

Publishing Energy Use: Inferences from a Prototypical Practice

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Abstract: Publishing or making public of material resource use like electricity through design interventions is presented here as an experimental design research practice. Building on field studies based on constructive design research and empathic design it presents three design based procedures in this article that highlight how publishing energy use can be a useful method for inferring into daily habits of energy use. Such a procedure of gaining inferences by publishing energy use through design based methods is aimed at generating a more empathic understanding of peoples energy practices. From this position it argues that the inference gained by publishing energy use is constructed between the interactions of all the actors within the context, which includes the participants, the researchers, and also by the design object used to publish the energy and its interaction with the context.

Key words: *Energy use, method, empathic design, constructive design research, experimental design research practice.*

1. Introduction

If technological infrastructure were a sheen that supports our daily notions of comfort, convenience and cleanliness [27], to examine the underlying essential flowing components, by exposing the structure and relations of what makes up that sheen has been the agenda of this emerging practice in design research. To mention electricity as flowing material is a matter not only for conceptualization. Here it is essentially viewed as a commodity that evolves the performance of our daily habits, reaching us through a complex of public infrastructure networks and yet largely remaining invisible [25]. It is this flow that is put under scrutiny here, to be made open and public as a design agenda. A question that one can argue to be essentially a matter for design is, since the complex of infrastructure that allows the flow is built and powered on fossil fuels like coal, oil and nuclear matter, which are invariably limited and having seen to have adverse effects on the environment, can this continue consistently in the future? One could say that design, as a discipline is not equipped to answer such large overarching questions. But on the contrary, one can argue that since design educates the dealing with the ‘halfway’ between people and things [10:15], it inculcates reframing of the problem space than solving known problems. And if there is a possibility of resource scarcity that in the future may affect material engagement, then can design not recommend a reframing of how material and people mediate? A design practice, that inculcates inclusion and empathy [16] is argued to be more adept at looking into issues and concerns of human and material interactions in contemporary daily living and its future. Thus this design research project broadly studies energy consumption

that takes place in daily living and questions the energy use resulting to generate an empathic understanding of peoples' practices. This critical assessment has taken a variety of forms, but a prominent mode of questioning that has emerged, is by making engagements of energy use open and public in small local scales in the field. To make energy use more visible and open has been the agenda of many prior programs and projects. In environmental psychology interventions have been undertaken to assess the effectiveness of periodic feedback in changing attitudes and behaviours [1][8][9][12]. Then in human computer interaction there has been a recent surge in interest for designing novel interfaces and approaches for residential energy consumption feedback [3][21][24][26]. Taking cues from such prior work the role of this design research project has been to construct and build further the agenda of understanding daily energy use, but for generating an empathic understanding of end user practices. This has been undertaken by deploying methods, by designing and deploying prototypes that makes energy use open to inspection by the researcher and the participating end users in various field settings. Then by systematically analyzing the resulting implications it generates inferences that are both insightful of, and empathic with, the users in their context. With such procedures the research has aimed at gaining a deeper understanding of the people and their relation with electricity use in their contexts.

Much of the making public of energy flows in this research has been undertaken either by using technological media that are based on Information and communication technologies or built on related methods [for eg. 14]. Yet it positions itself differently from Environmental psychology or HCI based interventions, where behavioral change of the end users or the technological medium as the feedback mechanism as design, plays a central role. Energy related research in environmental psychology has focused on energy awareness relating to conservation behavior or interaction with emergent energy systems [8][9][12] and in HCI the focus has been on the design of consumption feedback. Most energy related studies as reviewed in environmental psychology and in HCI are approached with behavioral and cognitive psychology background that differs from a design theoretic approach that is presented in this paper. Also there is no explicit agenda of making energy use public as a design method to infer about the users and their context whereas here to publish energy use is to explicitly gather inferences of the underlying mechanisms that shapes peoples interaction and understanding with energy use in their daily life. This position is thus different from energy related environmental psychology and HCI research. Also to utilize technological means to communicate and publish material use in this approach was a matter of contingency than being essential or a conscious choice. Paul Dourish [10] has indicated at an opportunity for the energy research related HCI community, *for a form of design intervention that takes into account the political, cultural, institutional and spatial aspects of environmental activism, not by resolving the question of scale but by adopting it as a site of productive engagement*. In today's context, ICT's ubiquitous presence, reach and scale [11], becomes a rather obvious choice. But to engage with technology in our research is not for solving a problem but rather in deciphering the nature of the problem of technological engagement as people interact with energy networks in their daily living. This position is also central to this approach and the article aims to clarify how such a process can arrive at understanding the nature of the problem rather than try out solutions through technological means. Thus making this approach different from more conventional environmental psychology and HCI based energy research. While the position is different from technologically centric HCI approaches it has utilized techniques from sustainable HCI research [5][26]. Also such an approach while being extremely broad has provided a direction for utilizing design to intervene. It has also certain leanings to specific streams of Science and Technological Studies and this has made it aware many a times that it is enmeshed and obligated within the

politics of technological means to measure and publish its own material concerns [18][19]. Within such a background ecology and context, this project presents itself as a field based experimental design research practice. Having been carried out as a set of small scale design interventions with design methods and prototypes of varying fidelities in various contexts it has wished to gather a deeper understanding of the underlying issues and concerns of the daily use of energy in contemporary living. Through this article it wishes to clarify such a procedure of gaining understanding of energy use in the daily by presenting the conceptual material and approach it builds on, the design methods and prototypes as tools that were used in the procedure, the contexts of its implementation and finally the inferences that have emerged from the procedure of making energy use public in the presented cases. Through such a clarification it wishes to present that making energy use public for an inferential understanding through design prototypes can be viewed as an emerging experimental design research practice.

2. Constructive Framing to Publish Energy Flows

Information and Communication technologies can be viewed as public infrastructures that allow flowing of content. But the nature of content in these networks can be viewed as being more semantic than the other traditional and conventional infrastructure flows like electricity through power cables, that do not get utilized directly to transfer media or data packets. While the ICT networks' underlying flows can be very well connected to flows of electricity, yet the content of these flows can be transferred through radio waves using electricity. In a similar vein the flow of water to reach the upper floors of a building is also connected to electricity, needing energy to pump the water into tanks in multi storey buildings. There are various instances where the technological flows are so interconnected with other material flows that when they stop, they threaten the entire notion of human control over its material being. The complex interconnected public infrastructure networks, with some more semantic than the others, do not reveal themselves easily, and neither the relation of their content with our daily actions. So as a design concern, one of the questions this project builds from is, what would happen when the semantic networks of communication get combined with the not so evident non- semantic networks of electricity? The intertwining also emerges when the flow encounters a common issue of crisis, one related to the environment, one that is ecological, that which is invariably also economical, thus which can be viewed as a common crisis, an eco-crisis. The making public agenda of this design research should be seen as a response to this eco-crisis, where in it situates as a design response to clarify and be informed of the future nature of our interactions with a material such as electricity.

The application of design in such a position is mainly to 'intervene' into the context and is for an inquiry towards what Dourish mentions as a potential for HCI interventions in environmental practice. To intervene may easily get mistaken as an activity of a manipulative and corrective nature, as a means to rectify. This term is well known in disciplines like organizational learning, economics, political science or health and behavioral psychology. Here to intervene is not for any correction, instead to intervene with a Constructive Design Research approach, is not for any rectification, rather it is what Andy Crabtree [7] refers to as 'breaching experiments' that maybe studied ethnographically. To intervene here is more as a research procedure with a design object, like with using prototypes and props that provokes a material practice and makes its components visible and available for design reasoning [6]. To this extent to intervene is used as a key means in constructing knowledge, rather than to

correct or rectify any situation. But the intervention is necessarily situated and grounded in a context, so the role of the intervention here is to deploy design objects into their natural settings and follow what transpires as activity. So this is essentially a field engagement, and what Koskinen refers to be as following design through society. Such a design intervention that involves constructing design objects as prototypes and deploying them in the ordinary social setting is in line with what Kurvinen [17] et. al suggest as guidelines for prototyping social interaction. While utilizing naturalistic research design methods, it observes and interprets the interaction that results from the design object in the naturalistic setting with empathy [15].

Such an engagement also utilizes a pragmatist background. The insights gained from the various field engagements are interpretive, open ended and abductive [13][23]. These are positioned as understands that are hypothetical in nature thus the reference to the interpretations as ‘inferences’, rather than them being inductive findings. Such understandings are essentially not verified entirely through large samples or even with extended time periods in the field but yet provide a nuanced direction for the scope of inquiry. The exercises have generated insights that would not have emerged otherwise but have been handled as hypothetical inferences that could be treated as new knowledge within the context in the field.

Thus having clarified the background and position for ‘intervention’ and ‘inference’ for gathering knowledge for the project, the article will proceed to present three cases of design intervention from the field that will clarify its context, the design objects, the procedure in which the intervention was carried out and what was inferred from such a research interaction.

3. Making Power Use public: A Prototypical Practice

To base such an approach, of publishing energy use as a field practice of experimental design research, would need some elaboration. To begin with it is positioned here as an emergent practice and so is termed as being a prototype of a practice. Such a practice, has utilized design as a basis not just for understanding but also for deploying it as a methodical procedure. It has strived to have *a focused curiosity coupled with exposure to relevant contexts, attention to elements that invite intrigue, visual documentation and revisiting these records later, percolation and talking about what was significant with the participants, and storytelling and exploration of design choices and details* [74:15]. While numerous cases were carried out of publishing energy use in varying depths, for the scope of this article we shall present three different cases as prototypical practice. The cases while varying in the nature of their contexts, approach and design objects, provide evidence of what has been approached as a practice of publishing energy use, how it has been carried out and the reasoning it utilizes to generate an understanding of the people’s relationship of using electricity in their daily living. Thus through the cases and its elaboration it clarifies the approach of the practice of engaging with concerns of energy use, making it public and gaining insights as inferences.

3.1 Case 1: Self Publishing Energy Space¹

The first case presented here is set within a typical office workspace context. This case is the closest to the approach of constructive design research and also with a design for research agenda, where a design object was constructed as part of the inquiry into making energy use public. This case also presents an attempt where electricity use tries to couple itself with a semantic ICT network, where the nature of communication gets intrinsically connected with material use. It presents the design attempt of combining social interaction and material interaction and highlighting it as a matter of collective feedback.

A design intervention was carried out in an open office that was 10 mtrs x 15 mtrs (Figure. 1A). It had fourteen people as colleagues sharing the workspace with individual desks. The intent of the intervention was to make public the varying energy used by the lighting of 33 different fluorescent tube lights of the workspace by text messaging information to the members. This was carried out over a period of two weeks. The first week was utilized to measure the pattern of usage of the same space for its lighting use. The following week text messages were used to inform of the lighting pattern use to the people using the space. The text message information as shown in Figure.1 B, contained the following elements as information, the time stamp of when specific lights were turned on and off, the number of lights that were being used, the consumption of electricity in watts for the number of lights that were in use and then a comparative equivalence of the wattage with another electrical device's energy usage which changed daily. The system did not reveal the identity of the person who switched on or off the light switches.

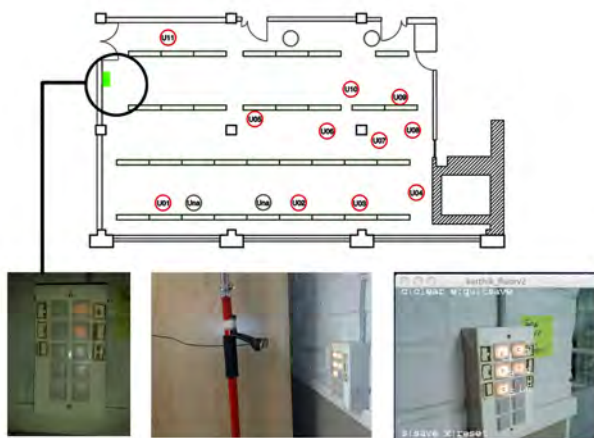


Figure.1 A. Intervention setup.

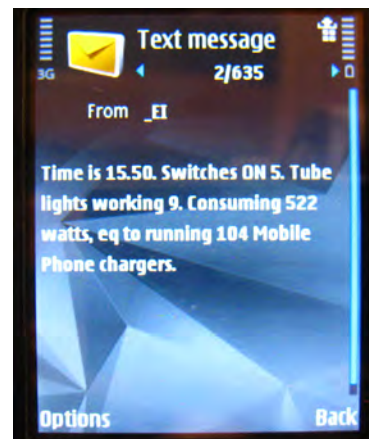


Figure.1 B. Text message

There were a number of design objects that could be considered in this intervention, but two of them will be presented here. The first is what can be viewed as presenting energy use equivalence as coupled feedback. The setup made the members using the switches to turn on or off the light, experience a mixed functional act. It combined two functions within one activity, i.e. the act of turning on or off a light, coupled with that of publishing information through a text message to the rest of the office members at the same time whether they were present in the office or not.

¹ For a detail description of the entire design intervention refer to the original paper [2], Acharya and Mikkonen, 2011 A Shared Space Texting Energy Use.

Having interviewed the participants after the intervention, it suggested that the coupling function, that of switching the light on or off with the switch, when combined with that of publishing information of its use through text messages, made the participants more conscious of the activity of using the switch to turn the lights on or off. Coupling such functions of consumption and publishing the material use, with another device resulted in making people more conscious of their acts. Such a design object also provided a more explicit social emphasis on the act of turning on or off the light, showing the possibility of collapsing the boundary between the semantic and the non-semantic and making evident a case of a flowing social materiality, where the object of design gathered itself into a self publishing object.

The second design object that is considered here is a section of the energy use informing text message (Figure 01B), one that provided an equivalence of the tube lights energy use with the wattage of another electrical device (Table. 01). During the interview after the intervention, when asked what of the equivalence they remembered most, three answers from three different participants are discussed here. One of them mentioned the video projector, one mentioned the printer and another mentioned the laptop computer. The person who mentioned the video projector is known to be a VJ, the second person mentioned that she remembered the laser printer because she also worked as a graphic designer and the third person was a design student who spent most of his time working on his laptop. As a hypothetical inference, one that provides a call for further investigation, is that people use objects and artifacts that use electricity to function. With this they develop a unique relationship with them over a period of time. This relationship could develop because of their roles or identities, like a graphic designer to a printer, a VJ to a video projector, a student to the laptop, and so on.

TABLE I: Typical Appliance and Energy consumption equivalents used in the intervention.

Typical Appliance	Typical consumption in watts	Number of typical appliances when equated to full consumption of 33 tubelights (1854 watts)
Laptop computer	16W	115
Cathode-ray display	110W	16
LCD display	34W	54
Projector	150W	12
Laser printer	500W	03
Modem	09W	206
TV	100W	18
Sony Playstation3	190W	09
Xbox	160W	11
Nintendo Wii	18W	103
Mobile phone charger	05W	370

Now as a matter of design for energy consumption feedback, if they were to be informed of energy use of another activity (with another artifact that consumes electricity, in this case lighting), then it is inferred that it could be useful to inform them through the equivalence of the energy consumed through the artifact or object with which they have developed this unique relation. How effective might this be for delivering an understanding of material usage through the aid of ICT? Such an inference while needing further investigation provides useful direction in designing personalized energy use feedback.

3.2 Case 2: Prop Intervention

This case, rather than being a single intervention event, should be seen more as a series of short but intense studies in the field. As part of the initial exploratory studies, this research project undertook fieldwork within the context of middle-income families living in mid-rise apartments in the southern state of Karnataka in India. The engagement was an exploration with twelve families living in three different apartments in three different cities. The study not only engaged with the families alone, but also carried out interviews with building maintenance personnel of the apartments, the designers and architects who were involved with the apartment design and even infrastructure personnel from the government. A day in the life of the apartment dweller charts, sketching and knowing the home, understanding consumption through the home dwellers bills and Situated and Participative Enactment of Scenario (SPES) [14] which is also popularly known as the 'Magic Thing' exercise were some of the exercises that were conducted with the participants. In this case we shall look at one part of the study, that of using SPES, involving specific participants and how intervening within the context using this method lead to an inference that highlights a certain limitation of using the ICT through the screens of personal mobile device to inform of their energy use.

After having conducted about an hour to an hour and half of interviewing with a participant in their own homes, which also involved them listing what they had done the previous day on a chart, the exercise of SPES was staged. Choosing one activity from the previous day that the participant had performed in the home and which had also been listed in their chart, they were asked to reenact this at the exact same place within their home. The participants performed activities such as television watching, cooking in the kitchen, Internet browsing on their computer and exercising within their home. While they were reenacting such activities their engagements within their material environments was observed and co-constructed with them. What devices and appliances they used and touched, what did their context as spatial configuration afford, what were the specific practices that were electrically constructed in the private home were some of the observations that started taking place during this procedure. Then within some moments of the activity, a wooden block or a mobile phone was handed to them and they were asked, if they were to be informed of their electricity use at that moment for that specific activity, then would they prefer it and if so how would they prefer it? The initial response usually drew a blank, they mentioned that they were not interested to know how much electricity was being consumed by the activity they were immersed in performing on a device such as a mobile phone. A loss of focus on the immediate task was the most mentioned reason for not wanting any feedback on the personal mobile device. Not carrying a mobile phone while cooking or watching television in their bedrooms, nor while they were reading mails on their computer was also cited as a reason. If the energy consumption of any activity was not revealed nor did any device or appliance attempt to do this within the activity itself, then how could any activity divulge its energy usage when it had not been designed to do so? Then, when they were asked if they were to be informed of the activity's consumption, then where and how should it be? Through a meter on the kitchen counter top, with a flip in the remote control of the television and on the computer screen were some design directions. But now for the scope of this article it can be inferred that the attempts being made to inform of peoples energy use on mobile phone screens or on their personal computer through Internet services, not only disembodies the consumption information that takes place during the performance of the activity, but the information delivery would be hard to focus on while performing a specific task. If energy use of a particular activity were to be informed and it were to be coupled with the task and

activity at the same moment, then it is only reasonable to concur that the feedback will be either processed as information or the focus would be on the activity at hand. So providing a live energy feedback that couples its attention with the focus on a task impacts on the choice of undertaking the activity itself. Then what is more important, knowing the results of ones action i.e. through the feedback or just carrying on with ones activities through the appliances? How does the value of live energy feedback matter while carrying on such any activity that uses electricity?

Such a question while needing further investigation, directs to the matter of design of the medium for informing of energy use. The highlighting of the limitation is felt necessary, not just for this article, but because there are numerous attempts to convey domestic energy use to home dwellers and continue to be attempted still. Live feedback on the screen through designed applications and services over the Internet, which can be accessed over the personal computer or over mobile phones are even suggested by environmental psychology studies [8][12] and also as shown in the previous case. As an inference, this exercise hopes to respond to such approaches by presenting the limitation of screen based visual feedback, as one of the many reasons of energy consumption displays not having enough uptake nor a huge success within the domestic environments. It also shows that the nature of feedback is highly context specific, depending on the task and the nature of its context.

3.3 Case 3: Compare and Inform

The final case can be seen as a continuation with the similar context of mid-rise housing and the energy flow in domestic spaces in Indian upper middle class income families. This case is from a single apartment block in which four families, who knew each other as living in the same apartment block were engaged with a study over a period of one month. As an exercise the energy use of each family was measured on a daily basis continuously over four days and reported to them. The measuring of the energy use was at the individual meter level of the homes. The size of the apartment varied between the four families but the size of the families itself was similar, with four members each. A family who lived in an apartment of 120 sq meters had consistent high consumption of energy over the period, when compared to the other families of which two were about 140 sq meters and one of about 280 sq meters. When this data was consistently revealed then the family member living in the 120 sq. meter whose consumption was nearly 1.5 times that of the family living in the 280 sq meter home, mentioned that he and his family had lived in Abu Dhabi for more than twenty years, and they had only recently moved to India. He said that they were used to living in the Gulf state which had very inexpensive charges for electricity and they would pay eight dollars a month for all the energy use there. He then said that he suspected he and his family had carried their habits from Abu Dhabi to India. On the contrary the family that lived in the 280 sq meter apartment is known to have spent about eighteen years in Mumbai a city in India, where energy costs are very high because of energy being provided by a private company. They also mentioned that their energy and water consumption habits had developed over their stay in that city. This could be read as what is known already within the interactionist perspective and in anthropology [28] that energy habits like any other habit, are also context evolutionary and dependent. If the access to energy were very easy and cheap and the cost of energy use in a place were felt to be low and thus its use not much a matter of concern, then does it mean these habits that evolved in that place get carried over to another place? What implication does this have for targeting energy reduction programs at specific families? Is it important to know their prior context and time frame of energy use? To answer these questions is not the aim of this paper, and while it is difficult to generalize a broad understanding from such a small exercise, it

reconfirms what Harold Wilhite [28] mentions through his ethnographic studies conducted around the same region in the south of India. So it provides useful hypothesis for further investigations for understanding of energy use habits that evolve in the context of consumption over a longitudinal time span within specific contexts.

4. From intervention to inference

The article has presented three separate cases terming them as design interventions that deal with the making material resource public in varying contexts. In the first case it presented mixed functional act of energy use of one activity with communication, by coupling the network of energy use with the ICT network. Through this it inferred that it could be useful to inform people of energy consumption through the equivalence of the energy consumed through the artifact or object with which they have developed a unique relation because of their roles and identities. In the next case of the prop intervention, it inferred the limitations of the screen based feedback of energy use. In the final case it infers that while considering energy use habits it could be useful to consider the prior energy use contexts in which the habits could have developed. All the three design intervention cases had varying fidelities of design based methods or prototypes and actions by the researcher in the field, but it was with the design object that facilitated the making public of energy use through prototypes and actions on the field the project could generate varying hypothetical understandings of daily energy use by the users. Such a design object of publishing energy use to gain inferences is presented here as an emerging activity and as an experimental design research practice. The fidelity of the methods and prototypes vary but the agenda of publishing energy use remains, utilizing a number of modalities, resulting in varying hypothetical understandings. The generation of such an understanding with deployment of design prototypes is inferred and is abductive, thus making the inference hypothetical in nature. The inferences while logical are also imaginative and interpretive [20]. While being hypothetical they are still argued to be a new understanding thus a form of knowledge that emerges from the practice. Such knowledge is co constructed and co-experienced [4] and situated in context, between the researcher, the participant/s, the design object and the material context. In such a process whatever understanding occurs, takes place because of the interactions within the context, between the design object, the material flow, the person/participant who use and experience it, the design researcher as the initiator and all the involved actors at that very moment. It is essential to denote that the stakeholders of this knowledge are all the interacting actors at the moment of knowledge generation and occurs due to the field engagement with the design object. While such a design interventionist approach is comparable to other design methods such as Culture and Design probes, it is similar in approach but also differs in the intent. While probes are deployed with the intent of gaining inspiration through user participation here the intent is to reach a hypothetical situation as new insight. The time frame varies and so does the approach. This calls for more rigorous field based studies with design methods and prototypes that can take forward the agenda of inferring deeper insights into peoples energy relationships in their daily living by publishing energy use in their contexts as a design research method.

5. Conclusion

Thus utilizing the above mentioned three descriptive examples as modes of publishing electricity use of by the deployment of design based methods or a design object in natural settings, these interventions have been presented as methods to infer further knowledge about energy use in daily living. We have presented that the creation of

such knowledge, as hypothetical inferences by intervening that make material use public with a design object, is seen to be within the framework of both empathic design and constructive design research practice.

The article thus presents that making public of material use as a design research agenda can lead to new knowledge especially relating to consumption and sustainability. The agenda could be seen as an emerging practice that fosters a better understanding of the small local contexts that could aid to develop new tools to make material use public for further inference to aid future living.

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