

Augmenting paper-based work practices

Sara Ljungblad, Maria Håkansson,
Lars Erik Holmquist
Future Applications Lab
Viktoria Institute, Göteborg
www.viktoria.se/fal
{sara, maria, leh}@viktoria.se

Magnus Bång, Erik Berglund,
Anders Larsson
Santa Anna IT Research Institute
Linköping, Sweden
www.santaanna.se
{magba, eribe, andla}@ida.liu.se

ABSTRACT

Paper artefacts are considered invaluable in many work settings and they are often used for overview in collaboration. In such cases, augmenting paper with computer power can be a suitable approach to gain digital benefits while still keeping the paper-based practices. However, augmenting paper introduces new physical and digital challenges, both for the designers and the users. We have compared two different research systems that augment paper and discuss emerging design challenges on augmented paper approaches.

Keywords

augmenting paper, NOSTOS, Pin&Play, ubiquitous computing, scheduling tasks

INTRODUCTION

Augmentation of paper-based routines is an important step in the computerization of human work practices. Several studies of collaborative work have showed that paper objects are very supportive, giving users control, flexibility, and overview of information in ways that are difficult to achieve with computer technology [1,8]. However, digital benefits such as trace- and search-ability of documents are almost impossible to achieve with solutions based on paper only.

Ubicomp technology makes it possible to use paper as the interface to computers, and augment paper-based work processes. When connecting paper-based information systems with digital information, new requirements and challenges arise.

RELATED WORK

In the past years, there have been several attempts to design technology that facilitates the use of tangible objects in face-to-face group collaboration. *Collaborage* is a system that uses computer vision to augment physical objects with digital information, so that paper notes are tagged with data glyphs [7]. *RASA* is another example, using speech support and tracking of Post-it™ notes on a chart [6]. Both [6,7] illustrate concerns that arise when designing such systems, for example the importance of feedback of the system's progress, minimal changes to the existing work practice and robustness.

We have compared two different augmented paper systems; *NOSTOS* [2], that supports the scheduling of patients in an

emergency room, and a *Pin&Play*-based prototype [3] that supports the scheduling of a film festival (see figure 1). This comparison has generated common challenges and requirements, which can be valuable for other systems that aim to support collaboration and augmented paper practices.

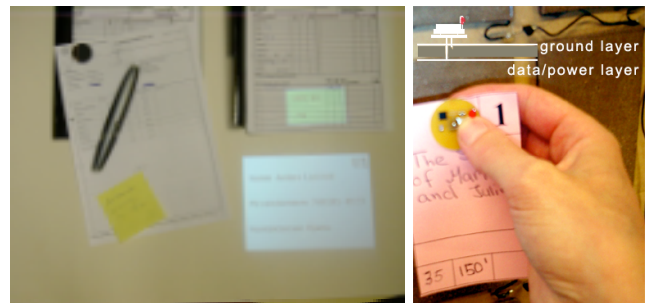


Figure 1. The NOSTOS system augmenting patient records (left) and a Pin&Play augmented paper note, representing a film (right).

CASE STUDIES

The two compared systems were preceded by fieldwork in two different settings, briefly described below.

Emergency room

We have studied the paper-based collaborative work in an emergency room in a middle-sized Swedish hospital, where the nurses plan ahead and prioritize patients according to the seriousness of their condition. The scheduling is performed by physically arranging the patient folders on a table, which provides an overview of the current patient priorities. That is, the schedule at the desk is created to display the current state of patients at the emergency room. The desk with its folders is an example of a convenient, dynamic and never-ending way of representing the situation at the emergency room.

Film festival office

The other study involved a team of 4-7 people, who schedule 500-700 films for the Göteborg film festival [4]. Three walls in the landscape-office setting is gradually filled with colored paper notes, where each note represents a film and is placed on a certain time, cinema and day. The team also works during the year to prepare and collect information about potential films. The physical scheduling on the wall commences a few months before the festival.

When it is completed, the finalized schedule is manually transferred to a database and distributed to a catalogue and other media.

TECHNOLOGY

In both work settings, people were initially skeptic towards technology support. They rely heavily on paper for collaboration and the current paper-based practices are also considered critical for overview. Still, much information needs to be “kept in mind”, particularly during stressful situations. Also, there is no existing support for avoiding errors, or a simple way of connecting the physical data to the digital database. Based on findings like these, we have developed prototypes that augment and support the existing work practice for each case. NOSTOS was developed to support the clinicians at the emergency ward, and the Pin&Play technology was used to develop a prototype for the film festival team.

NOSTOS [2] combines multiple technologies such as digital pens, walk-up displays, a digital desk, and sensors to augment ordinary paper tools and make them the user-interface to a computer-based patient record. NOSTOS supports overview and workflow by allowing the clinicians to spatially arrange patient records on a digital desk. The system tracks the position of the folders on the digital desk, which makes it aware of the patients and their ranking in the workflow. A projector mounted above the desk overlay virtual patient folders, when a physical folder is missing, to provide an accurate representation of all the patients at the clinic. Due to deficient OCR (optical character recognition) as well as the fact that paper is passive, it was difficult to maintain consistency of information between the physical paper forms and their digital counterparts. This made it hard to provide suitable digital and physical feedback on input, when using the pen.

The Pin&Play technology [5] combines physical and digital information on large surfaces. The technology uses a conductive surface acting as a physical medium for data and power (see Figure 1). When interactive pushpins are pinned to the surface, they are directly connected to the database. Based on this technology, a small-scale prototype has been developed for the festival team [3]. Each physical note (representing a film) becomes connected to the network and the database, when pinned to the wall. In this way, additional data about each film can be searched for and represented, and the system can keep track of several scheduling constraints. When the system tracks and represents scheduling constraints, the team can focus more on their expert knowledge and thus reduce their cognitive load. System feedback is given both via the pins (LEDs) and on a web-based interface. Combining a pin and a paper-note can be done in an already existing routine, causing minimally changes to the existing practice. If the system breaks down, the physical scheduling can still continue as usual, and the digital system can catch up when it is working again.

EMERGING CHALLENGES

Both systems are based on different technologies and settings, but deal with similar challenges of enhancing the existing physical practice with digital support.

- How to maintain the same information between the physical paper forms and their digital counterparts
- How to deliver tangible feedback to users to address system thrust and to verify correctness
- How to augment existing practices without introducing additional routines or removing important user activities
- How to design for minimal configuration and management to support the interlinking of paper and virtual documents
- How to recreate a systems digital state from paper state after system shutdown

We believe that these are challenges and requirements, relevant for other augmented paper-based systems as well. However, these issues are far from trivial, and need further exploration and discussion to become useful guidelines for design.

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