Connected Sketchbook:
Linking Digital Files to Physical Pages

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ABSTRACT

A lot of designers carry around sketchbooks, also called design journals, to record everyday inspirations. This paper describes a concept in which digital files are connected to specific pages of such a physical sketchbook. This way initial notes, drawings or other types of recordings can be united with their digital equivalents, related files or end results (like digital drawings and presentations). Our informal user evaluation points out that indicating file types is preferred over indicating number of files, since it helps users to recollect the digital files that are related to the work described on the physical pages.

Author Keywords

Tangible interaction, autobiographical memory, physical sketchbook, digital files, everyday remembering.

INTRODUCTION

The concept, the *Connected Sketchbook*, we present in this paper is a dedicated sketchbook which allows the user to make a connection between digital files and notes or drawings in the physical sketchbook (see Figure 1). The concept does not digitise notes or sketches made on the physical pages, instead it allows the user to link digital files to these physical sketches. This changes the way of accessing and navigating files, both on paper as on the PC, where the digital files can be viewed. This concept is beneficial for designers who use a design journal throughout their design process. The intended user is the industrial designer. A lot of industrial designers keep a design journal, or sketchbook, which functions as an important object for documenting individual thinking, both visual and textual [13]. Despite the increase of computational tools, sketchbooks have qualities that electronic devices cannot mimic. Therefore many designers make use of both [16].

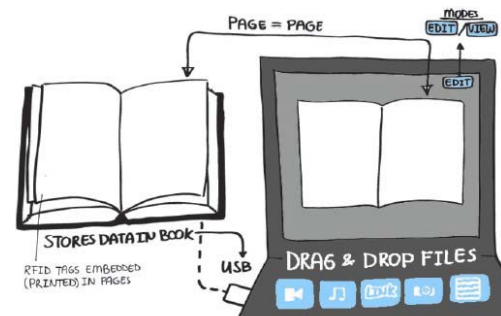The Connected Sketchbook makes navigating through digital files more haptic (flipping the pages of the

Figure 1. The Connected Sketchbook concept, with the physical sketchbook (left) linked to a computer for linking and viewing digital files (right).

sketchbook) and instead of having files in folders, the files are now linked to the mental model of the user (i.e. their own notes).

RELATED WORK

These physical and digital worlds will be discussed separately and combined in the following three related work sections: Physical Pages, Digital Files and Devices and Physical and Digital Combined.

Physical Pages

Sketchbooks or design journals are physical books that many industrial designers (and also designers from other disciplines) use for sketching and writing down their ideas. Reasons for keeping design journals are documentation of intellectual property, ease of mobility, to have a central storage of personal information and to support reflection [13]. This sketchbook carries a lot of information, ideas and material for inspiration and is therefore an important element in the design process as well as a personal diary (entries are often listed by date).

Even in this digital era, the value of paper is apparent. While certain activities, e.g. authoring and archiving, have migrated to the digital world, others such as reading are still frequently done on paper [14]. Paper offers many advantages over digital media, especially for designers: it is easy to annotate [10], but it is also cheap, light-weight, foldable, mobile and requires no power [11].

Digital Files and Devices

Apart from the obvious advantages of digital files, such as the ease to make copies, to share and to have them available in multiple locations, the use of the digital shows disadvantages too. E.g. a study on electronic document navigation showed that half of all manipulated documents are reopenings of previously used documents and the 'recent documents' list is rarely consulted [1]. Furthermore people tend to store a lot of bookmarks, but rarely clean up and only use a few frequently [1, 2]. These indicate that there is still a need for a useable central system for returning to documents.

There are a few concepts that focus on improving interaction with digital data. For example the Thumbnail Slider [5], which focuses on enhancing navigation by showing thumbnails of the pages in a document. This concept was based on prior work which showed that readers often have a mental image of pages containing specific information and use that for returning to pages [12].

Physical and Digital Combined

Another way of improving interaction with digital data is by linking the digital and the physical world. This section discusses examples of digital papers, augmented books and physical artefacts with a connection to the digital.

Interactive paper is paper augmented with characteristics of electronic devices. Like PapierCraft, a gesture-based system that allows users to manipulate digital documents by drawing command gestures on paper using an Anoto digital pen [7]. A different way of adding digital aspects to paper is through the use of Embedded Media Marks [8]. These nearly transparent marks are printed on paper documents to represent a media link (audio, video, text, webpage or image) that can be retrieved by taking a picture with the use of a cell phone. Ensemble Interactions [16] also makes the paper itself act as an interface. E.g. writing "Pizza in San Francisco" on this paper makes your mobile phone perform the search.

Within the field of *augmented books* we see a focus on adding digital or virtual extensions to physical pages. The Listen Reader [3] is a children's book in which a specific sound or piece of music is linked to specific pages to support the story. The MagicBook [4] uses augmented reality to show 3D virtual (and animated) content registered on real pages. Within the field of augmented books there are already several examples of physical paper linking to digital files. However, most of them discuss a link to a fixed digital file or file type.

This third category focuses on establishing a *relation between physical objects and digital documents* or actions. Like the Websticker system, in which barcode stickers are attached to physical objects making them act as internet bookmarks [9]. Similar is the technology Touch-a-tag [15], a physical tag that can be used to start digital processes, from opening a specific internet page, to sending an email. There are also other solutions, like SnapTable [6].

SnapTable allows an image on the tabletop screen to be transformed into a tangible printed image on a physical E-paper medium, accompanied by a link (e.g. file location).

Summarizing, these works all describe different ways of extending the physical with digital properties to improve or enhance the abilities of these physical artefacts.

CONCEPT CONNECTED SKETCHBOOK

The Connected Sketchbook however, offers the ability to the user to make an editable connection between a physical page and any type of digital file (see Figure 2), something we have not yet found in other related work. The digital files can even be viewed or edited on any other computer by simply connecting the sketchbook. Feedback is provided to the user by a row of lights incorporated in the book which shows the presence of files that are linked to a specific page. This helps making the digital files more visible and present even when not connected to a computer.

An advantage for linking digital files to the physical pages of a designer's sketchbook is that the owner's mental model of the sketchbook's content can be used to return to specific pages [12], and thus the belonging digital files. This combination can serve as efficient memory cues for the associated media and the assumption is that this will improve the workflow because there is no need for searching in two distinct databases of information. Furthermore related information can now be found together in a self-created context.
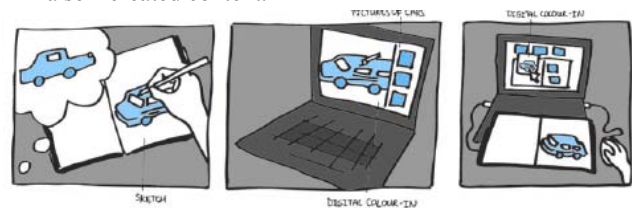

Figure 2. Connecting initial drawings with the digital end results through the Connected Sketchbook concept

Imagine the *scenario* of an industrial designer visiting a lecture. During this lecture she makes notes in her Connected Sketchbook, like she would in any other sketchbook. However, once back at her computer, the designer can link the PowerPoint presentation to the specific page(s) on which she made her notes. This way recalling the actual lecture will be made easier through the combination of cues: both digital and physical.

When having a meeting the designer can connect her Connected Sketchbook to the computer of her supervisor, to show digital files of work in progress. She would be able to prepare and quickly show her plans, drawings and collages on the pages of her sketchbook, while showing some of her initial research results (like websites, documents and presentations) or other digital work on the computer. Since the linked physical and digital work are simultaneously accessible, it becomes quicker and easier to show and discuss.

How it works

The Connected Sketchbook concept consists of a sketchbook, page detection, digital storage space, feedback lights and dedicated software (see Figure 3). Page detection tells the integrated software which page is open. The software then generates the unique virtual page associated with that page of the book. Now the user can drag computer files onto the virtual pages, which automatically creates a link between those files and the specific page on which the book lies open.

Figure 3. The pictures on the left show the setup of the user evaluation. The pictures on the right show the prototypes of both book (below) and software (above).

The files connected to the pages are actually stored on the book itself (integrated storage space), but a copy will be stored on the computer of the user. In this way the files remain mobile, yet safe and always accessible. One can connect the Connected Sketchbook to another computer and edit files or work on his/her computer without the book being present. Once the book is connected to the 'base' computer, the files will synchronize. When connected one has to flip to the associated physical page to get to a certain digital file on the PC. However, the software should still offer file retrieval options in case a physical page is not quickly found. We recommend a search function and a navigational preview (to show how much the user has to flip back or forward to find the right physical page). Another solution is to simply disconnect the book and use the PC's digital file organization.

When the book is not connected to a PC, integrated lights provide feedback to the user: they either show the type or amount of digital files (we implemented and compared both) that are attached to a specific page. Communicating the presence of files within the physical book away from the computer makes the digital files more physical and visible, plus there might be a secondary effect of motivating people to connect the book to the computer.

CONCEPT IMPLEMENTATION

A partially working prototype was built to test a specific aspect of the concept. The prototype consisted of a physical book, of which page detection (through the use of conductive page corners) was implemented on the first 12 pages. The prototype needed to be connected to a PC, running dedicated software which made sure that when flipping the pages, the associated computer showed the right virtual pages with the linked digital files. These were not actual files but merely graphic representations of files with the file types indicated (see Figure 3). Within the book also the feedback lights were implemented to show the user the presence of digital files even when the screen was turned off. Two versions of the feedback lights were implemented (see Figure 4): 1- the lights could represent the number of files (two lights on, indicates two files are linked) or 2 - the type of digital files could be indicated through icons (if the video icon is lit, one or more videos are linked).
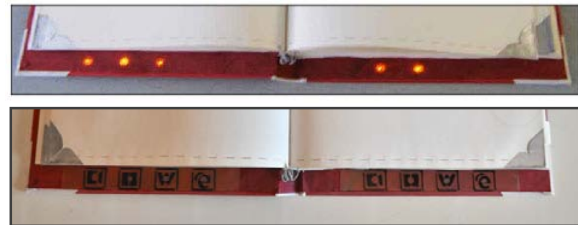

Figure 4. The feedback of lights showing number of digital files (above) or type of digital files, through icons for video, picture, text and website (below) connected to the open pages.

USER EVALUATION

We conducted an informal user evaluation to see whether the *number* or *type* (see Figure 4) of associated files to the physical sketchbook helped the user in recalling which digital files were connected to a physical page when not having access to a computer.

For our informal evaluation we decided to use senior industrial design students, because of their experience with design processes and the use of sketchbooks. The nine participants on average remembered 16 out of 24 digital files without the use of any feedback. When using the *number* lights an average of 19 files were remembered and with the *type* lights an average of 21, which suggests that *type* is the most effective cue to recall the files (Figure 5).
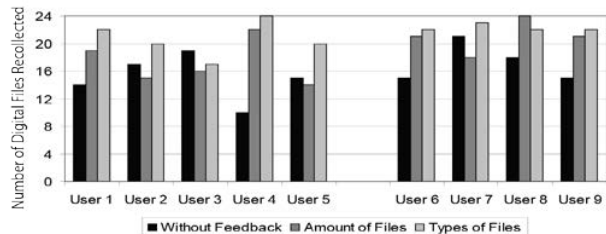

Figure 5. The results of the user evaluation, which were counterbalanced for order. Order for users 1-5: no cues, file number, file type. Users 6-9: no cues, file type, file number.

However, the number of participants was too small for any statistical significance. Since the participants were given fictional files and scenarios we expect that long term testing with actual files of the participants to have even better results.

DISCUSSION AND CONCLUSION

From our own observations two out of nine participants of the user evaluation wanted to make a little note or drawing as a cue for the digital file linked to a physical page. This could be better supported by allowing the user to create their own cues during linking.

When comparing the Connected Sketchbook to related concepts there are several differences and advantages. The pages of the Connected Sketchbook do not contain fixed media links like most augmented books and some interactive paper. Instead the relation between page and any type of media is made by the user and can be changed at any point in time. This makes the digital links flexible and personal, which can be an advantage for finding back specific files, especially since readers often have a mental image of pages and use that for returning to pages [12].

This combination of physical and digital creates new opportunities for any type of user of journals or notebooks, such as using the annotations made on a physical page related to a linked *digital* presentation and making good use of the mobility of digital files. The linking between physical pages and digital files as offered by the Connected Sketchbook makes file browsing physical again.

Concluding, this paper discussed the Connected Sketchbook concept which enables linking digital files to physical pages. By making this link visible, these become cues for recollection of the attached digital files. The user evaluations gave an indication of how cues helped in recollecting the digital files, even when not near a computer. The Connected Sketchbook concept is promising in the sense that it supports the mental model, habits and workflow of the individual designer in a physical way.

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