Mohamedally, D., Zaphiris, P., & Petrie, H (2005). Incorporating Digital Inking Methods in HCI Knowledge Elicitation. "Improving and Assessing Pen based Input Techniques" workshop; Proceedings of HCI 2005 Edinburgh, British HCI Group, British Computing Society, UK.

INCORPORATING DIGITAL INKING METHODS IN HCI KNOWLEDGE ELICITATION

Dean Mohamedally
Centre for HCI Design
City University
London EC1V 0HB, UK
cp496@soi.city.ac.uk

Panayiotis Zaphiris
Centre for HCI Design
City University
London EC1V 0HB, UK
zaphiri@soi.city.ac.uk

Helen Petrie
Centre for HCI Design
City University
London EC1V 0HB, UK
h.l.petrie@city.ac.uk

ABSTRACT

This workshop paper presents digital inking software tools designed to aid and enhance the capabilities of HCI practitioners. The advantages of using these inking tools as part of a HCI practitioners' toolkit are firstly to aid in user design and testing with non-technical participants, based on the aesthetic simulacra of digital inking methods as they closely mimic pen-based approaches. Secondly, the digital recognition, storage, processing and retrieval capabilities of such digital ink based data expand and enhance Knowledge Elicitation (KE) models that have been derived from psychology and design methods. The tools presented have been designed through expert Participatory Design (PD) sessions with several HCI practitioners at our research centre. Data is also presented from user-centred studies to illustrate the level of confidence that HCI participants have in using the tools.

Keywords

HCI methods, TabletPC Inking, Mobile Tools for HCI.

1. INTRODUCTION

Knowledge elicitation (KE) techniques exist for number of fields in Computer Science and Engineering, and the principles with which they are based on remain theoretically similar, i.e. the acquisition of knowledge through various models of learning processes and motivated experiences over time.

Human-Computer Interaction (HCI) KE models and practices are an invaluable resource for user centred computing. Examples of this start with initial questionnaire feedback, requirements task walkthroughs, interviews techniques, and focus group debates. It can rapidly scale upwards to more complex psychometric analytical processes for example prototype construction methods, direct and indirect observation practices for monitoring user actions and response time comparisons, and methods for eliciting mental categorisation models e.g. in distinguishing between expert and non-expert technology usage patterns. Knowledge elicitation methods in HCI are a critical function to the success of requirements and design gathering stages (Maiden et al., 1995), and usability testing and user evaluation stages of software development (Zaphiris & Kurniawan, 2003).

2. MOTIVATION

For HCI practitioners working as part of development teams whereby their results can lead to significant changes in design, it is important to define and incur the highest standards of empirical capture data. By adopting digital processes, analysis of such data can be enhanced with digital tools that accelerate data acquisition and processing times than humanly possible, along with large data storage and retrieval capabilities. Digital tools can therefore raises the quality of user centred knowledge elicitation and analysis.

The following sections outline two software developments on KE methods with a strong sense of visualisation of knowledge, as used by HCI practitioners. The software tools utilise the digital inking capabilities of TabletPCs as their experimental materials resource. In particular, we paid attention to methods that define KE through constructionist (Papert, 1991; Resnick, 1996) approaches, i.e. whereby new knowledge is potentially created by the end users constructing visible artefacts within the knowledge elicitation activity. This is potentially a key source of decision making in HCI design, based on the strengths of the participant's knowledge and contribution.

3. OUR IMPLEMENTATIONS

The Microsoft Windows Mobile and TabletPC Software Development Kits (SDK) provide rich API libraries for developing new pen interactivity models, post normal laptop user patterns. In particular, the flexibility of a TabletPC as a hybrid device between PDA and PC, feature pressure sensitivity and programmable gesturing in onscreen pen motion. These pen gestures correlate with event firing and real-time recognition of handwriting on visual user interface components to provide intuitive actions and automation of several tasks-at-once. The Microsoft Visual Studio.Net environment was used for prototyping the following tools.

We conducted expert design reviews of the tools with six HCI specialists from our department and an external professional designer.

A pre-test questionnaire and practical trials were conducted to:

- Evaluate their current understanding of the methods with each of the tools
- Present them with our TabletPC tools and enable them to the digital inking methods in their experimental practices.
- Engage them in contributing ideas for enhancing the scope on any further requirements for use in their field operations.

Throughout these expert trials they could raise any points of interest or complaints. Finally a post-test Quality of User Interface Satisfaction questionnaire (QUIS) (Chin et al., 1988) was given to collect information about their general impressions about the tools and any modifications they thought were necessary. From this data collected, minor user interface issues such as menu options, interface terminology, button sizes and integrated help requirements were modified into subsequent builds.

3.1 Categorical Ink Notes, Affinity Diagrams and Card Sorting with CATERINE and SAW

Affinity diagramming and Card Sorting allows users to organise ideas and opinions from a general topic, and break down complex concepts into more manageable atomic units, be it via high fidelity image, diagrammatically or textually. They are useful for giving structure to large or complex concepts and acquiring an agreement from a set of users over the categories that should be used to represent atomic units.

SAW (Software-based Affinity Workspace) is a TabletPC tool for users to organise visual, diagrammatic and textual element structures into categorical groups (Fig.1). Users may create ink notes in CATERINE (CATEgorical Rich Ink Notes Editing tool) much akin to writing on post it notes with the exception of arranging into multiple hierarchical groups and being able to be shared across the Internet to other SAW team users. Once imported into SAW, these ink notes enable users to debate the choices of their actions until they have refined their categorical structures.

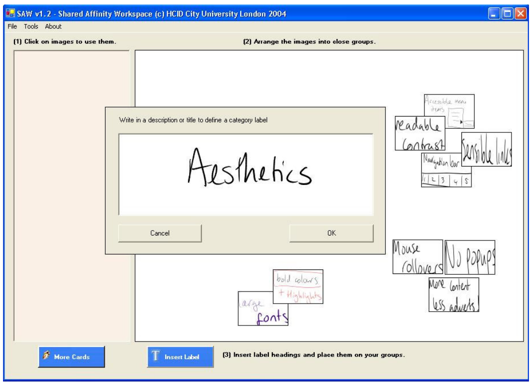

Figure 1: SAW with ink recognized labels on a software based affinity diagram

Users can quickly annotate clusters with pen based ink notes and ink-to-text recognition. The tool features cloning cards for multiple group instances – something that paper cannot replicate quickly and easily (without drawing it out again/photocopying) and can merge prior affinity diagrams by overlays. Even though the direct field of view on a tabletPC screen is not as large as regular wall whiteboard (Fig.2), the software affinity workspace can be resized and scrolled to custom scales to give much larger "virtual" arrangement space.

Figure 2: Paper based affinity diagram presented on a whiteboard

Our user testing of CATERINE and SAW consisted of 40 MSc Advanced HCI students from our department. An introduction to the experimental method and a consent form was given and signed by all of the participants. A Pre-test questionnaire was then given to acquire the participant's demographic details and an understanding of their use of mobile technologies. 82% were of age group 18-29, with

18% aged 30-39. 86% said that they had not used tools specifically for HCI methods before, and 14% said that they had. The gender demographics were approximately 3:2 ratio male to female, with 59% male, 41% female.

They were required to construct affinity diagrams of web accessibility guidelines (WAI) based on given information worksheets. Half of the group was requested to use the software (CATERINE and SAW) and the other half used the existing post-it note method. Working in groups of 5-7, they utilised 4 TabletPCs (Toshiba and Acer branded) in turns.

The results of this user testing showed no statistical significance between the expert assessment marking of the paper based affinity diagrams and the expert assessment marks of the software inked affinity diagrams ($t(4) = 1.37 > 0.05$). This indicates that using digital inking was of an acceptable quality in expert assessment and not a negative influence. Post user testing enquiry with a QUIS survey revealed positive user confidence in using digital inking to construct affinity diagrams (table 1).

Table 1: QUIS results in software affinity diagramming

QUIS Question (ratings are from 0 to 9)	Mean	S.D.
Overall user reaction to the inking software	5.96	1.82
Quality of elements on screen	5.41	1.95
Consistent terminology and system information (error messaging etc.)	5.88	2.07
Learning to use the inking software	6.31	2.04
Ink system facilities	6.8	1.7

3.2 Virtual Low Fidelity Paper Prototypes with PROTEUS

Paper Prototyping in HCI uses simple materials and equipment to create a paper-based simulation of low fidelity prototyping views to an interface or system with the aim of exploring user requirements through visible artefact constructions and team debate leading to consensus on a design.

PROTEUS (Fig. 3), as also reported more fully in the main Vol.1 proceedings of HCI 2005, is a TabletPC based digital inking tool that simulates the actions of a low-fidelity paper prototype being constructed with the addition of all user events being recorded. Using this data it can constructs temporal roll-back views of the prototypes creation so that every action of manipulation of the virtual paper prototype can be evaluated at a later date to elicit potential weaknesses or strengths to annotate at prior stages of the prototype design process.

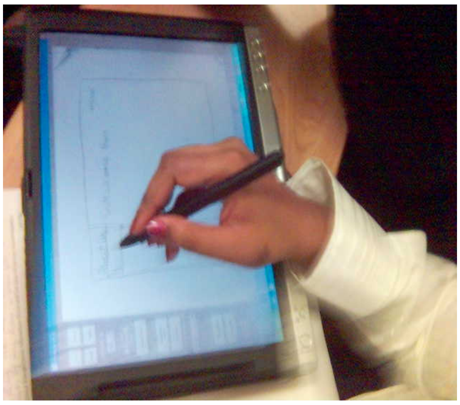

Figure 3: PROTEUS being used to design a sketch

User testing of PROTEUS consisted of the same prior reported 40 MSc Advanced HCI students from our department. This time they conducted a similar paper vs. software comparative experiment, based on several prototyping design scenarios. In summary of the HCI 2005 Vol.1 reported experimental design, no statistical significance was found between the expert quality assessment of paper version prototypes to the expert quality assessment of software version prototypes ($t(11) = 1.68$, $p > 0.05$) illustrating that digital inking is again not a negative influence on the practical methodology.

Upon post user testing enquiry with a QUIS survey revealed positive user confidence in prototyping with digital inking (table 2).

Table 2: QUIS results in software paper prototyping

QUIS Question (ratings are from 0 to 9)	Mean	S.D.
Overall user reaction to the inking software	6.01	1.87
Quality of elements on screen	6.05	1.99
Consistent terminology and system information (error messaging etc.)	5.87	2.29
Learning to use the inking software	6.44	2.06
Ink system facilities	6.91	2.11

4. CONCLUSIONS AND FUTURE WORK

It is already seen that software tools for HCI practitioners are becoming important aids in facilitating knowledge elicitation from users. Factors of mobility can bring about new qualities and reliability of collected user experiences and ideas.

Digital inking in HCI tools aid in lessening the need for requiring technically aware participants in user experiments, especially where pre-training for particular HCI experiment based tools can introduce understanding bias into the results. The simplification of user tasks with implicit pen gesturing and natural free-form writing can be designed to allow a user to focus more at the task required at hand and less of the experimental setup that they are involved in.

Our user testing experiments with CATERINE & SAW, and PROTEUS, have demonstrated that digital inking is not a negative influence on the existing practices and thus can be used as viable alternatives. Subsequently, the performance in relation to the user satisfaction of the digital inking experience in software (via the QUIS method) has been shown to be above the median average in both methodologies described in this paper, and thus is worth further investigation in improving the inking experience in HCI KE methods.

Commercial tools that allow digital inking in various formats already exist e.g. for questionnaire form filling, which can save HCI practitioners valuable transcription time. In future work, this and other HCI practitioner orientated tasks will hopefully reveal positive qualitative measures that can augment existing user data collection techniques. Digital inking is one step closer to creating tools that will allow HCI knowledge elicitation methods to become more standardized and streamlined in managing and sharing user-centred data with HCI practitioners and the quality of pen-based input in such scenarios of use can only improve as and digital ink recognition, aesthetics and features improve.

REFERENCES

Chin, J.P., Diehl, V.A., & Norman, K.L [1988], Development of an Instrument Measuring User Satisfaction of the Human-Computer Interface Interface. *Proceedings of ACM CHI'88 Conference on Human Factors in Computing Systems 1988* p.213-218

Maiden, N. A. M., Mistry, P.& Sutcliffe, A. G. [1995], How People Categorise Requirements for Reuse: A Natural Approach, *in* P. Zave & M. D. Harrison (eds.), *Proceedings of the 2nd IEEE International Symposium on Requirements Engineering (RE'95)*, IEEE Computer Society Press, pp.148–57.

Papert, S. [1991], Situating Constructionism, *in* I. Harel & S. Papert (eds.), *Constructionism*, Ablex, pp.1–12.

Resnick, M. [1996], Distributed Constructionism, *in* D. C. Edelson & E. A. Domeshek (eds.), *Proceedings of the Second International Conference on the LearningSciences (ICLS-96)*, Association for the Advancement of Computing in Education. http://llk.media.mit.edu/papers/archive/Distrib-Construc.html. Last accessed 2005.06.06.

Zaphiris, P. & Kurniawan, S. H. [2001], User-centered Web-based Information Architecture for Senior Citizens, *in* N. Avouris & N. Fakotakis (eds.), *Proceedings of Panhellenic Conference with International Participation on HCI: Advances in Human–ComputerInteraction*, Typorama, pp.293–8.