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# Contemporary Domestic Infrastructures and Technology Design

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**Abstract**

In this proposal, I describe my examination of two contemporary domestic infrastructures. Specifically, I am investigating whether we need to surface more information about these systems to make them intelligible to end-users. I describe my empirical research to date and the design of two technology probes which I will use to learn more how home infrastructure affects domestic technology design.

**Keywords**

Infrastructure, home, home networks, resource delivery systems

**ACM Classification Keywords**

H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

**Introduction**

Domestic HCI research has proliferated in the last decade yet as Rodden and Benford highlight, there has been a distinct lack of studies on how infrastructure affects technology design [4]. For example, few have examined as a central theme how the spatial location of domestic technologies affects both design and use. My research seeks to fill this gap in the literature through the study of home infrastructure and how transparency

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affects technology design. *Transparency* is an aspect of infrastructure highlighted by Star referring to the fact that it is usually only visible upon breakdown (and otherwise taken for granted) [6]. In other words, people use infrastructure without having to think about how it works until it is no longer functioning properly. Arguably, transparency increases with technology adoption. My goal is to study two contemporary domestic infrastructures to determine whether and how transparency affects system intelligibility. Further, I will determine how we need to surface “invisible” information to make these systems more usable and promote reflection on how they are being used.

For my dissertation, I have chosen to examine two case studies of domestic infrastructures where others have already noted challenges for helping householders manage these systems [3,7]: home networks (computers, modems, routers, audio/visual equipment and their interconnections) and resource delivery systems (for water, gas and electricity). Resource delivery systems have been integrated into homes for many decades more than home network systems. As such, resource systems are already more transparent to the end user. Thus, these case studies make for interesting comparisons since they differ in levels of transparency and could offer different implications for home technology design.

### **Background: Field Work**

*Home Networking:* I began my research by studying 11 households’ (with a total of 28 participants) engagement with home networking equipment. The focus of this study was to understand the relative transparency of this infrastructure. I conducted a follow up study of 15 households and their practices around

device management [1,5]. In terms of transparency, I found that many aspects of home networks are “invisible” to the user but that this is not always desirable. For example, people cannot easily discern when there are trespassers on their wireless network and this makes it less likely that they will be prompted to secure these networks. Participants also had to create many physical representations like post-it notes denoting which wires to plug into which outlet, in order to create an understanding of how to configure the network. Further, participants often understood their home networks in terms of where devices were located spatially in the home, e.g. in Susie’s bedroom or the office computer. Yet, the distributed nature of equipment and connections made it difficult to visualize the network as a whole. Clearly, having this infrastructure be totally transparent is not always desirable since many “invisible” aspects of networking need to be made more obvious if people are to understand how to secure, troubleshoot or form a somewhat accurate mental model of the network.

*Resource Delivery Systems:* Next, I decided to contrast my findings on home networking by studying another infrastructure that is largely transparent in today’s homes. This contrast will allow me to compare what “invisible” information people may need to know when using different infrastructures. I thus turned to the study of resource delivery systems in 15 households with 33 participants [2]. My research revealed that much like home networking systems, the even more pronounced transparent nature of resource delivery systems make it difficult for householders to equate how much resources different household activities consume *within home*. This is because there is no real time indication of resources being consumed. For

instance using a laptop is as easy as plugging it into the electrical socket and doing a load of laundry merely means turning on the washing machine. No longer does one have to self-generate energy through burning coal or fetch resources like water from a well to engage in these activities. Overall, this means increased transparency has reduced the awareness of the quantity of resources that different activities use.

Another “invisible” aspect of resource delivery systems that would help householders determine how to conserve resources is information on what lies *between homes* i.e. knowing more about what other homes are consuming for benchmarking purposes. Even if participants knew about how much energy different appliances consume, they had no anchoring or comparison points without knowing more about how other similar households (in terms of demographics and location) were behaving. Thus, surfacing information in this system for increasing intelligibility and reflection would mean showing people more information on their *within home* and *between home* behaviors.

Already, some contrasting themes for the two infrastructures have emerged. For instance, in the resource delivery case, we want to leverage the information about the infrastructure to promote reflection on resource consumption and encourage conservation—*within* and *between homes*. In this case, the question of how much and the type of information to provide is fundamentally different to home networks—where most of the information we want to surface is within the home.

### **Proposed System Designs**

My fieldwork has grounded my understanding of how transparency affects householders’ use of my two chosen case studies. I have realized that both infrastructures contain “invisible” information that could be surfaced *e.g.*, showing spatial and logical connections between devices on the network or real time use of resources. My next step is to use technology probes to deepen my understanding of what type of information should be surfaced to promote system intelligibility. Specifically, my probes will help me answer the following questions: What types of “invisible” information need to be surfaced to make an infrastructure more intelligible and usable to end-users? What kind of information should be surfaced to promote reflection on infrastructure use? How does the level of transparency of the infrastructure affect where and how the information is displayed to the end-user?

#### *Visual Network*

In my first system, I have led the development of a technology probe called Visual Network which collects information from a router and also allows for user input. The probe displays information about the home network such as how devices are interconnected, if they are connected to the network and where they are located spatially and logically in the home. This tool also provides certain metrics on how the network is being used, for example, showing the top 10 most recently visited websites and how much bandwidth different devices are using. I plan to complete the design of this tool and evaluate it with the goal of determining the types of information that makes home networking systems more intelligible. For instance, I will examine people’s reaction to more functional versus reflective information on network usage.

*Collaborative Energy Awareness Tool*

For my second technology probe, I plan to design, implement and evaluate an energy feedback tool that makes information about resource consumption more apparent. Moreover, this tool will make infrastructure arrangements outside the home more visible by giving people feedback on other households' energy consumption. Specifically, my system will give people feedback about their overall energy consumption in a more real-time fashion. The system will also provide householders with insight into how other homes are consuming energy to make the *between* home relations more apparent. This probe will help me determine if surfacing "invisible" information about *within home* and *between home* infrastructure will help not only make systems more intelligible but also promote reflection on infrastructure use.

Through my evaluations of my system designs, I intend to comment on how the transparency of systems affects how intelligible those systems are. Because these systems already have differing levels of transparency I can compare and contrast my findings from evaluating both these probes. My end results will allow me to comment on whether different levels of transparency in infrastructures affect the type of information needed to make systems more intelligible. I will also provide insight into how to promote reflection on these infrastructures leveraging what I know from my fieldwork and probe evaluations.

**Conclusions**

To fill the gap on infrastructure's effects on home technology design, I have chosen to study two contemporary domestic infrastructures to determine how transparency affects system intelligibility. My

research specifically examines home networks and resource delivery systems. My contribution to HCI will be design implications for domestic technologies given new insight into how to make "invisible" aspects of infrastructure more apparent.

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