SONIFYER
A Concept, a Software, a Platform

Florian Dombois[*], *Oliver Brodwolf*[*], *Oliver Friedli*[*], *Iris Rennert*[*], *Thomas Koenig*[†]

[*] Y (Institute for Transdisciplinarity)
Berne University of the Arts
Fellerstrasse 11, 3027 Berne, Switzerland
florian.dombois@hkb.bfh.ch

[†] Department of Psychiatric Neurophysiology
University Hospital of Psychiatry
Bolligenstrasse 111, 3000 Berne 60, Switzerland
thomas.koenig@puk.unibe.ch

ABSTRACT

In this article we would like to focus on two structural points that could be useful for improving the general acceptance of sonification research: On the one hand we will be advocating a new generation of sonification software that can be easily and intuitively used by researchers and amateurs alike. On the other hand we will argue for an acoustic forum for our sonification community to be established that will help to faster exchange and discuss listenable research results. For both aspects we will describe our ideas and prototypes as a possible starting ground for discussion.

1. INTRO

Sonification has a long history. Some people date it as far back as to the ancient beginning of science in pre-Socratic time, mentioning that already Pythagoras demonstrated mathematical relations by acoustic experiments on the monochord. Usually the liberal arts, which brought together music and mathematics, or Johannes Kepler's "Harmonices mundi libri V" (1619) are also named in this context to prove the importance of an audio-centered way of research.

You can however just as well maintain that sonification has a short history: e.g., for audification at least a loudspeaker and/or a phonograph is needed, which were not invented before the 1870s. From this time we can still find some few papers proposing methods such as [1] using the newly invented telephone to auscultate nerve and muscle cells. This pragmatic approach of trial and error has been followed for somewhat more than a century, even though there are only few papers published on sonification as a method of converting measurements into sound.

Insofar, ultimately one could even claim that sonification has almost no history at all. It is a young and avant-garde research field not older than 1992, coming into life with the first International Conference of Auditory Display in Santa Fe. With this conference Gregory Cramer, who invited for the event, started a new research movement, giving it a name and a kickoff meeting. A research community has been formed by the yearly ICAD, developing a corpus of scientific papers and, recently, even musical concerts.

An equivalent of sonification, which one might call its "sister method", is visualization. We will assume here that its starting point was the invention of the Cartesian coordinate system, which was developed in the 1630s and subsequently experienced an amazing scientific success story. Doubtlessly this success was not only owed to the visual evidence yielded by this new tool, but also to technical reasons: coordinate systems are very simple to use and their visual results can be easily printed and distributed.

2. USABILITY AND DISTRIBUTION

In the following we will argue for more attention to be dedicated to the aspect of usability and distribution in sonification. Sonification brings together know-how from very different fields such as sound, or music, on the one hand, and science, or scientific experiments, on the other. It involves sound experts and scientists, who sometimes will all be the same person, but sometimes not—and this is what demands a lot of exchange. Since most of sonification is done with software, we posit that the design of this tool should be designed as user-friendly as possible. Its design should allow easy and intuitive sonification also for non-professionals users, and it should follow the "plug 'n play" approach in order to be able to involve as many data producers and data interpreters as possible. Just to give an example, a great part of the success of Apple's Music Store was owed to the functional and handy design of iTunes. Hence, we encourage the ICAD community to pay special attention to software design and simplification of software installation. We need software that is so easy to download and install like "Sonification Sandbox", just to name one recent example from ICAD 2007. Likewise, we will propose our software "*sonifYer*" as another step towards a new sonification software generation.

The second argument we want to focus on in this article is distribution. Sonification will not become a proper and accepted scientific tool as long as we only talk or read about sound. So while we were delighted to discover e.g. the menu "Audio" at www.icad.org, we became somewhat disappointed when we only found one sound sample (last checked on 1st February 2008). But isn't this typical for a lot of our sonification research? Generally, one finds only few listening examples on the web compared to the abundant presence of visualization by pictures. But if sonified data are to be taken as serious as data in the form of scientific graphs, they must be widely published and distributed. And never have the underlying conditions for this move been better than today: the internet is the first medium and platform in human history that allows reproducing sound and making it universally available—at least within the scientific community. Marshall McLuhan would probably have termed this a "Gutenberg revolution". While we do not necessarily need to go that far, it seems however that there is a good chance for an acoustical turn in knowledge production. To make this turn possible, we need to develop formats for sound publications, just as scientific visualization uses its specific publication formats such as books and journals. In the following we will present some ideas on what could be done in this area.

3. PLUG 'N PLAY THE SONIFYER

Let us start with our personal experience: In the beginning of our sonification projects with EEG data from brain research (electroencephalography) and seismograms we developed our sonification tools within a Max/MSP framework. But the application became bigger and bigger, and soon the effort of installing the surrounding software package when introducing it to a new member became considerable. At the same time SuperCollider became popular for sonification—a tool which in our opinion is very powerful, but not easy enough to handle for amateurs. We decided therefore to go for a new bottom-up programming using the possibilities of Apple hardware and its operating system. The program *sonifYer* has now only a size of 2.5 Mb. There are no preparations or modifications of the system needed [2].—Our decision for the OS X platform was taken deliberately, since all our partners used Macs too and this OS could provide more stability. But as mentioned earlier, one should care for distribution, and hence comparable versions on Windows and Linux are needed.

We organized *sonifYer* right from the start in a way that allows working with several data streams, because in EEG as well as in earthquake research, data are organized in sets. One experiment often requires many measuring points: either at different points on the head of a test person, or at different seismic stations scattered all over the globe. We also paid a lot of attention to audification as our main sonification method when dealing with these data. Nevertheless *sonifYer* also works with parameter mapping—currently it uses frequency modulation synthesis (FM synthesis).

Secondly *sonifYer* works following a project approach; that is, just as Adobe InDesign or other programs, *sonifYer* brings together many different data sources. Different data sets can be imported and be handled on different levels (the formats that can be imported are so far: txt, eeg, and, from seismology, seed, saf, and gse; common audio formats such as aif, m4a, wav, mp3 can be used). A preset of parameters allowing instant play is provided. Changes are saved with every project.

For navigation we developed a Main Window (cf. figure 1) comparable to those of common audio programs showing oscillograms of the data and a player with, among others, start, stop, loop, and record buttons. The visual display can be controlled in the usual manner, i.e. in an adjustable window using mouse and cursor; markers can be set, different data sets can be selected or single channels be muted etc. Additionally, a slider for playback speed (forward and backward) is provided in a central position.

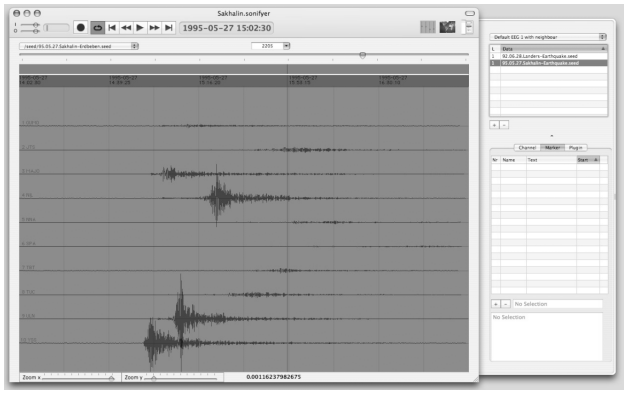

Figure 1. *Screenshot of Main Window of sonifYer (1.33)*

While allowing navigation in time in the Main window, *sonifYer* provides a second, parallel Map Window that allows listening to different channels in spatial order. E.g. in global seismology the location of each station results in a different listening position in relation to a given seismic event. With *sonifYer* one can do a virtual 3D walk through the different stations at every moment, just as if one walked through a room with each station being a speaker in a different point of that room. That makes it easy to compare the sound of e.g. the Sakhalin earthquake 1995 recorded at a station in East Russia versus its sound recorded at a station in California (cf. figure 2). Or when listening to EEG data one might want to focus for a moment on signals from the forehead, the next moment to signals from the back of the head. There is also a visualization feature: when playing the data a changing glow at the measurement points shows the sound output of each channel.

The Map Window also allows the organization of data sets. Each channel symbol can be selected and rearranged, so that channels one wants to neglect can be sorted out and vice versa.

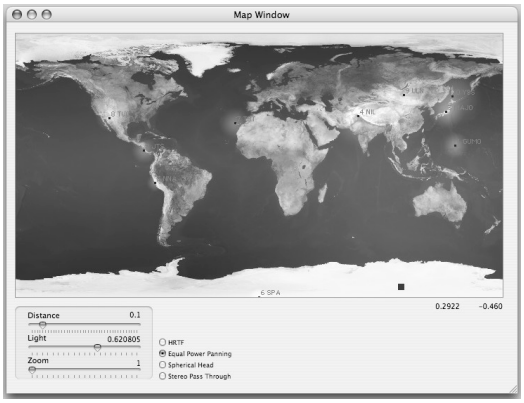

Figure 2. *Screenshot of Map Window (seismology)*

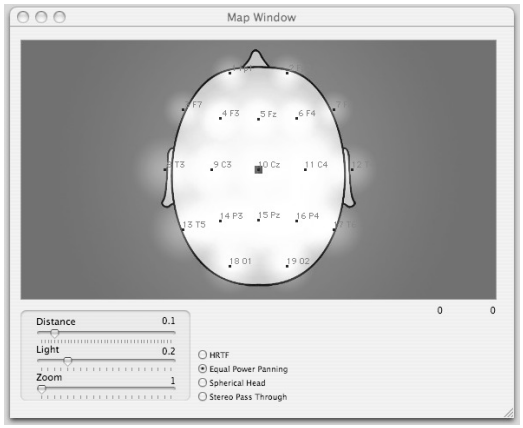

Figure 3. *Screenshot of Map Window (EEG research)*

Thirdly *sonifYer* provides a Data Window with all information from the imported files (headings of seismological seed files for instance containing information on the station's equipment, positioning etc.; or headings of eeg files containing markers and crucial experiment comments). This information can be edited, changed, extended etc.

Another window is reserved for the parameters of sonification: here one can modify in detail the settings for the FM-synthesis, our parameter mapping method so far. We have worked quiet a while on functional and aesthetically interesting presets of this synthesis, and these presets can be selected and

applied. It is also possible to use audification and FM for a data set at the same time.

Having learnt from experiences with partly unusable data we also built in a filter system that can be adapted (or used with presets) for each data set.

As already suggested in the last chapter, we see a major need (and also a chance) for sonification research in the involvement of more experts in each research topic, and in building up groups of experts. This could make some of today's user tests obsolete and instead of having a sound objectified by asking amateurs whether they hear an aspect or not, one could put a stronger focus on experts' opinions. Let us take a comparative look at the approach used for visualization in seismology: picking an event within a seismogram or interpreting a seismic cross-section is both done by purely visually-based decisions and thus requires extensive, long-standing experience. Once sonification data are informed by expert opinion as outlined above, there will be good reason to trust not only the judgment of a visualization expert about a picture, but also a judgment of a sonification expert about a sound.

Now to provide a platform for these experts (or new researchers who want to become experts), we integrated a Documentation Window in *sonifYer* (cf. figure 4). This window allows explaining and commenting on data sets. It is a kind of virtual forum, in which the group members involved can exchange their findings and interpretations. It personalizes and dates all statements, thus compiling a history of interpretation.—Technically this window has all opportunities of an Apple text editor. Pictures, sounds and movie clips can be integrated too with drag and drop.

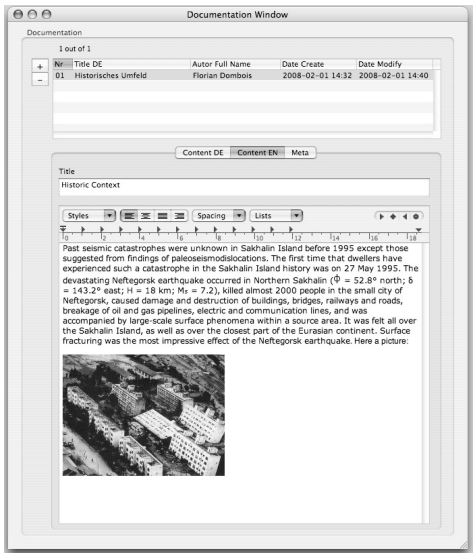

Figure 4. *Screenshot of Documentation Window*

We see the forum provided by the Documentation Window not only as an opportunity for internal group members to communicate, but we also want to connect it directly to our web concept described in the following section:

4. WWW.SONIFYER.ORG

Sonification communities working on one particular topic are today very small. You can consider yourself lucky if more than one group in the world is doing sonification research in the same area as you do. For instance, there are no more than five experts for audifying earthquake data around the world. Likewise, for EEG data you will also just find a handful of people scattered across the globe. Therefore bringing this knowledge together is essential for starting a scientific discourse.

Now for allowing such an exchange the internet seems to be the ideal platform for two reasons: First, when working together on a professional level, researchers need to communicate about interesting data sets, about sonification methods and appropriate parameterizations. Here we propose a kind of Wiki providing preliminary sound results as well as the opportunity to verbally describe and comment the hearing experiences.

Secondly, each research topic requires a corpus of proven results with well-chosen sound samples giving other researchers—who might so far only work with visualization techniques for instance—an opportunity to learn about sonification and to compare [3].

With *www.sonifyer.org* we have tried to set up a forum for such a sound-centered research. The website provides a general introduction to sonification and brings together research results from EEG sonification, audification of earthquake data and a collection of famous historical music pieces using sonification for artistic concerns. Most developed so far are the examples of EEG research. Here we provide sound samples as a kind of acoustic atlas, with EEG results typical of different ages (children, teenagers, etc.). There are also examples of "typical" EEGs taken from people suffering from schizophrenia, dementia, epilepsy, or depression. And for training, the website additionally provides an acoustical overview on typical EEG artefacts as a patient swallowing, muscle contraction, eye closing etc.

In EEG research there is a tradition of visual atlases as [4] [5], which we now try to extend into the audio world. The sound samples were chosen after listening for months, but it goes without saying that better examples may come up with time. Therefore the idea behind it is to share and to improve the listening experiences of the professionals.

We also found out that—especially with complex noises from audification—listening constitutes only one part of the process, while the other is to describe what has been heard. Here, a verbal modus of description needs to be developed that is not limited to a detailed verbal description on what to listen to; this undoubtedly helps in analyzing a sound, but also visual sketches can be useful. At the moment we are experimenting with both, verbal and visual sketches. But obviously this is a challenge which cannot be standardized, and certainly not within the near future.

5. CONCLUSIONS

Our title "A Concept, a Software, a Platform" may sound like an outlandish promise that cannot be fulfilled at the moment. But we are convinced that the two aspects of usability in sonification software and distribution of sound results are urgent topics for the next years of ICAD's development. We therefore hope to start a discussion on these questions, and we would want to follow the approach taken with *sonifYer*—or another software—and an internet platform for developing appropriate formats.

6. REFERENCES

[1] Ludimar Hermann, “Ueber electrophysiologische Verwendung des Telephons,” *Archiv für die gesamte Physiologie des Menschen und der Tiere* 16 (1878), pp.

504-509. This is the earliest published paper on audification we know; for further historical material cf.: Florian Dombois, "Sonifikation" in P. M. Meyer: *Acoustic Turn*, Paderborn, 2008, pp. 87-96; Florian Dombois, "The 'Muscle Telephone': The Undiscovered Start of Audification in the 1870s" in J. Kursell: *Sounds of Science—Schall im Labor (1800-1930)*, Max Planck Institute for the History of Science—Preprint 346, 2008, pp. 41-45.

[2] Download at http://www.sonifyer.org/softhardware/sonifyer/update/.

[3] Cf. as an example http://www.auditory-seismology.org/version2004/distance.html.

[4] E. Niedermayer and F. Lopes da Silva, *Electroencephalography. Basic Principles, Clinical Applications, and Related Fields,* 5th ed., Lippincott, 2004.

[5] M. Ebe and I. Homma, *Leitfaden für die EEG-Praxis. Ein Bildkompendium,* 3rd ed., München, 2002.