

WebStickers: Using Physical Tokens to Access, Manage and Share Bookmarks to the Web

Peter Ljungstrand, Johan Redström and Lars Erik Holmquist

PLAY: Applied research on art and technology

Interactive Institute, c/o Viktoria Institute, Box 620, SE-405 30 Göteborg, Sweden

{peter.ljungstrand, johan.redstrom, lars.erik.holmquist}@interactiveinstitute.se

<http://www.playresearch.com>

ABSTRACT

In the *WebStickers* system, where barcode stickers may be attached to physical objects making them act as bookmarks to the worldwide web in a convenient way to the user. Using readily available technology, i.e., standard barcode readers and adhesive stickers, *WebStickers* enable users to take advantage of their physical environment when organizing and sharing bookmarks. Starting from a user-centered rather than technology-driven point of view, we discuss how the affordances of physical tokens, as well as the context they are placed in, can act as useful cues for users. Since many objects already have barcodes printed on them, they can be used with the *WebStickers* system without physical modification. In addition, *WebStickers* meets proposed design criteria for information workspaces.

Keywords

Physical tokens, tangible interfaces, bookmark management, information workspaces, barcodes, world wide web.

INTRODUCTION

Resource discovery support on the Web such as search engines and online resource directories have attracted much attention. Even though most such services are less than perfect, they help a great deal when searching for online material. It is also quite common to use search engines in order to re-discover web sites that have been seen before, but where the reference (URL) has been lost or is otherwise unavailable.

Compared with systems that help users discover new web pages, the number of available systems that help users organize and maintain URLs is considerably smaller. Currently, *bookmarks*, also known as *hotlists* or *favorites*, are the dominating approach to managing personal URL collections [1, 14]. However, a bookmark list may quickly become overwhelmingly long and outdated, since many users tend to store bookmarks “just in case”, and rarely

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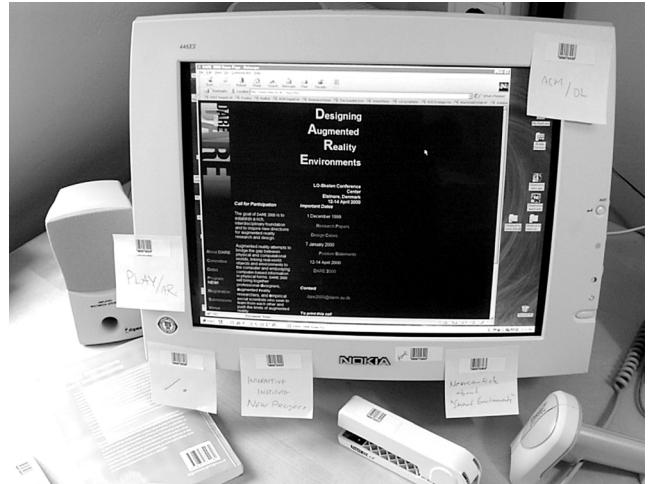


Figure 1: Picture showing PC surrounded with Web-Sticker-augmented Post-It notes.

spend time cleaning up the bookmark list. Empirical studies indicate that typically only a few entries in the bookmark list are actually being frequently used [1, 25].

The cognitive overhead associated with inserting bookmarks into a suitable folder and maintaining the integrity of the folder structure over time, seems to be significant enough to discourage the use of bookmarks on a regular basis. According to Takano and Winograd [24], the main reason why users infrequently use bookmarks is the management overhead, such as: interrupting navigation to add a new URL; varying the rule for whether URLs should be automatically stored; managing the continually growing number of URLs; adding structure to manage many URLs; and removing old and useless URLs. These problems have been addressed with a range of different interface technologies such as information visualization, adaptive agents and other automatic bookmark organizing tools [14, 16, 24, 25].

With *WebStickers*, we have taken a different approach to bookmark arrangement and management. Instead of modeling an application on existing metaphors, e.g., the desktop or the filing cabinet, we wanted to take advantage of the physical environment, and its rich set of affordances. By coupling web pages with physical representations, or *tokens*

[11], we literally moved the problem out of the computer (See Fig.1). The tokens are used to access web pages by scanning an attached barcode, and new associations between web pages and physical tokens are similarly created by scanning a barcode while simultaneously holding down a key on the keyboard. The tokens can easily be arranged in the user's environment or handed over to other users.

In this paper we present the WebStickers system, its integration with the users' physical workspace and discuss how the affordances of real-world objects can be used to reflect the properties of the virtual objects they represent. Finally, experiences of WebStickers in use will be presented as well as outlines for future work in this area.

COUPLING REAL AND VIRTUAL OBJECTS

The idea of a tight coupling between real and virtual objects has gained interest in recent years, perhaps most notably in the form of *augmented reality* and *tangible media*. Many augmented reality systems have used virtual reality techniques and devices such as head-up displays to superimpose virtual information and objects onto the physical world [cf. 20, 27]. Tangible media, on the other hand, has often been about tagging physical objects, making them act as representations of information and operators in various applications [cf. 11, 13, 26]. Thus, in terms of the technology used, the WebStickers system is most closely related to tangible media and work on different tagging techniques.

A number of systems for tagging physical objects in order to connect them with digital counterparts have been developed with various purposes in mind. Considering their intended use, the ones most closely related to WebStickers are: Paperlink [2], Informative Things [5], Palette [18], and the work of Want *et al.* on electronic tags [26].

Paperlink [2] uses a highlighter pen augmented with a camera, along with simple computer vision and pattern recognition, to allow marks on paper to be coupled with electronic information, and to "pick up" printed material for use as electronic input.

Informative Things [5] let ordinary floppy disks act as pointers to online information by associating them with a digital ID. Disks can thus be shared between users in the same way they usually are, but would seem to have "endless" storage, since no information apart from the ID was actually stored on the disk. The authors point out the particular usefulness of physical tokens for online media in shared, collaborative settings.

Want *et al.* [26] uses a combination of RFID-tagged everyday objects, wireless networking and portable computers to provide an environment where users can interact with computational media by placing augmented objects close to each other or pointing them in certain directions. However, the system requires some extensive infrastructure to be used.

Barcodes

The most widely spread commercial technique for coupling physical objects with digital information is barcodes. Examples of such include UPC or EAN numbers on merchandise and ISBN numbers on books and magazines. Such barcode tags have globally unique numbers, allowing for individual pricing of the goods in a merchant's price database.

Barcodes have been used in a number of related research projects [12, 18, 22, 23]. IconStickers [23] shares several characteristics with WebStickers, but the system builds directly upon the traditional desktop metaphor used in graphical user interfaces, by physically instantiating on-screen icons and does not appear to be designed for multi-user or collaborative settings.

Palette [18] uses a set of index cards to control the flow of a slide show during a presentation. Each card is tagged with a barcode and represent a single, previously arranged slide. To display a particular slide, the corresponding index card is scanned with a barcode reader. Palette is an attempt to move the user's focus away from the computer interface and to the primary task, in this case holding a presentation to an audience, which the authors call *tacit interaction*.

In research on learning communities, Houde *et al.* [12] let people put barcode-augmented project descriptions on a large wall with the purpose of improving learning and communication within different project groups in a large organization. People made a short, printed presentation of their current work. The paper was attached to the wall, and additional online (intranet) information could be accessed through an information kiosk next to the wall. Although their system was developed with somewhat different issues in focus, it is related to WebStickers, especially in terms of the user-centered approach.

WEBSTICKERS

Scenario

While browsing the web, Mary finds an interesting conference announcement. Since she is involved in a project related to the theme of the conference, she decides to give her colleague John a note about it. Mary writes down a few comments on a WebSticker-augmented Post-It note (Fig. 2) and associates it with the web page URL by scanning the WebSticker with her barcode reader (Fig. 3). She attaches the Post-It note to the inside of the door to her office in order not to forget it later (Fig. 4).

Later, she picks up the note when leaving the room and on her way to the lunchroom for a cup of coffee she meets John and hands him the note (Fig. 5). She describes the conference and he agrees to take a look at it. When John comes back to his office he scans the WebSticker on the note Mary gave him using his barcode reader. His web browser instantly displays the associated web page and he begins to read about the conference.



Figure 2: The user has found an interesting web page and writes down few comments on Post-It note with a WebSticker.

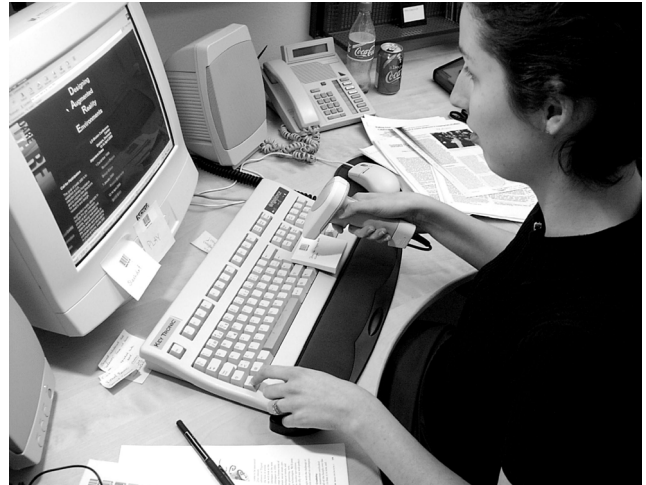


Figure 3: The user associates the WebSticker note with the web page by pressing the "control"-key while scanning the barcode.

A few weeks later the paper to the conference is beginning to take form. As John searches the web for related work, he thinks it would be useful to be able to easily share what he finds with Mary. John takes a look in his office and finds a souvenir mug bought at the same conference last year. Since the mug already has a barcode printed on it, he does not have to attach a WebSticker to it in order to use it as a token. John soon finds the first relevant article and associates the URL of the article with the mug. As he finds more and more material, the list of URLs associated with the mug grows. When he scans the barcode on the mug without associating anything new with it, his browser presents a list of the associated pages, also informing about when they were added and by whom.

Later, Mary comes by and asks John what he has found. Instead of searching through his extensive bookmark list he simply gives her the mug and tells her to take a look. When back at her desk, she scans the barcode on the mug and gets the entire list of resources that John has found. By clicking on the links on the list she has instant access to the different items.

How It Works

The WebStickers system lets users attach small adhesive stickers with pre-printed barcodes to any object, and then associate the barcode numbers to one or more web pages (or rather, their URLs). Users can later return to the web page by picking up the object and scanning the barcode with a barcode reader. For instance, a user could attach a WebSticker to a document that was printed from the web, and associate the hard copy with its online counterpart. As the system is networked, it supports work in shared and distributed settings, where users can easily copy and share bookmarks with others.

It is possible to associate more than one URL to a single barcode number. This enables, for instance, documents to act as anchors not only to an electronic version of a printed document, but to other related material as well, making an online resource collection easily accessible through a single scan with the barcode reader. Further, in many cases there is no need to attach a barcode sticker since so many objects, e.g., books, magazines and soft drink cans already have barcodes printed on them. The idea is to allow users to take advantage of the properties of any object in their surroundings, and use these properties as cognitive cues when finding or returning to a certain web location.

MATCHING THE PROPERTIES OF BOOKMARKS AND TOKENS

The use of physical representations makes it possible to use the *affordances* [10] of the tokens to reflect the properties of the virtual objects they are associated with [11]. Below we will discuss some properties of physical tokens and how they can be used to reflect properties of online media.

Using Tokens of Different Materials

Empirical studies of how people use both paper and electronic documents have identified three basic types of information considering how long they are being used: ephemeral, working, and archived [cf. 4, 9, 17]. Ephemeral information has a relatively short lifespan (in this context, a couple of days or so), and typically involves things like to-do lists, note pads and memos. Such items are often used in a collaboratively fashion, and we believe that many web pages can be used in the same manner, as temporary information. However, bookmark lists tend not to be used for short-term bookmarks, because it takes too much effort to manually delete unwanted bookmarks [1].

To facilitate a convenient way of working with ephemeral bookmarks, we used Post-It notes with pre-printed, unique



Figure 4: The user puts the note on the door to her office in order not to forget it



Figure 5: When she meets her colleague, she hands him the note so that he can take a look at the web page she has found.

barcodes that were distributed among the users. Post-It notes have a sufficient area for the user to write some text explaining what the bookmark refers to. This makes it natural to use them as transient notes that are used only for a short time or passed on to other people. Post-It notes also have a built-in aging process: after a while the glue loses its strength, and the note stops sticking to the surface where it was attached. This puts a natural limit on how long a note will exist, and users can then choose to either make a new note or to transfer that bookmark into some more persistent form.

For bookmarks that are expected to have a long life or are being frequently used, i.e., working or archived information, other kinds of physical tokens can be used. A familiar object can be tagged with a WebSticker, providing context and cues that reminds the user of a particular web page. For instance, a souvenir mug bought at the SIGGRAPH conference had a natural association with the ACM SIGGRAPH association. By attaching a WebSticker to the mug, the mug acts as a physical bookmark to the ACM SIGGRAPH website.

Since users are free to choose whatever physical object they feel best suited to act as a token (with the modest restriction of having to be able to attach a barcode to it), they can use objects made of materials with durability matching the expected lifespan of the information. However, the token and material chosen will also give other people a clue of the temporal properties of the information. A Post-It note could indicate that the associated information is transient; a worn and well read document could indicate that the associated information has been in frequent use for a while; a note or a paper with annotations in many different styles of handwriting could indicate that several people have taken part of the information, etc. Thus, if the association of

information with physical tokens is done in a consistent way, the physical properties of the tokens can give clues about the information even at a first glance. This also aids users in recognizing and classifying bookmarks.

Using Different Objects and Artifacts as Tokens

In many cases, there already exist useful connections between real world and digital information. Almost every item that can be purchased in a store has a UPC or EAN barcode, and most books and magazines have their ISBN or ISSN numbers represented as barcodes. These can easily be used in the WebStickers system by associating the barcode to a desired web page. Thus, many objects can be used without any physical modification.

Some resources on the Web also have a direct physical counterpart. For instance, many conference proceedings are available both online and in printed form. There are advantages associated with both forms: the printed version is more comfortable to read, but the online version might have search facilities and when making a quote, copy and paste functions can be used to reduce the risk of making unwanted mistakes. The book is likely to be an archival object that is stored away on a bookshelf most of the time. When working with the book, the user will bring it to her desk and by using the WebStickers association with the online version, she will have immediate access to the corresponding online documents as well. In both cases the book is placed in a certain context that can aid users finding and managing their workspace. On the bookshelf, the book will be organized along with other similar resources sorted by theme, author, publisher etc., and its placement on the desk will indicate that it is a part of current work. These are also cues that visitors to the office might benefit from.

WebStickers are also easily attached to working documents, for instance articles that are printed from the web. They can

be associated with the URL where they were found, but when the article is read and references are followed up, these too have a natural association with the original document and can subsequently be associated with the same physical paper. In this way, a single physical object can act as a pointer to a wealth of online information. In addition, a printed paper is very easily copied and shared with other people, in this case along with an attached barcode. Of course this is also possible to do digitally, without the need for physical tokens, but the point here is the ease in creating the index and sharing it with others, and in particular the reminding cues from the actual physical object.

When a certain project is finished, the working documents are generally not used as frequently anymore and hence turn into archived objects that can be used for reference later. When an old reference needs to be located, WebStickers allows physical browsing of the desk or bookshelf rather than primarily having to remember what keyword to search for, even though that option is also available.

Some online resources can be associated with certain activities. For instance, a user might be used to having a cup of tea while reading the morning news on the web. By associating the teacup with the online news site, the user will have a convenient way of accessing the URL using her teacup, while at the same time reminding her to read the news each morning. Similarly, a WebSticker put on the office window can act as a bookmark to a local weather report service, becoming an easy way of accessing more information about present and coming weather conditions. A Swedish-English dictionary might be associated with the web page of the Encyclopaedia Britannica, the thought being that when users are searching for a word, this web page will become handy as a complement to the physical dictionary.

INFORMATION WORKSPACES

The World Wide Web can be regarded as an information workspace [cf. 7, 21]. In this respect, the work by Shipman *et al.* [21] is the most closely related to our view: "But using the Web to perform real tasks is more than retrieving a list of documents. People need to answer questions, solve problems, write reports /.../ While work on storage, transport, and retrieval of documents is necessary, there is also a need for interactive environments to use the information retrieved." [21, p. 121]. To address these issues, the authors present a spatial hypertext system, *VIKI*, using multiple focus visualizations and reduced document representations. However, *VIKI*'s user interface is still limited to a traditional computer display.

Shipman *et al.* derived four main requirements for information workspace design from their empirical findings [21, p.121]: (1) support for performing multiple simultaneous tasks; (2) a variety of activity-based connections to infor-

mation resources; (3) tailorable and manipulable reduced document representations; and (4) visualizations to help users manage screen space. The WebStickers system fulfills all these requirements except (4), by using tokens that can easily be incorporated into activities, manipulated and shared among collaborators. The reason WebStickers does not meet the fourth criterion is that instead of limiting the user to the available screen space, WebStickers enables her to make use of the physical environment and the real objects around her.

Shipman *et al.* remark on the importance of the spatial properties of information spaces, for instance: "For long-term and infrequently accessed information spaces, the application of users' visual and spatial orientation abilities for relocating documents and remembering the state of a prior task is crucial. For collaborative tasks, a shared visual workspace can be used to coordinate and communicate." [21, p.122]. Our aim has been to support users in these respects even more by enabling them to use their physical environment. The rich context of the environment is something that on-screen bookmark management systems inherently lack, often due to the limited screen space. Further, this enables WebStickers to make use of the "shared visual workspace" that we already use to coordinate and communicate most frequently, i.e., our physical surroundings, rather than replacing it with an artificial workspace.

The importance of objects acting as reminders, e.g., a note put on a door or a document put at someone's desk, has been stated many times [e.g. 17, 19]. Using WebStickers, it is possible to place tokens representing web pages at such strategic locations. WebStickers also enables users to integrate the management of bookmarks with their overall organization of documents and other things in their workspace, for instance: tokens related to current work can be put on the desk; tokens representing material used in a finished project can be archived along with other material, etc. [cf. 11].

The context of everyday activities and objects might also provide cues that are important for finding relevant information. For example, it might be hard to remember the name of a document, or a web site, as it appears in a bookmark list. Even if one knows the bookmark is there, the sheer volume of other, distracting bookmarks makes it hard to find, and the only available cue is a short text string on the screen that needs to be identified and put into context. Having the bookmark index searchable would not be likely to help in a case like that, since one probably would not know what keywords to search for anyway. However, real-world context is often easier to remember, i.e., the appearance, color, or location of for instance a printed document. If the document is barcode-augmented, retrieving the associated online information is a simple point-and-click operation with the barcode reader.

Even though our skills at remembering where we put things sometimes fail us, our near surroundings often provide more cues than most currently available computer interfaces do. If the physical bookmark is lost, one can always resort to the traditional interface; to browse or search by keywords through the bookmark database. Since the system is backwards compatible with traditional ways of using bookmarks, there is always a complementary method available as a backup.

SYSTEM DESIGN

The implemented WebStickers system is client-server based. It has a central repository, a database that contains barcode numbers and their associated URLs, together with timestamps and the username of the person who created the entry. As with web servers, an arbitrary number of client computers can be used in conjunction with the server at any time. No client registration or configuration is necessary, and the only precondition is that the client must have an Internet connection. In order to fully utilize the system, each client computer must be equipped with an off-the-shelf barcode reader, a web browser and a WebStickers client. This is a small custom application that is installed locally on each computer and handles the communication between the server, the browser and the barcode reader.

As we wanted to create an inexpensive and easy-to-use system, the tagging of objects were based on ordinary printed barcodes. Custom barcodes can easily be produced with standard printers using readily available software, at a very low cost. We have printed barcodes on A4 sheets with stickers using a laser printer, but small dedicated barcode printers could also be used [cf. 23]. The use of barcodes requires no or little learning efforts from users, since their function is already well known to most people. Paper-based objects with barcodes can easily be copied and shared, e.g., on business cards, handouts or commercials, and the cost for creating barcodes is virtually zero. It is hard to match these properties using other tagging technologies, given the intended purpose of our system.

Programming and user testing has been tightly connected during the development of WebStickers. The very first prototype only allowed a single web page to be associated with a barcode. When users tested the system, we soon discovered that one token should be able to represent not only a single web page, but also collections of online material, i.e., several web pages. The main complaint about an earlier version of our system [15], was that an on-screen window needed to be active, or in focus, before a barcode could be scanned. Sometimes the user would have to first activate the window with the mouse, and then scan the barcode. From the user testing, it was clear that such extra labor could very well be the difference between the system being useful or not, and subsequently we changed it to allow for simply grabbing the barcode scanner when needed without having to use the mouse beforehand.

System Description

The WebStickers client software is designed to be as transparent as possible to the user, and uses the standard web browser to display all its results. When a barcode is scanned, the application matches the barcode number with corresponding URLs in the remote server database and instructs the browser to display the corresponding web page. Retrieval of stored bookmarks is the default mode of operation, performed by simply scanning a barcode with the reader. This action does not require the browser window to be in focus or on-screen, any program window can be active.

The second mode of operation is creating an association between the web page that is currently shown in the browser window, and a barcode-tagged object. This is done by holding down the “control”-key on the keyboard while scanning a barcode. Additional URLs can be associated with a single barcode number by repeating this action while viewing different web pages in the browser window. When retrieving a bookmark with more than one URL associated with it, the server-side of the system generates an intermediary web page with a list of hyperlinks to the associated web pages, showing the web page name, its URL, time of creation, and the creator’s username for each bookmark.

In order to eliminate the possibility for conflicts with pre-existing barcodes on everyday items, we have been using an EAN barcode prefix that is currently not allocated to any country or organization for the barcodes we printed during the course of our experiments.

It should be noted that the system is completely transparent to other applications that could be running at the same time. For instance, when a user is editing a document in her word processor, the scanning of a barcode activates the web browser and brings up the wanted web page without any need to grab the mouse or explicitly switch between applications. This is particularly interesting since it does not require the user to work according to the underlying software model or to have a sound understanding thereof. Rather, the system conforms to the user’s way of working. Interacting with the system using tokens that have a direct coupling to the task at hand, is also in line with research on taking advantage of a user’s changing focus and periphery when performing her activities [6, 13], and tacit interaction [18].

Using WebStickers without a barcode reader

Since barcode readers are not standard components of most current desktop PC systems, using WebStickers-augmented bookmarks could be problematic in some situations, for instance when a user is on the move and borrows a computer. However, since most barcode-encoded numbers are also printed as human readable numbers, entering the code by hand enables users to gain access to the stored URLs, although it requires more effort from the user. This can be done via a web page form. The system also allows

for a more traditional interface to the bookmark database, i.e., browsing through the bookmark database and performing keyword-based searches via a web-based interface. This should, however, be considered as the last resort if the physical bookmarks get lost.

Implementation details

The current WebStickers client was implemented for the Microsoft Windows platform and was written in Visual C++. It functions as a stand-alone application that detects and filters out incoming barcode numbers from the keyboard stream, as the barcode reader is hooked up between the keyboard and the computer. The client stores and retrieves bookmark data on the server using HTTP requests, and locally uses DDE (dynamic data exchange) interprocess communication to interact with the web browser. Even though the current prototype only runs on Windows, it would be relatively easy to implement a WebStickers client on other platforms. The server-side of the system runs on a Unix server, and consists of a set of CGI programs written in Perl, interacting with a Postgres SQL server and an Apache web server.

EXPERIENCES

WebStickers was continuously evaluated during the development of the system. Formative evaluations were performed and about 25 people, most of them employees at the Viktoria Institute, have been using different prototypes of the WebStickers system during a course of several months. Users spent various amounts of time with the system; some of them used it for several weeks, others for a few days and a few tested it briefly, for instance visitors to the institute. We have performed semi-structured interviews with the users and, as a complement, questionnaires. The purpose with the evaluation was to gain more knowledge about WebStickers, both in terms of the ideas behind its design as well as the implemented prototype, for future



Figure 6: During the evaluation, several users attached a WebSticker to their phones in order to have an easy way of accessing an online phone-book.

development. We have not performed any benchmark evaluations against other methods for accessing and managing bookmarks. Below we report on the experiences of WebStickers.

Results

Practically all subjects expressed positive experiences with using WebStickers. In particular the ease of use and the flexibility of the system was highly appreciated. The users were free to use the system at their own will, and they were highly creative in creating, at least to themselves, intuitive and relevant connections between web pages and physical objects. They also expressed that they had much fun figuring out such connections. Some of the examples below have been used in the descriptions of WebStickers above. This is because we felt it to be a more accurate presentation of WebStickers to describe how people used it in practice.

A number of users augmented their desktop telephones with barcodes, and coupled these to the local online telephone directory (Fig. 6). One user strongly liked being able to remind himself of a bookmark by using a physical artifact. In particular, he used the books in his bookshelf as anchors to corresponding online material on the same subject. He also pointed out the usefulness of being able to trace the history of such artifacts, and being able to see when a certain online resource was added.

Other users augmented their desktop surroundings with less work-related online media. For example, one user placed a WebSticker on his window and coupled it to a local weather service, and yet another user made a shortcut to an online email service out of a chewing gum package. In addition to this, many users re-connected documents printed from the web with their respective online counterparts.

The interface received mostly positive comments. One user remarked that WebStickers did not seem to slow down any other applications, thus functioning well in the background. Users were also positive to the possibilities with sharing bookmarks. In fact, to some users this seemed to be the most interesting property: "For personal use, I think it is more fun than useful. Maybe it's more useful in a group working together, sharing bookmarks."

However, there has also been criticism, some of which was addressed in the second prototype. One feature of the current implementation was frequently criticized: the cord of the barcode reader restricted what objects users could reach with it. One user expressed a need for a wireless barcode reader that could enable her to bring it to for instance the bookshelf and scan objects there without having to bring them to the desk.

Since most users only used WebStickers for a limited period, it is difficult to say anything about the long-term effects of using WebStickers, e.g., to what extent users will abandon traditional bookmarks or sending URLs in emails. Many users, however, stated that they were interested in

using WebStickers more permanently. In order to answer questions about the long-term effects of WebStickers, the system has to be evaluated when it is fully integrated and used by most people at a workplace.

DISCUSSION AND FUTURE WORK

Using physical tokens to access, organize and share bookmarks to the web have a number of advantages. It enables users to integrate their bookmarks with their physical workspace, and thus place them in different contexts. The benefit of a rich context is that it supports the user with many cues of when a bookmark was used, where it is and how it is related to other resources. The possibilities of using tokens with affordances that match the properties of bookmarks have also been discussed, for instance using Post-It notes with inherent glue aging for ephemeral book-marks. While this is a rather novel approach to the problems associated with bookmark management, we have tried to relate it to research on how documents and bookmarks are used and showed that WebStickers meet proposed criteria for information workspace design.

There are other issues that have to be addressed before Web-Stickers can be used to a larger extent, for instance access and modification rights for barcode numbers in the database. However, similar problems has since long been addressed by research on distributed filesystems. Other scalability issues, e.g., barcode number issuing schemes, will need to be addressed if the system is to be used in a larger setting. Future work will include expanding the use of WebStickers to other domains than bookmarks. WebStickers could be used to couple several different kinds of objects that exists both as digital and physical versions, e.g., working documents printed from a word processor could have a barcode printed on them automatically, in order to allow for instant access to the digital version of that very printout. Another interesting option is to use barcodes on publicly available material or for instance commercial merchandise. This allows a user to instantly access related web sites without the need for her to create the association herself. In fact, similar ideas are currently being realized commercially by ConnectThings [8] and Bar-Mail [3].

Generally, we believe that tokens acting as physical representations for digital objects can be a valuable complement to existing human computer interfaces. Since WebStickers takes advantage of human cognitive abilities in a way that most screen-centred interfaces do not, it offers new possibilities for convenient and transparent interaction, and integration with the overall workspace organization.

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