

**SONIFICATION AND INFORMATION
CONCEPTS, INSTRUMENTS AND TECHNIQUES**



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**A thesis submitted in partial fulfillment
of the requirements for the degree of**

Doctor of Philosophy

University of Canberra

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CERTIFICATE OF AUTHORSHIP OF THESIS

Except where clearly acknowledged in footnotes, quotations and the bibliography, I certify that I am the sole author of the thesis submitted today entitled

Sonification: and Information: Concepts, Instruments and Techniques

I further certify that, to the best of my knowledge, the thesis contains no material previously published or written by another person except where due reference is made in the text of the thesis. The material in the thesis has not been the basis of an award of any other degree or diploma except where due reference is made in the text of the thesis. The thesis complies with University requirements for a thesis as set out in <http://www.canberra.edu.au/secretariat/goldbook/forms/thesisrqmt.pdf>

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DECLARATION

Some material in this thesis has previously been made public. Parts of Chapter 1 are awaiting publication in 2009. Parts of Chapter 4 appeared in papers for The International Conference for Auditory Display 2007 and The Inaugural International Conference on Music Communication Science 2007. Parts of Chapter 5 are to appear in a paper for the International Conference for Auditory Display 2009. In accordance with general software engineering practices, all of the software described in this thesis utilises tools developed by other people, too numerous to mention. References to the major tools used are clearly indicated when they are first referred to in the text.

The cover image is a composite photograph of two musical serpents. It was created by the author as a logo for *SoniPy*, the sonification software outlined in this thesis. First appearing in Europe in 1590, the serpent is an amalgamation of tuba, trombone, bassoon, French horn and oboe. Played softly, it has a firm yet mellow timbre, at medium volume it produces a robust sound and when played loudly it can produce unpleasant noises reminiscent of large animals in distress (Schmidt 1997).

Abstract

This thesis is a study of sonification and information: what they are and how they relate to each other. The pragmatic purpose of the work is to support a new generation of software tools that can play an active role in research and practice that involves understanding information structures found in potentially very large multivariate datasets. The theoretical component of the work involves a review of the way the concept of *information* has changed through Western culture, from the Ancient Greeks to recent collaborations between cognitive science and the philosophy of mind, with a particular emphasis on the phenomenology of immanent abstractions and how they might be supported and enhanced using sonification techniques. A new software framework is presented, together with several examples of its use in presenting sonifications of financial information, including that from a high-frequency securities-exchange trading-engine.

Acknowledgements

I take this opportunity to thank a number of people who have played a significant rôle in assisting this thesis come into being. Most immediately, my thesis supervisors Dr Mitchell Whitelaw and Professor Roger Dean, whose different approaches with respect to its motivation and content, and execution provided me the opportunity to develop more rigorous arguments than I might otherwise have done. Their attention to detail was most valuable.

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The University of Canberra provided financial support, for which I thank them, as did the Capital Markets Cooperative Research Centre. Professor Michael Aitkin, provided a pragmatic but philosophically informed finance voice as well as positive feedback when the potential of the techniques demonstrated became apparent. Particular thanks go to Associate Professor Graham Partington, for his encouragement and support of what must have seen a very left-of-field proposal when I first suggested it to the CMCRC.

The opportunity to spend a concentrated period of time to develop this thesis came after twenty-five years of composition, teaching, research and public performance in electroacoustic and experimental music and the electronic arts more generally. I owe a debt of gratitude to the colleagues and students I was privileged to lead at the Australian Centre for the Arts and Technology at the Australian National University throughout the 1990s, for their enthusiasm for learning and their willingness to question. A special thanks goes to my colleague, collaborator and co-conspirator, the animator Stuart Ramsden. Our work together, and in particular the Design Structures course we taught, fortified the creative and technical foundations on which this thesis was built.

Last, but by no means least, there are my family and friends. You all know who you are. No words suffice. Simply, a heartfelt "thanks".

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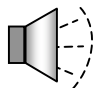
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THE ACCOMPANYING DVD

Audio Examples

Audio examples are essential for a full understanding of the sonification techniques discussed in the text of chapter 5. Sound examples are indicated in the outside margin of the text with a loudspeaker icon, as illustrated on the right of this text. Each of the examples folders on the disk has README textfile that summarises the files in that folder. Some of these examples require specific sampling rates not compatible with audio CD format, so, unfortunately it is not possible to play it on a standard CD player.



The audiofiles are playable using *SoundHack*, freely available for the Macintosh OS from <http://www.soundhack.com/freeware.php>
Another alternative is *play* a well crafted command-line tool, available from <http://www.hieper.nl/html/software.html>

Whenever suitable, the csound source files (.csd) used to render the examples are provided.

Code listings

The code listings provided in Appendix 4 and referred to in the text of Chapter 5. are also available .py text files on the disk

The *SoniPy* website

The *SoniPy* website is subject to ongoing modification. A reasonably recent version of this site is provided in the `www_sonipy` folder. The current version can be accessed at <http://www.sonification.com.au/sonipy/>

