

Domestic Appropriations of Tokens to the Web

Jung-Joo Lee^α, Siân Lindley^ε, Salu Ylirisku^α, Tim Regan^ε, Markus Nurminen^γ & Giulio Jacucci^{αβ}

^αSchool of Arts, Design
and Architecture, Aalto
University, Finland
{firstname.sur-
name}@aalto.fi

^εMicrosoft Research,
Cambridge, UK
{sianl, timregan}
@microsoft.com

^γDiagonal,
Helsinki,
Finland
markus@diagonal.fi

^βHelsinki Institute for
Information Technol-
ogy, University of Hel-
sinki, Finland
giulio.jacucci@hiit.fi

ABSTRACT

We present findings from a study of *Tokens of Search*, a system comprising physical RFID ‘tokens’ that point to web content, and a wooden tray fixed to a small screen, which can be used to access that content. Three families lived with the system for a month, as an exploration of how tokens might be used as resources for practical action. Our findings highlight existing web practices and their individual and collective nuances; tokens were employed in the creation of short-term collections and long-lasting mementos, their physicality giving bookmarking a visibility that could be used to attract attention, serve as reminders, and make observable progress through tasks. However, while all families saw the potential for shared use, only one used it this way in earnest. We reflect on design choices that were expected to encourage collaboration, and the need to support key users such as parents when establishing joint practices.

Author Keywords

Token+constraint; collaboration; field study; home; RFID.

ACM Classification Keywords

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION

Technologies for interacting with the web are changing radically, with web use at home shifting in recent years from family members sharing and collaborating around a single desktop PC [6], to them accessing the web through a multitude of devices [2]. While some of these devices are shared by family members [2], web use is increasingly also accessed through personal devices such as phones, even when at home [18], and leading web technologies tend to be designed around a model of individual, rather than collaborative, use [16]. Nevertheless, collaborative search is increasing, and involves ‘family’ in a quarter of instances surveyed [16].

In this paper, we report findings from a study of *Tokens of Search* [27], which positions the web as a resource for practical and potentially collaborative action in the home. We

Permission to make digital or hard copies of all or part of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. To copy otherwise, or republish, to post on servers or to redistribute to lists, requires prior specific permission and/or a fee.

Request permissions from Permissions@acm.org.

DIS '14, June 21 - 25 2014, Vancouver, BC, Canada

Copyright 2014 ACM 978-1-4503-2902-6/14/06...\$15.00.

<http://dx.doi.org/10.1145/2598510.2598542>

draw on Taylor and Swan’s [25] argument that informational artefacts are integral to the ways that families organise themselves, and that the material qualities of those artefacts are crucial in affording specific actions by specific family members. We propose that by enabling families to create tangible ‘tokens’ to online content, the web might become a resource to be drawn upon in daily routines and shared practices, outside of the systems to which it is normally bound, such as personal computers that are associated with individual use.

We deployed *Tokens of Search* with three families for a month each, with the aim of understanding the ways in which online content might be utilised when given a material form. Our findings highlight existing web practices and their individual and collective nuances in the context of the home. In the following, we detail the system, highlight the affordances for use that it offered, and show how the ways in which it was interpreted by different families reflected their existing web-based practices. We begin by describing related work.

RELATED WORK

Making the Digital Tangible

One of the concepts that pioneered links between digital and physical objects was the *Marble Answering Machine* [20]. In a concept sketch of the system [4], coloured marbles are used to represent and play voicemails, as well as to trigger phone calls to the persons who left them. The sketch also shows how marbles can be positioned for others to encounter and marked up with annotations. Although an early envisionment, the sketch foreshadows many of the possibilities that have been associated with tangible artefacts, through their integration into everyday practice [23].

The *Marble Answering Machine* is an example of a *token+constraint* interface [26], as is the system we study in this paper. *Token+constraint* systems feature tokens as discrete physical objects that represent digital information, and constraints that provide a structure to channel how the tokens can be manipulated. They are commonly implemented using RFID technology and have been traditionally applied in logistics and industrial settings, but have also been noted as offering rich possibilities for everyday life [15], as the *Marble Answering Machine* also illustrates. Prototypes that explore different contexts in which tokens are used include *Souvenirs* [17], which allows people to connect photos to physical memorabilia that remind them of a particular holi-

day, trip or event; *MyState* [8], which allows users to augment any kind of object with tags that can be annotated through their mobile phones and published to a social networking site; and of most relevance to the current paper, *WebStickers* [9, 14], which uses barcode stickers to serve as bookmarks to web content in the workplace.

These systems highlight the potential for tokens to provide novel ways for users to manipulate, share, and perform interactions with digital media in the context of everyday life (see also [3]). From Bishop's [4] scenarios of leaving marbles to represent things to do or to serve as signals to others, to Nunes *et al.*'s [17] notion of permanent markers to digital content, to Ljungstrand *et al.*'s [14] discussion of how bookmarks to web content can be integrated with physical space, tokens offer opportunities to place media where physical things happen. As argued by Hornecker and Buur [10], tangible interaction enables an interweaving of the material/physical and the social, in such a way that interactions with a system can be interpreted by others and can affect their behaviour. Of course, the setting for this matters, and while Ljungstrand *et al.* [14] report preliminary findings of how *WebStickers* was used at work, the study reported here is an exploration of how tokens to web content are used in a context with a very different set of social norms, roles and practices: that of the home.

At Home with the Web

The ease of accessing the web through laptops, tablet computers and smart phones has triggered studies of web use at home that emphasise its integration into domestic routines and everyday practices. Rattenbury *et al.* [21] argue that the internet is perfectly suited to modern domestic life, as it can be used to opportunistically fill the gaps that emerge between activities, and Lindley *et al.* [13] report how web use is a means of shifting across home and work boundaries, and a constituent of leisure time in the evening. Yet although set in the context of domestic life, most of this work has looked upon web use as something done by individuals rather than by families. This emphasis on the individual is also reflected in tools for digital information seeking and studies of bookmarking and web-page revisitation. For example, research has shown that individual users prefer small and manageable bookmark collections [19], and that revisitation patterns demonstrate distinct personal rhythms [1].

However, and despite the range of 'personal' devices that family members may use to connect to the internet, families continue to show complex and diverse relationships to their technologies, some being shared [2] in a way that is reminiscent of Frohlich *et al.*'s 'family' computer [6], some being associated with individuals and located in private spaces within the home [2]. Furthermore, recent research shows that collaborative search (which is in itself increasing) involves 'family' in 25.7% of the instances surveyed [16], this being the second most popular category after 'colleagues and classmates'. Finally, studies of web use at home show how this is

often situated in the context of interactions with others, such as parents finding content for their children [13].

This body of work raises the question of how we might better support web use at home, in a way that might bridge different user accounts, systems, and devices. Research into the organisation of domestic practices highlights the role that material artefacts could play here. For example, in a study of routines around household mail, Crabtree and Rodden [5] highlight how residents construct displays from the flow of communication media to coordinate action. The post is situated in particular places within the home in accordance with whom it is for, or what kind of response it requires. Taylor and Swan [25] argue that the use of informational artefacts, such as calendars, notes and lists, become integral to 'organising systems' in the home; the material qualities of these artefacts afford actions by specific family members. They propose that organising systems produce an order to family life, and that technologies should be designed as resources to be artfully appropriated by families, to support them in organising their everyday arrangements.

RESEARCH AIMS

Following the rationale detailed above, we aimed to explore how physical handles to web content might be used as resources by family members in their everyday routines and organising systems. We studied use of a system that, like *WebStickers* [9, 14], supports the creation of tangible pointers to online content, through a deployment with three families for a month each. We were interested in how giving online content a tangible representation would lead to different interpretations and opportunities for use. Specifically, we were interested in whether the system would be used to support routine and collaborative behaviour, and whether it would trigger the development of new practices and/or be integrated into existing ways of using information.

TOKENS OF SEARCH

The system we deployed to explore these questions is called Tokens of Search. The design of the system has been presented previously [27], but we describe it here to set the context for the study. The tokens in this case are knots, corded tags, and stickers, which are embedded with RFID chips (see Figure 1). These can be associated with a single URL via an RFID reader, when used with a computer running a piece of resident software. Other elements of the system comprise a wooden tray and a small touchscreen, which are used together to access web content associated with tokens (see Figure 2). The resident software can be installed on multiple computers, thus the system can be used on personal as well as shared machines. The design of the wooden tray is intended to encourage placement in a central location in the home, where it is available to all household members.



Figure 1. Three types of tokens: Knot, corded tag and sticker.



Figure 2. The wooden tray and touchscreen, designed to be placed somewhere central in the home.

Users can associate a URL with a token through the resident software application. They do this by dragging and dropping a URL address from a web browser onto the software window, and then selecting a specific token. This can be done either by scrolling through on-screen representations of all the tokens, or by physically placing one on an RFID reader attached to the computer. All instances of the software are connected through a web socket that keeps the software elements in sync. When a new connection is made between a URL and a token, the association is propagated in real time to the other software instances, including the software running at the tray.

Users can access the content on a token either by placing it on the wooden tray or on an RFID reader connected to a computer running the software. In both cases, this action triggers a web browser to open and display the associated URL. The system was designed to enable one-to-one connections between tokens and URLs based on an experiment with an early prototype, which enabled making multiple associations for a single token. Associating a token with only one URL made the system more intuitive to learn and helped to resolve complexities with regards to the interaction design. The simpler design was also expected to support a clearer exploration of the notion of making URLs tangible.

Before Tokens was deployed, it was evaluated with three families. The first two were shown a mock-up of an early version, to investigate the concept. The third lived with a functioning system for a few weeks, to iterate and refine the design and technology. Following this, the prototype described here was deployed with three families. This paper is the first to present an analysis of use of Tokens *in situ*.

FIELD STUDY

In-depth studies involving deployments of Tokens were undertaken in three households, in Finland, the UK, and South Korea. Our intention was not to perform a cross-cultural comparison, but we expected that the diversity supported by this approach would aid us in exploring how Tokens would be used in a range of households, with potentially different social organizations and practices. We were interested in

whether and how different interpretations and uses of Tokens would reflect the existing practices of the three families.

Method

The families lived with Tokens for four weeks. During the first visit, the tray and application were installed. The family (often led by the parents) decided where to put the tray and on which computers the application should run. They were then interviewed about their computer use, including how they share their computers as a family, what they use the web for, how they use bookmarks, and so on. At the end of each week, the family was interviewed at home about their experiences with the system. They could also record their experiences with Tokens, and related thoughts, in a diary.

In addition to the interviews, the system created a log of user actions. The log data includes the URLs attached to each token, the token type (i.e. knot, tag or sticker), actions performed with the tokens (i.e. adding, reading and removing links), the device used (tray or computer details), and time of interaction. The families were informed that a log of the URLs visited would be collected. The log provided an overview of use, and also gave an idea of the family's interactions with the system prior to each interview, so that the questions could be framed accordingly.

Participating Families

The three families are described in detail below. They were selected on the basis that they had broadband and at least two children living at home. Pseudonyms are used to preserve the anonymity of the family members.

Family 1 (F1)

F1 is a family of five, living in a village in the south-east of England. The father (Sam) is a software engineer and the mother (Jenny) works at a local church. They have three children, a daughter (Evie) aged 11 and two sons aged 9 (Lewis) and 6 (Ben). They have a "family" desktop computer, located in the dining room, and a laptop used by Sam for work. Sam also owns a smartphone. The web is used to research days out and holidays, for homework, to play games, and for shopping. The children use it to look for things they would like, a process that involves their parents: "I get Dad to buy it off his credit card and then give him the money" (Evie). Jenny and the children use browser bookmarks to support re-finding; Sam manages his bookmarks through Delicious. Jenny emails herself URLs as a way of sending content between work and home. Family members have different user accounts for the family computer, but generally speaking, "everything just happens in the same place", i.e. on the family account. The Tokens tray was put in the family living room, close to the family PC, which is situated on the other side of the door that leads to it. The Tokens application was installed on the family computer and eventually on Sam's laptop, although he was reluctant to do this early in the trial.

Family 2 (F2)

F2 is a family of four, living in a terraced (row) house in a satellite city of Helsinki. The father (Pertti) works for a sports association and the mother (Kati) works for a company that

collects and analyses data. They have a 17-year old daughter (Elina) and a 14-year old son (Ilmari). The web is used individually, mostly for keeping up with personal interests. For example, Pertti watches YouTube sports videos and Kati searches for information on Italian language courses. Their family computer, a desktop PC located in a study room, was getting old, and they had recently purchased a new laptop. This laptop was intended to be used by the whole family but was in practice regularly used by Ilmari, with other family members using alternative devices – all family members own smartphones – to go online. The family do not use bookmarks much because the websites they usually visit at home are highly routinized (Facebook, news sites, etc.). Where new web sites are concerned they feel that they “*have time to search at home*” (Kati). The Tokens tray was placed in the family living room next to the couch and the application was installed on the new family (Ilmari’s) laptop and the old desktop in the study room.

Family 3 (F3)

F3 is a family of five, living in a mid-sized industrial city in the south-east of South Korea. The father (Nam) is a system engineer and the mother (Hong) is a full-time housewife. They have two daughters aged 18 (Hana) and 14 (Gina), and one son aged 11 (Jun). They have a desktop computer as a family computer and a more recently-bought laptop for the children’s study. The desktop computer is located in the living room right next to the TV table, which is the centre of the family’s attention. The computer is used mostly by Hong for shopping and Jun for playing online games. All family members except the youngest child own smartphones and use them a lot to go online. The family used to create bookmarks, such as to financial news and stock market sites (Nam), online shopping malls (Hong), and school websites (Hong and the children). They didn’t separate the bookmarks lists from one family member to another, but collected them in the same list. At the time of the study their use of bookmarks had decreased, as visiting these websites had become routine and they went online with their smartphones more often. The family has never used separate login accounts for the family computer. Nam notes, “*It’s almost transparent and open for all family members. This is, in a way, culture of my family*”. The Tokens tray was put on the dining table, where it could be used during meal times.

Data Collection and Analysis

Interviews were carried out by researchers who natively spoke the same language as each family, with the exception of F2, where both Finnish and English were used in the interviews. The first author participated in some interviews with all families for consistency. Interviews were audio recorded and transcribed into English to be shared and cross-checked across the research team. The transcriptions were inspected, alongside the log data and diary notes, to understand the circumstances in which tokens were created, what they were used for, what their relationship was to the family’s usual practices of bookmarking and sharing web content, what other opportunities for use were envisaged, and

what challenges (technical or otherwise) were found to limit use. Log files were also analysed to understand patterns of use over time.

We present in this paper an analysis of how tokens were used and how this differed from the families’ envisionments of what uses they could support. We then highlight themes that emerged in our participants’ accounts of the system, which relate to two high-level categories: affordances of the system and the values that it supported. First though, we provide context with a brief report of some quantitative findings.

FINDINGS

Overall Usage

Inspection of the logs reveals that 62 URLs were associated with tokens during the four-week field trial. 13 were created by F1, 23 by F2, and 26 by F3.

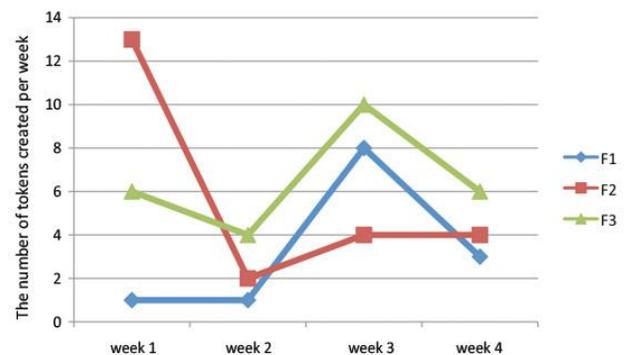


Figure 3. Graph to show the number of tokens created per week by the three families

Figure 3 points to differences across the families, which reflect the various ways in which they used Tokens of Search. As the qualitative findings reveal, F2 and F3 tended to use tokens for personal bookmarking, whereas F1 engaged in more collaborative use. F1 created tokens most actively in week 3, when there was a need for the parents to make a decision together (to buy a car; this will be described in more detail later). In F2, the majority of tokens were created in week 1, as links to routinely-visited websites were made by each family member. F3 began the trial by experimenting with the system, by creating one or two tokens to link to each family member’s most visited websites. In the middle of the trial (week 3), they created multiple tokens as personal bookmarks to several websites in the same category (university websites and online shopping malls). This was initiated by the mother and will also be described in more detail later.

First Impressions

Initial reactions to the Tokens concept differed across the three families. In F1, first impressions were positive overall. The parents articulated various possible uses for the device, which drew in the children and built on their existing web practices. These included finding videos to show to others with the Tokens tray, and the children finding content they

wished to buy and using a token to share that with their parents. More playful suggestions from Jenny included “*a romantic weekend collection [...] I could make a little collection and say ‘you have a look at those dear’, couldn’t I, you could have like a little subtle hint collection, like your Amazon wish list but in real life*”. The physicality of the tokens was also viewed positively in the domestic context, with Jenny noting, “*emailing each other is a little bit clinical isn’t it, for a relationship*”.

In comparison, F2 showed more reserved attitudes towards the system, raising concerns that tokens might easily be lost, and deciding on a safe place in the home to put the tray. Another question, raised by Pertti, related to whether the tokens would fit the family’s web practices, as they tended to use computers individually. He noted, “*I use it very privately. And I assume the other family members are not interested in my [sport] YouTube videos that I browse*”. He generated ideas for uses of tokens outside the home, such as sharing the videos with “*colleagues in the [sport] association*”. The family did view the system as having a “*cool effect*” (Kati), in that a particular webpage pops up when the tokens are placed on the tray. However, they questioned its efficiency when compared with browser-based personal bookmarking.

In F3, the father and the mother showed different reactions. Nam was unsure whether his family could come up with ways of using tokens, other than visiting their regular websites. However, Hong generated ideas for how she wanted to make tokens for her children, and also suggested ideas for other family members. In F3, use of the system started with each family member being assigned a set of tokens according to their colour (“*Mom’s is green and the red is for the eldest sister*” (Jun)), and then linking these to routinely-visited websites.

Examples of Use

As the field trial progressed, various instances of use of the system were reported at the weekly interviews. Some resonated with personal bookmarking, as might be accomplished through a browser. Others utilised tokens as ways of sharing content with others. Here, we consider each in turn.

Tokens as personal bookmarks

Scenarios whereby individual family members used tokens as personal bookmarks tended to involve content that was visited frequently. As already noted, F3 began the trial by assigning routinely-visited websites to tokens. However, these practices tended not to last, with family members in general using auto-complete and favourite bars to go to the sites they visited every day. Tokens seemed more appropriate for content that was in itself short-lived, or that was part of a collection of sites that was visited in order to accomplish something specific.

As an example of the former, Lewis from F1 created a token to link to his Nintendo DS, which was up for auction on eBay. Jenny observed, “*he’s checked on it very regularly [laughing]*”. In this case, the Tokens tray provided a useful

means to check something that could change at any moment, and in a home where the family computer was often in use. As an example of the latter, Hong from F3 created a collection of knots to represent online shopping sites, and another of tags to link to university application webpages, saying “*I want to check regularly whether there is new info about important dates*”. The different forms and colours of the tokens enabled the creation of distinct categories, however Hong also used a sticker to link to “*the university which is the top wish by my daughter*”. This was stuck onto the surface of the computer table, its particular status made clear by its fixture to the desk, which gave it a more permanent presence, made it easier to recognize, and reduced the risk of it being lost or cleared of content.

Tokens as a vehicle for sharing

Scenarios whereby tokens were created to share content with others took various forms. In some cases, tokens came to have a shared status within the family, being owned by everyone. In others, tokens were passed between family members as part of some collaborative activity.

An example of the former comes from F2, in which the children came across a picture of their cousin in an online photo-stream of a music festival. They initially created a token simply to show the photo to their parents, but it came to be kept and owned jointly. Similarly, the sticker that linked to the daughter’s first choice university in F3 also came to be jointly owned. Its fixture to the desk and its visibility meant that it came to be used by Hana, as well as by Hong.

Examples of tokens supporting collaboration were largely seen in F1. The family’s existing practice of the children finding content online, with the hope that their parents might buy it for them, was attempted with the system. Ben, the youngest child, created a number of tokens for small toys he found on eBay, although he did not always remember to pass these on to his parents. The older children were more successful in their endeavours; far from forgetting to give the tokens to their parents, they seemed to take advantage of the fact that the device could make bookmarking very visible, and used it to attract attention. Such behaviour during one of our visits prompted Jenny to teasingly say to Lewis (who was using a token to highlight an eBay item that was soon to expire), “*you’re a subtle bunny*”. Evie used the system to create a wish list for her upcoming birthday, which she could share with her mother.

In these examples, the children were using tokens to represent requests to their parents. The parents also used tokens, but their usage tended to support decisions that needed to be taken jointly. One example of this arose when their car unexpectedly needed replacing. Potential vehicles were assigned to green tokens, with an initial set of five being created by Jenny over two late-evening web sessions. Once formed, this selection of five tokens was left on Sam’s laptop for him to view when he got up in the morning “*because I knew that that’d be where he’d find them, he gets up before I’m awake*”. He selected three possibilities from the pile,

which were left for her to investigate further. The tokens enabled the parents to work across two computers, but also served as an indication of where they were in their decision making process, and as *“a reminder ... things that are on the screen and in the inbox do get forgotten”*. This example indicates how the toing and froing of tokens can support shared decision-making, and contrasts with the ways in which the children used them. For example, Evie’s wish list was understood as a *“base to let me know what she was after”*, which was used to trigger further searches that might uncover better value options.

Finally, in one instance the system highlighted a divergence of opinions regarding a planned joint activity. In F3, Nam wanted to go whale-watching with his children: *“We’ve been only talking about it for a couple of years. I want to make the token of the whale-watching website with my son.”* However, it transpired that Jun wasn’t interested in the trip. The transition from talk to action, even an action as simple as creating a token, seemed too much, and so the trip was abandoned.

Envisioned Uses

In addition to the examples of use that were described at interview, family members also frequently reported possible uses for the tokens that they did not actually enact. We include these here as they point to idealised uses of the system, whilst also highlighting challenges related to it. Some of these were technical, such as not being able to give tokens to people outside of the immediate family. Others were practical, such as having ideas for use on occasions that occurred outside of the field trial period. But some seemed to point to the difficulty of building collaborative practices. The families who did not engage in much shared use of Tokens nevertheless came up with a number of collaborative scenarios. This may point to the difficulties of developing and maintaining shared practices; it is likely to be easier to do something individually than to get others on board, and build a shared understanding of how a system should be used.

The only example of an imagined scenario that pertained to individual use was described to us by Evie. She had wanted to create a link to a music video, a song that she wished to listen to everyday when she arrived home from school, using the Tokens tray in the living room, and had intended to *“put it in my room or something so when I, I take my bag up with me to my room and unpack it, so I can just bring it downstairs and put it on”*. In this way, the token would become part of a physical routine through being embedded in particular spaces within the home.

With regards to scenarios that featured shared use, instances were envisaged that included using tokens to cue and support action, to build a collection of content for the whole family, and to be given to others outside of the family. For example, Kati discussed having a token to link to Ilmari’s football practice schedule. Visiting this website is normally initiated by Kati, who visits the site as a means of reminding her son about upcoming sessions. She felt that, instead of having to open a browser and search for the information herself, she

could give the token to Ilmari, to enable him to access updated information. In this instance, the token would serve as a reminder as well as a resource to support the activity, and for Kati to monitor it.

A scenario in which tokens were used to build family collections was articulated by F2. Here, the family talked about creating a *“recipe library”* (Kati) using tokens. She noted the difficulty of re-finding specific instances of recipes; a web search for ‘chicken salad’ may not make it easy to identify the chicken salad recipe that had been enjoyed previously. The family imagined keeping their recipe library amongst food jars in the dining room, a shared space for a shared collection, rather than on a computer that would be located elsewhere and associated with a particular individual. However, being able to *“somehow label the token”* (Pertti), making its contents visible, was noted as necessary here.

A further set of envisaged uses involved giving tokens to others. Some of these scenarios involved gifting, for example, Evie discussed making a token for Father’s Day, which would link to a YouTube video celebrating fathers. Others involved sharing content beyond the immediate family. F1 discussed the possibility of sending tokens to grandparents as a way of sharing photos hosted online. This was felt to be especially useful for people less confident with technology, and as a way of overcoming security features in email programs that inhibit the opening of URLs: *“it’s something that you can physically exchange, that’s a safer option than doing the emails”* (Jenny). Jenny also saw tokens as a way of representing a link between people: *“can you imagine boyfriends and girlfriends wearing them round their necks, dangling them from their belts, with like their little love song on ... a love token it would be called [laughs], with a little heart shape, you’d want to keep that wouldn’t you”*.

Finally, the parents in F1 felt that the system could be used as a way of offering internet time as a reward for good behaviour by their children (the children themselves weren’t keen on this idea). Jenny noted that physicality was important here: *“I think them seeing something and you being able to ... reward in a tangible form, I think I would have loved to have had a go at that”*.

Affordances of Tokens

Our findings reveal some of the affordances that families made use of when web content is made tangible. Firstly, tokens made the act of saving and accessing bookmarks publicly visible, and consequently offered certain opportunities for action. Examples of this were seen in F1’s children’s attempts to attract their parents’ attention and get them to buy them goods from eBay, but it could also work for parents. In F2, Kati recognised the potential to ask Ilmari to check the latest football schedule, by giving him a token to support the action, and by being able to clearly see whether or not he had done it. Relatedly, tokens were visible as bookmarks outside of the systems in which they were used. This meant that they could be left as reminders and to indicate jobs for others to do. Jenny remarked, in relation to the tokens representing

cars for her husband to view, “*he couldn’t have missed them, they were right there*”. Furthermore, the narrowing down of these cars was made very obvious by the shrinking pile of tokens, which indicated to all involved the progress made in coming to a decision: “*I was [looking through the cars] and then setting aside the ones that I’d done, then it’s like you know where you’re up to and which ones you’ve seen so far and, I remembered the squiggly shape of the one we were going to buy*”.

Secondly, the physical nature of the tokens underpinned a particular user experience, which was associated with ease and enjoyment. Sam commented “*I just really liked putting the token down and up pops the..., it’s something physical*”. The ease of accessing online content via a token was seen as being appropriate for a range of users, from young children who were just becoming literate, to grandparents who were not confident with technology. The flip side of this was that some participants felt that tokens could easily get lost. Additionally, their use could interrupt the flow of web browsing, where the hands are already at the keyboard and where using the browser’s auto-complete feature or a browser bookmark may be more convenient. Thus, while tokens were perceived as easy to use, they were not incorporated into routines involving regularly-visited websites.

Qualities Associated with Tokens

These affordances underpinned a number of qualities that were associated with the tokens and that were, in some cases, surprisingly contradictory. We present these here.

Transience vs. permanence

The association of tokens with ‘things to do’ meant that, for some families, their content was seen as fairly impermanent. Once the task was complete, the tokens would be cleared. In F1, for example, tokens were seen as more transient than browser bookmarks or Sam’s online Delicious collection. Tokens were used to create temporary collections, e.g. of things to buy for a birthday or of cars to be selected from. They were also seen as a way of saving something to be acted upon a short while later. Jenny noted, “*it’s a way for Ben to show me something he found earlier while I was cooking, without having to stay on eBay and have that site open and connected*”.

It is interesting to contrast this quality of transience with the example of the sticker that represented Hana’s first choice university in F3. While the sticker is nominally a prompt for action, it also seems to symbolize the importance of the activity through its fixture to the desk. The possibility of using tokens to represent content of lasting importance was noted in other scenarios, where they were seen as appropriate for long-lasting, personally meaningful content. For example, Pertti felt that tokens would be an appropriate way of linking to a video of his son’s sports match, a means of storing and representing stable content that resonates with the keeping of souvenirs. This quality is also reflected in Evie’s wish to use a token to give Sam a link for Father’s Day, as well as in the ‘love tokens’ scenario.

Neutrality vs. ownership

The fact that tokens were not associated with any one device, user account or browser meant that they had a quality of neutrality. This enabled some families to appropriate them as a useful go-between across people, being seen as an independent and convenient way of working across different systems. The fact that tokens were neutral also allowed for instances of shared ownership, such as in the case of the link to an online photo of a family member, and the example of a family collection of recipes.

However, their different form factors also enabled family members to ‘own’ particular tokens. In F3, Hong encouraged every family member to choose a colour to indicate whose tokens were whose, and over time each family member stored these tokens in separate places rather than in the tray; for example, Jun carried his silver tokens in his pencil case.

Embodiment of ‘things’

Implicit in much of the above is the fact that tokens link to only one URL, and often this was a specific piece of content, such as a particular music video, photo, toy or car, rather than portals to content, such as to YouTube videos, eBay toys or to a car retailer’s website. This could also be seen in the language that was used to describe the content, for example participants talked about “the chicken salad” or “the football schedule”, rather than the websites associated with them. This interpretation is integral to the uses that did emerge, underpinning values such as the symbolism of particular tokens, the ability to use them as reminders and the potential for them to indicate progress through a task.

Limitations of the System

As a final aspect of the findings, we report some of the aspects of the system that were perceived as limiting.

Transparency of content

One limitation of the system related to the difficulty of not being able to see what a token is associated with at a glance. When discussing tokens for the recipe library and sports videos, participants were concerned about how they would recognize which token is which without labelling them. Families attempted various ways of dealing with this, including separating out ‘empty’ and ‘full’ tokens, and using colour or shape to create categories to represent certain types of content or that belonging to certain people.

Integrating the tray with computer use

Some families reported that the Tokens tray was too disconnected from their routine computer use. As Jenny noted, “*I’d really question the need for the small screen at all, and the whole thing just lives with the family computer for me, because actually that’s where it all happened*”. Because the tray only supported the viewing of content, the discovery of content to be linked to a token and the creation of that link was done using other computers. Furthermore, any content that required action (be this playing a game or buying a product) was also best experienced through a device with a keyboard and mouse, rather than a small touchscreen.

DISCUSSION

Our aim in this study was to understand how physical handles, or tokens, to web content might be used as resources by family members in their everyday routines and organising systems [25]. In particular, we were interested in whether the material qualities of the system we developed, Tokens of Search, would support collaborative action in the home.

Our findings highlight some of the affordances that are offered by making web content tangible, in terms of support for memory, collaboration, and routine. These affordances show how tangible handles to web content can support joint action; tokens were used to attract attention, to serve as reminders for others, to support and demonstrate progress through a shared task, and to make interactions with web content observable and therefore underpin monitoring. Such findings resonate with Hornecker and Buur's [10] framework on the interweaving of the material/physical and social in tangible interaction. Moving and interacting with tokens communicated meanings to others, was performative and expressive, allowed users to think through tasks, and provided a record of decisions made. However, the qualities that were associated with tokens also supported alternative models of use. In coming to represent concrete things, rather than websites or services, tokens were linked to longevity and ownership; they could be gifted or kept as mementos, and integrated into individual web practices.

In this discussion, we consider firstly why the families in our study used Tokens of Search in such different, and sometimes contradictory, ways. We will argue that this is a reflection of the existing social arrangements and values of the three families. We will then consider what this means more broadly for the HCI community, through design reflections.

Making Tokens at Home

The contradictory values that are highlighted in our analysis emphasise how simply building technologies to afford collaboration does not mean that collaboration will ensue. While Tokens of Search offered a very different set of affordances to personal devices such as smartphones, as well as the 'family' computers that our participants had access to, instances of collaborative activity were relatively unusual during our study. Furthermore, this is not because the system was not recognised as having the potential to support collaboration. In contrast, all but one of the envisioned uses of the system were collaborative in nature. Participants recognised that the system *could* be a means of creating transient collections to be shared with others. But in many cases, they used it instead for the creation of personal, permanent, bookmarks. Interestingly, this resonates with Ljungstrand *et al.*'s [14] findings; they too envisioned shared and transient scenarios for WebStickers, but their deployment highlighted personal use and permanence. What is evident in our findings is that the existing practices of the families that took part in the study were a much more powerful influence on the uses the system than the affordances of the design.

This suggests that, in accordance with arguments made by Taylor and Swan [25], Tokens of Search was used as a resource that enabled the families in this study to design their *own* organizing systems, ones that reflected their own social arrangements. Indeed, this was evident from the beginning of the deployment, when participants initially considered how they might use the system. In F2 and F3, family members emphasised that they tended to use the internet separately. This seemed to reflect a broader understanding that family members had different interests, which were expressed both online and in the material world. For example, activities such as reading the newspaper were strongly associated with the fathers in both of these families, despite the fact that a paper newspaper can obviously afford shared reading or other forms of joint action. Similarly, although Tokens of Search was recognised as having the potential to support shared use, it was not necessarily expected to do so. Instead, integrating the system into the home meant dividing the tokens up. However, the fact that the system was, generally speaking, less efficient than browser-based bookmarks meant that its value had to be found elsewhere. Consequently, tokens were viewed as offering a handle to meaningful and long-lasting online content, where efficiency is less important than tangible embodiment.

In contrast, the parents in F1 came up with a number of scenarios for collaborative use of Tokens during the first interview, and these uses clearly involved their children. This framing of the system as a means for sharing content, and the creation of categories that represented joint tasks (e.g. green tokens for cars) rather than individual use (e.g. silver tokens for Jun), meant that the children could approach the system as a way of drawing their parents into web-based activities, and the parents could use them as a way of sharing decisions. Notably, the different relationships between parents and children, and husband and wife, were also reflected in the ways that the system was used. Children used tokens to highlight what they would like from their parents, their parents having the final say, whereas husband and wife used them to reach a decision of mutual concern together.

Thus, the ways in which Tokens was 'made' at home was influenced by existing web practices. F1 drew on examples of their children's ways of using the web when coming up with ideas for ways to use the system, while F2 and F3 considered the ways in which they usually used the web, and wondered how Tokens could support these. The system did not so much shape behaviour, as illuminate existing practices and their individual and collective nuances.

Design Reflections

This leads to a further question. If we accept the view that technologies for families should be resources that enable them to *design* their own organizing systems, we might ask how we can support users in doing this. Taylor and Swan [25] argue that technologies for families should be resources that enable them to design organizing systems that both *reflect and shape* their social arrangements. Our study serves

as a good illustration of how a system can come to reflect a family's existing social arrangements, but it also demonstrates how difficult it can be to shape new ones. Despite the potential for collaborative action that was recognised as being offered by the system in F2 and F3, these families did not use Tokens of Search in this way. Such findings resonate with prior work that has illustrated the difficulty of inspiring new routines around novel technologies in the circumstance of existing practices. For example, Lindley *et al.* [12] describe how a visual answer machine, *BubbleBoard*, failed to provoke families to appropriate its features in new and interesting ways. Drawing on Gaver *et al.* [7], they suggest that while their system was playful and enjoyable, it was not sufficiently ambiguous to provoke new ways of seeing, interacting with and using voicemails. Participants were not prompted to engage in new meaning-making processes regarding the system, and so it was simply assimilated into the established roles and routines of family life.

This was not really the case with Tokens of Search, however. It seems reasonable to suggest that the system did prompt participants to imagine uses for it that were unlike their existing ways of interacting with web content, and while our findings illustrate the ways in which collective family practices might build up around web content, the fact that these were often not enacted raises the question of how we can support users in forming new practices around novel technologies, especially when those practices involve others

Research has explored appropriation by individuals [e.g. 22], but in a family context this suggests developing practices that explicitly involve others, and the important role that parents play in establishing such practices. We might consider how to design a system that would enable parents to shape the ways that family members orient to it. Perhaps the physical structure of tokens could be designed to enable family members, and especially parents, to reconfigure their form in ways that are more meaningful to them. For example, the design of tokens could be intentionally left unfinished, to encourage family members to draw and write on them, or otherwise assemble and re-assemble them. 3D printing could also have a role to play here, by permitting the creation of tokens from templates that could be modified, or constructed from scratch. It was notable that some family members tried to organize the tokens, for example, by designating different places for those that were 'full' and 'empty'. Building openness and flexibility into the physical form of the tokens could allow family members to build more nuanced organizing systems, to appropriate the tokens more fully [cf. 7], and to express family identity and values through their aesthetics.

Our findings also lead us to reflect upon the design of the Tokens tray, which was intended to resonate with clutter bowls in the home [cf. 24]. While the tray was successful in communicating ideas of shared use, it also suggests a distinction between 'web clutter' and other types of material clutter in the home, by implying that web clutter should be kept together and viewed in one place. Our findings indicate that

this distinction is arbitrary; just because content is web-based does not mean that it belongs together. Like other resources for practical action in the home, tokens that point to web content are likely to form a part of everyday practice only if they are stored, used and viewed in different places. Indeed, these places need not even be located near web-connected devices. Just as letters might be placed not where they are to be read but where they are to be noticed [5], so might tokens be placed in bedrooms where they will slot into a routine that works around physical space (as in Evie's scenario of a token that triggers a music video) or collected together in contexts that bring meaning to them (as in F2's idea for a jar of 'recipe tokens' in the kitchen). Designing tokens so that they can be more easily positioned as indicators of things to do (as in F1's car-buying activity), things to aspire to (as in the sticker that represented the first-choice university), or even things to be kept (as in gifting scenarios) could support a fuller integration into the home, where material things come to support different practices through the ways in which they are stored, displayed and used [11].

Drawing these reflections together, we need to acknowledge that it takes time for new practices to develop and it is possible that a longer deployment of Tokens of Search may have enabled richer patterns of use to emerge. But our findings also highlight aspects of the design of Tokens that both conveyed the potential for collaborative use, and that may have hindered it. Family technologies are often positioned as things to be shared; to be viewed and used in communal 'hubs' within the home. Our findings demonstrate that it can be equally important for family technologies to be dispersed throughout the home. Collaborative use does not have to mean centralized use, and as technologies continue to take on more varied forms and smaller sizes, so further research is needed to understand how to support users in embedding them into their homes, relationships, and practices.

CONCLUSION

We have reported findings from the deployment of Tokens of Search, a token+constraint system [26] designed to provide tangible handles to online content. Three families lived with the system for a month, as part of an exploration of how the tokens would be used as resources for practical action, and how routines and roles would emerge in relation to them. Our findings highlight existing web practices and their individual and collective nuances in the context of the home. Tokens were employed in the creation of short-term collections as well as long-lasting mementos, their physicality giving bookmarking a visibility that could be used to attract attention, serve as reminders, and demonstrate and monitor progress through tasks. However, while all families saw the potential for shared use of the system, only one used it this way in earnest. On the one hand, this outcome can be said to reflect the social arrangements [cf. 25] and existing practices of the families in the study. But on the other, we consider whether aspects of the design of the system we deployed could have made the adoption of new social arrangements easier. We conclude by highlighting the design decision to

draw together ‘web clutter’, rather than allowing it to be more fully embedded into the fabric of the home as a potential limit on collaborative use, and emphasize the importance of flexibility and supporting key users such as parents especially, when forming new joint practices.

ACKNOWLEDGMENTS

The Domesticating Search project was a collaboration between Aalto University and Microsoft Research, funded by Microsoft Research and partially supported by EIT ICT Labs. We thank our colleagues for their contributions and our participants for their time, willingness and feedback. Lee and Lindley are co-first authors of this paper.

REFERENCES

1. Adar, E., Teevan, J. and Dumais, S. T. Large scale analysis of web revisitation patterns. *Proc. CHI 2008*, ACM Press (2008), 1197-1206.
2. Bernheim Brush, A.J. and Inkpen, K.M. Yours, mine or ours? Sharing and use of technology in domestic environments. *Proc. UbiComp 2007*, Springer (2007), 109-126.
3. Binder, T., De Michelis, G., Ehn, P., Jacucci, G., *et al.* *Design Things*. MIT Press, Cambridge, MA, 2011.
4. Bishop, D. Durrell Bishop’s Marble Answering Machine. (2006). <http://goo.gl/nmgBm>
5. Crabtree, A. and Rodden, T. Domestic routines and design for the home. *Computer Supported Cooperative Work 13*, 2 (2004), 191-220.
6. Frohlich, D. M., Dray, S. and Silverman, A. Breaking up is hard to do: family perspectives on the future of the home PC. *Int. J. Hum.-Comput. St.* 54, (2001), 701-724.
7. Gaver, W.W., Beaver, J. and Benford, S. Ambiguity as a resource for design. *Proc. CHI 2003*, ACM Press (2003), 233-240.
8. Hardy, R., Rukzio, E., Holleis, P. and Wagner, M. MyS-tate: sharing social and contextual information through touch interactions with tagged objects. *Proc. MobileHCI 2011*, ACM Press (2011), 475-484.
9. Holmquist, L. E., Redström, J. and Ljungstrand, P. Token-based access to digital information. In *Handheld and Ubiquitous Computing*, (pp. 234-245), Springer, 1999.
10. Hornecker, E. and Buur, J. Getting a grip on tangible interaction: a framework on physical space and social interaction. *Proc. CHI 2006*, ACM Press (2006), 437-446.
11. Kirk, D. and Sellen, A. On human remains: values and practice in the home archiving of cherished objects. *ACM Trans. Comput.-Hum. Interact.* 17, 3 (July 2010), Article 10.
12. Lindley, S.E., Banks, R., Harper, R., *et al.* Resilience in the face of innovation: household trials with Bubble-Board. *Int. J. Hum.-Comput. St.* 67, 2 (2009), 154-164.
13. Lindley, S.E., Meek, S., Sellen, A. and Harper, R. “It’s simply integral to what I do”: enquiries into how the web is weaved into everyday life. *Proc. WWW 2012*, ACM Press (2012), 1067-1076.
14. Ljungstrand, P., Redström, J. and Holmquist, L.E. Web-Stickers: using physical tokens to access, manage and share bookmarks to the web. *Proc. DARE 2000*, ACM Press (2000), 23-31.
15. Martinussen E. S. and Arnall, T. Designing with RFID. *Proc. TEI 2009*, ACM Press (2009), 343-350.
16. Morris, M.R. 2013. Collaborative search revisited. *Proc. CSCW 2013*, ACM Press (2013), 1181-1192.
17. Nunes, M., S. Greenberg and C. Neustaedter. Sharing digital photographs in the home through physical mementos, souvenirs and keepsakes. *Proc. DIS 2008*, ACM Press (2008), 250-260.
18. Nylander, S., Lundquist, T. and Brännström, A. At home and with computer access: why and where people use cell phones to access the internet. *Proc. CHI 2009*, ACM Press (2009), 1639-1642.
19. Obendorf, H., Weinreich, H., Herder, E. and Mayer, M. Web page revisitation revisited: implications of a long-term click-stream study of browser usage. *Proc. CHI 2007*, ACM Press (2007), 597-606.
20. Polynor, R. The hand that rocks the cradle. *I.D.*, May/June (1995), 60-65.
21. Rattenbury, T., Nafus, D. and Anderson, K. Plastic: a metaphor for integrated technologies. *Proc. UbiComp 2008*, ACM Press (2008), 232-241.
22. Salovaara, A., Helfenstein, S. and Oulasvirta, A. Everyday appropriations of information technology: a study of creative uses of digital cameras. *J. Assoc. Inf. Sci. Technol.* 67, 12 (2011), 2347-2363.
23. Shaer, O. and Hornecker, E. Tangible user interfaces: past, present and future directions. *Foundations and Trends in Human-Computer Interaction* 3, 1-2 (2010), 1-137.
24. Swan, L., Taylor, A.S. and Harper, R. Making place for clutter and other ideas of home. *ACM Trans. Comput.-Hum. Interact.* 15, 2 (July 2008), Article 9.
25. Taylor, A.S. and Swan, L. Artful systems in the home. *Proc. CHI 2005*, ACM Press (2005), 641-650.
26. Ullmer, B., Ishii, H. and Jacob, R. J. Token+constraint systems for tangible interaction with digital information. *ACM Trans. Comput.-Hum. Interact.* 12, 1 (2005), 81-118.
27. Ylirisku, S., Lindley, S., Jacucci, G., *et al.* Designing web-connected physical artefacts for the ‘aesthetic’ of the home. *Proc. CHI 2013*, ACM Press (2013), 909-918.