Chapter 7

EPILOGUE

Hamlet: Do you see yonder cloud that's almost in shape of a camel?
Polonius: By th' mass, and 'tis like a camel indeed.
Hamlet: Methinks it is like a weasel.
Polonius: It is back'd like a weasel.
Hamlet: Or like a whale.
Polonius: Very like a whale.
Hamlet: … They fool me to the top of my bent…

(Shakespeare: *Hamlet* Act III, Scene 2).

7.1 Chapter 2

The whole field of sonification research was reviewed in Chapter 2. Because the study was not period-limited, keeping pace with a number of developing topics proved daunting at times, but was mitigated somewhat by their currently being relatively few avenues of publication; *ICAD*, *Human Factors* and *HCI* being the principal ones. This has both positive and negative effects. The negative effects are the tendency for a little 'inbreeding', particularly in citations. The positive effects include that most researchers in the auditory display community have easier access to a larger body of research in the field than they otherwise might. While it is a sign of widening community acceptance of the discipline when more papers are accepted elsewhere, the institution of a Journal, which seems to be on the horizon, will be welcomed as it seems other journals now consider auditory display as a defined territory.

The ICAD website, which has recently been upgraded, performed a useful function in this regard too, although not all the papers that are listed are available. Papers from ICAD '94 are available as PDF format documents, however the contents are not accessible to search engines as each page within each document is in image format. A scan and OCR produced enough of a workable copy for personal use but also revealed that some fine papers have been all but ignored by subsequent researchers.

An attempt at too-taxonomic a classification of sonification techniques was a dilemma until it became clear that there is not much to be gained from trying to

make fine, often somewhat arbitrary distinctions in a field that is so fecund with possibilities. When reviewing so much material, perhaps it is part of the process to become as taken with possibilities as astounded by the depth of insight of those who build the foundations, but that occurred in this instance. There has hardly been a week pass without a new revelation arising from those two books from 1994: Kramer et al. and Bregman. Having the opportunity to write a review of the field for a book was an added stimulus and the sonification literature review for this thesis probably would not have been as broad otherwise.

In reviewing a number of other theses in the field it became clear that there was little to be gained by including a cursory overview of the physics or psychophysics of sound in this thesis. Another was the ability to reference personal material previously published that covers the topic more fully[1]. However, the most important reason was a sense that the discussion needed to move on. While physics or psychophysics is important from an analytic perspective, for it to be useful for synthesis it needs to be in the form of inverse filters, such as that for Fletcher-Munson described in Chapter 6 (§6.9). There is some peripheral work currently being undertaken in this area (Cabrera Ferguson and Schubert 2007) and it would be useful if were to be generalised. The concern of this thesis, however, was to look further forward, to try to find a theoretical basis for the better mental instantiations of multivariate datasets using sonification.

At the outset it was unclear how to best confine the discussion of sonification in such a way as to avoid having to deal with those now broad applications of the term to indicate a 'datasound' oriented media arts practice, in which the primary motivations are socio-cultural. Often such work is not concerned with informational relations within the data–and is sometimes specifically interested in obscuring it–yet in some compositions the concern for aural clarity in such matters *is* important. Coining a new term, *soniculation*, was useful in clarifying the different motivations. In any event, given the importance of (the action of) *intent* in defining information in a particular context, as discussed in chapters 3 and 4, the need for a nominal definition of sonification may be misplaced.

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[1] http://worrall.avatar.com.au/courses/PPofM/

7.2 Chapter 3

Chapter 3 was a difficult chapter to write, given that it finally covering two–and–a–half millennia of Western thought. It was as good to become reacquainted with Kant, as it was to discover the 'back-story' of Brentano and his mentors, Husserl, and Peirce's less–well–known work in phenomenology. Music's closest association with that philosophical movement is through the work of Pierre Schaeffer (1966), which, despite its importance in the history of Western music in the twentieth century, is eclectic enough to have resisted being translated from the original French.

So many different threads emanate from or react to Kant, that Mozart of philosophers, and a constant problem was what to do with those in the nineteenth and early twentieth century; particularly those influenced by Martin Heidegger and William James. Goethe, Schopenhauer, Hegel and Deleuze were entertained for a while, but eventually not included. Much of the literature on consciousness and the theory of mind that deals with sensation and mental imagery is a 'mind field' for the casual reader 'arriving' in the middle of a discourse, as finer and finer distinctions result in new terminologies that are invoked seemingly without a backwards glance. David Chalmer's websites are very useful resources in this regard.

It has never been clear whether it is ignorance of arrogance that keeps many scientists from reading philosophy, but after reading the professionals it is hard to entertain the clowns, especially those who believe they have discovered a resolution to the mind/body dualism in the application of systems theory. In any event, the distinction between data and information, how they function with each other, is now quite clear; as is the understanding that abstract immanent phenomenal objects of the type produced in the mind of a listener in response to conventional parameter mapping sonifications are unlikely to ever work very effectively until embodied in ways that afford their mundane comprehension with a low cognitive load. In fact it was only on reading Husserl's work, in particular, that the Platonism of his aims become so clear, and the reason why his desire for a theory of pure phenomenal immanence continually seemed to collapse in that direction. If this inadequacy is a reality, it is probably dealt with more effectively if it is considered a feature of the human condition rather than as a 'bug', as discussed in the introduction (§1.1.4).

While much of the chapter oscillated back-and-forth as appendices, part of the introduction and the conclusion, the essential threads eventually became clearer and

in the end it seems to work. The biggest regret is that there wasn't the opportunity or time to pursue the work of Michael Polanyi on tacit knowledge, as mentioned in Appendix 1. For those who wish to pursue the thread, the Robert Innis' book (1994) is a gem.

7.3 Chapter 4

In some ways, Chapter 4 was a questioning of the findings of Chapter 3 as a broad basis for the principles needed for Chapter 5. In practice, Chapter 4 remained as a sketch until the other two were almost complete. Currently, most work on embodiment seems to be being undertaken in the context of artistic performance that, though interesting, is of limited value for the work of this thesis without any resulting empirical biomechanical data. Sports science is probably a more appropriate experimental context, though building models that include untrained actions as well as those of movement artists seems like a possible path forward, perhaps collaboratively with animators and the support of the film industry. There are quite a few possibilities and if this thesis was building on the back of what it eventually became, that is the direction it would take.

7.4 Chapter 5

The *SoniPy* chapter and the interim publications that came out of that work was the result of a lot of detailed, sometimes pleasant, work on the discovery of material in the public domain that was well documented, easy to install and did what it said it could. Equally invigorating, but negatively so, was the frustration of being caught rewriting code that seems to have been placed in the public domain for the express purpose of claiming credit for the work of others who happen to come across it. The design of some reasonably rigid selection criteria soon followed! There are good reasons why *Python* has become such a popular language in which to think. It is elegant and powerful and very well supported. To go back to a specialist computer music language after experiencing the breadth and depth of the tools that are available for the asking is not even worth entertaining.

SoniPy is clearly not a completed software application, nor even a mature toolkit. How quickly, and if, it moves past the current 'proof–of–concept' stage will depend on community response, of which there has been some. From a research

perspective, there is a clear need for the seamless integration of a controlled experimental environment for empirical testing, including the addition of tools for Internet–based experiments. The components are there, they just need to be integrated.

7.5 Chapter 6

The early experiments in sonifying securities data and the discovery of the simplicity of the discovery of the Net Returns approach to transforming the data into an oscillation was a positive beginning. It may be a point of conjecture how often one human being can listen to countless 600 millisecond examples of various types of noise before insanity sets in, but to some, such as this writer, it never ceased to be enthralling! It was surprising to find so little work has been undertaken to empirically test the differentiability of sonified stochastic functions, despite them having been used so extensively in the computer music community.

If the 'joy of *Python'* was ever going to be tested, it was during the weeks spent using it to clean the high-frequency trading engine data. Both parties survived, however, and the tools developed for *mySQL* and *HDF5* databases permitted searching that would have been extremely difficult using a contiguous flat-file format. In the beginning, it was a mystery why the $value sonifications were so heavily loaded towards small trades. Tracing the probable cause and developing and implementing a sonification scenario that *soniculated* the volatility model was, in the end, quite successful and satisfying.

From the beginning of work for this thesis, a decision was made to keep the sound synthesis models as simple as possible. Perhaps it is perverse, but the structures always appear more lucid that way. And partly as a result, it is clearer now than ever before that the way forward for producing more powerful multivariate sonifications is likely to lie in the incorporation, along with better psychoacoustic models, of subtle queues to an embodied mind; perhaps through coherently resonant physical simulations that afford attention, or perhaps through models that modulate the vestibules and proprioceptive centres of the body, but it is unlikely to be through the application of more synthetic reverberation to disembodied multidimensional sample-realised abstractions. Some well-formed synthetic physical models of musical instruments do exist, however it was not clear

at this stage whether they will be adequate without the inclusion of their other halves–their players. There are many examples of timbrally-challenged synthetic resonators that seem to function perfectly adequately for *Gebrauchsmusik* and if the postulation that embodiment is to be an important and workable design feature of sonifications in the future, it seems unlikely that it will matter whether or not they will succeed simply as beautiful resonators.

The floating ephemeral nature of immanent objects means that they are susceptible to being 'grounded' by ideologies, and the current Cartesian, timbre-fetish orientation of much computer music software will need to embrace a sophisticated sense of embodiment if it is to be of real use in multivariate data sonification. It is not too hard to imagine that the necessity that is driving this may, in turn, be a lasting legacy to music composition.