the division between the activities of wives and husbands was rather more permeable, especially in towns where men typically worked within the same properties as the family home (Peters, 2004, p.49). Keith Wrightson notes that 'urban wives of craftsmen and tradesmen were busy in the shop as well as above it' (2003, p.101). Essential daily tasks such as lighting the hearth or bearing water from a communal well were integral parts of a household servant's, wife's or widow's

daily routine, but such tasks might not have been considered explicitly as 'work'. Sir William Brereton noticed, in 1635, that the inhabitants of Edinburgh 'fetch not fresh water every day: but onely every other day: which makes their water much worse (espetially to drinke) which, when itt is att best, is bad enough' (Brereton, 1635, p. 31). Brereton's shock at Edinburgh's inhabitants' practice of bearing water every other day perhaps reveals the normality in his native England of bearing it on a daily basis. This underlines an important difference between the seventeenth century, when everyday lives were very labour intensive for all but a wealthy few who could afford to pay others to perform such tasks on their behalves, and today when essential utilities are supplied to all but a few homes without any physical labour on the part of the householder.

Nowadays, working from home, as opposed to commuting to a central place of work, is also known as teleworking, or e-working – terms that emphasize that current domestic work practices are usually technologically-mediated. Whereas seventeenth-century working often required large amounts of space, such as an entire workshop, and quite large-scale tools, such as a tanning vats, today digital technologies have enabled most domestic homes to become workplaces by simply opening a laptop at a dining table. However, a recent overview of homeworking activities around the globe (Felstead and Jewson, 2000) reveals that manual jobs, such as stuffing envelopes, or assembling piecework, are also currently conducted in domestic settings. Worldwide, the number of people working from home is increasing exponentially. In the UK, the number of people whose work practices included teleworking increased to 59% in 2011, from only 13% in 2006 (CBI). In terms of energy demand, it has been suggested that increasing the number of UK employees working from home can save over 3 million tonnes of carbon a year (Carbon Trust, 2014), by reducing commuting and office energy consumption. However, this shift might increase domestic energy consumption, especially for people who live in homes that are energy inefficient.

As well as changing the patterns of energy demand, it has been argued that homeworking changes the temporal distinctions between the domains of 'work' and 'home'. The experience of temporal flexibility (Tietze and Musson, 2002) emerges in these cases, with work-related and home-related activities becoming integrated, rather than being kept separated. This form of integration where, for some, work tasks are increasingly enmeshed with domestic activities such as doing the laundry, picking up the kids, peeling potatoes (*ibid.,* p.325) is similar to the work and life rhythms described in historical accounts of the seventeenth century. There are many similarities, therefore, between an urban craftsman living in a seventeenth-century British town who lived above the workshop where he manufactured and sold his wares, and for whom the concept of 'going' to work would have made little sense, and a modern health and safety consultant or envelope-stuffer who works from home five days a week, perhaps moving to a particular part of his or her residential property to carry out daily work tasks.

In the seventeenth century, townswomen regularly and very flexibly supplemented the familial income by increasing the amount of brewing and baking they undertook for consumption to create a surplus to sell, forming a substantial by-employment within the domestic economy (Peters, pp.53-54). Subsequently, in the eighteenth century, the expansion in the scale of brewing and baking

together with its increasing centralisation undermined the once viable 'concept of the complementary domestic sphere of the household economy' (Peters, pp.66-67). Very similarly, today, an increasing number of people who have trained in a wide variety of crafts commonly create homemade items to sell online. While they flexibly utilise periods of available time in the home to produce these items, similarly to seventeenth century townswomen, the activities of marketing and selling the products are heavily reliant on new digital technologies that might include an internet-enabled device, a camera, and the use of websites such as eBay and Amazon. In 2014 eight million people in the UK ran online businesses from home, and the numbers of what are called 'homepreneurs' are expected to increase (Enterprise Nation, 2014). Such modern-day craftspeople would, perhaps, find much in common between their daily routines and those of seventeenth-century craftsmen and small-scale female brewers and bakers.

Self-sufficiency

Seventeenth-century townscapes differed markedly from those of the later industrial epoch. They were patchworks of residential, industrial and agricultural buildings where dunghills and livestock were common features. By the seventeenth century, the integrated household economy was not yet fully specialised and it still largely retained its medieval pattern. Sheep, cattle and oxen were supposed to be kept in fields beyond towns, whereas small numbers of pigs, hens, geese, horses and milk cows were often accommodated in the backlands behind townhouses to supplement familial income (Palliser, 2000). Some townsmen owned or managed small holdings of arable land within towns. For example, in 1670, Carlisle Dean and Chapter filed a suit in the Court of Chancery against Erasmus Towerson, a gentleman, over the details of a lease of 'tenements, stables, barnes, gardens, orchards and other houses ... scituate in Castle Gate' (Court of Chancery, 1670). Castle Gate was a busy and major thoroughfare in the heart of Carlisle. Seventeenth-century people were far more directly and physically engaged in obtaining their foodstuffs, and in bearing their water and fuel into their homes, which arguably gave them more control over it. While some homes and workshops had to be heated throughout the day, this pre-industrial society did not demand large quantities of energy to heat and light large-scale workplaces and to power very large-scale commuting infrastructures. Rather, they exploited water transport far more efficiently out of necessity and utilised organic muscle-powered transportation methods, such as walking, packhorses and horse-drawn carriages.

The ways in which nature and the built environment were integrated in the 1600s towns resonates with recent movements and trends for 'greening' cities. New techniques for bringing nature back into the city include green roofs and living walls (Dunnett and Kingsbury, 2008), as well as initiatives for converting derelict and unused urban spaces into gardens (by grassroots organisations such as Cultivate London).

While the contribution of these new green initiatives to reducing the carbon emissions related to current urban living practices is important, it is hard to imagine that a level of self-sufficiency comparable to the 1600s could ever again be reached in cities. We must accept that at least some historical changes are largely irreversible. Instead, new forms of self-sufficient and off-grid lifestyles are being articulated in small rural communities and in remote natural

locations, as documented by Vannini and Taggart (2015). Their ethnographic research, conducted all across Canada with 200 people living in self-built houses disconnected from centralized electricity, gas and water infrastructures, shows the ways in which new technologies can be used to facilitate lifestyles based on simplicity and self-sufficiency. From finding open-source information on the Internet about how to build a house from renewable or recycled materials – such as dirt and discarded tires – to employing green energy generation technologies, such as solar panels, to power one's dwelling, new technologies were central to the off-grid projects of the people interviewed by Vannini and Taggart. Moreover, these technologies were employed in a variety of combinations and arrangements that could produce, for every household, the right balance between frugality and domestic comfort that people wanted to achieve. Information and communication technologies that made working from home a viable option supported further these flexible and individual articulations of what a good life meant for each and every. This flexibility would not have been possible in the 1600s when frugality was a necessity for the overwhelming majority of urban populations, rather than a choice. One striking similarity between seventeenth-century towns and those of today is the common practice of recycling, albeit formerly out of economic necessity and more recently for environmental reasons and in response to wider government schemes which are designed to counteract the negative consequences of consumption. Most seventeenth-century people recycled food waste, by feeding it to livestock, and they sold unwanted possessions, especially clothes, out of necessity, which limited how much waste was produced (Lemire, 1988). Moreover, urine was used by dyers and tanners and stable manure and human excrement was used, and very much valued, by nearby arable farmers as an essential fertiliser (Skelton, 2015, pp.41-45). What the seventeenth century practices teach us is how comparatively detached we have become from obtaining and controlling our access to the essential utilities which sustain our everyday lives, i.e. water, energy and food.

Conclusion

This working paper has widened the temporal scope within which we can think about the development and cyclical rhythms of work and home life. This comparison has demonstrated that it can be equally useful to compare case studies in very different and chronologically distant time periods as it is to compare much more proximal time periods, as Southerton did (2009). By using an interdisciplinary approach, the paper has blended a historian's understanding of a distant period with an anthropologist's understanding of recent and current work and life rhythms, highlighting the similarities between the structural frameworks within which people lived and worked, and live and work now, despite the enormous differences between the substance of daily life in these two eras. There is much more scope for such ambitious temporal comparisons conducted by teams representing a wide range of academic disciplines, from departments of anthropology, planning, human geography, history, politics, law and literary studies. Paying more attention to how differently and how similarly people lived and worked in the past could enable policymakers to reimagine in a much bolder manner just how differently people might be able to live and work in the future. The technological innovations which are facilitating the development of futuristic, 'smart' homes should certainly

be celebrated and analysed in their own right by social scientists trying to make sense of the very important ways in which they will undermine, shape and ultimately improve daily life and work patterns. However, a much greater appreciation that these frameworks are not entirely new and indeed have important historical precedents, learned experiences, successes and failures in particular times and places, which are very well documented in both primary historical archives and academic historians' secondary case studies is much needed. It could substantially improve academic analyses of 'smart' technologies and their impact on daily life and work in the past, present and future by enabling us to see the strengths rather than exclusively the weaknesses of historical practices in comparison to those of more modern times.

CONTROLLING BUSYNESS:

THE PROMISES OF SMART HOME INDUSTRY DISCOURSES.

FOULDS AND
MOROSANU

Abstract

Smart home technologies are often advocated on the basis that they can help households to re-organise their lives, and as a result reduce energy use too. Another suggested benefit of this reorganisation is that smart homes will also address people's feelings of busyness. The aim of this working paper is to investigate what sorts of 'promises' (propositions for technologically-facilitated change) are made by smart home industry discourses for managing busyness (intensity of human activity). From analysing a cross-section of discourses, we ascertained that smart homes technologies are promising to provide households with peace-of-mind in terms of how their domestic lives are managed. This peace-of-mind is said to be achieved through enhancing control as a means to increase efficiency. Mobile phones are typically proposed as the tool to do this work with, mainly because they are easy to use and ubiquitous. We finish by reflecting on how smart homes are promising to make people busier in various ways. This is in part because smart homes promise to be good at organising and scheduling tasks, as well as helping households to multi-task, but they promise to be much less good at encouraging a slowdown of domestic life, including reducing how long it takes to actually do a task for instance.

Introduction

'Smart home' technologies are commonly advocated as an efficient means of saving energy. In this short paper, we delve deeper into some assumptions that underpin these claims. We shift the focus away from 'energy', towards how (smart) technologies influence the organisation of everyday life. In particular, we are interested in notions of 'busyness' in relation to smart home technologies. Indeed smart homes are often justified because they help reorganise busyness in some way; the implication being that such reorganisation enhances well-being and also acts as a means to reduce energy use.

This paper aims to investigate what sorts of 'promises' (propositions for technologically-facilitated change) are made by smart home industry discourses for managing busyness (intensity of human activity). Reflecting on these promises can provide insights on: (1) how smart technologies are presented, which can influence meanings attached to different smarts and thus how they may be used in practice; (2) what industries perceive the priorities of different publics to be; (3) the future services offered by future technologies, as part of anticipating likely/ possible trajectories of practice; and (4) underlying commercial interests which the smart evolution may assist in facilitating.

We begin by defining busyness for background context, before detailing our methodology. The core of this paper then discusses three promises for busyness (peace-of-mind; control; mobile phones).

Chris Foulds[1] and Roxana Morosanu[2].

[1] Global Sustainability Institute, Anglia Ruskin University;
[2] Dept. of Sociology, Loughborough University/ Royal College of Art.

Background: defining busyness

Levine (2005) argues that busyness consists of two main components: speed and activity. The experience of feeling busy, we would add, comes therefore from the interplay between the speed of one's body in performing a task, and the amount of activities that one knows they need to complete within a given time. Using a different vocabulary, Southerton and Tomlinson (2005) identify three mechanisms that generate a sense of feeling 'harried': the volume of time required to complete a task; temporal disorganisation, as the failure to coordinate practices; and temporal density, which accounts for multi-tasking and the sense of intensity in the conduct of activities.

In seeking to apply these notions of busyness, scholars investigating British and American cultural contexts have argued that being busy has become a mark of having a privileged social position (Gershuny, 2005) or of being "a worthwhile person" (Levine, 2005, p.355). The positive valorisation of busyness can be linked to speed being equated with progress (Wajcman, 2015).

All this research illustrates a wider interest in speeding up everyday life, which Rosa (2003, 2010, 2013) argues is a symptom of our 'acceleration society', whereby 'our age is obsessed with speed: faster cars, faster trains, faster broadband, even speed dating' (Wajcman, 2015, p.13). It is this preoccupation that this paper explores, but with particular attention given to smart technologies as a means of enabling a particular form of busyness that suits – and supports – a faster life. This is especially pertinent given that the current (now, digital) information age has accelerated both the pace of social/temporal change and the daily rhythms that underpin it (Beck, 2000; Giddens, 1990; Wajcman, 2015) – and the rise of 'smart' means that this trend shows no sign of relenting. Therefore, we will discuss some ways in which smart promises contribute to normalising approaches to human activity based on assumptions that equate speed with progress and busyness with success.

Methodology

Our sample of smart home industry discourses[i] (n=14) was mostly adverts and focused on specific products (or product ranges), which often constituted descriptions, sales information, and demonstrations. Such discourses were prioritised over other types of industry documents (e.g. instruction manuals, user trial reports) because they better portrayed explicit, public-facing promises. As a working paper, the purpose of our sampling approach was to yield a cross-sectional flavour (rather than be comprehensive) of the smart home industry discourse. As such, our discourses represent a range of: media (videos, infographics, websites, images, etc.); manufacturers (LG, Philips, Google, Apple, etc.); solutions (thermostats, lighting, appliances, whole home, etc.); and means of control (automation, manual, hybrid, etc.). The themes discussed in the following section emerged from cross-comparing the outcomes of both authors' thematic coding of these discourses.

[i] Smart home industry discourses included: Samsung's Now you know you know videos; Honeywell's Smart homes of the future – An industry view; Rexel's Smart solutions; GAMP's Vision of smart home: The role of mobile in the home of the future; LG blogs, e.g. Smart appliances, A brighter future; PassivLiving HEAT; Nordek's GoControl; Tado; Google's NEST; Apple's Homekit; Panasonic's Smart Home; British Gas' Hive; Bosch's Home Connect; Philips' Hue.

Smart home promises

Smart home promise #1:
Giving you peace-of-mind

Loaded within the industry discourses is the assertion that busyness is a problem and, as such, everyone should be concerned about how that inhibits one's peace-of-mind. Ultimately, people were told that they needed to start 'simplifying your life' (Philips Hue). Whilst it is talked about in more general terms (i.e. for everyone), the examples typically centre around combinations of busy family life and/or work life. Thus, peace-of-mind was often implicitly regarded as being especially a problem for 'high-flying' professionals with families. Alongside this problem emphasis, it was also evident through their exclusion that drastic lifestyle changes (e.g. slowing down) were not a solution to achieving peace-of-mind. Similarly, work-related busyness was only presented in a conventional sense, which left almost no room for more dynamic management of busyness (e.g. working from home; flexible working). Instead, the solution to busyness usually involved a tweaking of the *status quo* through the careful selection of the most appropriate (smart) domestic technologies.

The specified benefits of achieving this peace-of-mind were based on certain terms of reference. For example, two emergent themes involved being (1) secure in the home and (2) a good family provider; both were a common basis of adverts for many smart home products. In addition, peace-of-mind was also said to be achieved through satisfying curiosity linked to, for instance, not knowing if you had locked the front door or turned off the iron (Samsung). All these benefits were grounded in a wider framing of some sort of 'better life'. For example, smart technologies would give you peace-of-mind which would then also give you more time to better utilise your home, including the other opportunities offered by smart technologies (e.g. your coffee machine becomes 'your personal barista' (Bosch Home Connect)). Thus, there seemed to be an implication that there could be a 'double win' for one's peace-of-mind and personal well-being. Also implicit to these smart home industry discourses was that this peace-of-mind was less linked to managing work (pressures).

All these stated benefits relate to social understandings regarding the connection between the ability to judge and manage one's life and the speed and intensity of that life. As Aristotle once said, 'a wise man is never in a hurry' (Gunn, 2001, p.12). Indeed, this is a central tenet of the peace-of-mind promise, in that the discourses are promising efficiency in living, which would then facilitate getting more done in the same amount of time and thereby reducing one's sense of busyness.

Smart home promise #2:
Giving you control

'Control' of one's everyday life is put forward as a primary means for achieving peace-of-mind; 'rest assured, you're always in control' (Samsung). This was particularly the case for homemaking-related tasks, with smart technologies being able to remove the 'hassle from home chores and management' (LG). In terms of what we specifically mean by control here, we note that it was not necessarily to do with controlling whether or not a particular activity was performed. Indeed, by emphasising the need to control one's activities, the implicit message was that those very same activities needed to be performed. These technologies were in many ways, then, locking one into being busy but in an organised, rather than disorganised, way. Moreover, there were numerous examples of smart technologies

only promising to make certain activities more efficient in certain ways, which were reinforcing gendered visions. For example, adverts would include images of women when presenting the benefits of chore management as part of homemaking, with images of men utilised when selling the benefits of new ways to manage hot water and heating controls.

The control of *when* and *who* performed domestic practices was usually enabled through enhanced (smart) capabilities of domestic technologies, either by: (1) giving more choice to the householders, or specifically to the household members that were regarded as key decision-makers, such as the adults/parents in the case of families. This may simply involve improved feedback (e.g. 'See your home. Away from home' (Google NEST)) or could involve providing a new range of options for how certain tasks may be actioned, both of which tended to blur boundaries between domestic life and other (e.g. working) life. Alternatively, control may be sought by (2) bypassing the individual so that the technologies take control. As was noted, this means that 'without you even giving commands, your home is always at the ready' (Apple Homekit). As such, this can represent a design choice between skilling the social and skilling the technology.

These smart technologies thus facilitate busyness, whilst also predominantly offering an opportunity to choose how to manage (rather than, say, prevent) that busyness. This in part drives a focus on achieving (temporal) efficiency through convenient means; 'smart home control convenience that makes your busy life easier to manage' (Nordek GoControl). Indeed, efficiency and convenience are reiterated throughout the discourses as products and characteristics of controlling everyday life.

Smart home promise #3:
Mobile phones are remote controls for your (smart home) life

The mobile phone is presented as a tool for achieving peace-of-mind, through having control over all domestic aspects of one's life. In fact smartphones were mentioned, and/or shown visually, in all the smart home industry discourses that we examined. In eight cases, images of mobile phones are included on the principal/home page of the website. While other devices (e.g. tablets) are sometimes mentioned, these appear as an afterthought for showing the capability of technology that can allow alternative assemblages. The mobile phone, thus, appears as the remote control for the smart home, as well as the primary tool for controlling busyness. Two qualities of mobile phones are especially emphasized – ease-of-use and ubiquity – each of which we now discuss in turn.

Smartphones are presented as enabling the easy operation of a multitude of smart home functions, from controlling indoor temperature and individual appliances, to providing instant access to home security cameras. Any of these operations can be executed effortlessly 'with a couple of taps on a touchscreen' (LG); it is 'as easy [...]as to change the TV channel' (British Gas Hive). By emphasising the act of tapping a touchscreen – which stands, here, for smartphone literacy – as the only action required for controlling busyness and the operations of one's home more widely, smart home discourses also emphasise the expectation of faultlessness in the connection between smart elements. Smart home systems are thus put forward as always working smoothly with no errors, which is perhaps unsurprising given that the industries are seeking to sell these products.

Mobile phones also make the operation of smart home systems ubiquitous. While the physical house is situated in a fixed location, all smart home functions can be accessed from anywhere. Whether you are 'at work, on the bus, or in the pub' (British Gas Hive), in your lunch break (Samsung), 'on the train, [...] picking up the children, or even on holiday' (PassivLiving HEAT), you can control the temperature of your house through your mobile phone. The promise of remoteness and ubiquity of control is based on the assumption that smart home owners always have their mobile phones with them and are able to check/use them at all times, even during work hours. Moreover, some manufacturers introduce the function of geo-location, allowing the smart home system to use the phone's location to, for example, automatically turn the heating on/off (Tado).

Ease-of-use and ubiquity are, here, qualities of mobile phones that make good tools for controlling busyness. But the actions of checking/using one's mobile phone at all times might contribute to a feeling of busyness throughout the day. The alertness of being 'always on', of always being in touch with one's smart home system, as well as with one's work tasks, transforms the idea of 'work-life balance' into 'work and life on a loop'. Similarly, the quality of ease-of-use suggests time saving, but for example in emphasising the act of tapping the touchscreen in order to change indoor temperatures, what is absent is the much more time-consuming task of setting up the smart home system and of connecting all the technologies involved. As discussed, the possibility of error – which is actually part of the everyday use of any smartphone application – is also missing in the discourses.

Final reflections

This paper aims to investigate what sorts of 'promises' are made by smart home industry discourses for re-organising busyness. It is clear that busy lifestyles are facilitated, rather than counteracted, by new smart technologies, through promises related to control, peace-of-mind, and by proposing a specific tool to do this work with – the mobile phone. Thus, smart home discourses are normalising busyness and seeking to accelerate life even further. Indeed, they are so dominated by talk of 'efficiency' because 'doing more' is inherently assumed to be a good thing to do in the first place.

In further reflecting upon the emergent themes from the discourse, it is useful to return to Southerton and Tomlinson's (2005) three mechanisms for feeling 'harried' (see Section 2). Specifically, it strikes us that smart homes promise to help householders manage certain mechanisms of busyness better than others, and thereby they only confront certain aspects of harriedness. For example, smart home technologies are good at helping households organise, schedule and co-ordinate their domestic lives. They can often also be effective at helping reduce temporal density because they allow householders to multi-task to a greater extent and hence do more in less time. However, since smart home promises involve households benefiting from using this spare time to do even more tasks, the suggestion is that households may end up doing more activities than before. Moreover, households are likely to feel especially busy because smart homes are not promising to change how long it takes to actually most day-to-day tasks.

A strong implication of this paper is hence that smart homes are implicitly promising

to make people busier in various ways, whether that actually ends up happening or not. More research is required to delve deeper into this argument, as part of better understanding the promises made by different actors and the actual impact of such promises on people's busyness. For example, how do these explicit ('end-user facing') promises relate to the actual visions that industries have of smart home end-users? How do promises vary across actors, within industry and beyond (e.g. policymakers), and how may those differences/similarities change as the smart home concept itself evolves over time? It would also be interesting to research how policy and/or technological design could better direct people's (domestic) lives in less busy directions. For instance, is it possible for smart home technologies to successfully intervene in all three mechanisms of harriedness?

In reflecting on re-defining busyness more broadly, we also wondered what this new alliance between smart and busyness means at a wider scale. The discourses we examined suggest that smart busyness means having peace-of-mind about being busy, by being able to control, and to rank between, all aspects that make everyday life hectic. Therefore, smart home industry discourses propose a rather ordered and, almost, mindful busyness. Linked to this, at a wider socio-political scale, what smart busyness proposes is not reflection over the conditions that made us busy in the first place – which concepts such as 'slow' and 'degrowth' actually do – but solely a more efficient way to manage 'business as usual'. Indeed if attention was to be shifted towards a deceleration of our domestic lives, then we must consider how to develop 'slow smart homes' or (assuming the wise man is indeed never in a hurry) 'wise homes'.

ARE YOU IN OR ARE YOU OUT?

CONSIDERING INCLUSIVE AND EXCLUSIVE FEATURES OF DIGITAL ENERGY MANAGEMENT TECHNOLOGIES AND WELLBEING.

BUCHANAN, ROBISON AND WHITTLE

Abstract

The increasing prevalence of digital technologies in our daily lives provides motivation to develop our understanding of their impact on wellbeing (quality of life). In this exploratory paper, we define and develop the idea that features of technology can be more or less 'inclusive' or 'exclusive', and that these two modalities make fundamentally different assumptions about how wellbeing is enabled. At the inclusive end of the spectrum, ultimate choice and responsibility is laid with the user: the technology (designer) aims to raise awareness, enable, and inspire user action. Exclusive features, on the other hand, aim to 'serve' by taking on tasks that (it is assumed) the user cannot / doesn't want to / doesn't have time to undertake. These concepts build on notions of active/passive technology use, but more explicitly consider: (i) user perception; (ii) designer intention; (iii) interconnectedness with sociological setting. Using existing data from users' reactions to prospective and existing Home Energy Management Systems (HEMS), we illustrate how inclusive/exclusive features of technology may better satisfy (or thwart) user's psychological needs. This holds consequences for wellbeing, but depends in large part upon the very particular context of the user during that instance of technology use. We suggest scope for design of different technology 'modes', which recognise how users' needs may change over time. We conclude that future research which explores the relationship between inclusive and exclusive *experiences* of technology and wellbeing could be of use to designers, and holds implications for technology uptake/ rejection, performance and longevity of use.

Introduction

The increasing prevalence of digital technologies in our daily lives means it is important to develop our understanding of how they impact our wellbeing, for example facilitating or obstructing personal growth. One expanding area is that of digital technologies which offer households the chance to 'better manage' their energy use. While there has been considerable interest in evaluating the energy-reduction capabilities of these products (e.g. Faruqui *et al.*, 2010) only one study (Pelenur and Cruickshank, 2013) has considered how energy management products influence wellbeing. Yet, aside from the fact that wellbeing is important in its own right[i], the extent to which people are convinced that a technology is going to help rather than harm their wellbeing is likely to contribute to both its adoption and longevity. Indeed, promises of enhanced wellbeing are currently implicitly used to market smart home technologies (Foulds and Morosanu, 2016).

In this exploratory paper we develop the idea that features of technology can be more or less 'inclusive' or 'exclusive', and that these two modalities make fundamentally different assumptions about how wellbeing is enabled. We contend that the extent to which the user is included or excluded by a technology will affect wellbeing via the impact on a user's basic psychological needs. Thus our

Kathryn Buchanan[1], Rosalyn A.V. Robison[2] and Colin G. Whittle[3].

[1] Department of Psychology, University of Essex;
[2] Global Sustainability Institute, Anglia Ruskin University;
[3] Department of Psychology, University of Sheffield.

contribution is twofold: firstly, we set out our inclusive/exclusive typology (building on active/passive concepts) and secondly we explore how this typology might assist consideration of wellbeing aims in technology design, alongside other aims. Using qualitative data on the perceptions and usage of Home Energy Management Systems (HEMS)[ii] we illustrate how the inclusive and/or exclusive features of a technology may satisfy to greater or lesser extent users' basic psychological needs. We attempt to build on interdisciplinary debates, across e.g. HCI/psychological theory (e.g. Hassenzahl and Tractinsky, 2006) and STS work on configuring the user (e.g. Woolgar, 1990).

What do we mean by inclusive and exclusive?

In this paper we propose a spectrum exists between more or less 'Inclusive' and 'Exclusive' Features of Technology (respectively IFoT and EFoT). We describe these as follows:

Inclusive Features aspire to the maxim *"greater effort = greater reward"*. Designers of these features aim to actively involve the user and repeated interaction (involving time/effort) with the technology is either required, or strongly encouraged. The algorithms underlying IFoT (e.g. how graphs are generated/conclusions drawn) are intended to be transparent to the user and may be customisable.

Exclusive Features sell themselves on *"I do this so you don't have to"*. Thus, EFoT tend to exclude or omit the user from the process where possible, instead aiming to predict and serve a user's needs. Thus control lies at the network level, and very little is required from the user apart from an initial period of opting in to the service, or in some cases, not opting out.

The term 'inclusive' is often applied to technologies designed to aid accessibility for those with disabilities (e.g. Abascal and Nicolle, 2005). Equally, 'exclusion' from technology has been previously explored in terms of the cognitive and physical demands placed on the user, which may mean a technology is beyond the user's capabilities (e.g. Combe *et al.,* 2011). Our discussion of IFoT and EFoT seeks to extend beyond these cognitive and physical demands to include three additional elements: (i) the *user's perception* of their ability to use the technology; (ii) the *designers' intentions* regarding user involvement; and (iii) the wider *sociological setting* (including the user household) which every instance of technology use is intertwined with. These distinct elements may not be aligned within a particular technology (i.e. a user may feel empowered to engage in-depth with a feature, even if the designer did not intend this) however they do tend to bundle together.

Our spectrum is related to notions of active/passive technology use. However the latter is generally defined through *actual tasks undertaken* by a user. For example, Montague & JieXu (2012) state that 'if most of the tasks are monitoring tasks, rather than tasks such a prediction, planning, control, etc., then the work could be considered passive', and vice versa for active work. We note that this conceptualisation does not include the possibility of technology which the user has little (or no) awareness of and thus is not

[i] A fact evidenced by the UK government's decision to assess general wellbeing (as in, quality of life rather than simply standard of living), alongside Gross Domestic Product, as an indicator of Britain's success.

[ii] HEMS typically consist of an electronic display screen which provides households with greater information about and control over their devices and energy consumption (Bouhafs, Mackay, & Merabti, 2014).

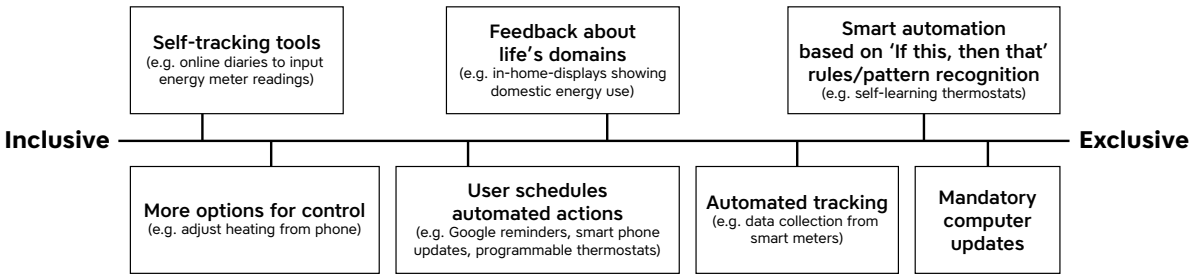

Figure 1. The inclusive/exclusive spectrum. Note some features may be difficult to place, e.g. when typical user involvement and design intention are hard to pin down.

even monitoring. Our spectrum therefore extends the active/passive framework, and encompasses a broader range of elements, notably those listed in the preceding paragraph, which we see as a good place to start in widening discussion.

We intentionally refer to *features* of technology. Often a product is comprised of both inclusive and exclusive features (e.g., the self-learning feature of NEST[iii] is an EFoT, while the ability to control heating remotely using NEST's smart phone app is an IFoT). See Figure 1. for illustrative examples.

Relating the inclusive/exclusive framework to wellbeing

Wellbeing is a complex construct which can be defined in multiple ways - see Henderson and Knight (2012) for a review. In the psychological field, distinction is drawn between eudaimonic approaches, which focus on aspects of personal growth (Swindells *et al.*, 2013) and hedonistic perspectives, which focus on life satisfaction (Keyes *et al.*, 2002). Within digital technology, emerging concepts such as 'positive computing' aim to more fully incorporate wellbeing into design. For example, Calvo & Peters (2014) identify three categories of *Wellbeing Factor for Positive Computing:* (1) interpersonal (individual); (2) intrapersonal (relationships); and (3) extrapersonal (higher goals).

In this paper, we adopt a (eudaimonic) framework which broadly maps onto these categories - Basic Psychological Needs Satisfaction theory (BPNS; Deci and Ryan, 2002). BPNS has the advantage of being widely investigated and empirically supported across a diverse range of cultures. BPNS contends that wellbeing is more likely to occur when three universal needs are (better) satisfied: (1) *competence* (effectiveness and capability); (2) *relatedness* (connecting with others, belonging and social acceptance); and (3) *autonomy* (personal agency/direction) (Ryan and Deci, 2008).

In Table 1 (following page), we use qualitative data relating to a HEMS to illustrate how autonomy, competence, and relatedness may be satisfied (or thwarted) by IFoT/EFoT. Quotes, collated from focus groups and consumer reviews, demonstrate users' reactions to either a HEMS that they are using or a HEMS concept they have been presented with (data sources indicated in table).

[iii] NEST (http://nest.com) is a digitally connected device for automatizing and scheduling household heating/cooling.

		Inclusive Features of Technology "Greater effort = greater reward"	**Exclusive Features of Technology** "I do this so you don't have to"
Competence	*Satisfied* "I feel a sense of accomplishment from what I do"[f]	Feedback technologies ideally provide users with knowledge needed to manage their lives better. "*I discovered the reason why my [energy] bills went up…my electric shower was malfunctioning*" (IHD[a])	Allocating management of tedious or complex tasks to an automated system may achieve better performance. "*It's great! Set your heating to a target temperature and NEST works out how long it will take*" (NEST[b])
	Thwarted "I often do not feel very capable"	May require active management that takes time away from other tasks. "*That's inconvenient, you're looking at your monitor every five minutes*" (concept presented: IHD + specified, 'off-peak' intervals[c])	Competence can be violated when the system 'gets it wrong'. *"Without manual intervention, you return to a cold house, despite a schedule asking for it to be warm*" (NEST[b])
Relatedness	*Satisfied* "I get along with people I come into contact with"	Feedback technologies can be used with other people to gain and share insights or to encourage one another to implement changes. *"Seeing the number of watts we are burning has encouraged the family to turn lights off behind them"* (IHD[a])	Self-learning technologies may adapt to suit multiple people, alleviating household tension through ensuring tasks get done without reminders. "*I think it has the potential to change the behaviour of even those who do not care about it*" (concept presented: automated HEMS[d])
	Thwarted "The people I interact with regularly do not seem to like me much"	May create friction, especially where one user is 'in control' and the other is 'locked out' or multiple parties are vying for control. "*My only complaint is… [my wife] can now remotely check on the house temperature and turn it down*" (NEST[b])	Conflict may arise when the end-goal of the technology conflicts with one or more users or they have had little say in introduction of the technology into their lives. *"This is a great idea but my kids would hate it"* (concept presented: automated HEMS[e]).
Autonomy	*Satisfied* "I feel like I am free to decide for myself how to live my life"	Can grant increased access to choices or options that were previously unavailable. "*Can control heating from anywhere in the world*" (NEST[b])	Automated systems can free up time/effort while still enabling users to feel in control. "*You might not have control…because you've chosen not to have control but it's still up to you*" (automated HEMS[c])
	Thwarted "In my daily life, I frequently have to do what I am told"	Users may feel controlled due to "compulsive" checking behaviours, or desire to meet aspirational targets. "*I can't have [the heating] on because I'm wasting money, but it's cold*" (IHD[d])	Opaque algorithms underlying self-learning systems, may mean users are unable to opt out of automated processes. "*Unfortunately there is no way to roll back the software to an earlier, functioning, version"* (NEST[b])

Note. IHD = In-Home Display showing energy use and cost; HEMS = Home Energy Management System. Data sources: [a=] Buchanan et al., 2014; [b]=Amazon reviews of NEST; [c]=Buchanan et al., 2016; [d]=Hargreaves et al., 2010 ; [e]= Buchanan, 2014; [f]Quoted examples from the BPNS measure (Illardi, Leone, Kasser, Ryan, 1993).

Table 1. End user quotes illustrating how inclusive and exclusive features of technology may tend to satisfy or thwart competence, autonomy, and relatedness.

Discussion

In this short paper we have illustrated how technology features lie on a spectrum between *inclusivity* and *exclusivity*, and that *both* of these modalities can tend to thwart or satisfy wellbeing needs. Thus we emphasise that neither IFoT nor EFoT is 'better' than the other. In different contexts, users will need or want technology that is more inclusive than exclusive, or vice versa. One approach then is to aim for technology that is somewhere 'in the middle', however a further possibility exists of different 'modes'. When first encountered, a product may involve the user more, but a period may then follow where it can operate without extensive user input. In time a user's requirements may change, leading to an aptly timed review period that once again actively includes the user, perhaps with new features. This is of course how many technologies are experienced, and may be implicit in designers' working practices, but is rarely made explicit to users which could improve longevity of use.

It is also clear the IFoT and EFoT classifications are highly personal. Whether the user *perceives* themselves as being included / excluded will vary depending on who the user is, their technical know-how, the situation they are in, and their motivations (or the basic needs they are pursuing). Given this, we speculate that future research could fruitfully explore inclusive and exclusive experiences of technology, which may necessarily involve on-the-ground observations of 'technologies in use'. These could potentially be contrasted with design intentions via e.g. interviews, observation, or marketing materials. This would help develop a more critical appreciation of the relationship between *experiences* of technology use and wellbeing, with implications for technology uptake/ rejection and performance.

We hope to have provided a provocative framework that could feed into the future design and marketing of technologies, or indeed to technology-related policymaking (which often downplays, for example, the complex household negotiations that take place when adopting a new technology). During the design process, IFoTs and EFoTs could be identified and mapped onto potential opportunities to better satisfy or avoid thwarting basic psychological needs. By explicitly considering impact on wider wellbeing, we can move beyond the narrow motives that are often targeted (e.g., X product can help you reduce your energy bills/carbon footprint) and alternatively promote benefits for wellbeing.

A NATION OF ADDICTS?

MORLEY AND ROBISON

Abstract

According to some accounts, the UK is a nation addicted to smartphones. A similar rhetoric and set of concerns extends to other digital technologies, such as the internet and social media. In this short paper, we unpack ways of thinking about addictive, compulsive or otherwise frequent use of such technologies by drawing on a variety of disciplinary perspectives: from clinical assessments to the psychology and sociology of more widespread experiences. We begin by examining the most tightly specified definitions of addiction, as used in the diagnosis and treatment of abnormal psychological conditions. Here, digital addictions are extreme conditions that bring highly detrimental impacts for those affected. This contrasts with the widespread and more ordinary ways in which digital technologies are used; some of which may be nevertheless be defined as compulsive and detrimental through their affects on health, relationships and general sense of (im)balance. Reframing the discussion, we then consider how such experiences could be seen as outcomes of the organisation and interconnections of social practices. Finally, we argue that some aspects of the widespread and frequent use of digital technologies are not articulated through a language of addiction or compulsion but rather represent *dependence*, which is not necessarily problematic, at least for the individuals concerned. However, just as with car dependence, internet dependence may be problematised in terms of its consequences at societal level, that is, in relation to growing energy demand and equity and security of access.

Janine Morley[1] and
Rosalyn A.V. Robison[2].

[1] DEMAND Centre, Lancaster University;
[2] Global Sustainability Institute, Anglia Ruskin University.

'It's the action of an addict ... I'll go down a Beyoncé Google hole for 4 hours ... anything but write.'

Zadie Smith in interview with Lena Dunham, quoted in the Guardian (Delaney, 2015).

Introduction

In 2011, an Ofcom survey revealed that 'the UK has become addicted to smartphones, with people confessing to using them everywhere from the dining table to the bathroom and bedroom' (Ofcom, 2011). In 2015, half of UK smartphone users surveyed agreed that they were 'hooked' on their smartphones (Ofcom, 2015). Concerns are raised about toddlers' and teenagers' 'screen time' and fixations with tablet computers and the detrimental effects of so much time online (e.g. Turkle, 2011). Are we a nation of addicts?

The problems we perceive as being associated with digital technologies affect whether and how initiatives are designed to change how they are used. Concepts of addiction, and related connotations of excessive, uncontrolled and detrimental use, may inform goals as diverse as promoting wellbeing and work-life balance and reducing the carbon emissions associated with information technologies. In this short paper, we seek to unpack ways of thinking about addictive, compulsive or otherwise frequent use of digital technologies by drawing on a variety of disciplinary perspectives: from clinical diagnoses to the psychology and sociology of more widespread experiences. Our aim

is not to argue for one of these approaches or another, nor indeed to synthesise them. Rather, we hope to promote and contribute to a discussion of more subtle, varied and differentiated ideas about the increasingly widespread use of digital technology, in particular smartphones and the internet, and where and how concepts of 'addiction' might be relevant.

We begin by examining the most tightly specified definitions of addiction, as used in the diagnosis and treatment of abnormal psychological conditions. Here, digital addictions are extreme conditions that bring highly detrimental impacts for those affected; this contrasts with the widespread and more ordinary ways in which digital technologies are used. But, as we consider next, some of this might still be defined as compulsive and detrimental for those involved. Reframing the discussion, we then consider how such experiences could be seen as outcomes of the organisation and interconnections of social practices. In concluding, we suggest that some aspects of the widespread and frequent use of digital technologies are not articulated through a language of addiction or compulsion but rather represent *dependence*, which is not necessarily problematic.

Addiction as a clinical condition

In order to aid diagnosis and treatment, volumes such as the Diagnostic and Statistical Manual of Mental Disorders (DSM-5, 2013) generally characterise *clinical* addictions (or 'substance use disorders') as diseases involving dysfunctions of brain reward circuitry. Yet clinical understandings of addictions differ. A behavioural understanding focuses on addictions as *learnt behaviours*, for example, when a psychoactive 'high' is experienced which then leads to a reinforcing cycle of repeat behaviour (Young, 2011). In addition to psychoactive substances, such 'highs' might also result from online gambling, gaming, pornography or even social media. In contrast, psychoanalytical approaches might be interested in compulsive behaviour as a *symptom*, a means of coping with underlying conflict that needs to be understood and resolved before the addiction can be dealt with[i]. For example, the desire to be both a good worker and a good parent, when one's own father was largely absent due to a demanding job, might be seen to manifest in compulsive checking of work emails when at home. Treatment solutions differ in each case. Indeed, clinic-based treatments for internet addiction are currently being offered[ii].

However, gambling is the only behavioural (rather than substance-based) addiction formally recognised in DSM-5; internet gambling is noted but requires further research before full inclusion. There is a continuing debate about the clinical status of internet addiction (Starcevic, 2013; Kuss *et al.*, 2014), internet gaming disorder (Petry and O'Brien, 2013), smartphone addiction (Kwon *et al.*, 2013) and social network or Facebook addiction (Andreassen *et al.*, 2012). Proponents cite the degree to which 'excessive' engagement with these technologies, services or activities can be seriously detrimental to health and wellbeing. For instance, in South Korea, large numbers of

[i] Many thanks to Rosemary Randall (psychotherapist) for helpful discussions on this.
[ii] http://www.priorygroup.com/addictions/internet.

young people spend significant amounts of time gaming, which is thought to contribute to heart attacks (Block, 2008).

Clinical formulations 'individualise' addiction: diagnoses and assessment tools aim to mark out those who are most affected and would most benefit from treatment. For instance, the idea that high (but socially normal) levels of smartphone use qualify a 'mild' version of internet addiction is refuted by some clinicians (Gitlow, 2013). Instead, they report that those who experience *clinical* addiction did not start out as 'normal' users, that they always had a difficult relationship with the substance/behaviour of interest, quite different from mainstream experiences. The clinically defined 'addict' is therefore distinguished by contrast to the 'normal' population; a conceptualisation that renders the image of a 'nation of addicts' somewhat contradictory.

Compulsion as a common experience

A more colloquial language of addiction, nevertheless, has resonance in contemporary narratives and experiences, particularly associated with smartphones and social media. Moreover, some authors point to evidence of widespread negative consequences of using digital technologies that affect not just small numbers of individuals, but large groups and even whole generations. This includes impairments in attention (Carr, 2010), self-reflection (Annisette & Lafreniere, in press) and the quality of interpersonal relationships (Turkle, 2011). Indeed, Compulsive Internet Use (CIU; involving loss of control, mood change, and withdrawal) was found in a recent survey to affect 63% of British adults to some degree (Quiñones-García & Korak-Kakabadse, 2014). Here, the lack of a 'substance' of addiction has led some researchers to prefer the term 'compulsion'. In contrast to diagnosing individuals as 'addicts', this helps shift attention to the particular qualities of digital devices and services and the interactions with them that may become 'addictive' or at least compulsion-forming (e.g. 'checking habits'). For instance, Greenfield (2010, p.140) suggests that the 'addictive potential of the internet and other digital media technologies' lies in high degrees of access and availability to generally pleasurable content which is also unpredictable in its relevance and reward.

A number of 'solutions' and advice aimed at helping people cope with the compulsive and undesirable aspects of smartphone, social media and internet use have emerged. These include digital detox holidays, self-help books and software that enforce periods of 'down-time' and disconnection[iii]. Whilst often framed in terms of (im)balance across different aspects of daily life, such 'solutions' also reproduce a prevalent problematisation of digital technology-use as a form of substance misuse; this is by drawing on abstinence strategies and a language of (de)toxification. Furthermore, just as with addiction, such solutions tend to be framed in terms of individuals and their (in) abilities to cope. Yet there may be other ways to think about forms of addiction and compulsion related to digital technologies.

[iii] See, for example itstimetologoff.com for a range of digital 'diets' and retreats, and internet blocking software like Freedom (freedom.to) and SelfControl (selfcontrolapp.com).

Addiction and compulsion as outcomes of practice

One family of sociological theories, known as theories of practice, are increasingly being used to analyse everyday life by focusing on the shared practices in which people engage and how these are organised, maintained and evolve over time (Reckwitz, 2002; Schatzki, 2002; Warde, 2005; Shove *et al.*, 2012). When extended to health and particularly to lifestyle diseases (Blue *et al.*, 2014; Maller, 2015), this perspective re-interprets addiction. For instance, Blue *et al.* (2015) argue that there is more to understanding smoking and how it has become a health problem than the fact that tobacco is addictive. Rather, individual addictions are seen to be both an outcome, and a part, of engaging in the activity of smoking, and the other activities of associated with it, such as drinking, going out for a meal and working. Importantly, these activities have changed over time, including their associations with one another, as seen in the recent ban on smoking in public places.

In the case of digital technologies, this prompts us to think more carefully about the activities in which they are embedded and that they allow for, and how these have emerged and change over time. Importantly, this is not only a matter of direct engagement in activities such as going on Facebook, using Twitter or emailing, but also the many other activities (working, keeping in touch, organising a meal, marketing) of multiple groups including companies and institutions (in various industries and roles). Indeed, some groups may have a particularly keen interest in designing services and devices to gain and sustain attention (for instance, for advertising revenue).

In addition, the fact that certain digital devices and services 'fit' at the intersection of many different activities might also offer insight into how and why compulsions emerge and become disruptive. Devices like the smartphone, or a facility like the internet, bring together possibilities for so many different kinds of activity, such that one thing leads to another and it is rather too easy to end up in a 'google hole'[iv] or spend longer than planned on social media. With mobile and pocket-sized devices and widespread communications infrastructures, internet-based activities are portable and possible throughout the day regardless of whatever else one might be doing. For example, it seems that 'checking' a smartphone first thing in the morning has become common (Lord *et al.*, 2015; Ofcom, 2015), perhaps by virtue of the many ways that this intersects with other activities: turning off an alarm, checking the news or weather, avoiding getting out of bed, waiting for the bathroom, and so on. Thus, further insight may be gained into disruptive experiences by questioning what other activities are inhibited and how. In other words, by situating the use of digital technologies within wider sets of practices, we can better understand the social arrangements that make possible, support and come to define the compulsions and imbalances that many people experience.

[iv] As explained in the Urban Dictionary: 'when you use Google to search for a piece of meaningless information, and that thing leads you to search something else, and then something in that makes you search for more meaningless information'. http://www.urbandictionary.com/define.php?term=google+hole

Concluding thoughts: Beyond addiction

Yet a fuller appreciation of the prevalence, centrality and significance of digital technologies in everyday life, as evoked by the image of a 'nation of addicts', is a challenge that, ironically, goes beyond concepts of addiction and compulsion, to more a mundane notion of dependence.

Again, there are a variety of ways to conceptualise dependence. Mattioli *et al.* (2016) have explored 'car dependence', suggesting a typology consisting of a) micro framings, based on dependent individuals; b) meso framings, in terms of dependent practices or activities; and c) macro framings of dependent societies or locales. In particular, these authors use time-use data to explore how different practices depend on car travel to a greater and lesser extent, highlighting those that are rarely ever undertaken without a car. Such an approach might be extended to digital technologies. For instance, it may help account for, and indicate, forms of use that are not necessarily experienced as addictive; but are simply unavoidable in going about the 'normal' course of everyday life. Thus, a sense of individual dependence on internet services, and the devices by which they are accessed, can be understood by reference to the central positioning of internet-connectivity within a range of different practices, which are themselves central and valued in everyday life. As an expanding array of activities and services 'migrate' online (television, music, telephone calls), what forms of practice continue to exist, and remain possible, when not connected to the internet? This is an important question because, as with other infrastructures, the internet is vulnerable to disruption, not everybody has equivalent access and competence, and it is becoming increasingly energy intensive (Andrae and Edler, 2015). Thus, even though dependence may not be problematic, routinely, at an individual level, problems may still be defined at a societal level (just as with car travel).

In considering different perspectives on digital technology addiction and dependence, this paper highlights a range of contemporary experiences that are more or less compulsive and more or less detrimental for those involved. This calls forth a range of responses. However, it is also worth noting that these perspectives may themselves be evolving. Indeed, as new technologies are introduced they are often 'problematised' in popular and academic debates; technologies are challenging and highly visible when held in contrast to more familiar ways of getting things done. We do not think about dependence on biros, clocks or trousers but each (most likely) caused a certain 'moral' concern in their early histories. Addictive and compulsive *experiences* associated with digital technologies may also be changing. For instance, Brigid Delaney (2015) claims that '[t]he phrase 'digital detox' seems quaint, like something from another era'. Rather than self-enforced restricted access to browsers and certain apps, and days or weeks spent offline she suggests that 'we have to be able to fold it into our work to create new kinds of work', that is, to collectively negotiate ways of being with digital technologies that incorporates them, normally and routinely into what we do, even if this changes as a result. Indeed, it may be that the widely shared experiences of 'addictions' and 'imbalances' associated with the use of various digital technologies are already receding from attention, just as everyday life becomes more dependent on them.

WHAT IDEAS OF USERS AND THEIR LIFESTYLES EXIST AMONGST ACTORS INVOLVED IN THE DESIGN AND DELIVERY OF HEATING TECHNOLOGIES?

WADE AND NILSTAD PETTERSEN

Abstract

Advanced heating control technologies are associated with goals about reduced or changed patterns of energy demand. Ideas of those expected to use these technologies may vary between the many actors involved in planning and making these systems work, including policy-makers and private firms, installers and citizens. In this paper we explore the ideas of users that exist amongst the different actors involved in shaping technologies that support the management of domestic heat. We do this by drawing on data from the designers, developers and installers operating in English and Norwegian contexts. In this, we consider how these different actors construct their ideas of users and what these ideas are. We end by discussing what the implications are for current ambitions around smart technologies and reduced energy demand.

Introduction

Influencing how people live in buildings is an important aspect in meeting the European Union's long-term goal of reducing its greenhouse gas emissions by 80-95 % by 2050 when compared with 1990 levels (EC, 2011). This paper draws on data from English and Norwegian contexts, where technologies that enable the management of heat in the home are currently receiving attention for their role in reducing emissions and enabling increasingly flexible energy systems. In both contexts, ideas of home heat have over time moved towards all day heating, comfort and cosiness (Palmer and Cooper, 2011; Wilhite *et al.*, 1996; Gullestad, 2001). Meanwhile, the boundaries between work and personal life are becoming ever more blurred, with consequences for the social meaning and use of time and space, including the home (Gant and Kiesler, 2002). This has implications for domestic heating and energy use. For example, increasing amounts of home working might lead people to heat their homes throughout the day, or conversely, busy lifestyles might result in a demand for more flexible heating. In both England and Norway, smart heat management technologies are expected to help engage end-users in 'energy efficient' behaviours, flexibly manage their heating around their lifestyles and reduce their energy consumption (NVE, 2015a; b; HW, 2014). However, we know little of how these devices, and the ideas surrounding them, are shaped. In this paper, we draw on the concept of scripting to look at how ideas of users might shape the management of heat in

Faye Wade[1] and
Ida Nilstad Pettersen[2].

[1] UCL Energy Institute, University College London;
[2] Dept. Product Design, Norwegian University of Science and Technology.

the home, before discussing what these scripting processes might mean for smart technologies and energy demand.

Theory: how users are scripted through design and installation processes

Akrich (1992, p.208) introduces the idea that innovators 'inscribe' or 'script' visions or predictions about the world into the objects they design, with the result that 'technical objects define a framework of action together with the actors and the space in which they are supposed to act'. Multiple scripts may be inscribed into the same product (Ingram *et al.*, 2007). With regard to heating technologies, such frameworks of action might include ideas about users and when they are in or out of the home. Scripts may be relatively closed or prescriptive, for example, a mechanical heating control with a set number of functions, or open and flexible, for example, a 'smart' heating app with a range of daily time and temperature options. For such 'open' technologies, with opportunities for broad interpretation by the end user, this idea of scripting may not be so applicable (for some limitations of scripting see Hyysalo, 2009); this paper deals with devices that have more closed scripts. Of particular importance to this note are the different actors involved in the development of user scripts, and the strategies that they employ for this process (Akrich, 1995). Organisations might use a series of 'explicit techniques' for the development of user representations, namely market surveys, consumer testing and feedback on experience (Akrich 1995), and also, user-centred design and co-design processes (Sanders and Stappers, 2008). However, the use of these techniques is 'surprisingly limited', and is not often applied in bringing new products to market (Akrich 1995; Rohracher 2003, p.183). Furthermore, the process of configuring the user is not confined to design and development, but frequently extends into the deployment and installation of technologies (Rohracher, 2003; Abi Ghanem, 2008). In particular, Rohracher (2003) notes the 'sometimes conflict-ridden' process between users, producers and other actors. In his study of ventilation systems, he identifies that intermediary installers might try to convince users of their own preferred vision of the technology design and use. The idea that intermediary actors, with their own ideas about users and their daily life, may influence the scripting process (or the de-coding of designers' scripts) is particularly relevant for this note, where the role of different actors in the scripting of heating technologies is investigated.

Context: Investigating heating technologies in England and Norway

For investigating different actors' ideas of end users, we discuss technologies in two contexts: Norwegian electric heating and English gas central heating. In Norway, domestic heating is dominated by electric systems, including electric panel heaters, which are the main heating source for 48% of households, air-to-air heat pumps (21%), heater cables (7%), and electricity-based central heating systems (SSB, 2014). Norway has a goal for all households to have two-way electricity meters installed by January 2019 (NVE, 2015a). These may be combined with feedback instruments providing energy use and price information, and with automated management systems, e.g. for heat. Meanwhile, England primarily uses systems where a gas boiler acts as the heat source, and heat is distributed via a network of panel radiators containing water. According to 2011 census data, 98% of all households in England and

Wales have central heating, the vast majority of which are gas boilers (ONS, 2011). In the English context, it is advanced central heating controls, enabling complex time and temperature control, which are receiving increasing amounts of attention.

In both cases, a series of actors, including government, manufacturers, utilities, and installers can be involved in delivering these technologies into homes, and this process can be shaped by these actors' ideas about those using them. For our Norwegian example, we draw on interviews conducted between 2010-2011 with representatives from a public enterprise responsible for restructuring energy generation and consumption in Norway, an electricity utility, and a manufacturer of electric heaters and heating management systems. The English data presented was collected through ethnographic research conducted between 2012-2013. This included interviewing heating installers, shadowing them as they installed the systems in homes, attending manufacturer training days and spending time in plumbers' merchants. In the following we focus on two themes: section 4 investigates how ideas about users are constructed and what different actors believe they want and; section 5 explores ideas and suggestions about time and temperature settings and work-life balance.

How are ideas about users constructed by different actors?

Developing ideas with users in the distance
The Norwegian public agency subsidising heating management systems primarily focuses on the market performance of products and what might make people buy them. With this prioritisation of purchasers and not users, the agency conducted a survey on purchasing motivations and realised savings, suggesting that the decision to invest in heating management systems was primarily motivated by the opportunity to save money, followed by comfort and convenience (Rambøll, 2010). Meanwhile, manufacturers have relied on limited interaction with end users. For example, a designer from the Norwegian manufacturing company explained that, traditionally the heating management systems were developed by engineers, for engineers, and that systematic gathering of feedback from users did not occur. These products were considered to be overly complicated for the user. With regards to expectations about what people want, a product development representative from the same firm assumed householders to be more interested in comfort than in energy and monetary savings.

Developing ideas by interacting with users
Exploring business opportunities for the upcoming introduction of two-way meters, the Norwegian utility company had, in collaboration with a design consultancy, carried out user studies to understand how services could be designed to make householders want them and find them useful. Firm representatives imagined a strategy of first making people aware of their own consumption, e.g. through feedback, and second, providing them with tailored advice and smart energy management services. Moving closer to the home however, heating installers studied in the English context enter homes on a daily basis, interacting with those intended to use the devices being fitted. One installer explained that he enters the settings into the digital programmable thermostat that he installs, according to a series of questions that he asks his customers: *"I would say, 'what time (...) d[o] you get up? What time d[o] you go to bed? Are you in during the day? Or are you out and about?' And explain that keeping your house warm is cheaper than cooling*

it down and heating it up again." (Brian, interview). In this way he can ensure that the end user's settings are appropriate for them, perhaps also limiting their need to interact with the device in the future. However, some heating installers also noted that they would provide settings based on their assumptions about particular user types (see Wade *et al.* 2016), or use manufacturers' settings. These suggested times and temperatures reflect expectations of smart daily life, as discussed below.

Suggested times and temperatures for users' lifestyles

Heaters and heating controls are programmable, and come equipped with pre-programmed weekly schedules. In both the Norwegian and English cases, these pre-programmed weekly schedules assume that end users will be in or out of the house at certain times of the day, and thus have embedded assumptions about when people are at home and away. Further, despite both Norwegian and English devices offering flexibility and the ability to be programmed by the user, the procedure for doing so was regarded as difficult to carry out and remember. Two of the ten pre-defined programmes for the electric heater in the Norwegian case propose two hours of comfort temperature from 6 am, followed by a six hour gap before a new comfort temperature period until 11 pm. On Saturdays and Sundays, however, people are assumed to be in the house for longer periods of time, with four programmes proposing comfort temperature periods from 7 am until 9 pm or midnight. The instruction manual recommends users to spend some time mapping how the different rooms are used before deciding how to programme the system. These ideas about end users' lifestyles were reflected by heating manufacturers in England. During observation of a manufacturer training day, it was suggested that families in larger properties may benefit from zoning, where the heating in different areas of the house can be independently controlled. In this family scenario, cooler settings might be used during the early evenings, *"sort of 16 degrees"*, whilst *"the kids are coming in from school, they're running around frantic"*. Later in the evening, *"when you've put them upstairs to do their homework and you just wanna sort of settle down"* you might *"up the temperature accordingly"*. For heating installers in England, working people and families are those with particular routines. For example, in family life, activity levels are greatest during the morning and evenings, and the property is presumed to be unoccupied during the middle of the day. Meanwhile, working customers are likely to be *"out the house at certain times of the day"* and have different weekday and weekend schedules (Roy, interview). These ideas about customers can lead heating installers to enter particular settings into the controls. In this way, ideas about customers' lifestyles shape the settings that heating installers suggest.

Discussion

With the installers as an exception, those who develop and support the introduction of new (smart) heating technologies have little explicit interaction with the prospective end users of these devices. Manufacturers and utilities focus on how to sell ideas of comfort and convenience to foster technology uptake, and technical automation to make heating more efficient. Meanwhile, when manufacturers and installers establish heating schedules, assumptions are made about work-life balance, what this means for when users

will be in or out of the home, and their subsequent space heating needs. Further, we have seen that the different actors involved in the design, development and delivery of these technologies into homes can develop quite different ideas about those intended to use them. For a new technology to be integrated into its intended socio-technical landscape, these constructions of users must be reconciled with real users (Akrich, 1995). Some of the strategies for this reconciliation have been identified above, for example, where heating installers enter settings on behalf of the users that are assumed to be unable to perform this task. Bringing the actors involved in inscribing and de-coding scripts together could enable them to draw on each other's expertise and experience and develop more successful scripts.

This opens up questions about the relationship between national expectations for smart technologies about active engagement and energy efficient behaviours as means to achieve reduced emissions and more flexibility in household energy systems (e.g. NVE, 2015a; b). Further, installers have been identified as influencing users' understandings and use of their controls (see Wade *et al.*, 2016 for a review), suggesting that their reconciliation strategies are key to shaping how these devices eventually come to be used. Smart technologies offer new opportunities for technical learning and automation, but also for providers and end users to override settings. With more advanced smart heating controls than the ones studied in this paper, it might be important to reconsider these scripts, and how the increased flexibility of these devices may lead to the actions of users being less constrained by design.

CRACKING THE CODE:

HOW ALGORITHMS AND SOFTWARE ARE SHAPING EVERYDAY LIFE.

MACRORIE, KRAGH-FURBO, AND MORLEY

Abstract

Algorithms, step-by-step sequences of operations that solve specific computational tasks, are at work all around us. Heralded for their efficiency and consistency, they support, for example, sophisticated search engines, voice recognition software, online transactions, data compression, and when coupled with data analytics, are increasingly relied upon to help inform policy decisions. The majority of research in this field focuses on optimising the predictive and calculative power of algorithms, the inter-operability of automated systems, and the filtering and deductive capacities of data analytics. Crucially, the roles and effects of algorithms remain largely unquestioned, in part due to their inherent invisibility and inscrutability. Yet, arguably, algorithms are progressively implicated in how everyday life changes and remains stable, and are subtly and consistently transforming the world around us, and how it is experienced. Drawing on real world examples, this paper begins to unpack the logics, 'automagical' work (Kitchin and Dodge, 2011), and effects of 'smart' algorithms, as implicated in three inter-related domestic activities (home heating, watching television, and car driving). We contend that algorithms contribute to shaping these social practices, and therefore whilst 'invisible', they form critical governance agents. We highlight important implications for energy demand, wellbeing and broader socio-political issues, and begin to set out a future social science research agenda for investigating the work and effects of algorithms and software code in daily life.

Introduction

New ways of monitoring and analysing everyday life are heralded as an efficient and reliable means to inform solutions to complex contemporary challenges, such as climate change, public health and economic productivity. Consequently, algorithms are expanding throughout diverse domains (e.g. home, work, transport) aided by the spread of innovative software, hardware (wi-fi infrastructures, new sensing technologies, smart phones, digital dashboards and control rooms), and real-time data analytics. Crucially, the roles and effects of algorithms remain largely unquestioned, in part due to their inherent invisibility and inscrutability. Yet, arguably, algorithms embedded in software, represent powerful rules and analytics that, as increasingly encountered, are progressively implicated in how everyday life changes and/ or remains stable. Exploring how and where these processes are occurring is therefore important for better understanding emerging directions of socio-technical change, with respect to energy demand, wellbeing, and broader socio-political issues.

The topic of 'algorithms in everyday life' emerged from the EPSRC Balance Network funded 'Daily life, digital technologies and energy demand' interdisciplinary working party held at the Urban Institute, University of Sheffield, in November 2015. Through a series of discursive webinars, and building on peer review from invited academics and practitioners, we have sought to explore this topic in this working paper. Drawing on real world examples, we begin to unpack

Rachel Macrorie[1], Mette Kragh-Furbo[2] and Janine Morley[2].

[1] Urban Institute, University of Sheffield;
[2] DEMAND Centre, University of Lancaster.

the logics, 'automagical' work (Kitchin and Dodge, 2011), and effects of 'smart' algorithms, as implicated in three inter-related domestic activities (home heating, watching television, and car driving). We contend that algorithms contribute to shaping these social practices, and therefore whilst seemingly 'invisible', they form critical governance agents. We highlight important implications for energy demand, wellbeing, and broader socio-political issues, and begin to set out a future social science research agenda for investigating the work and effects of algorithms and software code in daily life.

How algorithms work

Algorithms are not new: since the 1970s, everyday practices, social interactions, economic transactions, and political decision-making, have become increasingly suffused and mediated by the algorithms inherent in digital software (Kitchin and Dodge, 2011, p.3; Williamson, 2015). At their most simple definition, algorithms, when constructed through computer programming and combined with read/write instructions, describe a sequence of rules to follow in order accomplish a task, and enable a particular desired response (Goffey, 2008). Such algorithmic tasks include; search, recommendation, pattern recognition, secure encrypted transactions, auto-correction, profiling and optimisation (MacCormick, 2013). Coupled with automated systems, algorithms can complete millions of operations per second, reduce operational costs, help create new products and services for customers, and enable faster, and arguably improved, decision-making that minimises bias and error (Kitchin and Dodge, 2011). Given these powerful capabilities, and their promise to revolutionise increasingly digitised processes across multiple societal domains, it is no wonder that 'the bounds of algorithms get pushed further each day' (Steiner, 2012). What is often overlooked, however, is how exactly algorithms exercise this 'power' and with what socio-political implications.

Analysing algorithms

The majority of research on algorithms, and related software, focuses on design, efficiency and optimality from a purely technical perspective (Seaver, 2013): rules and analytics are understood to be neutral and stable, and algorithms are assumed to work towards a linear endpoint where a particular task will be achieved. Within the 'smart' agenda, much research seeks to improve sensing, actuation and control functions and to develop predictive or adaptive automated 'decision-making'; the smartness of a system is frequently attributed to autonomous operation based on closed-loop control, energy efficiency and networking capabilities. Consequently, the vast majority of research on algorithms seeks to optimise their predictive and calculative power, the inter-operability of automated systems, and the filtering and deductive capabilities of data analytics.

Yet a growing *corpus* of multi-disciplinary social research is concerned with the role and implications of digital technologies, including software, in society (Gillespie and Seaver, 2016). For example, it is increasingly recognised that algorithms can transform knowledge generation and modes of societal governance, with distinct implications for the organisation and experiences of everyday life (Kitchin, 2016; Gabrys, 2014; Mackenzie, 2006 etc.). Critical social scientists study these transformations by examining single algorithms or classes of algorithms, investigating the use of algorithms in one domain, or providing accounts of how algorithms work and with what effects

(e.g. Gillespie, 2014; Seaver, 2013; Kitchen, 2016). Such research understands algorithms as 'far from objective, impartial, reliable and legitimate' (Kitchin, 2016, p.4) and instead contends that they have 'significant social, political and aesthetic dimensions' (Montfort *et al.*, 2012, p.3). As such, these researchers highlight the 'pressing need to focus critical and empirical attention on algorithms and the work that they do in the world' (*ibid.*, p.3).

Analysing three 'everyday' sites of algorithmic operation

Adopting this critical social science mode of analysis, our paper exploratively extends ways of studying algorithms from their most commonly discussed applications in online services accessed through computing devices (e.g. internet search and social media), to their emerging instantiation in everyday objects (e.g. learning thermostats, smart televisions, assisted vehicle 'black boxes'). Adapting a conceptual framework developed by Ananny (2016), we propose that algorithms work by: (i) selecting and grouping people and/ or entities (e.g. thermostat settings, television programmes, vehicle movements) using pattern identification and inferred associations, (ii) predicting action and practice change based on the probability of similarity, and (iii) organising the temporal and spatial rhythms of everyday life. Drawing upon pertinent research articles, websites and grey literature, here we apply the modified Ananny framework (2016) to analyse the intentions, operation, and effects of three cases of software code, as applied to the management of; home heating, television viewing, and car driving. In so doing, we seek to understand how, and to what extent, algorithms shape interrelated practices, and with what implications for energy demand, personal wellbeing, and broader socio-political issues.

Heat comfort – learning thermostats
First launched in 2011 in the US, and expanding to the British market in April 2014, release of the third generation advanced Nest learning thermostat occurred in September 2015. This intelligent device comprises a wall-mounted unit and mobile and web applications to enable remote real-time control and provide access to the home energy history. The company behind Nest aims to utilise machine learning, sensing and networking technology, as well as feedback features 'to save energy, keep our families safe, and keep an eye on what matters most' (Nest, 2016). These promises are founded on the ability of Nest Sense algorithms to 'constantly learn[], automatically updat[e], and balanc[e] comfort and energy savings' enabling the thermostat to collect data, make decisions about, and adapt to: the home in which it is installed (e.g. how long it takes to heat up and how draughty it is), the heating system, the weather, patterns of daily household routines, and the spatio-temporal rhythms of household heat preferences (*ibid.*).

Work by Yang and Newman (2013) shows the Nest to be well received overall by a sample of early users in the United States[i]. However, 'the intelligent features of the Nest were not perceived to be as useful or intuitive as expected due to the system's inability to understand the intent behind sensed behaviour and users' difficulty in

[i] Yang and Newman (2013) conducted telephone interviews (of 45 minutes duration) with 23 Nest users from across 8 U.S. states (recruited by email and social media), ten of whom also participated in a three-week diary study (between February and September, 2012). The participants were disproportionately male, technically skilled, fairly affluent and highly interested in new technology. Participants used the Nest thermostat for up to nine months.

understanding how the Nest work[ed]' (*ibid.*, p.93). The authors describe how participants came up with strategies that interpreted certain intelligent features, but highlight how several householders felt that the Nest simply memorised their input without generating an energy-efficient heating schedule (*ibid.*, p.99). Rather, by making interactions with the heating system easier, they may well have become more frequent and this might 'lead people to pursue greater comfort which eventually consumes more energy rather than sav[ing] energy' (Yang and Newman, 2012; p.1107).

Whilst evidence from elsewhere suggests that smart thermostats can offer substantial savings on heating and air conditioning-related energy use, it is clear that their presence and role in the home is not neutral. Although subtle, a process of co-adaption is taking place: people learn to live with the thermostats, whilst the thermostats 'learn' to live with people (both in individual households and through a rolling programme that upgrades the Nest algorithms in response to analysis of how they are being used and the kinds of outcomes that result). On the one hand, the algorithms themselves are crucial components in this process: they are changing and leading to other changes. On the other hand, this process of 'change' appears to be one of largely keeping things the same, of 'fitting in' much better to peoples' expectations and everyday patterns of activity. This may serve to reinforce the spatio-temporal patterns of particular domestic practices, reproducing, entrenching and even raising (some) expectations of comfort in more energy-demanding directions.

Television viewing – smart televisions

Smart televisions (STV), with integrated interactive internet capabilities are increasingly being adopted by households around the world, whilst regular televisions can also be made 'smart' through set-top boxes that enable advanced functions. By delivering content directly, STV enables viewers to not only navigate live-broadcast programmes, but also to check online content, browse the internet, and to use online social networking, amongst other services (Shin *et al.,* 2013). Three key capabilities separate STV from existing TVs: integration – of a computer system within a television set unit enabling the user to run advanced applications; interactivity – the ability to easily surf between channels and web sites; and synchronicity – provision of real-time data and related content (*ibid.*, p.158). Given this expanded functionality, STVs are marketed as 'systems that are responsive, easy to control, and personalised' (*ibid.*, p.159).

STV and digital streaming services have enabled the entertainment industry to undergo a shift from analogue broadcasting of scheduled television shows, to time-shifting via digital playback television (where programmes are recorded and made available to view after the live showing), and niche programming (which opens up an endless number of channels to cater to smaller, more targeted audiences). In order to capture a larger proportion of this 'new' viewing market, and to enhance audience experience, top entertainment providers (such as, Netflix and Amazon) now employ large engineering teams dedicated to 'crack the code' of viewer preferences and personalise entertainment services. Inherent to these systems are purposely-designed algorithms that undertake 'collaborative filtering'; sorting large data sets into groups sharing certain affinities, and clustering existing interaction patterns. These categories are then used to guide viewers to particular TV shows, films, products and advertisements that are calibrated to individuals' tastes and habits. Algorithms are also used in some digital

recording systems (like Tivo) to make decisions about what programmes to automatically record (Cohn, 2016).

Whilst collaborative filtering has many 'blind spots and glitches' (Collins, 2014), digital streaming is enabling these algorithms to gain in their 'precision' as entertainment providers develop greater understanding of, track, and attempt to influence viewers' interactions, preferences and habits. Television plays a central role in many households, and the social impact of restructuring and personalising programming in this way could dramatically affect what households talk, learn about, and purchase or share (Hadas, 2011). Whilst on-demand viewing extends (some) audience choice, collaborative filtering could actually narrow-down the content to which viewers are exposed. As television viewing becomes more measurable (in real-time), adverts and information will be targeted at an increasingly granular level (based on these new analytical opportunities). The implications of these developments for how, where and when people watch television programmes are as yet unclear. Although, overall, time spent watching TV in the United Kingdom has been relatively stable over many years, the timing of viewing has been changing (unpublished analysis, DEMAND centre). Algorithmically-enhanced on-demand television may reinforce, or counter, these shifting patterns, whilst at the same time aiming to 'keep us watching'. In any case, since watching TV has important implications for energy demand during peak hours of electricity use, this is a significant space to observe.

Car driving – assisted vehicles

Supported by international organisations and trade bodies, a transformation in driving is underway (e.g. OECD/ITF, 2015). Automated vehicles are underpinned by hyperbolic claims that they 'will make driving easier, improve road safety, reduce emissions, and ease congestion' (DfT, 2015, p.12) and that ultimately access to fully automated vehicles will improve mobility for those unable or unwilling to take the wheel. Consequently, prototype autonomous vehicles are increasingly being tested on public roads in Europe, Japan and US. Accompanying this conversion, assisted driving technologies are being deployed in commercially available vehicles, and adaptations are being made to conventional vehicles to allow drivers to delegate tasks, such as parking, to automated systems. This deployment is being enabled by; increased electronics within cars, improved sensor-processing technologies, high-definition mapping and, vehicle-to-vehicle and infrastructure-to-vehicle communication technologies. Crucially, adaptive algorithms are imperative for operating assisted and autonomous driving features.

Cars now increasingly have a rudimentary version of 'black box' data recorders installed to collect information on the moments just before an accident. Using this feature, and undertaking large-scale geo-data collection using GPS and an accelerometer, Floow (a Sheffield, UK based digital technology company) (The Floow, 2016) provide an assisted driving service to deliver insight to insurers and customers. Analysing data including; location, speed, distance travelled, length of time driven, time of day driven, accelerations/ decelerations, braking or swerving events, and crashes, the company have designed powerful adaptive algorithms to monitor and quantify risky driving behaviour and to predict, and help mitigate, the likelihood and severity of a traffic accident occurring. The Floow use monitoring data to power tailored educational services that provide a means for drivers to monitor, moderate and improve their personal driving

performance, with benefits for reducing energy demand and carbon emissions, as well as potentially delivering a reduction to their insurance premiums.

Whilst this goal is socially beneficial, concerns about tracking-based insurance are raised when considering how this data will be used. Alongside insurers in North America, European firms are now encouraging telematics policies, particularly targeting 'risky' newly qualified drivers. In the near future, it is likely that if a driver doesn't agree to be tracked, they will not only pay higher premiums, but may not even be eligible for insurance (possibly prohibiting driving). But as well as potentially discriminating (either positively/negatively) against particular driving groups, concerns are highlighted in relation to limitations to personal freedoms, by 'forcing drivers to have a telematics device installed in their car, which is capable of recording and transmitting exactly where and when they are driving...' (Carr, 2014). As well as question marks over data security, concerns are raised as to how this data might be used to open-up the city, or to segregate and contain particular populations.

Research and policy implications of algorithmic governance

Analysis of these three cases has demonstrated how algorithms lying behind everyday software applications, function as part of a socio-material assemblage, and whilst often invisible and unquestioned, critically have the ability to condition how, where, when, and by whom social practices are performed. Accordingly, the spatio-temporal organisation of daily life, the experiences, wellbeing and identities of practitioners (i.e. people undertaking particular practices), and domestic energy demand and associated carbon emissions, can be substantially shaped through software code. It is this potentially 'disruptive and transformational effect' of algorithms, coupled with the increasing application of software throughout everyday life, which has led to suggestions that 'we are entering an era of widespread algorithmic governance' (Kitchin, 2016, p.2). In this paper, we have investigated three sites of practice to examine the modes of algorithmic operation, as well as explore the potential benefits and detrimental effects of governance by algorithms. This initial exploration of software code at work has highlighted the centrality of algorithms in shaping everyday life and potentially 'structuring contemporary social and geographical inequalities' (Graham, 2005, p.575). This recognition, leads us to pose three critical questions.

First, we have highlighted the importance of analysing algorithms, not just in terms of their technical efficiency and effectiveness, but also in terms of the rationales inherent to their design and use, and the power that they orchestrate. More than an objective calculative exercise, programming software and designing data analytics have been shown to be complex and contingent processes. These processes are shaped by how relevant individuals and organisations frame pertinent challenges, how these understandings render everyday life 'programmable' (i.e. translated into code), and how these codes and rules take effect in the world (i.e. transduction from code) (Kitchin, 2011). What then would constitute a social science agenda for opening up and critically examining the technocratic 'black box' of software code, together with its inherent cultural and spatial politics (Graham, 2005)? Here we suggest that the examination of algorithms at work in particular sites of daily practice, and analysis of their (potentially

overlapping) effects, can provide a useful entry point.

Second, recognising that critical social science research is required to better understand algorithmic governance, we highlight three interlinked areas for potential enquiry. First, what actors are involved in writing algorithmic code (e.g. for smart interventions), and what assumptions do they hold regarding the software's purpose and mode of operation? What scope is there for algorithmic governance to be more transparent and inclusive? Second, where, when and how is algorithmic governance occurring? What are the implications of an increasingly patterned landscape of algorithmic control? And third, what are the consequences of software for restructuring or reinforcing; spatial and temporal patterns of activity, associated levels of consumption (e.g. domestic energy demand and carbon emissions), personal identities and wellbeing, and/ or modes of citizenship and democracy?

Lastly, what type of administrative, practitioner-based, and civic responses are required to address the political, social and environmental implications of 'software-sorting' (Graham, 2005)? This article has begun to show how algorithms can have powerful effects in reinforcing or reorganising contemporary society, and has also highlighted how such techniques often rely on the invisibility, adaptive nature, and rapid expansion of software implementation across societal domains. Our research has highlighted how digital encounters within increasingly technological spaces at home and work, can 'imprint neoliberal, consumerist logics... onto a growing proportion of social and economic exchanges' (*ibid.*, p.577). We have also shown how algorithmic governance of our routinised everyday activities, can help to categorise market sectors and provide detailed user data, enabling greater commercialisation and potentially exacerbating societal fragmentation (*ibid.*, p.577). In what ways then, can policy-makers, practitioners and civil society, gain understanding of, and leverage over, these rapidly expanding software-enabled techniques, tools and domains? Furthermore, how can we examine different ways of knowing and governing society for environmental sustainability and social justice, that better account for the complexity of everyday life, and that may lie outside the lines of code?

Bibliography

Macrorie, R. and Wade, F. *Introduction.*

BIS., 2014. *The fourth work-life balance employer survey* (2013). BIS Research Paper No. 184. [online]. London: Department for Business, Innovation and Skills. Available at: https://www.gov.uk/government/publications/fourth-work-life-balance-employer-survey-2013

Climate Change Act 2008. London: HMSO.

Gram-Hanssen, K., Kofod, J. and Petersen, N., 2004. Different everyday lives - different patterns of electricity use. In: *Proceedings of the 2004 American Council for an Energy Efficient Economy Summer-study in Buildings.*

Guy, S. and Shove, E. 2000. *A sociology of energy, buildings, and the environment.* London: Routledge.

Hargreaves, T., Nye, M., and Burgess, J., 2013. Keeping energy visible? Exploring how householders interact with feedback from smart energy monitors in the longer term. *Energy Policy*, 52, pp.126-134.

Kitchin, R., 2014. The real-time city? Big data and smart urbanism. *Geojournal*, 79, pp.1-14.

Macrorie, R., Foulds, C., Hargreaves, T., 2015. Governing and governed by practices: Exploring interventions in low-carbon housing policy and practice. In: Strengers, Y. and Maller, C. eds. *Social practices, interventions and sustainability: Beyond behaviour change.* London: Routledge, pp.95-111.

Strengers, Y., 2013. *Smart energy technologies in everyday life.* London: Palgrave Macmillan.

Tech City & NESTA, 2016. Tech Nation 2016: *Transforming UK industries.* [online] London: Tech City UK in partnership with NESTA. Available at: http://www.techcityuk.com/wp-content/uploads/2016/02/Tech-Nation-2016_FINAL-ONLINE-1.pdf

Skelton, L. and Morosanu, R. *Qualities of time: A comparison of work-life balance in 17th and 21st century urban Britain.*

Barnwell, P., 2004. Workshops, Industrial Production and the Landscape. In: Barnwell *et al.*, (eds.), *The Vernacular Workshop*, pp.179-82.

Brereton, Sir W., 1635. *Journal of Sir William Brereton.* In: Hodgson, J. C., ed., *North Country Diaries*, second series, 124, Durham: Surtees Society, 1914, pp.1-50.

Bristol Record Office, 1636. 28048/D1: Lease of a Sope Workhouse, Grotelane, Bristol, between James Birkin and Abraham Barnes (21/05/1636).

Carbon Trust. 2014. *Homeworking: Helping Businesses Cut Costs and Reduce Their Carbon Footprint.* London: Carbon Trust.

Carlisle Record Office, 1596. Carlisle Probate Wills and Inventories.

CBI. 2011. *Navigating Choppy Waters: CBI/Harvey Nash Employment Trends Survey.* London: CBI and Harvey Nash.

Clarkson, L., 1960. The Organization of the English Leather Industry in the Late Sixteenth and Seventeenth Centuries, *Economic History Review*, 13(2), pp.245-56.

Cultivate London, 2016. *Cultivate London Urban Farm and Social Enterprise.* Available at: http://cultivatelondon.org/ [Accessed April 2016].

Dunnett, N. and Kingsbury, N., 2008. *Planting Green Roofs and Living Walls.* Portland, Oregon: Timber Press.

Enterprise Nation, 2014. *Home Business Report.* London: Enterprise Nation in association with Direct Line.

Felstead, A., and Jewson, N., 2000. *In Work at Home: Toward an Understanding of Homeworking.* London: Routledge.

GLA, 2012. *SPG the All London Green Grid.* London: Greater London Authority.

Lemire, B., 1988. Consumerism in pre-industrial and early industrial England: the trade in second-hand clothes. *Journal of British Studies*, 27, pp.1-24.

Palliser, D., 2000. The Origins of British Towns. In: Palliser, D., ed. 2000. *The Cambridge Urban History of Britain, vol. 1, 600-1540*, Cambridge: Cambridge University Press, pp.17-24.

Palliser, D., Slater, T., and Dennison, E., 2000. The Topography of Towns, 600-1300. In: Palliser, D., ed. 2000. *The Cambridge Urban History of Britain, vol. 1, 600-1540*, Cambridge: Cambridge University Press, pp.153-86.

Palmer, M., 2004. The workshop: Type of Building or Method of Work? In: P. Barnwell *et al.*, eds. 2004. *The Vernacular Workshop from Craft to Industry, 1400-1900*, York: Council for British Archaeology, pp.1-16.

Peters, C., 2004. *Women in Early Modern England, 1450-1640.* Basingstoke: Palgrave Macmillan.

Skelton, L., 2015. *Sanitation in Urban Britain, 1560-1700.* London: Routledge.

Southerton, D., 2009. Re-Ordering Temporal Rhythms: Co-Ordinating Daily Practices in the UK in 1937 and 2000. In: Trentmann *et al.*, eds. 2009. *Time, Consumption and Everyday Life*, pp.49-63.

Still, G., 2002. Housing in the Two Towns. In: E. Dennison, D. Ditchburn and M. Lynch, eds., *Aberdeen Before 1800. A New History*, East Linton: Tuckwell Press, pp.97-108.

The National Archives, 1670. C 6/192/35: Court of Chancery, Carlisle Dean and Chapter v Erasmus Towerson, Gent.

Thompson, E. P., 1967. Time, Work Discipline, and Industrial Capitalism, *Past and Present*, 38, pp.56-68.

Tietze, S., and Muson, G., 2002. When 'Work' Meets 'Home': Temporal Flexibility as Lived Experience. *Time and Society*, 11(2/3), pp.315–34.

Trentmann, F., *et al.*, 2009. Introduction. In: Trentmann, F., *et al.*, eds. 2009. *Time, Consumption and Everyday Life: Practice, Materiality and Culture.* Oxford: Berg.

Vannini, P., and Taggert, J., 2015. *Off the Grid: Re-Assembling Domestic Life.* New York and London: Routledge.

Wrightson, K., 2003. *English Society, 1580-1680.* London: Routledge.

Foulds, C. and Morosanu, R. *Controlling busyness: The promises of smart home industry discourses.*

Beck, U., 2000. *The Brave New World of Work.* Cambridge: Polity Press.

Gershuny, J., 2005. Busyness as the Badge of Honor for the New Superordinate Working Class. *Social Research*, 72(2), pp.287–315.

Giddens, A., 1990. *The Consequences of Modernity.* Cambridge: Polity Press.

Gunn, B., 2001. Time and wisdom. *Strategic Finance*, 82(7), pp.12–14.

Levine, R., 2005. A Geography of Busyness. *Social Research*, 72(2), pp.355–371.

Rosa, H., 2003. Social Acceleration: Ethical and Political Consequences of a Desynchronized High-Speed Society. *Constellations*, 10(1), pp.3–33.

Rosa, H., 2010. High-speed society: *Social acceleration, power, and modernity.* Pennsylvania: Penn State Press.

Rosa, H., 2013. Social Acceleration: A New Theory of Modernity. New York: Columbia University Press.
Southerton, D. & Tomlinson, M., 2005. 'Pressed for time' – the differential impacts of a 'time squeeze'. *The Sociological Review*, 53(2), pp.215–239.

Wajcman, J., 2015. *Pressed for Time: The Acceleration of Life in Digital Capitalism.* Chicago: University of Chicago Press.

Buchanan, K., Robison, R., and Whittle, C.
Are you 'in' or are you 'out'? Considering inclusive and exclusive features of digital energy management technologies and wellbeing.

Abascal, J., and Nicolle, C., 2005. Moving towards inclusive design guidelines for socially and ethically aware HCI. *Interacting with computers*, 17(5), pp.484-505.

Bouhafs, F., Mackay, M. and Merabti, M., 2014. Home Energy Management Systems. In: Bouhafs, F., Mackay, M. and Merabti, M., eds. 2014. *Communication Challenges and Solutions in the Smart Grid.* Springer: New York. pp. 53-67.

Buchanan, K., 2014. *Will People Like DANCER? Presentation on survey data exploring participants reactions to a prospective home energy management system.* Colchester: University of Essex.

Buchanan, K., Banks, N., Preston, I., and Russo, R., 2016. The British public's perception of the UK smart metering initiative: Threats and opportunities. *Energy Policy*, 91, pp.87-97.

Buchanan, K., Russo, R., and Anderson, B., 2014. Feeding back about eco-feedback: How do consumers use and respond to energy monitors? *Energy Policy*, 73, pp.138-146.

Calvo, R. A., and Peters, D., 2014. *Positive computing: Technology for wellbeing and human potential.* [e-book] MIT Press. Available at: https://mitpress.mit.edu/books/positive-computing [Accessed June 2016].

Combe, N., Harrison, D., Craig, S., and Young, M. S., 2012. An investigation into usability and exclusivity issues of digital programmable thermostats. *Journal of Engineering Design*, 23(5), pp.401-417.

Deci, E. L., and Ryan, R. M., 2008. Self-determination theory: A macrotheory of human motivation, development, and health. *Canadian Psychology/ Psychologie Canadienne*, 49(3), p.182.

Deci, E. L., and Ryan, R. M., 2002. Overview of self-determination theory: An organismic dialectical perspective. *Handbook of self-determination research*, pp.3-33.

Faruqui, A., Sergici, S., and Sharif, A., 2010. The impact of informational feedback on energy consumption – A survey of the experimental evidence. *Energy*, 35(4), pp.1598-1608.

Foulds, C., and Morosanu, R., 2016. Controlling busyness: The promises of smart home industry discourses. In: R. Macrorie and F. Wade, eds. 2016. *Daily life, digital technologies and energy demand – A working paper collection:* Sheffield, Cambridge: Urban Institute (University of Sheffield), Balance Network (Anglia Ruskin University).

Keyes, C. L., Shmotkin, D., and Ryff, C. D., 2002. Optimizing well-being: the empirical encounter of two traditions. *Journal of personality and social psychology*, 82(6), p.1007.

Hargreaves, T., Nye, M., and Burgess, J., 2010. Making energy visible: A qualitative field study of how householders interact with feedback from smart energy monitors. *Energy Policy*, 38(10), pp.6111-6119.

Hassenzahl, M., and Tractinsky, N., 2006. User experience-a research agenda. *Behaviour & Information technology*, 25(2), pp.91-97.

Henderson, L. W., and Knight, T., 2012. Integrating the hedonic and eudaimonic perspectives to more comprehensively understand wellbeing and pathways to wellbeing. *International Journal of Wellbeing*, 2(3), pp.196-221.

Ilardi, B. C., Leone, D., Kasser, T., and Ryan, R. M., 1993. Employee and Supervisor Ratings

of Motivation: Main Effects and Discrepancies Associated with Job Satisfaction and Adjustment in a Factory Setting. *Journal of Applied Social Psychology*, 23(21), pp.1789-1805.

Keyes, C. L., Shmotkin, D., and Ryff, C. D., 2002. Optimizing well-being: the empirical encounter of two traditions. *Journal of personality and social psychology*, 82(6), p.1007.

Newell, A., 2003. Inclusive design or assistive technology. In: J. Clarkson, S. Keates, R. Coleman, and C. Lebbon. *Inclusive Design: Design for the Whole Population*, London: Springer. pp.172-181.

Montague, E., and Xu, J., 2012. Understanding active and passive users: The effects of an active user using normal, hard and unreliable technologies on user assessment of trust in technology and co-user. *Applied ergonomics*, 43(4), pp.702-712.

Pelenur, M. J., and Cruickshank, H. J., 2013. Investigating the link between well-being and energy use; an explorative case study between passive and active domestic energy management systems. *Building and Environment*, 65, pp.26-34.

Rubens, S., 2015. *Smart, connected devices: the emerging user experience. A white paper based on in-home research.* London: New Experience. Available at: http://www.newexperience.com/_downloads/Smart%20connected%20devices%20white%20paper.pdf [Accessed April 2016].

Ryan, R. M., and Deci, E. L., 2000. Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American psychologist*, 55(1), p.68.

Swindells, R., Lawthom, R., Rowley, K., Siddiquee, A., Kilroy, A., and Kagan, C., 2013. Eudaimonic well-being and community arts participation. *Perspectives in public health*, 133(1), pp.60-65.

Waterman, A. S., Schwartz, S., and Conti, R., 2008. The implications of two conceptions of happiness (hedonic enjoyment and eudaimonia) for the understanding of intrinsic motivation. *Journal of Happiness Studies*, 9(1), pp.41-79.

Woolgar, S., 1990. Configuring the user: the case of usability trials. *The Sociological Review*, 38(S1), pp.58-99.

Morley, J. and Robison, R. *A nation of addicts? Exploring disciplinary perspectives on digital dependence.*

Andrae A. and Edler T., 2015. On Global Electricity Usage of Communication Technology: Trends to 2030. *Challenges*, 6, p.117.

Andreassen, C. S., Torsheim, T., Brunborg, G. S., & Pallesen, S., 2012. Development of a Facebook Addiction Scale. *Psychological Reports*, 110(2), pp.501-517.

Annisette, L. E., & Lafreniere, K. D., In Press. Social media, texting, and personality: A test of the shallowing hypothesis. *Personality and Individual Differences.*

Block, J. J., 2008. Issues for DSM-V: Internet Addiction, *American Journal of Psychiatry*, 165, pp.306-307.

Blue S., Shove E., Carmona C. and M.P. Kelly, 2014. Theories of practice and public health: understanding (un)healthy practices. *Critical Public Health*, DOI: 10.1080/09581596.2014.980396

Carr, N. G., 2010. *The shallows: what the Internet is doing to our brains.* New York, London: W.W. Norton.

Delaney B., 2015. A 'digital detox' sounds too quaint for 2016 – I don't want to ban social media, it's the way we live now. *Guardian*, [online] Available at: http://www.theguardian.com/commentisfree/2016/jan/01/a-digital-detox-sounds-quaint-in-2016-but-are-we-past-the-point-of-no-return [Accessed June 2016].

DSM-5 American Psychiatric Association, 2013. *Diagnostic and statistical manual of mental disorders.* Arlington: American Psychiatric Publishing.

Greenfield, D., 2010. The addictive properties of Internet usage. In: Young, K. S., and de Abreu, C. N. *Internet addiction: A handbook and guide to evaluation and treatment.* John Wiley & Sons, Hoboken, NJ, USA. pp.135-153.

Gitlow, S., 2013. Commentary: DSM-5: New Addiction Terminology, Same Disease. [online] Available at: http://www.drugfree.org/join-together/commentary-dsm-5-new-addiction-terminology-same-disease/ [Accessed June 2016].

Kuss, D. J., Griffiths, M. D., Karila, L., and Billieux, J., 2014. Internet Addiction: A Systematic Review

of Epidemiological Research for the Last Decade. *Current Pharmaceutical Design*, 20(25), pp.4026-4052.

Kwon, M., Lee, J.-Y., Won, W.-Y., Park, J.-W., Min, J.-A., Hahn, C., Gu, X., Choi, J.-H. and Kim, D.-J., 2003. *Development and validation of a smartphone addiction scale (SAS). PloS one*, 8(2), e56936.

Lord C., Hazas M., Clear A.K., *et al.*, 2015. *Demand in my pocket: mobile devices and the data connectivity marshalled in support of everyday practice.* Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems. ACM, pp.2729-2738.

Maller C.J., 2015. Understanding health through social practices: performance and materiality in everyday life. *Sociology of health & illness*, 37, pp.52-66.

Mattioli, G., Anable, J., and Vrotsou, K., 2016. Car dependent practices: Findings from a sequence pattern mining study of UK time use data. *Transportation Research Part A: Policy and Practice*, 89, pp.56-72.

Ofcom, 2011. *A nation addicted to smartphones.* Available at: http://consumers.ofcom.org.uk/news/a-nation-addicted-to-smartphones/ [Accessed June 2016].

Ofcom, 2015. *The communications market report.* Available at: http://stakeholders.ofcom.org.uk/binaries/research/cmr/cmr15/CMR_UK_2015.pdf [Accessed June 2016].

Petry, N. M., and O'Brien, C. P., 2013. Internet gaming disorder and the DSM-5. *Addiction*, 108(7), pp.1186-1187

Quiñones-García, C., and Korak-Kakabadse, N., 2014. Compulsive internet use in adults: A study of prevalence and drivers within the current economic climate in the UK. *Computers in Human Behavior*, 30, pp.171-180.

Reckwitz A., 2002. Toward a Theory of Social Practices: A Development in Culturalist Theorizing. *European Journal of Social Theory*, 5, pp.243-263.

Schatzki T.R., 2002. T*he Site of the Social: A Philosophical Account of the Constitution of Social Life and Change.* University Park: Pennsylvania State University Press.

Shove E., Pantzar M. and Watson M., 2012. *The Dynamics of Social Practice: Everyday Life and How it Changes.* London: SAGE Publications Ltd.

Starcevic, V., 2013. Is Internet addiction a useful concept? Australian and New Zealand *Journal of Psychiatry*, 47(1), pp.16-19.

Turkle, S., 2011. *Alone together: Why we expect more from technology and less from each other.* New York: Basic Books.

Warde, A., 2005. Consumption and Theories of Practice. *Journal of Consumer Culture*, 5, pp.131-153.

Young, K. S., 2011. CBT-IA: The first treatment model for internet addiction. *Journal of Cognitive Psychotherapy*, 25(4), pp.304-312.

Wade, F. and Nilstad Pettersen, I. *What ideas of users and their lifestyles exist amongst the actors involved in the design and delivery of heating technologies?*

Abi Ghanem, D., 2008. Installing photovoltaic technology in the UK: Some user constructions. In: Bamme, A., Baumgartner, P., Berger, W. and Kotzmann, E. (eds.) *Yearbook 2008 of the Institute for Advanced Studies on Science, Technology & Society.* Profil: Wien, pp.185-205.

Akrich, M., 1992. The description of technical objects. In: Bijker, W. and Law, J. (eds.) *Shaping Technology/ Building Society: Studies in Sociotechnical Change.* Massachusetts Institute of Technology: Cambridge, Massachusetts; London, England, pp.205-224.

Akrich, M., 1995. User representations: practices, methods and sociology. In Rip, A., Misa, T. and Schot, J. (eds.) *Managing technology in society: the approach of constructive technology assessment.* Pinter: London and New York, pp.167-184.

EC, 2011. *Energy Roadmap 2050, European Commission.* [online] Available at: https://ec.europa.eu/energy/sites/ener/files/documents/2012_energy_roadmap_2050_en_0.pdf [Accessed October 2015].

Enova, 2015. *Kjøpsveileder varmestyring: Hjelp til deg som skal kjøpe varmestyringsanlegg.* [online] Available at: https://www.enova.no/download.aspx?OBJECT_ID=/upload_images/

F965F7F987444541B0DCB43A2EE1C588.pdf [Accessed April 2016].

Gant, D. and Kiesler, S., 2002. Blurring the boundaries. Cell phones, mobility, and the line between work and personal life. In: Brown, B., Green, N. and Harper, R. (eds.) *Wireless World: Social and Interactional Aspects of the Mobile Age.* Springer: London, pp.121–131.

Gullestad, M., 2001. *Kitchen-table Society: A case study of the family life and friendships of young working-class mothers in urban Norway.* Universitetsforlaget: Oslo. First published 1984.

HW, 2014. *Smart homes of the future: an industry view.* Honeywell International Inc. [online] Available at: http://www.honeywelluk.com/file_uploads/pdf/116837_Honeywell_Smart_Homes_Final_Int.pdf [Accessed May 2016].

Hyysalo, S., 2009. Figuring technologies, users, and designers: Steps towards an adequate vocabulary for design-use relation. In: Prenkert, F., Baraldi, E., Håkansson, H. & Waluszewski, A. (eds.) *Use of Science and Technology in Business: Exploring the Impact of Using Activity for Systems, Organizations, and People.* Emerald: UK, pp.291-314.

Ingram, J., Shove, E. and Watson, M., 2007. Products and Practices: Selected Concepts from Science and Technology Studies and from Social Theories of Consumption and Practice. *Design Issues*, 23(2), pp.3-16.

NVE, 2015a. *Smarte strømmålere* (AMS). [online] Available at: https://www.nve.no/elmarkedstilsynet-marked-og-monopol/sluttbrukermarkedet/smarte-strommalere-ams/ [Accessed March 2016].

NVE, 2015b. *Ny teknologi og forbrukerfleksibilitet.* [online] Available at: https://www.nve.no/elmarkedstilsynet-marked-og-monopol/sluttbrukermarkedet/ny-teknologi-og-forbrukerfleksibilitet/ [Accessed March 2016].

ONS, 2011. QS415EW – *Central Heating.* Office for National Statistics. [online] Available at: http://www.nomisweb.co.uk/census/2011/qs415ew [Accessed October 2014].

Palmer, J. and Cooper, I., 2013. *United Kingdom housing energy fact file.* London: Department of Energy & Climate Change.

Rambøll, 2010. *Evaluering av tilskuddsordning for elektrisitetssparing i husholdninger.* [online] Available at: http://www2.enova.no/minas27/publicationdetails.aspx?publicationID=566 [Accessed April 2016].

Rohracher, H., 2003. The role of users in the social shaping of environmental technologies. *Innovation: the European journal of social science research*, 16(2), pp.177-192.

Sanders, E.B.-N. and Stappers, P.J., 2008. Co-creation and the new landscapes of design. *CoDesign*, 4(1), pp.5-18.

SSB, 2014. *Energibruk i husholdningene.* [online] Available at: https://www.ssb.no/energi-og-industri/statistikker/husenergi/hvert-3-aar/2014-07-14 [Accessed March 2016].

Wade, F., Shipworth, M. and Hitchings, R., 2016. How installers select and explain domestic heating controls. *Building Research & Information.* DOI: 10.1080/09613218.2016.1159484.

Wilhite, H., Nakagami, H., Masuda, T., Yamaga, Y. and Haneda, H., 1996. A cross-cultural analysis of household energy use behaviour in Japan and Norway. *Energy Policy*, 24(9), pp.795-803.

Woolgar, S., 1991. Configuring the user: the case of usability trials. In Law, J. (ed.) *A sociology of monsters.* Routledge: London, pp.57-102.

Macrorie, R., Kragh-Furbo, M., and Morley, J. *Cracking the code: How algorithms and software are shaping everyday life.*

Ananny, M., 2016. Toward an Ethics of Algorithms: Convening, Observation, Probability, and Timeliness. *Science, Technology and Human values*, 41(1), pp.93-117.

Carr, E., 2014. Cited in: Winch, J. 2014. Drivers without insurance 'black box' could be forced off the road within 10 years. *The Telegraph*, [online] Available at: http://www.telegraph.co.uk/finance/personalfinance/insurance/motorinsurance/10837263/Drivers-without-insurance-black-box-could-be-forced-off-the-road-within-10-years.html [Accessed June, 2016].

Cohn, J., 2016. My TiVo Thinks I'm Gay: Algorithmic Culture and Its Discontents. *Television & New Media.* DOI:10.1177/1527476416644978

Collins, S., 2014. TV seems to know what you want

to see; algorithms at work. *Los Angeles Times*, [online] http://www.latimes.com/entertainment/tv/la-et-st-tv-section-algorithm-20141123-story.html [Accessed June, 2016].

DfT., 2015. *The pathway to driverless cars. Summary report and action plan.* February 2015. London, UK: Department for Transport.

Gabrys, J., 2014. Programming environments: environmentality and citizen sensing in the smart city. *Environment and Planning D: Society and Space*, 32, pp.30-48.

Gillespie, T., 2014. The Relevance of Algorithms. In: T. Gillespie, P.J. Boczkowski, and K.A. Foot, eds. 2014. *Media Technologies: Essays on Communication, Materiality, and Society.* Cambridge, Mass: MIT Press.

Gillespie, T. and Seaver, N., 2016. Critical Algorithm Studies: a Reading List. *Social Media Collective: Research Blog*, [blog] https://socialmediacollective.org/reading-lists/critical-algorithm-studies./ [Accessed June 2016].

Goffey, A., 2008. Algorithm. In: M. Fuller, ed. 2008. *Software studies – A lexicon.* Cambridge: MIT Press. pp.15–20.

Graham, S.D.N., 2005. Software-sorted geographies. *Progress in Human Geography*, 29(5), pp.562-580.
Hadas, N., 2011. Why Smart TV's will change Society as we know it. [blog] August 30th. Available at: https://nevoda.wordpress.com/2011/08/30/why-smart-tvs-will-change-society-as-we-know-it/ [Accessed June, 2016].

Kitchin, R., 2011. Commentary. The programmable city. *Environment and Planning B: Planning and Design*, 38, pp.945-951.

Kitchin, R., 2016. Thinking critically about and researching algorithms. *Information, Communication & Society*, DOI: 10.1080/1369118X.2016.1154087

Kitchin, R., and Dodge, M., 2011. *Code/space: Software and everyday life.* Cambridge, MA: MIT Press.

MacCormick, J., 2013. *Nine algorithms that changed the future: The ingenious ideas that drive today's computers.* Princeton, NJ: Princeton University Press.

Mackenzie A., 2006. *Cutting Code: Software and Sociality.* New York: Peter Lang.

Montfort, N., Baudoin, P., Bell, J., Bogost, I., Douglass, J., Marino, M. C., ... Vawter, N., 2012. *10 PRINT CHR$ (205.5 + RND (1)): GOTO 10.* Cambridge: MIT Press.

Nest., 2016. *Meet the 3rd generation Nest Learning Thermostat.* [online] Available at: http://www.nest.com [Accessed June 2016].

OECD/ITF., 2015. *Automated and autonomous driving: Regulation under uncertainty.* Paris, France: OECD/International Transport Forum.

Seaver, N., 2013. *Knowing Algorithms.* [online] Media in Transition 8. Cambridge, MA. Available at: http://nickseaver.net/papers/seaverMiT8.pdf [Accessed June 2016].

Shin, D.H., Hwang, Y. and Choo, H., 2013. Smart TV: Are they really smart in interacting with people? Understanding the interactivity of Korean Smart TV, *Behaviour & Information Technology*, 32(2), pp.156-172.

Steiner, C., 2012. *Automate This.* London: Penguin

The Floow., 2015. *The Floow.* [online] Available at: http://www.thefloow.com [Accessed June 2016].

Williamson, B., 2015. Governing software: networks, databases and algorithmic power in the digital governance of public education. *Learning, Media and Technology*, 40(1): 83-105.

Yang, R., and Newman, M.W., 2012. Living with an intelligent thermostat: advanced control for heating and cooling systems. *2012 ACM Conference on Ubiquitous Computing.* Pittsburgh, Pennsylvania.

Yang, R., and Newman, M.W., 2013. Learning from a Learning Thermostat: Lessons for Intelligent Systems for the Home. *ACM International Joint Conference on Pervasive and Ubiquitous Computing (UbiComp)*. Zurich, Switzerland, September 8–12, 2013.