The History Tablecloth: Illuminating Domestic Activity

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ABSTRACT
The History Tablecloth is a flexible substrate screen-printed with electroluminescent material forming a grid of lace-like elements. When objects are left on the table, cells beneath them light to form a halo that grows over a period of hours, highlighting the flow of objects in the home. The Tablecloth explores an approach to design that emphasises engaging, open-ended situations over defined utilitarian purposes. Long-term deployment of the History Tablecloth in a volunteer household revealed complex ways that people experienced and interacted with the Tablecloth. Beyond evoking reflection on the flow of objects over a particular table, the Tablecloth served as a ground for interpretative reflection about technology, an asset for social interaction, and an aesthetic object. Even behaviours we saw as system errors were interpreted by the users as interactively rich. Their experience highlights the subtlety of domestic ubiquitous computing, illustrating alternatives to traditional views of technology's domestic role.

Author Keywords
Domestic technology, information appliance, ubiquitous computing, interaction design, interpretation, aesthetics

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

INTRODUCTION
The increasing proliferation of affordable microprocessors, sensors, actuators, displays and wireless networking over the last several years has given rise to a strong push for new forms of digital technology to enter the home. Visions for how this might evolve differ both in the technical infrastructures that are foreseen and the basic values and particular applications that are imagined [12, 13, 14].

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What most domestic systems share, whether they are integrated centres for entertainment or distributed systems for tracking older people, is an implicit or explicit narrative about what they are *for*. Through their interfaces and form design, their packaging and documentation, and the scenarios of use conveyed through marketing, technological systems are designed to communicate how they are to be used, the values they serve, and the likely outcomes of using them. By implication, they imply a user model that extends from our capacities as system operators to the sort of people we are if we use these systems: what our values are, the activities we privilege, our aesthetics and cultural identities (c.f. [5, 2]). They commodify our identities, creating representations of certain ways of approaching and experiencing the world that we can adopt to help construct ourselves. At a larger level, then, the domestic technologies developed in the research world and sold in the marketplace have cultural repercussions. They both reflect and shape the experience of home through the perceptions they reify and the actions they afford.

The way that current and emerging technologies represent and constitute the home may be critiqued on several grounds. To begin with, we may believe simply that they misrepresent the experience of home, unfairly emphasizing some forms of engagement while dismissing others. For instance, commercial forces encourage new technological products and research to address mainstream activities and values at the expense of more idiosyncratic ones, potentially leading to increasing cultural uniformity. In response to this, some researchers have advocated designing for idiosyncratic or extreme users [4] [5], if only to ensure a flow of new ideas to the mainstream.

A different objection to current representations of the home is that they tend to emphasise utilitarian versions of work, entertainment, and consumer activity. From this point of view, less purposeful, more exploratory and playful engagements in the home are poorly served by current technologies. In response to this, we might focus on designing for *homo ludens*, people as playful creatures [10]. Ludic design is not just a matter of entertainment or whimsy, but focuses on providing resources that encourage people to explore, speculate and wander, finding new perspectives on potentially serious issues [8].

The argument for supporting more playful, ludic forms of engagement itself becomes a new critique of the tendency for technologies to act as embodied representations of the home, however. For inherent to the notion of ludic engagement—of playful explorations, new perceptions and reflections—is that this is not an experience to be passively consumed, but an intrinsically motivated and personally defined form of engagement. This requires that ludic technologies offer a great degree of scope for personal engagement. From this perspective, then, *it is the very tendency for technologies to embody a representation about privileged activities and values that is problematic.*

Designing for Interpretative Appropriation

It appears impossible in principle, and undesirable in practice, to develop technologies without *any* embodied representation of users, settings and usage. Choosing a set of technical capabilities inherently implies rejecting others, and thus a judgment about desirable opportunities for action. Similarly, there is no such thing as a neutral aesthetics. Choosing to avoid particular aesthetic styles (e.g. modernist, punk, childlike) is not the same as avoiding an aesthetic commitment altogether. Even if perfectly unbiased systems were possible, they would offer nothing for people to react against or be inspired by. Making statements about people and activities is an integral feature of design.

Nonetheless, several tactics have emerged over the last several years for designing technologies that avoid overly constrained representations of users, settings or usage [see 16]. Two basic strategies can be distinguished by the way they handle the semantic mapping between a system and its environment. On the one hand are systems that leave this mapping unspecified or open-ended; on the other are those that specify a semantic mapping, but create ambiguity around its extent or implications.

Semantically unspecified systems use technology to create interactive situations without specifying their meaning in terms external to the system itself. For example, Tobie Kerridge and Andy Law's Media Mediators [11] are a collection of objects that exhibit remote controlled movements such as rolling, unfurling, and opening without a priori mapping to external events. Their intention is to explore the connotations of these movements by asking volunteers to determine the mappings for themselves, thus leaving open the possibility that these interactions could mean radically different things to different people. Similarly, the Key Table [16] uses the force with which things are placed on a table to control the tilt of an associated picture frame. Although this was conceived as a form of emotional expression, this mapping was (inadvertently) not communicated to volunteers, who were thus in the position to develop their own interpretation of the situation.

Semantically ambiguous systems use technology to respond or refer to external situations or events, but employ various tactics to undermine a simple interpretation. One approach is to develop systems that embody representations of external situations, but then subvert the authority of these representations. For instance, Böhlen and Mateas's Office Plant #1 [1] is a robotic "plant" that uses AI techniques to assess and respond to the emotional and social tenor of its owners' incoming email stream. Though its configurations and movements represent incoming email, they are purposefully crafted to be somewhat opaque, creating an "alien presence" requiring effort to interpret.

Another tactic for creating ambiguity is to create systems that clearly relate to external situations without indicating a judgment about their meaning. This creates an *ambiguity of relationship* [6] in which designers can suggest a topic for consideration, while allowing considerable scope for peoples' interpretation and evaluation of the meaning it might have for them personally. This is the tactic we used in designing the History Tablecloth.

The strategies for designing systems that refrain from imposing strong representations on users have different strengths and weaknesses. Semantically unspecified systems promise the most latitude to users in determining their own meanings, but risk failing to afford any meaningful semantic relationship outside of the system itself. Semantically ambiguous systems allow designers to raise issues without determining their interpretation, but need to be sensitive in how they indicate openness for (re)interpretation lest they appear too prescriptive on the one hand, or simply nonsensical on the other.

Nonetheless, both strategies appear promising in allowing users the possibility of *interpretative appropriation* of interactive systems. Rather than embodying clear and constrained representations of people, activities and contexts that threaten to commodify our experience, they remain more or less open to people determining their own meanings. In this paper, we describe a system we developed that uses semantic ambiguity to permit interpretative appropriation in the home, and report on a long-term user study indicating the range of meanings people found.

THE HISTORY TABLECLOTH

The History Tablecloth is a flexible plastic substrate screen-printed with electroluminescent material printed to form a grid of lace-like elements (Figure 1). We applied research by the Lancaster Equator team [15] to develop a system in which load sensors placed under the table's legs are used to track the position of multiple objects on the tabletop. When objects are left on the table, cells beneath them are lit to form a halo that grows slowly over a period of hours. When objects are removed, the corresponding halo is designed to disappear over a period of about 30 seconds.

Figure 1. The History Tablecloth (design visualization)

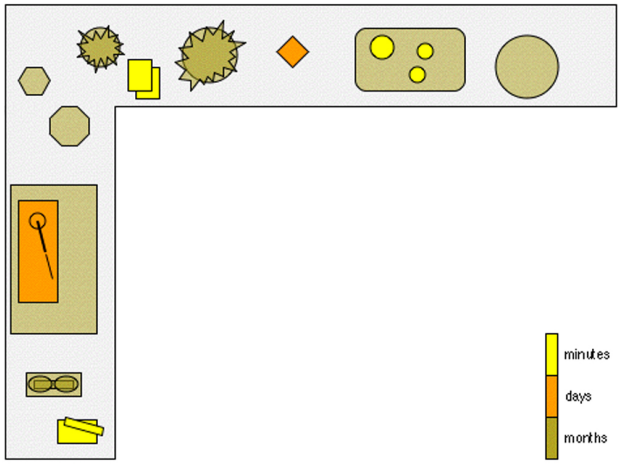

Figure 2: A sketch diagram of objects on a dining room shelf.

Making History Visible

The History Tablecloth was designed to create a situation in which the history of objects in the home could become perceptually salient. There were several sources of inspiration for the design.

First, our Equator colleagues reported an ethnographic study of how information moves around domestic spaces [3]. The study focused largely on tangible information (i.e. printed materials such as post) but also electronic information such as email (which often becomes tangible through printing). Through their observations of several households, they identified key sites that, though manifesting differently in different homes, appeared across those they studied. These included locations where information was held on initially entering the home, places where information was "processed" (e.g. mail is filtered, bills are paid, etc.), and places where information is displayed. These key locations corresponded to surfaces in the home such as tables, shelves and notice boards.

This study highlighted the importance of information flow over surfaces in the home as a phenomenon relevant for design. It also resonated with our own informal observations about the history of objects within the home. For instance, Figure 2 shows a sketch diagram of objects within the dining area of one of the authors' in-laws. As the key indicates, of particular interest here were the extremely varied time-scales of objects on the shelves surrounding the dining table. While some of the objects on the shelf, such as post and newspaper, might be moved on an hourly basis, other objects, such as decorative vases and similar artefacts, appear not to have been moved significantly for about 20 years. This tendency seemed ripe for design intervention.

In fact, earlier design explorations in other projects had already dealt with similar issues. For instance, one of the twenty or so proposals developed for the Alternatives project sponsored by Hewlett Packard [9] was called Benevolent Poltergeists (Figure 3). This was based on the observation that artifacts displayed around the home, often including our most emotionally charged memorabilia, tend to lose their ability to attract attention over time, becoming essentially invisible to long-term inhabitants. The Benevolent Poltergeist would be a robot that would emerge late at night, moving items around on their shelves to new configurations. For instance, objects might be moved to teeter on the edge of a shelf, stacked upon one another to create a precarious totem, or simply ordered according to size. Through such tactics, the device would disrupt people's habitual sense of order in the home, rekindling their interest and sense of possession.

Like the Benevolent Poltergeists, the History Tablecloth also addresses issues concerning the movement (or lack thereof) of objects in the home. Rather than implying that objects shouldn't be neglected, as the Benevolent Poltergeists do, the History Tablecloth simply makes visible

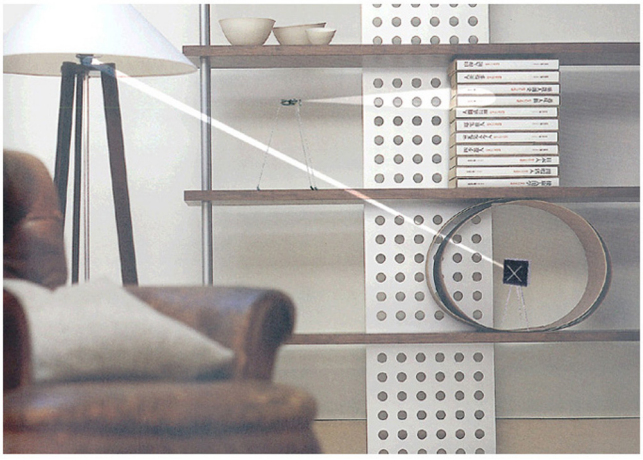

Figure 3. Benevolent Poltergeists: A sketch proposal for devices to reawaken interest in overlooked possessions.

a state of affairs. The interpretation of that situation is left to the people who encounter the Tablecloth. Some might feel that it is a prompt to tidy up more often, others might become reluctant to move objects on the table lest they disrupt a particularly pretty pattern of lights. Unlike the Benevolent Poltergeists, which use a strategy similar to Matteus' alien presence [1] in service of a particular understanding (that objects left on shelves tend to be neglected), the History Tablecloth was designed to raise the issue of object movement without imposing a particular point of view. It is intended to establish an ambiguity of relationship for people to resolve themselves.

Developing the History Tablecloth

The original proposal for the History Tablecloth was for a table, not a tablecloth. The proposal showed a grid of lights embedded in a tabletop, lighting under objects left on the table. The sequence of sketches (often shown as an animation) made clear that the patch of lights should grow slowly the longer objects were left on the surface, and fade quickly after they had been removed.

The original proposal did not specify the technologies to be used in constructing the History Tablecloth, but the grid of red lights clearly implied using high-intensity LED's, and this is the approach we took in initial feasibility tests of the technology (see Figure 5). We constructed a number of grids of LED's both to assess the aesthetic appearance we could achieve and to understand the technical issues of creating a very large grid of lights.

Although the visual appearance of the LEDs was appealing, using them had several drawbacks. First, it appeared that a large grid of LED's would draw too much power to be feasible. One estimate was that a full-scale table would use around 30 amps (roughly equivalent to an electric cooker), though we might have been able to reduce this. In addition, though we experimented with a number of means to power the lamps, ending with a Maxim LED display driver chip, a clever arrangement would have been necessary to control a full complement. It also became clear that wiring the table would be a large and tedious job, and that the table itself would be relatively inflexible once built.

As an alternative to using LEDs, we experimented with electroluminescent material of the sort used for, e.g., backlighting laptop screens. This material had the advantage of being relatively inexpensive and requiring little power. Moreover, we soon discovered that we could cut the material into more-or-less arbitrary shapes, allowing us to create more interesting patterns for the tabletop than

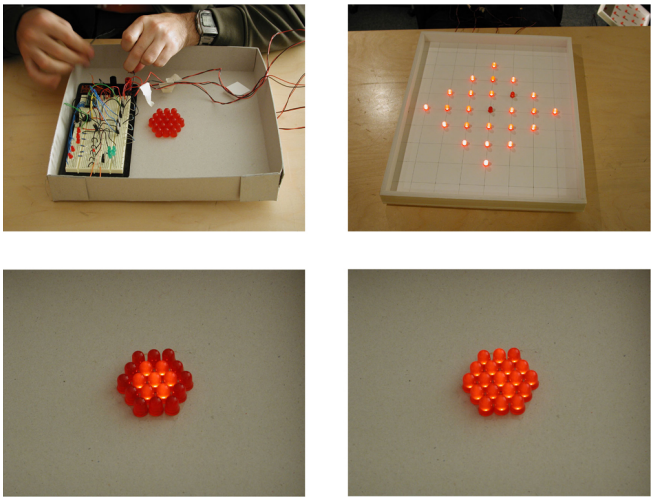

Figure 5. Our first technical tests explored LEDs.

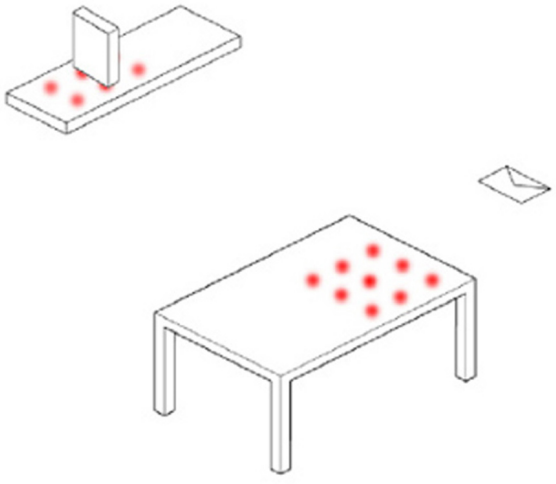

Figure 4. The original sketch proposal for the History Tablecloth implied the use of a grid of LEDs.

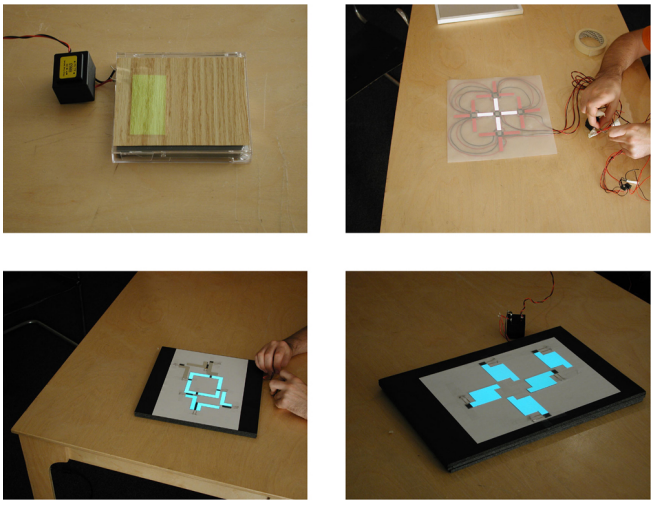

Figure 6. Later development focused on electroluminescent material.

that suggested by the initial proposal. Our initial experiments involved cutting up 50x50 mm pre-made sheets and driving them with off-the-shelf inverters (see Figure 6).

Soon after we began experimenting with electroluminescent material, we saw work by Rachel Wingfield, a graduating textile designer at the Royal College of Art (see http://loop.pH). Her final-year piece was a prototype curtain with electroluminescent material screen-printed upon it in a floral pattern that could be lit in three independent stages. This introduced us to the possibility of using screen-printing to create the large-scale grid needed for the History Tablecloth. Not only would screen-printing allow us to lay out the material much more easily than by hand, but it would allow us to create a much more intricate pattern for the piece. Thus we hired Rachel Wingfield to help us specify the pattern for the History Tablecloth's cells, and to liase with Elumin8, the Southampton company that specialized in electroluminescent screen-printing.

Our initial hope had been to arrange the electronics of the Tablecloth as a matrix, so that any given cell could be powered by running current along appropriate rows and columns of a wiring matrix. Unfortunately, this proved infeasible due to cross-talk among the cells, so that using this strategy lit up rows and columns rather than just the target cell. In the end, we had to specify separate printed electrical connections to each of the 95 independently controllable lights on the Tablecloth.

The final design for the History Tablecloth, then, involved screen-printing 5 layers of conductive ink, insulating materials, and electroluminescent material onto a flexible plastic substrate. The electrical connections ended in a wide ribbon cable running from one of the ends of the Tablecloth (see Figure 7).

It has to be said that we were initially disappointed by the aesthetic appearance of the prototype Tablecloths. Most notably, the borders between the hexagonal cells were darker than the cells themselves, giving the appearance of an imitation tile pattern (see Figure 7). Fortunately we were able to solve this problem by covering the Tablecloth with a sheet of semi-opaque paper that masked the offensive pattern while allowing the lights to shine through.

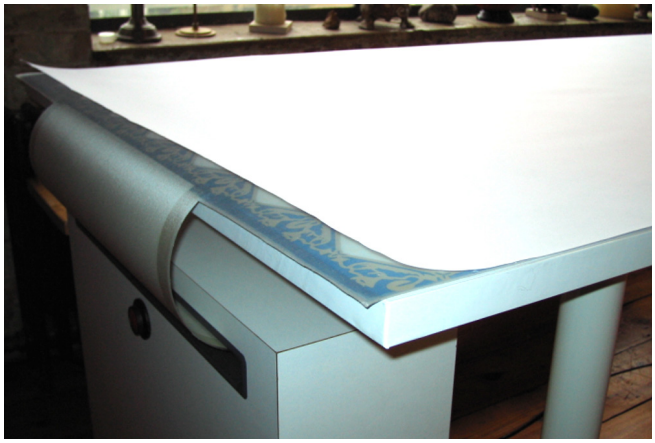

Figure 7. The History Tablecloth on a table, showing the hardware housing, ribbon, and a portion of the Tablecloth.

Using Load Sensing to Track Objects

Perhaps the most significant advantage of deciding to use printed electroluminescent material instead of LEDs is that it allowed us to develop the design as a tablecloth to be used with peoples' existing tables rather than as a complete table. This meant that instead of imposing a new piece of furniture into peoples' homes, we could simply modify their existing furniture. This flexibility promised to make field trials much less intrusive, and in the long run to open new usage possibilities.

Developing the design as a tablecloth was also made possible by our strategy for tracking objects on the table surface. As it turns out, the History Tablecloth was one of a number of designs we developed to use a weight-table system that had been developed by our colleagues at the University of Lancaster ([15]; for another example of a design using this system see [7]). This uses the different output of industrial load-cells placed on table corners to track the location of weights upon the surface. By storing the history of weights appearing on and leaving the surface, the system is able, in principle, to do a good job of tracking multiple objects at the same time. This ability was one of the direct inspirations behind the History Tablecloth.

Using the Weight Table system meant that we could modify any table to track objects upon it simply by mounting load sensors under the table legs. We achieved this by embedding the load-sensors in custom-designed plastic cups that held the sensors and table leg securely together.

Computational system

The output from the load sensors was wired to a Smart-It microprocessor board also developed by our Lancaster

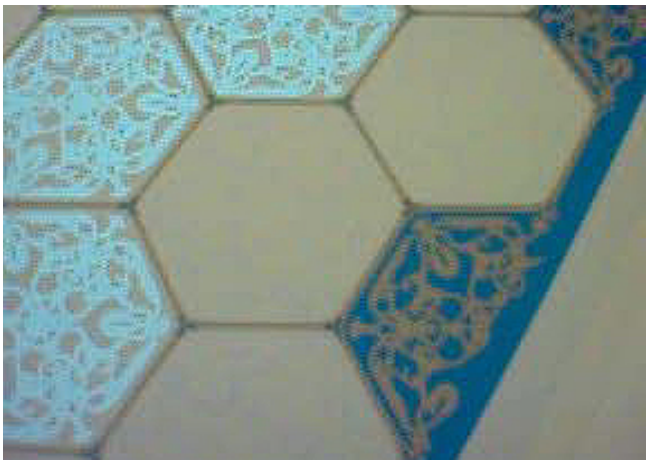

Figure 8. Detail of the Tablecloth. Note conspicuous borders.

colleagues [15]. This bridged between the weight sensors and a dedicated PC which ran the location-tracking algorithm, used this to track the history of objects on the table, and send appropriate commands to the inverter used to control the lighting of the History Tablecloth.

The computational hardware was contained in a purpose-built housing to be placed under one end of whatever table was used with the History Tablecloth (see Figure 7). The housing was somewhat larger than we would have liked, and the use of smaller computers (e.g. the so-called 'gum-stick PC') would allow the design of a much smaller unit to be, for instance, hung underneath the edge of a table. Nonetheless, our design at least partially de-emphasised the fact that the system used a standard PC.

We developed a graphical interface to track the operation of the sensors, including the raw output of the sensors, the system's hypotheses about weight locations, and the corresponding patterns to be lit on the Tablecloth. This interface was invaluable for debugging but was not presented to the people who encountered the final design.

The system was equipped with only two control points for users. The first, a large red "panic button" mounted on the front of the computer housing, allowed people to reset the system if its internal representation started to diverge from the reality of weights on the table, e.g. because of erroneous readings or missed placements or removals of weight. The second was a simple power switch mounted on the back of the housing, arranged to allow people to reboot the computer and automatically restart the Tablecloth software in case of more serious problems.

The Best Laid Plans: Problems with the Prototype

The basic History Tablecloth system we implemented was reasonably straightforward. To summarise, load cells under the table legs provided continuous data about weights on the table's surface. This data was used by the system to try to determine the location of potentially multiple weights, and the history of each detected object was tracked over time. When the system recognized that a new weight had been added, the closest cell on the tablecloth was lit, and if the system recognized that a weight remained, additional rings were lit over a period of about 6 hours. When the system saw a weight removed, the corresponding "halo" was faded down over a period of about 30 seconds.

With tuning, the prototype worked well in our studio. But even in this relatively controlled environment, the system tended to diverge from its intended behaviour over time.

First, individual cells and groups of cells began to burn out as we tested the system. Sometimes this was because small folds in the Tablecloth caused a break in the thin electroluminescent film. Other times, the insulating layer seemed to develop small cracks, causing a brief but dramatic "lightening" effect across several cells as they short-circuited. The underlying problem was that the Tablecloth was "about 10 times more complicated" than anything the printing company had made before (as they later admitted) and the resulting prototypes were more fragile than we had expected. In fact, most of the ten Tablecloths we had fabricated ended up with burnt out cells before we started our field trial. Fortunately, we found that under-powering the Tablecloth, and mounting a piece of glass on top to protect it, substantially decreased burn-outs, and we observed few if any during our field trial.

A more enduring problem involved inaccuracies in the object-tracking software. The algorithm was reliable when used carefully in our studio, but in casual use was liable to being misled. For instance, leaning on the table when placing a weight offset the registered position, causing the halo to appear in the wrong place. When the weight was removed, the algorithm might fail to associate it with the original placement, and the halo would remain behind. Sometimes the threshold signaling an end-of-placement event would not be crossed, leaving the system waiting while other events occurred. Other times, floor vibrations triggered spurious placement or lifting events. The end result was that, over time, the system's representation (and the Tablecloth's display) of objects would become increasingly inaccurate, and because this meant that lifting events wouldn't be recognized, an increasing number of cells would remain continuously lit.

We became aware of these problems while developing the History Tablecloth in the studio. Through careful redesign of the system, and tuning of the electronics, we managed to reduce them significantly, and hoped that a similar process of on-site tuning would help us minimize them in the field. Nonetheless, we recognized that some problems would remain—this was one of the motivations for including the reset and reboot switches on the prototype device.

DEPLOYING THE HISTORY TABLECLOTH

We deployed the History Tablecloth in a volunteer household for over four months and conducted an extensive program of empirical observation of it in situ. The intention of this study was not just to assess the Tablecloth per se, but to gain a deeper insight into what it means to design artefacts that allow for interpretative appropriation in domestic settings. Our research strategy favoured a detailed examination of a single home through an extended period rather than point studies over a much smaller timescale. By concentrating on a single deployment we were able to see how use and appreciation of the Tablecloth varied over time, how it related to the rhythms of domestic life, many of which extend far beyond the daily (e.g. seasonal feast days and their preparation), amongst many other issues.

Although we focused on a single home, more than 20 people encountered the Tablecloth during its deployment. This enabled us to sample both a range of casual

experiences of the Tablecloth and examine the householders' encounters with it in particular depth. In common with much field research concerned with studying a setting in depth, ethnographic observation formed our core methodology. As such methods have become an established contribution in many areas where technologies are studied in real world settings, we do not give more details here but refer to [7] as another example of these methods in our own work.

The household we studied consisted of a male/female couple living in an apartment in the east end of London. Their living space was part of the second floor of a converted factory that offered one large open space with a separate bathroom. The main space (some 100 square meters) contained recognizably separate relaxing, cooking, working, storage and sleeping areas. It occupied the width of the building and so had light from both sides. The couple typically both worked from home though were often called out to appointments during the working day.

Situating the Tablecloth

In consultation with the man (whom we shall call G) and woman (B), it was decided to best deploy the History Tablecloth and its table in their kitchen area (see figure 9). G and B told us that the observance of mealtimes was important to them and that B often worked at the existing kitchen table. It seemed to us that this spot would give the maximum chance for interesting object-traffic to occur in a way that the Tablecloth could react to. With the existing table removed, we sited the Tablecloth so that it could have access to power and oriented it so that the computer housing at one end would cause least obstruction. Some initial concern was raised by B and G as to whether the Tablecloth would be liable to heat damage given its position in a kitchen environment. Our lab testing had not considered such situations so we were content to find that out in the field. We did warn of the dangers of liquid spills near the edges of the table in case of seepage between the Tablecloth's various layers and asked that B or G turn off the mains power to the table if such problems occurred.

Figure 9. The History Tablecloth in the volunteer household.

The apartment floor (the original wooden factory floor) was quite uneven and presented some challenges for setting the table level and calibrating the load sensing. Pads were placed under each table leg and the surface aligned with a spirit level. A series of tests were run and once the Tablecloth reliably recognized the placement of a saucepan and its removal, things were left to run.

The Tablecloth was described to G and B as minimally as possible. They were told that it would respond to objects placed on the table by lighting up and that the research team was interested in what it is like having such an artefact in their home. No specific details were given about how the table and cloth work. The reset button was pointed out by comparison with similar controls on existing computing technology with which G and B were familiar, but no particular occasion for using it was highlighted.

Domestic Objects and Their Detection

As our experiences in the studio suggested, the History Tablecloth's behaviour in G and B's home was a complicated mixture of intended reactions to weight with various false alarms, offset errors, missed pick-ups, etc. The Tablecloth responded regularly to weights appearing on and leaving the table, but its response was far from perfect from the point of view of our original design intent. This could, of course, be assessed in formal terms from log data and more formal testing. What was of interest to us, however, was what G and B and their callers made of the detection abilities of the Tablecloth, what they noticed, how they became sensitized to features of objects placed upon the table and their traffic through it, and how all of this impacted upon their interpretative appropriation of the Tablecloth. To foreshadow, what surprised us about their response is that *what we perceived as errors in the Tablecloth's behaviour were perceived by them as interactive richness*.

It was clear to G and B immediately that the Tablecloth illuminated where a notable domestic object was placed. But within their first day of living with the table, it became apparent that some objects would consistently pass undetected (very light ones, e.g. a pencil). Some objects were detected in a surprising and engaging fashion. A lightweight

wine glass was missed on its initial placement but became illuminated once wine was poured in. Placement of B's laptop on the table would usually lead to some cells in the cloth's design brightening but as the laptop had four 'feet' it could be any one of these that was illuminated or, occasionally, a light might come on underneath the laptop and not be visible (yet). There could be considerable uncertainty about what to expect of the response of the table to objects with an extended footprint and/or multiple pressure points.

Pushing or leaning direct on the table might also lead to the detection of an object, as occasionally did walking heavily by the table on the old floorboards. Of course as the load sensors detect incident forces, it is not possible to discriminate between occasions where someone has just leant on the table and is maintaining their posture from those where an object has been placed and left. Placing a heavy hand on an object that is already there can also lead to anomalous detection (eg a new object is detected just adjacent to the existing one or the existing one is taken to have gone once the heavy hand is released).

One should not get the impression from this that the Tablecloth's patterns of illumination were effectively random. A typical scene would be one in which some objects were clearly encircled by light, some had been missed, and some light patches were close to but not exactly where the object had been placed (see Figure 10). Equally, as the patterns spread over time, more and more objects on the table will come to be illuminated from below whether they have been detected or not. This makes for an overall relationship between objects and light that is noticeably non-random. As such, and this is a point we will return to, G and B *preferred* the incomplete but noticeable coincidence of the light pattern with the layout of objects. This, to them, was more subtle and intriguing, as were the occasionally enigmatic behaviours of the table in response to objects being placed and removed.

The nature of object detection on the Tablecloth also sensitized G and B to features of objects and their traffic that might not otherwise have been attended to, their footprint, their edges, their weight; more generally: their behavioural repertoire on the Tablecloth. Domestic objects were interpreted from time to time in a new light, not only as wine glasses, plates, pencils, laptops but as variable and intriguing in how they can be detected and illuminated.

Interpreting the Light

Another feature of the History Tablecloth's real-world behaviour that we had not picked up in the studio was how its sensitivity seemed to vary over time as the population of objects increased. That is, a weighty object placed carefully on the table just after reset might well be reliably detected. However, that same object placed on the table when it was already full of detected objects might be missed. G: "Maybe it reaches a state where it'll stay put. It'll get stuck and you'll have to press reset to get it to start being reactive again". On another occasion when the table did not respond to a quite heavy bowl of tomatoes, G suggested: "with all this weight on the table, it probably cannot sense more". G and B also noted that the table, once it got 'stuck', was often less sensitive to objects being removed. Occasionally (but not always), they could get the table to retain a 'stuck' pattern but with no objects on the table. Once, we observed B working at the table with a neat pattern of illumination around the laptop. "But this is the pattern I made with last Sunday's lunch!"

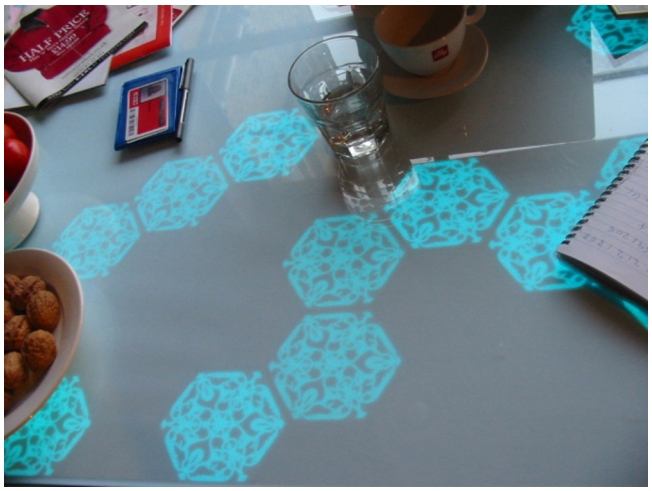

Figure 10. Complex patterns formed in practice.

It is clear that G (most notably, but B too) was beginning to offer interpretations of how the Tablecloth worked, what its 'states' were, its operational trajectory, and how one might intervene in this or work with it. "Maybe it's computing things, measuring for how long things are on, and gets less responsive when it builds up knowledge of what you have on the table. Then it has its view of what you have on the table so it stops. But when you reset, it knows nothing so it responds quickly."

Our point is not to evaluate G's interpretation as true or false, still less to compare it against how *we* would understand the table's behaviour. Rather, it is important to note that such interpretative activity occurs and is occasioned by specific behaviours of the table that are in some ways intriguing and non-obvious. Indeed, the table's behaviour became a talking point between G and B and their callers. G and B developed a *local knowledge* of the table's behaviour (its occasionally anomalous detections, its changes in sensitivity over time) complete with ways of *interpreting* things that occurred, both expected and unexpected. Very commonly, this knowledge and interpretations of phenomena were compared with other views. G (to a visitor, J): "It's interesting you're trying to give sense to it and you do it in a different way from me. You said it was confused. I just think it is doing its thing".

Noticing phenomena worthy of interpretation in the table's behaviour, offering and discussing interpretations, looking out for things in the future, and so forth are valuable activities for G and B in their appreciation of the Tablecloth and *not* obstructions to its use and enjoyment. Indeed, the Tablecloth seemed to offer a quite open ended set of things to observe even with four months of co-habitation. A number of phenomena occurred with *requisite rarity* to keep G and B's interest piqued. Occasionally, they would observe lights pulsing on and off. Once, all the cells lit up at one end around objects placed there and, when those objects were removed, a pattern of light cascaded to the other end of the table rather than gently fading at the spot. This unique occurrence "kept us talking for days".

Enhancing Everyday Activities

In the case of the History Tablecloth, such moments of interpretation and wonder are not problematic for folding the artefact into customary domestic activities. Whether it lights up or not, there's still a table there with all its usual capabilities. The failure of a cell to brighten or fade does not lead to any crisis of affordance such as pots and pans crashing to the floor. Finding the Tablecloth's behaviour intriguing and worthy of interpretation is quite a natural affair to accommodate into the ordinary domestic activities the table is used for: working, preparing food, eating.

Indeed, more than that, G and B found some of these activities to be engagingly 'illuminated' (all senses intended) by the History Tablecloth. For example, a common routine for them just before guests arrived for dinner involved "resetting the table", not just 'setting' it (G's joke). Then, as places are marked and serving dishes placed, a pattern unfolds before the guests' eyes. At these moments the nature of that pattern, its partial coincidence with the objects placed, how it grows, strange happenings at other meals, and so forth can be discussed. Then, when the dishes are removed the pattern remains. It may fade or if it is 'stuck' it may stay for days depending on whether B or G press reset. Either way, there is a momento of the meal.

Some everyday routines (here dining) were enhanced by the Tablecloth. Other routines were not disrupted (eg using the table for work activities). Some other activities came into existence where the playful opportunities of the table were more to the fore, for example, predicting whether a particular object would or would not be detected. In all this, that the Tablecloth's behaviour is commonly a matter for interpretation does not disrupt its use. On the contrary, it provides engaging opportunities for new activities or enrichments of existing routines.

Appreciating the Tablecloth Aesthetically

Sited as it was next to a large (old) factory window on the (now) kitchen side of B and G's living space, the cells of the cloth did not appear very clearly during daylight hours. But as it grew dark, the glow from the History Tablecloth became noticeable. G: "It's like an electric doily. At night it really comes into its own". A number of B and G's friends, who were skeptical when they first heard of 'an electronic tablecloth' became fascinated when the table was seen first hand and in the good viewing conditions of an autumn evening. B: "It was quite spectacular when A was sitting here and the light came out from her. She said "it likes me'. It looks great when it's dark". Particular patterns might be found appealing even if the table is unresponsive. G: "I like this pattern, it was yesterday's dinner". Clearly then the Tablecloth has a visual aesthetic that was found appealing.

We would like to argue, however, that the Tablecloth has an *interactional* and *interpretative* aspect to its aesthetics too. That G can preserve a 'stuck' pattern until the next reset is a feature of the (intended and unintended) interactional behaviour and capability of the Tablecloth. In many respects, there is not so very much you can do with the Tablecloth: move objects around, press reset. But, as we have observed in previous work [7], this minimal interactive repertoire can come to be strongly appreciated. As one does not have to continually attend to the artefact and make selections from a rich set of actions to engage with it, there is little to learn and little to disrupt ongoing domestic routines. Initially, B and G expected a richer visual display, "something photographic, or text perhaps, or for activity to be recorded and replayed". However, the minimalism of cells brightening and fading, and the simple means by which one interacts with the Tablecloth, came to be preferred. G: "As I don't have control over this, I can just enjoy it". Perhaps also helped by this minimalism, the table can become an occasion for interpretation, talk and speculation. This seemed also to be important to B and G's appreciation of the table. B: "I like how it sometimes does strange things". In this way, the sometimes anomalous behaviour of the Tablecloth and its minimal interactivity added to the aesthetic appeal of the piece.

CONCEPTUAL APPROPRIATION IN THE WILD

G and B appreciated the History Tablecloth as an enhancement to their home. As B concluded: "The table's trying to fit in with people and their lives rather than people having to fit in with the table—that requires someone to understand how you live your life." We had not designed the Tablecloth for B and G, however. Instead, we designed it to be appropriated by them (or anybody) through the ways they understood it explicitly and through their actions. Because this appropriation was personal, the Tablecloth seemed particularly well designed for their circumstances.

The Tablecloth became, for G and B, the focus for complex, multi-layered interpretation. They valued it in ways and along dimensions that we had not anticipated: as an aesthetic artefact, a responsive one, as an adjunct to everyday activities, and as a resource for social interaction. It had appeal both in itself and in the way it interacted with everyday things and activities. While we had explicitly

sought to support some of these modes of appreciation, others emerged that we had not anticipated.

Most notably, the systematic ways in which the Tablecloth's behaviour diverged from the interaction we had intended created a different situation for the volunteers than we had expected. What was interesting about this was the strong tendency of G and B to see system behaviours we perceived as erroneous as interactively rich. While we worried about the fragility of the load-sensing algorithm, they seemed rarely to consider that the system might be broken, and instead entertained various speculations about the complex reactions the Tablecloth had to objects placed upon it. In part, this was because we had never defined for them the conditions in which the Tablecloth should be considered as working or broken. Instead, they were free to consider all reactions of the table as legitimate interactions with the weights upon it.

Several conditions seemed important to the experience that our volunteers had with the Tablecloth. First, it clearly reacted to weights placed upon or taken off of it. But the occasionally anomalous behaviour it exhibited lent greater richness to the experience, without becoming so random that subtle, emergent patterns could not be perceived. Indeed, it appeared that the complexity of the 'erroneous' behaviour afforded a more interesting interactive experience than might have been created had the Tablecloth been working 'properly'. This was possible because the Tablecloth's behaviour could be accommodated in its setting—it was not disruptive nor destructive—and could engender new activities as well. Indeed, the actual behaviour of the History Tablecloth led to a range of phenomena, from those that were common and predictable, to those that were relatively uncommon but intriguing, to those that were extremely rare and valuable as such.

In sum, the History Tablecloth exhibited a range of semi-reproducible, intriguing behaviours that G and B could make sense of as illuminating their everyday lives. Many of the phenomena we observed were unanticipated and, it must be admitted, the load sensing algorithm did not work as intended. Ironically, this constitutes a better demonstration of the viability of design for interpretative appropriation than we anticipated.

G: "I like it that it takes time to fade. If it faded instantly, it'd look far too abrupt, not gentle or abstract enough. I like it that sometimes it gets stuck and then you can see how things were. I'd be very self-conscious at the table if it always followed me and reacted to me. It adds interest to what you are doing, which would not happen if things moved randomly. It's reacting but it's doing so in a way that gives it a life of its own. That makes it like an artwork. For a tablecloth that's pretty good going."

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