HaptiSonic Artefacts: Malleable Prototypes & Audio Diaries for Designing with Visually-Impaired Practitioners

Oussama Metatla
Bristol Interaction Group
University of Bristol
o.metatla@bristol.ac.uk

Nick Bryan-Kinns, Tony Stockman
Centre for Digital Music
Queen Mary University of London
n.bryan-kinns@qmul.ac.uk

ABSTRACT
Methods to engage users in the design process often rely on visual techniques to facilitate the expression and communication of design ideas. The visual nature of these tools makes them inaccessible to people living with visual impairments. We used haptic and sonic artefacts in the form of highly malleable prototypes combined with audio diaries to engage with visually-impaired sound engineers and audio production specialists to explore access to digital audio workstations (DAWs). We present our approach to using these artefacts and reflect on the role they played in our design process.

ACM Classification Keywords
H.5.2 User Interfaces: Auditory (non-speech) feedback, Haptic I/O, User-centred design,

Author Keywords
Design artefacts, prototyping, visual impairments.

INTRODUCTION
In the audio production industry, visual-impaired sound engineers, musicians and audio production specialists rely on screen-readers to access DAWs, which are the primary tools for modern sound editing. However, unlike traditional audio production tools, modern DAW interfaces are highly visual and incorporate a number of graphical representations of audio parameters to support editing and mastering, such as waveforms and automation graphs, which are inaccessible to users of screen-readers. In this context, we were interested in engaging practitioners to examine how non-visual interaction techniques can be used to design effective access to modern DAWs. We propose to use highly malleable haptic and sonic prototypes as artefacts mediating design ideation and exchange between sighted designers and visually-impaired practitioners

PARTICIPATORY PROTOTYPING
We invited 3 visually-impaired participants to a series of participatory prototyping workshops. The participants were part of a larger cohort who also took part in an initial scoping workshop in which we identified tasks that visually-impaired practitioners find problematic when accessing industry standard DAW software. This is reported elsewhere [4]. Our participatory prototyping activities thus focused on real tasks, with the aim to expose the participants to prototype designs that embody ideas generated in the initial workshop of how such tasks could be supported, and to work closely with them to improve on the implementations of these ideas through iterative prototype development. Each set of participatory prototyping sessions were held with the same group of participants through a collection of three to four workshops that were one to two weeks apart. While the design team worked on implementing participants' feedback in the interim periods, participants were asked to keep detailed audio diaries of domain activities.

Malleable HaptiSonic Prototypes
To facilitate the exchange of ideas between designers and practitioners, we developed the prototypes that embody initial design ideas into highly malleable form. Malleability was achieved by *supporting a variety of alternatives* for presenting a given information or supporting a given task or functionality. The malleable prototypes were customisable and alternatives were readily accessible in real time. We developed specialised *control panels*, which we had available to us throughout the participatory prototyping sessions to help us quickly switch between alternatives. An example of this is a prototype controller that supports the scanning of a waveform representation; the user moves a proxy of a haptic device in a given direction and receives haptic and sonic effects whose parameters are mapped to the data values represented by the waveform (e.g. amplitude mapped to pitch and friction and frequency mapped to texture). This design was malleable in a number of ways; the direction of scanning could be altered to be horizontal or vertical and could be initiated at different starting points; the mapping used to drive the haptic and sonic output of the waveform could also be adjusted in terms of scale and polarity; and finally, the haptic and sonic effects themselves could be altered to display, for instance, friction, timbre, vibration, rhythm or viscosity [1].

The malleability of prototypes allowed participants to explore different implementations of the same functionality in real-time, which in turn facilitated the contrasting of ideas and the expression of more informed preference and feedback. The prototypes could also be *reprogrammed in real-time*. That is, if participants wished to explore an alternative implementations of a given functionality or feature that could not be

[1] Open source download of the prototype: http://depic.eecs.qmul.ac.uk/?q=dawprototype

readily customised using the control panels, we reprogram these features on the fly as and when this was needed.

Audio Diaries

We also asked participants to record audio diaries in the interim periods that preceded each participatory prototyping session. Participants were asked to attempt to complete similar tasks to the ones explored during the sessions at their homes or workplaces. We asked them to do this while using their current accessibility technology setup and encouraged them to reflect on the process of completing these tasks in light of the particular iteration of prototype development that they were exposed to in the preceding participatory prototyping session. Whenever participants produced an audio diary they would share it with the design team prior to the next prototyping session. This provided the designers with further feedback, thoughts and reflections that they could then incorporate in the next iteration of the prototypes and present to the participants in the next round of development.

Example Outcome: Sonification of Peak Level Meters

One of the tasks that was identified as difficult to achieve using screen-readers is identifying areas of interest within an audio track, for example whether the amplitude of an audio track goes past a threshold that causes the signal to distort – also known as clipping. This is typically represented within a waveform or a visual indicator called the peak level meter, which conveys audio levels in real-time by flashing amber and red coloured signals. Together with our participants, we explored how the malleable sonifications could be modified and used to monitor variations in the shape of a waveform and to highlight clipping areas. The result was a sonification that can be used in two modes: a continuous mode in which the peaks of a signal from an audio track are used to modulated the frequency of a sine wave and a clipping mode in which the sine wave modulation is only displayed when parts of an audio track exceed a user specified threshold. The clipping mode produces a short alarm beep (200 ms) each time the audio level goes past the threshold set by the user. We also used stereo panning to indicate whether the clipping occurs on the left or right audio output channel [2].

REFLECTIONS

The collection of participatory prototyping workshops were valuable in helping us delve deeper into the design of the developed solutions. These sessions were an opportunity to collectively scrutinise finer aspects of design and thus provided a further joint learning space where participants learn more about the technology and the techniques, e.g. sonification mappings, and designers learn about detailed workflows and processes. The highly malleable prototypes and audio diaries acted as a medium for facilitating design ideation and exchange in this space. The malleability of these HaptiSonic prototypes was critical in ensuring the success of the participatory prototyping sessions. Being able to present participants with different alternatives and reprogram features on the fly captured an essential characteristic that is found in, for example, paper prototyping techniques that make them an extremely effective design tools [1]. The prototypes capacity to be adaptable in response to changes and feedback generated from the joint prototyping process is crucial in prototyping activities [2], and non-visual design tools should therefore incorporate flexible levels of adaptability for them to attain the same level of efficiency as their visual counterparts.

The use of audio diaries was also valuable in a number of ways; first, they expanded the space of reflection on designs to reach beyond the bounds of the participatory sessions themselves. Participants were able to go back to their familiar home or workplace settings, re-experience the tasks with their own technology, compare this to what they have experienced with the new prototypes and record these reflections on an audio diary. Secondly, audio diaries provided the designers with an extra resource of feedback, it gave the designers access to actual in-situ experiences with current accessibility solutions – often these were screen-reader based technologies, and so the audio diaries capture both participants commentary and the interface interactions in speech. Users provided running commentary, explaining rational for certain interactions, issues and potential solutions to them in light of their experience in the initial workshop session and the participatory prototyping sessions. Audio diaries thus gave direct access to actual experiences with accessibility technology that would have been harder to tap into otherwise.

In our experience, close interaction with participants through detailed and thorough workshops and the use of HaptiSonic artefacts allowed us, even as sighted designers, to gain an appreciation of the issues faced by practitioners living with visual impairments and a deeper understanding of how these could be addressed. Similar findings were reported by Magnusson *et al.* [3] who showed that a longitudinal study design consisting of a linked sequence combining a focus group discussion, interviews, a diary study and lo-fi design workshops can be a useful tool for the exploration of non-visual interaction designs. In our case, practitioners and designers brought different sets of expertise to the sessions. Practitioners had knowledge about the domain of their expertise but also in-depth knowledge about the practical limitations of current accessibility solutions, while designers brought design and technical knowledge. There was an element of serendipity in the design process, specifically in terms of our awareness about certain technologies: it was only through the networks of practitioners and designers that some of us were involved with that we came into contact with the technology that allowed us to develop the prototypes. The use of highly malleable haptic and sonic artefacts – that support a variety of alternatives and can be reprogrammed in real-time – afforded a level of flexibility that allowed it to be an effective medium for shared design activities, while audio diaries expanded the users' reflection space to reach beyond design sessions and provided designers with a further resource of feedback.

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[2]The Accessible Peak Meter: https://youtu.be/2AttmKzsi6Y

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