Sonically-Enhanced Widgets: Comments on Brewster and Clarke, ICAD 1997

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This paper presents a review of the research surrounding the paper "The Design and Evaluation of a Sonically-Enhanced Tool Palette" by Brewster and Clarke from ICAD 1997. A historical perspective is given followed by a discussion of how this work has fed into current developments in the area.

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1. HISTORICAL CONTEXT

In its early stages research in the area of auditory display work focused on two main topics: data sonification and interface sonification. This work falls into the latter category. Work within that area was focused on using Auditory Icons and Earcons. This work again falls into the latter category. It was undertaken with Catherine Clarke who was an undergraduate student in the Department of Computing Science and did the work as part of her honors project. She looked at tool palettes and the sonification of drawing tools in a graphics package [Brewster 1998c].

One of the strands of work within interface sonification was the sonic enhancement of graphical widgets (buttons, scrollbars, menus, etc.). Brewster began work on adding sound to graphical user interfaces as part of his PhD work [Brewster 1994] when he developed sonically-enhanced scrollbars [Brewster et al. 1994], buttons [Brewster et al. 1995] and windows. The work with Clarke continued this strand of research. Others working in this area at the time included [Beaudouin-Lafon and Conversy 1996], [Karshmer et al. 1994] and [Alty 1995] and [Barfield et al. 1991].

In 1998 Brewster began the UK Government EPSRC funded "Guidelines for the Use of Sound in Multimedia Human-Computer Interfaces" project. One of its key aims was to expand upon these initial ideas of sonically-enhanced widgets, develop a full set of widgets and produce guidelines into how non-speech sounds should be incorporated into graphical user interfaces (project website: www.dcs.gla.ac.uk/research/audio_toolkit). During this project many widgets were sonified, including menus [Brewster and Crease 1999], drag and drop [Brewster 1998b] and progress bars [Crease and Brewster 1998].

2. RESEARCH PROCESS

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One of the key reasons for sonically enhancing widgets was that users could become overloaded with large amounts of visual information. Large, high-resolution screens meant that information could be missed by users looking at one area of the screen when something was happening in another. One reason for this was that computers communicate most of their information via visual displays (which is still the case in 2005). The design of systems that share information across the visual and auditory senses has the possibility to improve usability and reduce workload. They allow the user to employ appropriate sensory modalities to solve a problem, rather than just using one (usually vision) for everything. The three aims of our research in this area were to:

- Ensure sounds added to interfaces were effective and improved usability;
- Allow designers who were not sound experts to create successful sonically-enhanced interfaces;
- Ensure sounds were used in a clear, coherent and consistent way across the interface [Brewster 1998a].

The sonic enhancement of a widget was undertaken with a thorough usability investigation of the particular widget to find the display problems that it had (in the case of tool palettes the problems were related to mode switching between tools). A set of Earcons was then designed to deal with these problems (and to fit into the overall structure of a set of Earcons for an interface). A formal usability study of the new widget was then performed to assess if the enhancement solved the problems identified.

3. BODY OF WORK

A wide range of widgets were investigated and sonic enhancement was found to add benefits to them all. In the case of the tool palettes, we found a significant reduction in the mode errors that occurred when switching between tools. A very different widget was the progress bar [Crease and Brewster 1998]. Here we found that bars were often hidden and had to fight for visual attention with the rest of the graphical display resulting in users missing information and not knowing the status of downloads. We added Earcons to indicate the state of the download in a way that did not conflict with the rest of the visual display. Two sounds were used that got closer together in pitch as the download progressed; when the pitches matched the download was complete. The results of a detailed usability study showed that subjective workload was significantly reduced and users noticed the end of download far more quickly than with a visual progress indicator.

An important part of the research was to develop a toolkit and some design guidelines based on the widgets we designed. A survey we conducted [Lumsden and Brewster 2001b] showed that many designers did not know how to use sound. A set of guidelines [Lumsden and Brewster 2001a] and a toolkit of widgets that a designer could use were the most effective ways of getting the right sounds used in the right places.

The toolkit used a client-server architecture, like X Windows; widgets do not generate their output directly, but pass feedback requests to an output manager [Crease et al. 2000]. It is the output manager’s responsibility to adjudicate between the requests, a set of output modules (e.g., graphical, auditory, haptic displays) and a context (e.g., the size of the display, the ambient noise and light levels, etc.) to provide the best possible allocation of output resources to requests. The toolkit worked on top of the standard Java Swing widget set and was therefore easy for any Java programmer to use.

We also looked at using three-dimensional (3D) sound for new widgets. For example, we created a 3D version of the progress bar. The user's head was at the centre of a circle and a sound source moved around this circle clockwise, starting at 12:00 (directly in front of the user). The position around the head gave the amount downloaded (when the sound reached 12:00 again the download had completed) and rate of movement around the head gave rate of download [Walker and Brewster 2000]. Our work on 3D audio interactions is still continuing, with a focus on the design of basic display elements and interaction techniques [Marentakis and Brewster 2004].

The work initially focused on desktop interactions but during the period of the research mobile devices such as mobile telephones, personal digital assistants and wearable computers became more and more important. These had many similar (and more difficult) problems to the ones we were attempting to solve (e.g. very limited visual displays meant that only a very restricted amount of information could be displayed visually, a user's eyes were also needed to monitor the environment so could not always look at a display). We therefore took our results and applied them to this new domain. We found that sonically-enhanced buttons, for example, had a very significant effect on improving stylus interactions when the user was on the move [Brewster 2002]. Usability was improved, the size of the widgets could be reduced and users could walk further when using a sonically-enhanced interface.

Work in the area of sonically-enhanced widgets also moved into computer haptics (using the sense of touch for interaction). With the use of a PHANToM force-feedback device (www.sensable.com) we looked at how force-feedback display might solve some of the same problems we identified with graphical widgets. The advantage of haptic devices is that they could physically stop users from making some of the errors that we could only report to them using sound. In particular we looked at the addition of force to buttons and scrollbars [Oakley et al. 2000]. Similar positive benefits were found. In more recent studies Brewster and King [Brewster and King 2005] used vibrotactile feedback to create a tactile progress indicator which worked in a similar way to the sonic one mentioned above. In this case the time between tactile pulses encoded the amount of download remaining; the closer the pulses in time, the nearer to completion. Experimental evaluation of the widget showed that it could perform better than a visual one in a visually demanding task. Further study is needed to compare this to a sonically-enhanced progress bar to see which is the most effective, or how they might combine.

4. RELATIONS TO THE FIELD OF AUDITORY DISPLAY

The use of sound to improve human-computer interaction has been a long running one within the field of auditory display. The seminal issue of the HCI journal in 1989, edited by Bill Buxton [Buxton 1989], laid the foundations for much of the work on Auditory Icons, Earcons and the sonification of interaction. This was the starting point for Brewster's work and that of many others. In recent times the amount of work published in the area of interface sonification at ICAD has reduced with [Vargas and Anderson 2003] or [Marila 2002] as some of the more recent examples. One reason for this might be that much of the work on the sonification of existing widgets has been completed. The next, but more complex, task is to design new widgets that allow users to interact in new ways to solve a range of new problems.

One of the areas where the work has progressed is in the domain of mobile device displays. This is a fruitful area (as mentioned above). Much of the work is being undertaken by researchers from within companies such as Nokia

[Marila 2002; Ronkainen and Marila 2002]. Audio displays are also being combined with gestures for input to create a new range multimodal mobile displays [Eslambolchilar et al. 2003].

5. CONCLUDING THOUGHTS

The work on sonically-enhanced widgets showed that non-speech sounds could have a positive effect across a wide range of different interactions within an interface. The benefits of sounds also spanned a range of different interfaces, from static desktop systems to small devices used on the move. There is still much interesting work to do in the area developing new interaction techniques, bringing together audio and other forms of output and combining them with novel forms of input. This will allow the creation of flexible and natural interaction techniques that will allow a wider variety of users to use new computing systems and services in the most efficient and satisfying ways.

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