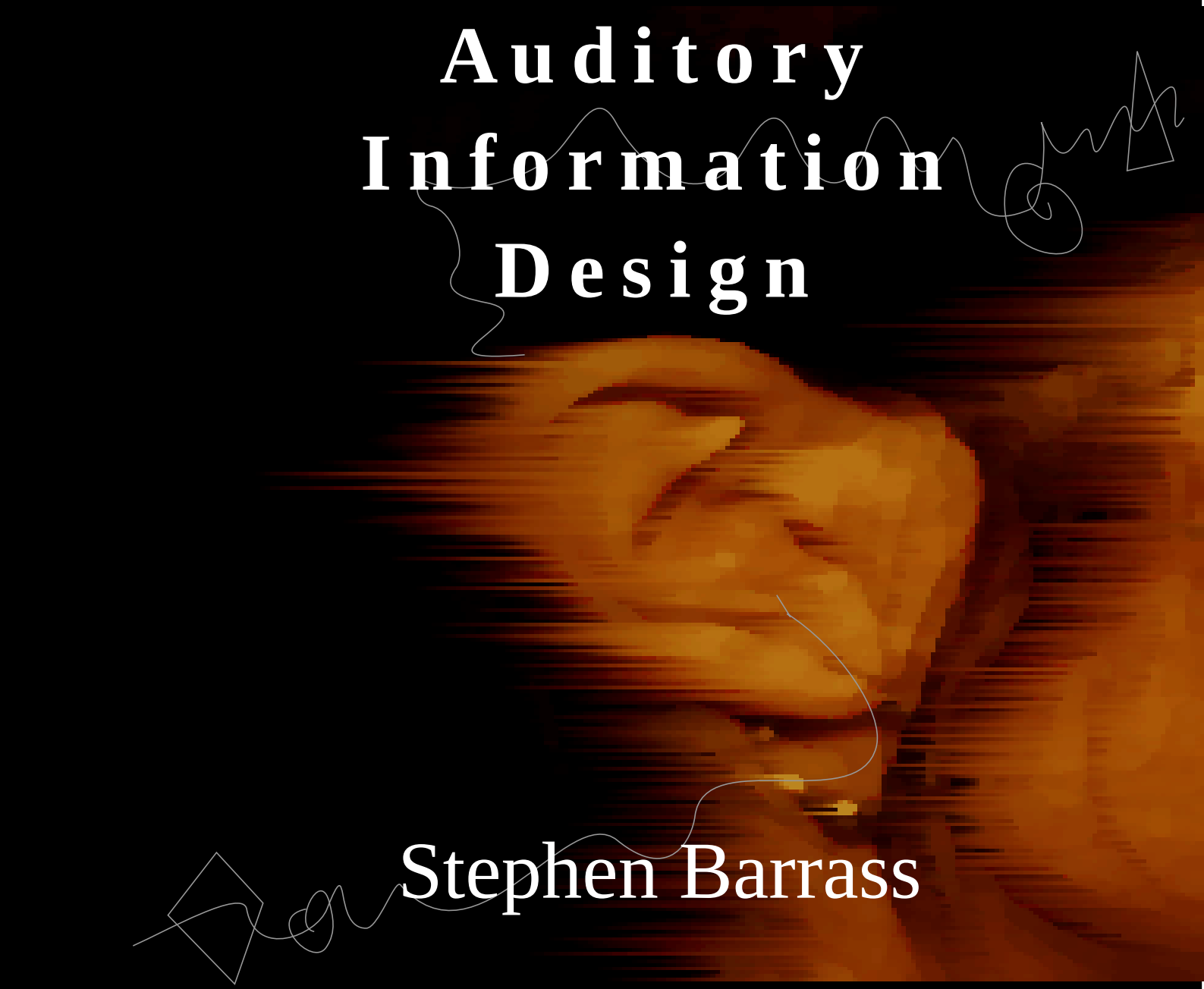
Auditory Information Design



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Declaration

Some material in this thesis has previously been made public. Parts of Chapters 3 and 10 appeared in a paper for the International Conference for Auditory Display 1996. Parts of Chapters 4, 5 and 10 appeared in a paper for the Asia-Pacific Conference on Human-Computer Interaction 1996. Chapter 6 is in a book on the Csound audio processing language to be published by MIT Press in 1997. Parts of Chapter 7 were presented at the Australian Computer Music Conference 1994. Other parts of Chapter 7 appeared in a paper, co-authored with Phil Robertson, in the proceedings of SPIE '95. Parts of Chapters 6, 7 and 8 appear in the proceedings of the International Conference on Auditory Display 1994. Parts of Chapters 7 and 8 are in an article for the Organised Sound journal 1,2 published by Cambridge University Press in 1996. Parts of Chapter 9 were presented at the Australian Computer Music Conference 1995.

Some of the tools and demonstrations described in this thesis utilise tools developed by other people, and I am pleased to declare their contributions. Don Bone wrote the tools for modelling colour output devices which were used to construct the sound space in Chapter 7. Matthew Hutchins wrote graphic interfaces and colour mapping algorithms that were extended to become the Personify tool in Chapter 9. The demonstrations in Chapter 10 build on the work of Simon Kravis in the RiverAndRain visualisation, Rochelle O'hagan and Danielle Landy in the GeoViewer, and Chris Gunn in the MicroSeismic Animator.

Except where otherwise stated, I declare that this thesis is my own original work

Stephen Barrass
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Abstract

The prospect of computer applications making “noises” is disconcerting to some. Yet the soundscape of the real world does not usually bother us. Perhaps we only notice a nuisance? This thesis is an approach for designing sounds that are useful information rather than distracting “noise”. The approach is called TaDa because the sounds are designed to be useful in a Task and true to the Data.

Previous researchers in auditory display have identified issues that need to be addressed for the field to progress. The TaDa approach is an integrated approach that addresses an array of these issues through a multifaceted system of methods drawn from HCI, visualisation, graphic design and sound design. A task-analysis addresses the issue of usefulness. A data characterisation addresses perceptual faithfulness. A case-based method provides semantic linkage to the application domain. A rule-based method addresses psychoacoustic control. A perceptually linearised sound space allows transportable auditory specifications. Most of these methods have not been used to design auditory displays before, and each has been specially adapted for this design domain.

The TaDa methods have been built into computer-aided design tools that can assist the design of a more effective display, and may allow less than experienced designers to make effective use of sounds. The case-based method is supported by a database of examples that can be searched by an information analysis of the design scenario. The rule-based method is supported by a direct manipulation interface which shows the available sound gamut of an audio device as a 3D coloured object that can be sliced and picked with the mouse. These computer-aided tools are the first of their kind to be developed in auditory display.

The approach, methods and tools are demonstrated in scenarios from the domains of mining exploration, resource monitoring and climatology. These practical applications show that sounds can be useful in a wide variety of information processing activities which have not been explored before. The sounds provide information that is difficult to obtain visually, and improve the directness of interactions by providing additional affordances.

Keywords:
Auditory display, sonification, information design, interaction design, sound design, task analysis, computer-aided design, human-computer interaction, user interface, multimedia interfaces, visualisation, data representation.

Acknowledgements

The work in this thesis grew out of a project on colour applications and modelling (CAM) for scientific visualisation at the Commonwealth Scientific and Industrial Research Organisation (CSIRO), and I would like to thank Don Bone, Phil Robertson, Matthew Hutchins, Duncan Stevenson, Chris Gunn and Dionne Smith for what I learnt from them in that work. Ideas of extending the colour framework to sounds arose from conversations with my brother Tim, who has always been a source of imagination and inspiration for me. Thanks to Kim Marr, Joni Bryan and Anne-Marie Crowe who read my thesis proposal and said "go for it" when I wasn't too sure. Thanks to Phil Robertson for his positive response and support for the proposal.

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There could be no better place than CSIRO to work and study, and I am very grateful for the environment and the people there. My colleagues helped me and taught me by reviewing and discussing my work - thanks to Matthew Hutchins, Neale Fulton, Simon Kravis, Phil Robertson, David Worrall, Don Bone, Ken Tsui, Danielle Landy, Tao Lin, and John Lilleyman. The demonstrations of my ideas depended on the willingness of people to let me to work on one of their projects - thanks to Simon Kravis for RiverAndRain, Rochelle Ohagan and Danielle Landy for GeoViewer, and Chris Gunn for MicroSeismic Animator. Thanks to Don Bone for helping me to use his colour modelling tools, and to Matthew Hutchins for his work on the graphical interfaces that are the basis for the Personify tool. There are many other people at CSIRO to thank as well - some lent me their ears by taking part in the Gold and Dirt experiment, others lent me their voices for the cOcktail demonstration, and others lent me stories for the EarBenders database. My enthusiasm for my topic was kept alive by the interest of those around me, and I particularly remember Neale Fulton's drop-in visits as sparks that helped keep my research spirit alive. Thanks to the other postgrads for sharing the spirit and talking the thesis talk - Matthew Hutchins, Ron Li, Kevin Moore, Andrew Lui, Mark Cameron - good luck.

One of the most important and enjoyable events in the course of this project was the opportunity to meet other researchers at the International Conference on Auditory Display (ICAD). The forum provided by ICAD helped focus my research and was a vital part of my experience. Thanks to the organisers of ICAD - Greg Kramer, Steve Frysinger and Stuart Smith, and to CSIRO and ACSys for funding my attendance.

Finally there are the people who kept me sane during this single-minded endeavour. Lunch-hours were regularly stretched in the company of Stephen Pratt, Ninh Hyne, and Sarah May, and I thank them for the cappuccinos, bad-jokes, good advice, and hot gossip. Eternal thanks Mum and Dad for my education, for listening and talking with me about what I was doing no matter what it might be, and for a place that always feels like home. Thanks to Linda, Robert, Lauren and Joel for fun and games, more dinners and another place that feels like home. A woof to Ziggy for all the walks up Mt. Ainslie, and for teaching me to both throw and fetch the frisbee. Finally, my heartfelt thanks to Bettina for being with me through all the ups and downs on a long ride, but at last the end of the tunnel is in sight and its sunny outside so let me pick you some flowers.

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