eSpace: integrating novel displays and devices for augmenting collaborative transactions

Mike Scaife, Yvonne Rogers, John Halloran
INTERACT Lab,
School of Cognitive and Computing Sciences
University of Sussex
Brighton BN1 9QH
UK
mikesc, yvonner, johnhall@cogs.susx.ac.uk

Abstract
Recent technological developments have provided us with opportunities for novel ways of mediating and supporting different user activities by interconnecting different devices for distributing, broadcasting and accessing information. However, little is known about how best to design such ‘shared information spaces’ to augment current work practice and promote new forms of cooperative access to information. Here we report development of one such arrangement, eSpace, designed for a situation where a customer, in a travel agency, is trying to find out about a product and the agent is trying to develop a product that matches the customer’s needs. eSpace integrates a shared, horizontal table display and augmented paper brochure to promote both independent customer exploration of information and better collaboration with the agent. The work raises issues about which tools should be provided for interacting with the display and how the common screen real estate is to be managed.

1. Introduction

Ubicomp is based on the premise that it is inappropriate to channel all of one’s activities through a single computer (3). Recent technological developments have provided us with opportunities for finding alternative ways of mediating and supporting user activities. Many technologies now exist that can be interconnected (e.g. handhelds, laptops, mobile phones, large displays), allowing novel ways of distributing, broadcasting and accessing information. Little is known, however, as how best to design for information display and transfer between mixes of devices of different sizes/constraints, serving different user needs. Our research is concerned with understanding and augmenting such shared information spaces. A key issue, here, is how to integrate displays and devices such that they augment how people currently carry out their work, whilst also promoting new forms of cooperative access to and sharing of information in shared spaces.

A work space particularly well suited to novel arrangements of devices and displays is where selling and buying takes place, where a customer is trying to find out about a product and decide what and whether to buy it and where an agent is trying to provide the information and develop a product that matches the customer’s needs. Currently, such sales transactions typically take place in settings where access to the displayed information is often impoverished. An all-too familiar situation is one where the agent sits behind one side of a desk, retrieving and displaying information on a PC, with the customer marooned on the other side, staring at the back of the computer (Figure 1A). The arrangement has the effect of restricting access to information and diminishing collaboration: the agent (necessarily) does all the work and the peripherally-involved customer has little satisfaction from engaging in, or input into, the process.

How can we make this process more collaborative and productive? We argue that one way is to change the methods of displaying and sharing information and its accessibility, particularly for the customer. To do this we have begun developing and combining different arrangements of displays and devices. Here we describe one such ‘device and display’ configuration, known as eSpace, intended to support a sales transaction, that essentially integrates a large shared, interactive table display, together with an interactive
paper brochure. Information about the product being researched and developed can be readily accessed by both customer and agent, alike, using this combination.

2. Past and current work on display and device integration

Many new technologies exist that can be combined in interesting ways. Here we give a brief overview of recent developments in displays, augmented paper and attempts at creating shared interactive workspaces. Displays: Wall-based vertical displays are increasingly commonplace, being used in a variety of settings, including offices, classrooms, shopping malls and other public spaces, supporting collaborative learning and communication (e.g. 7) or providing public information from the web (e.g. 2). There has been less innovative use of horizontal interactive displays, although notable exceptions include:

- **Active Desk**, which is a desk-based interactive surface, serving as an electronic drafting table, aimed at supporting individual use by designers carrying out graphic design (3);
- **InteracTable**, which has been designed for display, discussion, and annotation of information objects by a group of two to six people sitting or standing around the table (12).

Augmented Paper: This offers much potential for improving shared information access and there has been considerable progress in this area since Johnson et al. (1993) first coined ‘the paper user interface’ (8). For example, Robertson and Robinson (1999) describe ‘live paper’, which uses an ordinary desktop with an overhead projector and camera unit for recognition of individual sheets of paper and marks made on them (10). Heiner, Hudson and Tanaka (1999) describe the ‘paper PDA’, a hybrid paper-electronic system, that allows input of written material into the PDA and the use of ‘stickerlink’ technology which supports on-paper hyperlinking using removable stickers (7). Listen Reader (Back et al., 2001) has also combined RFID tags and sensors into a physical book, augmenting the printed pages with sounds, which are triggered by page turning actions (1). All of these researchers emphasise the need to integrate digital computations with real paper in order to obtain the best properties of each.

Integrating devices and displays: One of the earliest examples of designing new arrangements of devices and displays was the PARCTAB system (11). This consisted of palm-sized mobile computers with wireless links to a workstation-based application (Liveboard) using shared software tools, such as Tivoli (9), to support distributed meetings. Subsequent notable attempts at combining different technologies to support group work, are:

- **I-Land** – which integrates several roomware components, including an electronic wall, table and computer enhanced chairs (13).
- **Interactive Workspace** – which is an environment comprising several integrated smartboards and an interactive desktop, designed to support group tasks, such as project review, project planning, and decision-making (5).

An underlying concern of these projects is to support open-ended meetings, like collaborative design activities, through interacting with multiple displays of information. Our research project has similar aims, but focuses more on how information can be created, shared and accessed for transaction-based collaborations.

3. Design requirements for eSpace

An in-depth ethnographic study was carried out looking at how travel products, like round the world trips are researched and created at various travel shops in the UK. The aim was to get a good understanding of existing work practices together with identifying possibilities for new technological arrangements. Based on our findings we have developed a model of how transactions, which may involve several consultations, evolve and develop. The model outlines the various stages that take place during a transaction, encompassing everything from initial contact to sales closure (Halloran et al., in prep). The model allows us to think through which stages of the transaction we want to support with the different arrangements of displays. These include:

(i) **the approach phase**. Customers’ initial approaches to agents are sometimes unsuccessful, because agents require a level of definition of the product before they are prepared to start developing it (the ‘service threshold effect’). Customers can be better supported working by themselves, in exploring possibilities of where they want to go, before they actually interact with agents.

(ii) **the engagement phase**. Both customers and agents could be better supported when, after the approach phase, they collaboratively work up an initial itinerary, either face-to-face or at a distance.
During this phase a detailed itinerary is built up. There is a need to support a variety of ways of collaboratively accessing and coordinating information represented in different media, both online (e.g. timetables, websites) and paper (e.g. brochures, forms), again collocated or distant.

(iv) the tuning phase. Customers often want to make changes to itineraries, and again this can be better supported.

A main design implication of our study was the pressing need to remove the PC as the focus of the interaction and to replace it with a display surface that allowed a greater degree of common action and a shared reference space. Our initial thoughts were for a large, vertical display since this can promote communication and collaborative planning (15). However, this was ruled out because of (i) issues about overlooking from people not involved in the transaction, i.e. privacy; (ii) the space implications in an office environment and (iii) the problems people have in gesturing to and reaching all parts of large wall surfaces (4). We wanted a display space for the co-located agent and clients, one that would suggest a collaborative, though semi-private, interaction. Having a shareable, (semi-) public space may be beneficial because its visual and public nature encourages belief in, and commitment to, the results of planning (15). Taking these considerations into account we settled on a table arrangement to support interactions, using the surface of the table as a display space. This has the potential to be used for agent-customer interactions, but also allows for a customer-friendly space for doing work by themselves.

Importantly, current resources involve both physical and virtual media. For customers this is essentially (i) leafing through paper brochures - a familiar and well-liked activity, part of the trip-planning experience; and (ii) some work elsewhere on travel-related websites. Brochures serve as an orienting function, allowing some narrowing-down of choices, as well as prompting further ideas. However, they are constrained as to what information they provide and often they do not go far enough in helping the customers make decisions. This suggested to us the possibility of developing an augmented mixed-media prototype, the eBrochure, embedding barcodes in the paper pages. Using a wireless infra-red reader in the store the user can bring up (previously-linked) web-based material on the table. This has several advantages. Firstly, it brings together the known affordances of paper (its format and interactivity) with the power of virtual hyper-information, supplementing the fixed information on the page. Secondly, it allows the storage of details of what was of interest by keeping a record of which codes have been clicked. This has the potential for providing feedback on brochure design, and for profiling customer interactions, by later inspecting the trace of where they have been (analogous, in some respects, to the history function in a web browser).

4. eSpace: integrating eTable and eBrochure

The eSpace built to support the sharing and creation of information for transaction-based collaborations, currently comprises an eTable and an eBrochure. The eTable prototype (Figure 1B) is essentially a horizontal display surface, using back-projection from an xga data projector-mirror arrangement under the table. The size of the table, 1m x 1.5m, and the embedded screen was designed to give a space that allowed two or three people to view and work with the display in relative comfort. People can sit or lean on/stand at it, and the asymmetric display location allows an area for placing and working on things such as paper/brochures. Interaction with the display surface is pen-based, using an inexpensive mimio unit. The current eBrochure prototype (Figure 1C) is a glossy, multi-page colour brochure, covering itineraries, hotels and trips around Australia. It is augmented by small barcodes that are fixed to key information points on the pages and linked to a PC via a cordless reader. On reading a barcode, additional information about a place or itinerary (e.g. videos, commentaries, webpages) pop up on the eTable.
The way the arrangement works in promoting a shared information space is to provide external aids and resources to progress the different stages of a transaction, as outlined previously in our transaction model. To illustrate how it works we describe one of our existing user scenarios. Connie and Charlie (CC) are planning to take six weeks to travel around the world. They have a rough budget and some idea of some places that are ‘must-see’ and some that are possible. Entering the travel agency, Alan, the travel agent greets them. CC’s plans are vague, but rather than giving a business card and some brochures, requesting that they come back when they are clearer (the service threshold effect), A briefly discusses their wishes and enters some cities into his PC. CC sit down at the eTable and A brings up a world map with those cities already marked (the ‘overview’). This is achieved by linking the PC to the eTable. CC use the screen pen to click on cities, marking out a provisional itinerary. Various visualisations are then displayed on the eTable, for example showing the total cost of the proposed trip so far, computed from the agency flight database. At this point Alan suggests that CC consider how long they want to spend at each place and what extra trips they might wish to make. To do this he suggests they spend some time, by themselves, looking through the eBrochure. He explains that clicking on the barcodes on the pages will bring up more web-based information on the table and shows them how to toggle back to the overview planner when needed. This part of the scenario, then, shows how the eTable can help customers through the approach phase.

After this, CC look through the brochure, making paper notes about what they might consider. They use the barcodes to supplement the information in the brochure. On this basis they guestimate a time spent in each place, entering it on the overview display. This acts as input for a ‘total time’ display window. After a period of this A returns to the table and, together, they review the current state of the plan; i.e., they enter the engagement phase. At this point CC have some questions, about the trip and possibilities and A uses the stored current state of the overview to supplement the ideal trip with information accessed via his own PC on agent-centric databases. Some of this information is sent to the table, as additional representations, such as arrival/departure times and visa requirements.

At this point CC wish to go away and think about the final decision. A closes down the table display which stores the current state of all representations, including the overview. At home CC access a secure web archive and retrieve this information which they can then use for further elaboration/investigation: they are now in the development phase of the transaction. They are able to save this information for later retrieval when they revisit the store.

5. Preliminary findings and discussion

The eSpace arrangement has worked well in initial evaluations with trip-planning tasks. Users found it rewarding and easy to understand. Feedback and observation showed that the shared space and augmented paper promoted a much richer interaction, and significantly enhanced planning, over the more usual agent-led didactic model. However, the evaluation also raised two immediate issues about optimising the ways for people to build up a shared visualisation of the evolving product across devices. The first concerns the
provision of tools for interacting with the display surface and how these facilitate/constrain collaboration. Conventionally there is the provision for a single pointer, operated by a device such as a mouse or pen etc. This means that, in practice, there is often turn-taking, rather than synchronous collaboration. We are implementing a system with the capability for multiple concurrent pointers and activities, but this raises new issues about how to manage control. The optimum interaction style for the different parties is a further complication, here. Using the mouse/pen is not likely to be the best way of allowing shared access. A second issue concerns the need for multiple views of the data and how we manage the generation of views (multiple representations) on the table surface. Here we have provided an overview representation of the whole trip with dynamic links to displays of constraints such as price and time via the system database. However the database that the agent uses is not well-suited for extracting anything beyond the standard cost/time parameters and, more importantly, the format which works well for agents does not typically do for customers. This reinforces the need for separate, as well as common, information spaces. Possible solutions that we are trying, are (i) to partition the display into spaces for agent and for customers and (ii) trialling the use of hand-held devices as personal, portable displays that can hold/send/receive parts of the common display and (iii) to extend the range of ubiquitous functionality to include more tangible forms of interactions, such as picture cards for customer planning.

6. Acknowledgements
The authors gratefully acknowledge the support of a grant from the UK ESRC/EPSRC ‘People At The Centre Of Communication & Information Technology Programme’, Grant Number L328253027. Thanks go to Tom Rodden, our research partner in the Computer Science Department at Nottingham University; and also to Jerry Bridge, James Bell, and Gillian Armstrong at Bridge The World Travel Services.

7. References


