Augmenting Refrigerator Magnets: Why Less is Sometimes More

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ABSTRACT

In this paper we present a number of augmented refrigerator magnet concepts. The concepts are shown to be derived from previous research into the everyday use of fridge surfaces. Three broadly encompassing practices have been addressed through the concepts: (i) organization/planning in households; (ii) reminding; and (iii) methods household members use to assign ownership to particular tasks, activities and artifacts. Particular emphasis is given to a design approach that aims to build on the simplicity of magnets so that each of the concepts offers a basic, simple to operate function. The concepts, and our use of what we call this *less is more* design sensibility are examined using a low-fidelity prototyping exercise. The results of this preliminary work suggest that the concepts have the potential to be easily incorporated into household routines and that the design of simple functioning devices lends itself to this.

Author Keywords

Home life, fridge surfaces, magnets, ethnography, design.

ACM Classification Keywords

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

INTRODUCTION

In CHI and its related fields (e.g. CSCW, Ubicomp, etc.) there has been growing interest in designing technology for the home. The home, in its broadest sense, has become the new frontier for technological innovation. Rather than simply transferring the accepted wisdoms born of the now well-studied workplace, studies of the home are building their own established place in these fields, with a rapidly growing corpus. Researchers such as Crabtree and Rodden [5] have built up compelling arguments detailing the patterns of interaction in the home, while similarly oriented research has focused on how the social organization of home life and its relations with everyday artifacts and routines have implications for domestic technologies [23, 25].

Other related work has centered on various visions of the Smart Home, including, for example, the Aware Home (Georgia Tech) and Place Lab (MIT) projects. Samsung's Smart Home venture has been particularly prolific, designing a multitude of appliance-based technologies for the home [11, 12, 17]. These "intelligent home appliances" span designs that range from "smart pens" that translate foreign languages to "smart bathrooms" that offer "a wide range of multi-media options, including the control of atmospheric sounds" [17]. Although many of these suggestions appear particularly novel, creative and interesting, there is an overarching sense that if the potential exists to computerize some feature of home life, it should be attempted. Indeed, the stated aim of Samsung's smart home project is "digitally engineering analogue home life" [17].

While this sort of wholesale innovation no doubt has its place, the home, as that place, may be less than ideal. If the studies of home life referred to above have taught us anything, it is that the social organization of the home, with its particular rituals, traditions and practices, is partly instantiated through the routine use of artifacts. Moreover, it is evident that the use of these artifacts occurs in idiosyncratic ways where simple, easy to use (i.e., lightweight) artifacts are appropriated into creative assemblages to manage the household's routines [5, 23, 24]. Indeed, it would seem there is a remarkable adversity to using complex, difficult to operate/program appliances in the home [19]. Thus, any introduction of new artifacts or alteration of existing artifacts should be considered with care. Not only must one be sensitive to the practical implications that technology might have, but one must also consider how it might impinge on the ways households collectively organize themselves.

With these matters in mind, this paper presents an approach to design that attempts to accommodate as far as possible a home's social organization by building on established practices that are already a part of the home's daily functioning. The presented work is based around the premise that mun-

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dane artifacts used to accomplish everyday routines, such as paper-based lists, wall-calendars, pin-boards, and fridge-doors, provide a non-intrusive point of entry for technology. As in studies of the workplace [8, 20], the everyday use of low-tech 'solutions' are seen to be instructive in designing technologies that are sensitive to people's ongoing relations with each other and the settings they work and live in.

In this paper, we have chosen to address this research initiative by looking at refrigerator surfaces and the uses of what might be considered the rather technologically primitive refrigerator magnet. In previously published research we presented the findings from a study of fridge surfaces [22]. Examining the findings, we argued that the popularity of the fridge as a display is due, in large part, to its physical form, with its relatively expansive surfaces, and to its central location in a household. We suggested that these properties lent themselves to a common pattern of usage, resulting in interspersed collections of work-related, sentimental, family-oriented, and child-related materials regularly found across household fridges.

Furthermore, we described how the particular properties of magnets were of crucial importance to the use of fridge surfaces. The magnet was seen to afford the idiosyncratic arrangement of materials across fridges, and also, interestingly, to promote a fluid structure and movement to these arrangements. That is, magnets allow a household's members to easily arrange the items attached to their fridge according to particular tasks, activities, people, etc., or to their emotional value, and also allow for the configuration of these items on a continual basis. Magnets are thus considered to enhance the fridge's role as an interactive surface in the home's ordinary affairs. Below, we aim to expand on this work by demonstrating how our previously reported findings have helped us to design a number of augmented fridge magnets. More generally, we set out to make three contributions that can be summarized as follows:

1. We introduce a number of preliminary design concepts for refrigerator magnets. We show how the design of these simple (even modest) concepts has been guided by our motivation to build lightweight resources that families can easily incorporate into their organizational routines.

2. We provide an example of how qualitative and, in particular, ethnographically oriented fieldwork can be used to inform design. Our hope here is to add to the small but growing number of projects that have demonstrated the practical value of ethnographic research to design.

3. We demonstrate the application of a *less is more* design sensibility [3]. Our work illustrates how, when designed with less functionality, digital technologies can become more easily integrated into everyday routines. The simplicity of functioning allows the operations to be made more intelligible to users and thus more readily available in amongst the ordinary use of fridge surfaces. In short, *less* immediate complexity is seen to give rise to the eventual possibility of *more* overall functionality.

Related Work

Past research has sought to build on the properties and functionality of similar vertical surfaces and their mechanisms for attaching objects. An unfortunate weakness of these projects, however, has been their failure to capitalize on what we consider a central reason for the popularity of these surfaces. That is, that magnets, pins and tape succeed on their respective surfaces because their modes of interaction are almost immediately *intelligible* to the user [1, 2]. They require virtually no forethought to successfully operate, allowing them to be *ready-to-hand*—simply and directly used in a lightweight and opportunistic fashion (for a thorough explanation of ready-to-hand, see [4, 6]).

The *rototack*, a 'computationally enhanced' thumbtack for corkboards [27], provides an example of such research. The rototack builds on the standard pin-board tack, giving it the capacity to be programmed to rotate, mechanically. The premise is that this capacity for rotation might enable craft-store hobbyists to design individually dynamic pin-board displays with moving objects, flashing lights and sounds. While the rototack's designers have been keen to keep the tack's operations simple and have sought to limit its computational capabilities (veering away from the general-purpose/convergence model of computing), the 'programming' of the tack is disaggregated from its physical, or tangible, form; the tack's rotational movement is configured in a programming environment on a computer and must be transferred to the device using either a tethered or wireless connection. Thus, the inherent features of the tack that make it simple to use—its intelligibility and to-handedness—are not built upon, but, to the contrary, are detracted from by the computational enhancement.

Another case in point is the *Pin&Play* system [13], that again seeks to extend the functionality of the common pin-board. At first sight, the system provides an appealing proposition because some of the anticipated applications seem reasonably consistent with our everyday practices. Through a well-thought out mechanism for networking and powering augmented pushpins (via a conductive board), Pin&Play, for instance, allows attention to be drawn to attached items via LEDs or alarms. Important or out of date documents can thus herald a user's attention via the pin. Compellingly, it is the pin that stores a document's 'meta-information', building on the pin's tangible properties. The trouble with the implementation described, however, is that the 'meta-information' stored in a pin, such as a document's expiry date, must be entered using a separate display. Like Rototack, the Pin&Play's method of input disaggregates some of the operability of the pins from their physical form. Reflecting on the concepts of intelligibility and to-handedness, this may add a level of complexity, albeit minimal, that could be enough to deter use of the system.

Also seeking to augment vertical surfaces, various efforts allied to the *tangible computing* project [10] have been more successful at addressing both intelligibility and to-handedness. For example, *Senseboard*, a whiteboard aug-

mented to interact with magnetized 'pucks', allows users to manipulate abstract 'data objects' by pressing their associated pucks or locating them on a gridded whiteboard [18]. Other pucks, shaped differently, provide a means of applying commands to the data objects, such as "view details" or "group/ungroup". Commands are applied by physically placing pucks on top of one another or combining them. Thus, the system is largely based on direct manipulation and, as such, purposely aimed to be to-hand, as well as intuitive and intelligible to the user. In this form, Senseboard supports the organization of structured information. For the purposes of the presented research, however, a potential shortcoming with the system (as well other comparable interactive surfaces) is in its ability to accommodate the arrangements that are particular to the home. As the authors of Senseboard readily admit, their system is not designed to cope with loosely structured and idiosyncratically arranged displays, something we have noted to be common in homes and particularly on fridge doors. Because of this, it would seem that solutions like Senseboard might have to be reconsidered when situated in the domestic context.

Overview

In the following, then, we aim to consider the implications for design of, one, the home's distinctive qualities and, two, the common use of simple, lightweight artifacts. We do so by addressing both the *physical* and *social affordances* [7, 16] of fridge surfaces combined with the use of magnets. To begin, we detail a number of ways in which fridge surfaces are routinely used and discuss how these uses are afforded (and sometimes constrained) by their interplay with fridge magnets: we call these their *properties of interaction*. Drawing on the presented fieldwork findings, we then describe some initial design implications. These implications are illustrated and developed through several concept ideations, with thought given to their implementation. Finally, we report on a paper prototyping exercise in which we sought to assess our design approach and gain an early sense of households' perceived usefulness of the concepts.

FIELDWORK FINDINGS

The presented findings are drawn from a larger corpus of field interviews and observations and form part of an ongoing, ethnographic study of family life, so far spanning 18 months, with 12 families living in the UK. Below, the findings have been divided into four main classes of fridge and magnet use, making up some of the activities recorded in the fieldwork: organizing/planning, reminding, ownership, and family memories. It is worth noting that these activity classes are not seen as a definitive, mutually exclusive nomenclature, but rather as a useful resource to inform design.

Organizing and Planning

We found that the planning and management of family activities was one of the key areas of family life that the fridge surface supported. This related to many different aspects impacting families including school, social, leisure, community and even work-related activities and events. Fridge surfaces in most of the homes we visited were liberally scattered with a wide array of artifacts to support the management of family events. We found that the type of artifact, its placement alongside other artifacts, and its movement on and around the fridge surface supported the displaying, planning and organizing of information about family life in many interesting ways.

The following example illustrates the use of the fridge/magnet combination to organize information. Harriet, mother of two, has a children's party invitation displayed on the front of her fridge alongside pictures and other family memorabilia. The invitation has been moved from the side of the fridge—what Harriet calls her "working area"—to denote she has accepted the invitation. Placed originally in the working area, the invitation stood as a reminder for Harriet to call the party's hosts. Now on the front, the invitation takes on another role, drawing attention to the upcoming party and containing the all-important address needed on the day. Harriet's working area also contains other important pieces of paper. It acts as a holding space for things she must act on or remember to do, or for lists and information she wants to hand. For example, this is where she keeps shopping lists, important phone numbers and so on. Occasionally she will cross reference her portable paper diary with dates and information kept in this working area (Fig. 1).

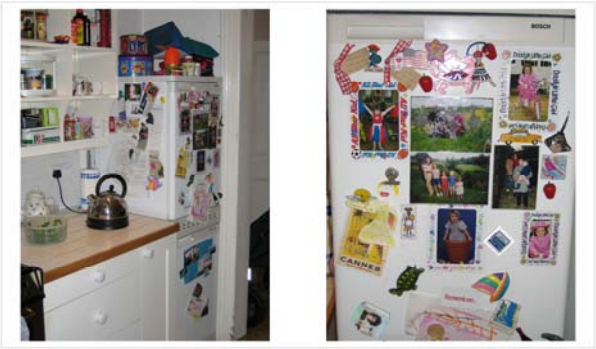


Figure 1. The working (left) and display (right) surfaces of Harriet's fridge.

Properties of interaction

1. *Information to hand* – Because information is displayed and contained in a limited area, it can be easily located and to hand. Further, because this display surface is always on and to-hand in the kitchen, it is easily cross-referenced with other artifacts such as portable diaries.
2. *Liminal information* – Items attached to the fridge can be liminal; the fridge can act as a catch-all for things that are pending or that simply have no better place. The items can thus have an in-between status where they can neither be immediately dealt with or jettisoned, they must simply be kept in a 'holding pattern'.
3. *Easily moved* – Physical qualities of magnet and fridge surface mean that movement is easy, even compelling.
4. *State determined by relative location* – The fact that the fridge has distinct sides and areas—in Harriet's case a "working area" and one primarily acting as a "family

display"—makes an item's movement meaningful. The state is assigned by placing the item amongst other items with shared meaning.

Reminding

Closely related to organization is reminding. As we saw above, with Harriet, the placement of the invitation stands first as an embodied reminder of the need to reply, and then of the party itself and its whereabouts. A more striking example of this practice of 'distributing' cognition and imbuing objects on the fridge with mnemonic qualities is evident in an arrangement another mother, Olivia, has instituted. On her fridge, Olivia uses a clip attached to a magnet to hold incoming correspondence from her children's schools (Fig. 2). As school letters and other materials are brought into the house, usually by way of the children's school bags, Olivia notes their content and then adds them to the other items that are held by the clip. Olivia has found that when the attached correspondence gets too heavy it, along with the clip, falls to the floor. With some ingenuity, she has come to use this apparent failing of the magnet as a reminder to sort through the materials to see what she can now file away or throw out: the magnet enforces an activity that Olivia might otherwise forget or indeed wish to avoid.

Figure 2. Olivia's working area (left) and her husband's magnetic man (right).

Properties of interaction

1. *Location* – The fridge surface's 'public' and 'on-display' status, and its frequent and routine use make information available in the course of everyday activity. These features act to continually make the fridge surface's attached items available and to hand. Somewhat paradoxically, these same features also make it likely that family members habituate to the attached materials.
2. *Visual persistence and availability* – The items and information on the fridge are static representations spread out in space. This means that information can be exposed and made visually available to function as effective reminders when household members come across them. Such reminders are not active, as in the way alarms draw attention to themselves, yet nor are they hidden from view, needing to be sought out.
3. *Enforced attention* – Olivia overcomes the possibility of habituation by establishing a kind of forcing function. The limits of her clip magnet's strength actually function to remind Olivia on a sporadic basis to sort through her school correspondence. This then entails rearranging items and discarding obsolete ones to bring to the forefront important items that need to be dealt with.
4. *Activity centered* – Arrangement lends itself to grouping materials related to specific activities or people. It overcomes the limitations magnets have of attaching only a limited number of documents to a surface, thus allowing grouping. At the same time, this hides some documents from view that can detract from their capacity to remind.

Ownership

Olivia's refrigerator also provides several nice illustrations of the concept of *ownership*; for example, a magnetic Barbie and her extensive wardrobe take up the lower half of the side of the fridge (Fig. 2). The representational qualities of certain magnets lend themselves to belonging to particular classes of people, and in this case, the fact that Barbie and her clothing belong to the two young daughters in the family is not surprising. Another aspect of magnets is the possibility for iconic representation. On the top right side of the fridge, a magnet representing a stick man wearing a tie has been appropriated by the father of the family, who uses it to affix a leaflet he wished the family to notice (Fig. 2). Finally, the left top half of the side of the fridge is being used by Olivia as a 'working' area, with school notices, grocery lists, train tickets and theatre tickets displayed. The fact that the left side of the fridge abuts a worktop with a phone, notepad and diary suggests that this is Olivia's space. Thus, although less explicit than Barbie or stickmen, the usage and placement of materials can denote ownership.

Properties of interaction

1. *Fridge shape and height* – The rectangular cube shape has a built-in delineation of the fridge surfaces (e.g., side vs. front) as does the height children can reach. These properties promote a division in space and lend themselves to being assigned to people or activities.
2. *Fridge placement* – The relative location of the fridge surfaces, e.g., next to countertops, the phone, pens, papers, the kitchen, table etc. can lend themselves to particular uses/activities.
3. *Representational and iconic magnets* – Magnets with familiar imagery can have in-built expectations. It isn't unexpected, for example, that Barbie belongs to a family's daughters or that a tie-wearing stickman would belong to the father.

Family Memories

Returning to Harriet's fridge, we see a carefully arranged display of family photos intermixed with other bits of family memorabilia (Fig. 1). She begins her discussion of her fridge by declaring: "This is my family", and proceeds to explain how each of the photos and assorted items have personal significance to her family. These include magnets from the states in which her adopted children were born, gift tags from christening presents given by the children's godparents (which she has attached magnets to in order to display them on the fridge), and souvenir magnets from various holidays they have taken. There are also two photos

of her extended family prominently displayed in the centre of the fridge, taken in the same setting but five years apart. She explains that this shows the evolution of the family, and points to the various changes.

Harriet's creation of a family history is echoed in less explicit ways on the other fridges we looked at. For example, amongst Olivia's theatre tickets and school notices are photos of her parents, baby pictures of her daughters, a photo of a favorite niece and a homemade birthday card. Likewise, on another family's fridge is a photo of two boys visiting their grandparents, as well as a number of Curious George magnets, reflecting the father's childhood in America.

These forms of 'family' display are important for two main reasons. First, they are a way of preserving important memories, some of the objects persisting over long periods and the collection itself evolving over time. Because objects hold special meanings and associations, the fridge door thus takes on a shrine like quality. Second, they act as a display of the family to others. The family history found on Harriet's fridge is intentionally constructed to a large degree. Harriet has chosen to display and arrange an assortment of pictures, magnets and other memorabilia in such a way that visibly renders a chosen version of her family's history.

Properties of interaction

1. *Photo frames* – Magnetic photo frames allow for easy, casual placement of photos without permanent affixing; easily changeable, photos can be put up without much thought. There is no chronology which one might find in a photo album; photos can be placed without context, solely because of their momentary appeal.
2. *Family ownership* – The fridge belongs to the household and therefore acts as a shared display, relating to all. This lends itself to the 'idea' of family being played out on the fridge. It also means that the rendering of the family can be seen by all, contested by all, embraced by all.
3. *Temporary display* – Items such as children's artwork might not be kept permanently, but can be prominently displayed for its limited life (or might become imbued with sentimentality and stay on the fridge longer).
4. *Invisible content* – Things on the fridge can become invisible, resulting in them being left up for long periods. This persistence is different to horizontal worktops, for example, which must be regularly cleared to function.
5. *Dual purposes* – Magnets both affix things and represent things, so magnets can stay on fridges because they are useful, but become imbued with sentimentality after being up for a long time.

DESIGN IMPLICATIONS

In this section, we turn to the implications the above findings have for design. For the purposes of illustration, we consider three of the four activity classes. We will look at, in turn, reminding, organizing/planning and ownership, ordering the ideas so that the technological suggestions develop on one another. In each of the examples, we propose digital enhancements and additions to the existing interactional properties of the fridge as a display surface, giving particular attention to the augmentation of magnets. As noted earlier, a central principle in the presented concepts has been to maintain the lightweight and simple interactions afforded by magnets. In this light, each of the concepts aims to provide a basic level of functionality that can be easily understood and operated. The richness of features is seen to arise from the range of augmented magnets offered, as opposed to a complex feature set provided by any one magnet. To conclude this section we will address the general problem of electrical power for augmented magnets.

Reminding

We have seen that the fridge provides an effective place for information to act as a reminder, even though this information can be essentially passive in nature. Two things undermine this however. One is the fact that the household can habituate to the objects displayed on the fridge. As a result, new information or new arrangements of objects may not be noticed. The second is that as space becomes crowded, some information may be hidden from view. The question then is how can digital technologies provide simple ways of drawing attention to objects on the fridge.

One simple idea relates to the fact that many objects kept on the fridge concern events that are time critical. This includes appointments, social events, vouchers that expire, concert tickets and so on. A problem with passive displays such as those found on the fridge is that they rely on people coming across them at the right time to trigger a time-critical reminder. In fact, these reminders often fail because, being passive, they cannot draw attention to themselves. One idea is to construct collections of magnets which allow users to set alerts for upcoming days or hours. The different units of time could correspond to different magnet sizes (see Fig. 4 for day of month timer). Consider, for example, a card with an impending dentist appointment on the 21st of the month. The person who fixes the card to the fridge chooses the day-of-month magnet and sets the dial to '21'. On the day the magnet begins to intermittently glow, with the color or light pulsating more quickly as the day passes. The alert would continue until the magnet is explicitly switched off.

Technically, such an idea would seem quite straightforward to implement. Simple timer electronics could be embedded into a fridge-magnet type form factor, and a basic rotary switch would detect when the timer was being set along with the required timing period. There is, however, likely to be one problem in implementation, namely providing appropriate visual feedback at the appointed time. Due to the relatively small size of fridge magnets, there will not be enough room for a particularly large battery to power the electronic timer. (We have assumed that, like traditional fridge magnets, the augmented electronic magnet would be wireless!) This means that when the timer expires, the feedback to the user needs to be as power efficient as possible.

There are a number of approaches to providing a suitable alert to the user in a power-conscious manner. A light emitting diode (LED) is a relatively efficient means of providing active illumination, and a flashing LED not only draws more attention to itself, but also consumes less power because it is illuminated for just a fraction of the time. In addition, we imagine a number of different ways to conserve power further by not illuminating the LED at all when it is unlikely to be effective in attracting attention. For example, an ambient light sensor could be used to detect a dark room at night time, and save power by not operating.

A second idea for supporting reminders is to construct magnets that are sensitive to movement. They might glow or change color when moved, with this change gradually fading over time (Fig. 4b). In a simple way, this would display new items that had been added to the fridge, or that things had been sorted and rearranged. Such a method could be combined with the timer concept so that magnets labeled with, for instance, days of the week would be set to glow on their respective day if moved (Fig. 4c).

From an implementation point of view, these ideas are very similar to the timed alert outlined above. The main difference is that the alert would be triggered by some kind of electronic movement detection. The most obvious candidate for this would be a simple mechanical movement/vibration switch with an appropriate sensitivity. However, the fridge door itself will of course move frequently (as the fridge is opened and closed) and it should be ensured that this regular operation does not trigger any of the attached magnets. It *may* be possible to distinguish between different types of movement (e.g. the movement of the magnet across the door vs. the movement of the door itself), but an alternative approach would be to detect when the magnet is lifted away from the fridge surface with a mechanical or optical switch built into the magnet. This would reliably detect the redeployment of the magnet to a different task, but would not falsely trigger when the fridge door itself is moved.

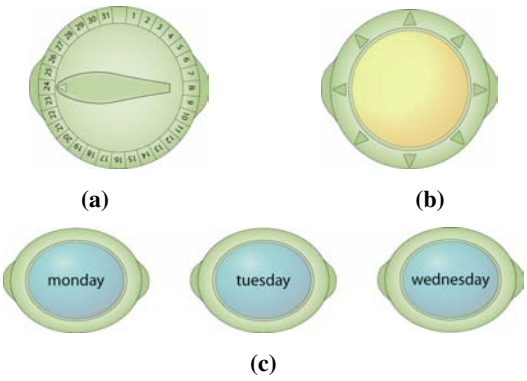


Figure 4a. Example of timer alert designed for days of month. The magnet is manually turned to set alert. **4b.** Glowing magnet designed to glow for 24 hours when moved on/attached to fridge surface. **4c.** Three of the possible seven magnets assigned to days of the week. If, for example, the 'Monday' magnet is moved on the fridge surface, it will glow on the upcoming Monday.

Organizing and Planning

The fridge surface, in combination with physical objects such as paper and magnets, provide a place where important information is kept to hand. One of the important properties of such a working space is that family members who are at home can locally access it. A downside to this, however, is that these important bits of information cannot be accessed remotely. This means that artifacts such as shopping lists, telephone numbers, details of party invitations and so on cannot be made available in other places where household members might need them, such as when planning activities at work, or when mobile (while shopping, for example). One implication of this is to think about how technology might make such information available remotely.

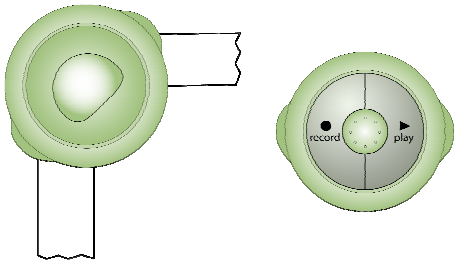
Since we know that people often designate areas of the fridge to display important pieces of information, one idea is to construct a magnetic frame with an attached camera, where the frame corresponds to the field of view of the camera (Fig. 5a). The frame could be moved about, and could be placed over important documents and objects. Householders could then place into the frame items to which they think they might want remote access, such as shopping lists, schedules, important phone numbers, addresses and so on. This in effect delineates the "working area" of the fridge as in the example presented earlier. A simpler version of this might simply be a camera that magnetically attaches to single items to allow remote access to smaller fields of view. Ideally such camera views could be seen remotely not only from desktop PCs but also over mobile devices such as cellular phones.

Whilst there are technical challenges involved in implementing this scheme, a number of solutions exist. Digital camera technology has evolved significantly over the last few years due to the popularity of camera phones. Consequently, a wide range of small, high-resolution, low power camera modules are available. More challenging is making the image data remotely accessible. Assuming once again that we require a wireless solution, a communications technology such as WiFi or GRPS would need to be embedded into the device, and a suitable system infrastructure would need to be put in place to make the images available to an appropriate set of client devices (such as PDAs, computers and mobile phones). Similar systems have previously been built for the domestic environment [e.g., 9], so this should not present a technical impediment. One of the most obvious difficulties to be addressed is the delivery of power to the augmented magnet. The power requirements almost certainly mean that a battery is inappropriate, yet our requirement is for a wireless device. A possible alternative is the idea of powering the magnet through the surface of the fridge. We address this issue in more detail later.

Another issue related to organizing that comes to light is that family members have different, idiosyncratic ways of indicating the state of actions with respect to some activity, such as the example of Harriet who moved a party invitation from one part of the fridge to another as evidence of

having replied. These actions may well be opaque to other members of the household, yet there may be times when it is important to be able to record a history of actions taken with respect to some event that is shareable with the rest of the household. This kind of activity could be simply supported by allowing materials to be annotated using a lightweight audio record/playback magnet.

The technology to support audio recording and playback in a fridge magnet is readily available today, and is present in many different devices such as electronic toys. The basis of the implementation is a single IC that could process and store voice input to be subsequently replayed. Power is supplied using a battery (either rechargeable or simply disposable); depending on use, a reasonably sized battery would provide many months if not years of operation. In addition to the modest power requirements, the size and cost of such a recording/playback device are modest and therefore quite acceptable. The issues related to implementing a visible 'reminder' to indicate when a new message has been left are very similar to those discussed in the previous section and are not repeated here.



(a) (b)

Figure 5a. Camera magnet attached to partially drawn frame. **5b.** Audio record and playback magnet.

Ownership

We have seen that fridges are used collaboratively in households. Yet, it is often the case that areas of the fridge are understood to be the domain of one person, or that personalized magnets are used to convey to others who has posted an item on the fridge, who needs to attend to it, or who is accountable for taking action on something.

Digital technology points toward new and interesting ways that people might personalize or claim ownership over magnets and the materials they are attached to. As display technologies become cheaper and more ubiquitous, one can envision that magnets might incorporate small display screens. This means they could be capable of displaying text, still images or possibly full motion video clips. One could imagine magnets as display screens to which one beams (via Bluetooth, for example) content from camera phone images. This functionality could be used to assign ownership, allowing people to tailor the objects on a fridge in a wide variety of ways. Most obviously, someone could beam an image of himself or herself to claim ownership of a magnet and the materials it holds on the fridge (Fig. 6). Further, it might be useful to remotely send information to the fridge magnets, as actions taken with respect to items may happen in other locations. Text messages or voice recordings, as well as pictures, could be sent to a magnet (Fig. 6) from a multi-media enabled mobile phone to leave messages related to the items attached to the fridge.

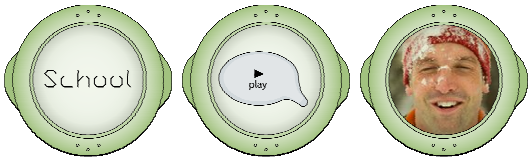


Figure 6. Magnets that can be individually labeled with text, voice or picture messages using a mobile phone.

In many ways, this is technically the most challenging idea presented in this paper. The requirements of the display embedded in the magnet are more demanding than for any of the previous applications because we require a complete image to be rendered, rather than a simple indication of state. This in turn means a bigger, brighter, high-resolution display that will be more costly and will require more power. In addition, the image to be displayed needs to be rendered onto the display which may require a reasonable processing capability, especially as the image may be provided in different formats from a number of different sources (e.g. picture messages from different types of mobile devices). As with the previous example, electronic communication to the device would have to be provided via WiFi, GPRS or a similar wireless networking technology.

General problem of power

As the fridge magnet designs presented here demonstrate, ubiquitous computing technology often involves small, portable, autonomous devices whose behavior is somehow governed by electronics and which are deployed in relatively large numbers. It is widely accepted that one of the key technology constraints (possibly *the* key constraint) on such designs is power: how to provide sufficient electrical power to these devices without overburdening users with the continual need to change or recharge batteries. (See, for example, Weiser's seminal work on ubicomp [26].)

The fridge and fridge magnets, however, provide us with an interesting design opportunity. The special place of the fridge in the home, and the special role of magnets on the surfaces of the fridge, as described throughout this paper, mean that it is entirely feasible to incorporate modifications to the fridge itself in the design of electronically instrumented magnets. We can then take advantage of another inviolable property of the fridge, namely that it is connected to the electricity mains, to overcome the problem of supplying power to the magnets.

The same inductive technology that allows an electric toothbrush to recharge its batteries without any direct electrical connection between it and the charging unit is now being used to charge a range of portable devices by simply placing them on a special mat [21]. One possible way to instrument a fridge to power its magnets would be to incor-

porate such a pad onto (or ideally into) the fridge door. The pad would draw its power from the fridge's mains electricity supply and the magnets would draw their power inductively from the pad. Magnets whose electronic functions are only required when attached to the fridge might not even require batteries at all, but those which should continue to operate while temporarily removed from the fridge could do so using small rechargeable cells.

Whether or not this specific technology does eventually provide the means to power our fridge magnet designs is immaterial. The point is that the fridge and fridge magnets are bound to each other in such a way, and their properties are such that the power problem is fundamentally more readily addressable than in many other ubicomp domains.

PAPER PROTOYPING

With these concepts in mind, and with consideration of some of the technical challenges to be faced, we wanted to gain early feedback before embarking on any full-fledged development. To do this, we carried out a prototyping exercise using mockups of the concepts and *in situ* interviews.

The prototyping exercise consisted of semi-structured interviews in five family homes. In all cases, the interviews were held with the mothers in the families as they saw themselves to be the main overseers of the fridge surfaces. Two of the interviews had other family members attend (in one, the father and eleven-year old daughter and, in the other, two sons). Each interview began by showing and describing the range of concepts printed on paper, cut out and then attached to foam core and magnets. This was done to give the interviewees some sense of how they might combine the concepts with the materials they had attached to their fridge. The interviews were then guided, loosely, by the following three primary questions:

1. How would you imagine using these magnets with the materials you have attached to the fridge?
2. What other new or different materials might you put on the fridge and how might this change the way you currently organize some of the household activities?
3. How might the magnets be changed and are there other concepts that might be useful?

Interviewees were asked these questions in front of their fridges and also asked to elaborate on their answers using the paper prototypes provided (Figs. 4-6). (In one household, rather than the fridge, the interview centered on a magnetic whiteboard on which the family uses a weekly timetable for arranging the activities and to-dos for the five daughters and parents.) Below, we report on some of the main points that arose in this preliminary work recognizing the limitations of both a paper prototyping exercise and the small number of interviews we carried out.

Reminding concepts

Overall, the considered impressions of the concepts suggested that the interviewees had particular favorites and saw some of the concepts to be more useful than others. The reminder concepts appeared to be the most popular. As the main organizers in the households, the mothers interviewed saw these to be something they could integrate into their existing practices or something they could incorporate into newly developing ones. Most of the households, for example, had letters or notices of appointments attached to their fridges and the mothers felt the various reminder magnets (Figs. 4a-c) could help when attached to them. Karen, for example, suggested she could set timers to draw attention to messages for her two children on their return from school in the afternoons when she was not able to be home.

One interesting reaction to the reminder concepts was given by Philipa, the mother in the household using a large whiteboard. Philipa had drawn a matrix on her whiteboard, listing the seven family members in the leftmost column against the days of the week across the top. An additional column to the right of the matrix was given to upcoming events and activities that fell beyond the immediate week. Information was both written into the matrix and also attached using magnets. During the interview, Philipa struggled with the concepts; she appeared to find uses for them in an effort to be accommodating rather than for any genuine reasons. Upon reflection, it is evident that Philipa had essentially preempted the concepts by establishing a relatively formal reminding system. The matrix, alongside the use of magnets, gave Philipa a quick and easy way to associate events/activities both with upcoming days and people.

Philipa's whiteboard is illuminating because it lends support to the ways in which we have envisaged setting and displaying reminders using our concepts, i.e., lightweight ways to draw attention to physical items that are planned for the near future. Philipa's ingenuity to manage her large family could very well mean she would not make use of our concepts in the ways we anticipated. However, it does suggest, in a rather exaggerated fashion, that family management can and indeed does operate like this and that smaller and/or less busy families might choose to adopt the similar but less formal strategies afforded by our concepts.

Organizing and planning concepts

The interviewees generally seemed taken by the camera/frame concept and the possibility of remotely viewing information on the fridge. Lists that were often forgotten were referred to and the camera/frame combination was seen as a solution to this. The audio recorder was harder to grasp for the interviewees. The idea of annotating items attached to the fridge using audio was not immediately grasped and did not seem appealing. Two of the interviewees thought they might employ the recorder to record lists of to-dos but both saw the one-time recording as limiting in this respect. Developing the list making idea, one mother, Olivia, also imagined a voice to text recorder that would allow her recordings to be translated to written items on a list attached to the fridge. While this idea raises the usual technical difficulties, it does indicate how, when situated in everyday experiences, something such as voice recognition could be used in a simple and practical application.

Ownership concepts

The ownership concepts were possibly the most difficult to grasp for the interviewees. One of the mothers interviewed liked the idea of sending announcements to her household via the remote voice recorder or text magnets and having them glow to signify a message had been left. Two mothers also came up with the idea of sending pictures to a magnet on an extended family member's fridge (e.g., granny). Again, however, the interviewees found it difficult to imagine attaching these concepts to items on the fridge for any functional purpose, such as assigning them to a person or activity. Rather than functional, they were largely seen as playful magnets and in four of the five households it was suggested the children would appreciate them for this.

Notably, the mother of one household, Karen, did after some thought come up with an idea similar to Philipa's whiteboard matrix. She imagined combining magnets displaying pictures of each family member with the day reminder magnets on the side of her fridge, near to the telephone. She described how this would help in being more organized, providing a weekly reference to the more important things pulled from the family calendar as well as a place for letters and notices that had not been noted in the calendar. The thought given to this idea shows a sensitivity on Karen's part to how the concepts might be situated within the home's physical and social arrangements.

Technological skepticism

The gradually increasing interest Karen showed towards the concepts and the subsequent thought she gave to their use reflects a pattern to the interviews held with four of the five mothers. In these interviews an initial skepticism was gradually given over to a warming towards the concepts. It seems the mothers were generally averse to having more things and particularly more technological things introduced into their homes. There seemed a palpable sense that the concepts were initially thought of as unhelpful 'junk'—stuff simply adding to a home's clutter.

The concepts increased in appeal as the mothers began to see that the designs could potentially support ordinary routines. Key here was the perceived simplicity of use. In noting the importance of their simplicity, one mother conveyed the ease with which they could be integrated with mundane chores: "The most important thing is that they're easy to do, that you don't have to turn them on. You can use them on your way to the sink to do the dishes or something."

There are, of course, limits to the conclusions that can be drawn from interviews with five households. However, the apparent skepticism of technology by the mothers interviewed does draw attention to the problematic efforts made to introduce information technology (IT) in the home. The initial doubts throw into question the success IT has had in addressing ordinary domestic routines, indicating IT might be considered something that adds a further burden to the practical work involved in home care.

Appropriation

The ways in which the interviewees imagined appropriating the magnet concepts seems illustrative of their overall acceptance. We see this to be an indication of how the simplicity of functioning made them readily accessible to the households. Karen's idea for using the magnets to arrange a semi-formal matrix on her fridge demonstrates how she was able to think about combining the different magnets to devise a system she saw to be useful. Karen's husband, Bill, also suggested the use of the glowing magnet alongside a chart they used to encourage their son, Harry, to read. The chart, attached to the side fridge, had been designed so that Harry could write, daily, what page he had got to in his book before playing on his game console. The magnet was seen as a way for Harry to visually signal, in a playful and hopefully encouraging fashion, he had done his reading.

Rather than questioning the functionality of our proposed concepts, we consider this re-thinking and re-appropriation to be in keeping with a basic principle in our designs: that, because of their basic functionality, the magnets should be easily incorporated or (re)appropriated into a family's existing or developing practices. Of course, it remains to be seen whether this re-appropriation would occur in practice.

In sum, as an initial exercise, the low-fidelity prototyping of the concepts has given an early indication of the value of the design approach we have adopted. It appears that people are able to grasp the basic functions of the fridge magnet concepts with relative ease and imagine incorporating them into existing practices. The suggested re-appropriation of the concepts for unexpected uses offers further evidence of this. It also highlights the importance of having technologies that are open to having their practical uses evolve in ordinary routines [6, 23]. The difficulty interviewees had in envisaging how some of the concepts might augment materials on the fridge, for example with voice annotations or picture messages, raises some question as to the extent of this openness to appropriation, particularly where the complexity of remote interaction is involved. With working prototypes now at an early stage of development, effort will be given to addressing this issue in future design iterations.

CONCLUSION

In this paper we have proposed to augment the commonplace fridge magnet in such a way that it easily fits into people's ordinary practices. Drawing on field studies of fridge surface use, we have attempted to outline a number of design concepts for magnets that support (i) organization and planning in households; (ii) reminding; and (iii) the methods household members use to assign ownership to particular tasks, activities and artifacts. In order to assess the feasibility of the described concepts, we have also undertaken a preliminary, low-fidelity prototyping exercise.

In presenting this work, we have sought to show how a particular approach to augmentation might be used in designing technology for the home. We hope to have illustrated that in some cases a model of simple, lightweight design

can override the capabilities we have to build all-encompassing, computationally complex solutions. Our proposals, although undoubtedly modest in the technical sense, are designed to perform straightforward tasks—that our findings suggest to be important—in a simple and direct fashion. The magnet that glows brighter when moved provides a nice example of this. The relationship between movement and brightness is immediately evident once the magnet's location has changed.

The proposed concepts are also considered to complement each other so that combinations of the lightweight solutions might operate in an integrated way on the fridge (and possibly elsewhere). Magnets enabling timed alerts could, for instance, be combined with the camera/frame concept so that alerts to items on the fridge might be 'delivered' to household members at designated times. Key to this 'networking' of magnets is that possible combinations are not dictated by the system, but left to emerge through the creative methods deployed by a household's members.

With these points in mind, our broadly defined aim has been to demonstrate that a design philosophy of divergence—of less is more, rather than convergence [3]—can lead to a range of practicable solutions for settings like the home. Indeed, by taking into account the notions of intelligibility and to-handedness, we believe this design sensibility might encourage the ubiquity of technology in the home because it fits with the mindset and penchant households have for using heterogeneous collections of low-tech artifacts to manage their everyday routines.

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