Portfolio of Compositions and Exegesis:
Conflict and Resolution -
modelling emergent ensemble dynamics

by

Luke Adrian Harrald

Submitted in fulfilment of the requirements for the degree of

Doctor of Philosophy

Elder Conservatorium of Music
Faculty of Humanities and Social Sciences
The University of Adelaide

February 2008
Contents

Volume 1 Scores and Exegesis

Abstract vi
Declaration vii
Acknowledgements viii
List of Figures x

1 Introduction 1
   1.1 Problem and Research Methodology 2
   1.2 Performance Indeterminacy 4
   1.3 Prisoner’s Dilemma Game 6
   1.4 The Prisoner’s Dilemma and the Arts 7

2 Two Creative Works: testing the waters 8
   2.1 Fight or Flight: the Prisoner’s Dilemma (2003) 9
       Performance Notes 10
       Score* 12
       Commentary 31
   2.2 PARADOX eleven (2004) 35
       Performance Notes 36
       Score* 37
       Commentary 40
   2.3 Discussion: research outcomes 42

3 Software Development 43
   3.1 System Design and Implementation 43
   3.2 The Iterated Prisoner’s Dilemma (IPD) Engine 44
   3.3 Anatomy of an Agent 48
   3.4 Time 48
   3.5 Musical Considerations 49
   3.6 Discussion: implementation of strategies 50

*All scores are transposed.
4 Non-Real-Time Applications: software and scores

4.1 IPD Score Generator

4.2 Graphic User Interface (GUI) Design and Implementation

4.3 Output Module (IPD data to MIDI file conversion)

4.4 Surroundings (2004)

Score*: First Movement
Second Movement
Third Movement
Commentary

4.5 Irene’s Myth 3 (2005)

Score*
Commentary

4.6 Give in to Light (2006)

Score*
Commentary

4.7 Discussion: the implications of strategy

5 Real-Time Applications: installations and films

5.1 CONflict (2004)

5.2 Drowning (2006)

5.3 The 9:13 (2005)

5.4 Monuments (2006)

5.5 Installations and Screenings

5.6 Discussion: research outcomes

6 Interactive Work

6.1 Software development for ENSEMBLE (2006-2007)

6.2 Incorporating the performer’s actions into the IPD Engine

6.3 GUI Design: ENSEMBLE video game

6.4 Fr@gm3nT (2007)

6.5 Discussion: ENSEMBLE and game-play

* All scores are transposed.
Appendices

Appendix A: MaxMSP Patches

**IPD Engine**
- Time Module 159
- Patch Sequencer 160
- Behavioural Engine 161

**IPD Score Generator**
- GUI and Main Patch 162
- MIDI output Module 163

**CONFLICT**
- Main Patch 163
- Patch Sequencer 164
- Sound Output 165
- Video Output 166

**fr@gm3nT**
- Main Patch and Fuzzy Logic Module 167

Appendix B: compositions conceptually unrelated to the main portfolio

**The Pacific Solution (Ocean Floor 2)** (2003)
- Performance Notes 170
- Score* 171

**Last Exit** (2004)
- Score* 179

* All scores are transposed.
Volume 2 Electronic Documentation

Video Documentation (Disc 1)

Surroundings (third movement)
Performed by Topology at the 2005 Australasian Computer Music Conference at the Queensland University of Technology, Brisbane. Reproduced by Permission.

Irene’s Myth 3
Performed by Katherine Howard and Lilly Leaver as part of the 2005 Sight Specific Music concert series, with the artwork of Annette Bezor, at the Greenaway Art Gallery, Kent Town. Reproduced by Permission.

CONFlict

Drowning (Build Shots)
Unfortunately, there was no footage taken of Drowning actually installed in the gallery prior to its untimely demise. These photos were taken during the building and testing phase of the project, and the shots are accompanied by the recording used in the alternate loop-based set-up described in Figure 5.2.2.

Monuments
Monuments was created at the studios at the Centre de Creation Musicale Iannis Xenakis in Paris, France. This particular version is a stereo mix of the work, which is normally presented in quad surround.

fr@gm3nT

AUDIO CD (Disc 2)

Track 1: PARADOX eleven

Tracks 2, 3 & 4: Surroundings
Performed by Fiona Corston (piano), Wendy Heilengenberg (violin) and Katherine Howard (cello). This is a reproduction from the compilation CD ‘Sight Specific Music Volume 1’, recorded by Radio Adelaide and released commercially by the Greenaway Art Gallery in 2006. Reproduced by Permission.

Track 5: Irene’s Myth 3
MIDI mock-up produced using Finale 2008.
Track 6: *Give in to Light*

Track 7: *fr@gm3nT*

DATA DVD (Disc 3)

The data on this DVD can be navigated by opening the start.html file on the disk.

**Software:** *IPD Score Generator 2.0*, and a version of *ENSEMBLE* that was used for a performance of *fr@gm3nT* at the 2007 Australasian Computer Music Conference. Please note that the software has not been widely tested, and that no support will be offered for these applications. The applications are MaxMSP standalones for OS X only.

**Media:** All the content from the video and audio disks in .mov and .aiff formats for computer playback.

**Digital Exegesis:** Written Documentation in .pdf format.

The 9:13 Commercial Release (Disc 4)

Donated by Sacred Cow Films.
Abstract

This portfolio of compositions explores Game Theory as an approach to generative composition and interactive computer music. Inspired by the notion of Performance Indeterminacy, software has been developed that attempts to simulate the interactions of improvising performers using a multi-agent system based on the ‘Iterated Prisoner’s Dilemma’. Composition activities and programming activities have formed a symbiotic relationship throughout the creation of the portfolio as each has constantly informed the other. Stylistically, the works presented fall into the experimental genre, although individually they address a wide range of aesthetic goals.

The main contribution of this portfolio is a new approach to generative composition based on behavioural models, creating a sense of form bottom-up through modelling the social dynamics of music performance. Through this approach, the direct modelling of musical structures is avoided; instead larger scale forms emerge through the interactions of an ensemble of ‘improvising’ agents. This method offers a departure from previous complex systems work in the area of music, creating computer models of specific musical situations. Links between the Iterated Prisoner’s Dilemma and music are also established and combined with current music technologies.
Declaration

This work contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text. I give consent to this copy of my thesis, when deposited in the University Library, being made available in all forms of media, now or hereafter known.

Signature: ___________________________
Date: ___________________________
Acknowledgements

This portfolio would not have been possible without the combined help, encouragement and criticism of many friends and colleagues over the years. I am grateful for their contribution to many aspects of this submission as follows.

First and foremost, special thanks to my principal supervisor Stephen Whittington for his ongoing support and mentorship throughout the duration of this project. Our conversations have been critical in shaping the concepts presented in this submission, and you have helped me through many difficult times during the candidature. Special thanks must also go to Derek Pascoe for his collaboration on the work fr@gm3nT, and to Hugh McLean for his collaboration on the installation CONflict. Both your contributions were instrumental in shaping these works.

Thanks to Matthew Phipps and Sonya Humphrey for having enough belief to run with an experimental soundtrack for their short film The 9:13, and for donating the commercial copies of the film for inclusion in the portfolio.

Thanks also to my other supervisors, Professor Charles Bodman Rae and Professor Graeme Koehne, and to Head of Post Graduate Studies, Associate Professor Kimi Coald rake.

Many others have contributed to this submission through interesting conversations, organising performances, or commissioning new work. Thanks to Michael Yuen (Project 1, 2 & 3 concert series), PJ Noack and Lilly Leaver (Sight Specific Music concert series), Tristan Louth-Robins (Tyndall Assembly concert series), Peter Bentley, Tim Blackwell and the Live Algorithms research network, David Burraston, David Harris, Gordon Monroe, Sebastian Tomczak, and finally, Robert Axelrod for his encouragement and kind words of support.

Thanks to the performers involved in various performances and recordings, including: Vanessa Tomlinson, Matthew Timmis, Katerina Stevens, Joe Fragnito, Allye Sinclair, Fiona Corston, Katherine Howard, Wendy Heilingenberg and Topology. Thanks also to Joanna Drimatis for helping with the bowings for Give in to Light.

As with any technology-based project, tech support has been of vital importance. Thanks to my colleagues in the Electronic Music Unit, Christian Haines and Peter Sansom for their excellent debugging suggestions and assistance on many occasions.

Finally, special thanks to my wife, Melanie Harrald for her loving support, patience and understanding throughout the many trials of this project. Without your support, I may have walked away many times.
The following materials have been reproduced with thanks, by kind permission:

Figures 4.4.1, 4.4.2, 4.5.1 and all materials relating to the Sight Specific Music series appear courtesy of Paul Greenaway.

Figure 5.1.4 and all materials relating to Projects 2 and 3 appear courtesy of Michael Yuen, left photograph in Figure 5.1.4 by Tristan Louth-Robins, right photograph by Paul Armour.

Figure 5.4.1 appears courtesy of the Estate of Stan Brakhage and Fred Camper (www.fredcamper.com)

Figure 6.4.1 and the recording of fr@gm3nT at the Tyndall Assembly appears courtesy of Tristan Louth-Robins.

The performance of Surroundings by Topology appears courtesy of Greg Jenkins (QUT).

The video of fr@gm3nT at EARPOKE appears courtesy of Jacob Morris.

The 9:13 appears courtesy of Sacred Cow Films.

Figure 2.1.2 was generated by the author using the software ‘Life 32’ by Johan Bontes. Available at: <http://psoup.math.wisc.edu/Life32.html> (14/2/2008).

Figure 2.2.1 was generated by the author using a Java applet by Serge Helfrich. Available at: <http://prisonersdilemma.groenefee.nl> (14/2/2008).

This submission has spawned three publications available on the author’s website (http://www.lukeharrald.com.au):


List of Figures

Figure 2.1.1 *Fight or Flight*: score extract 32
Figure 2.1.2 Cellular Automaton: glider used in *Fight or Flight* 32
Figure 2.1.3 *Fight or Flight*: beat divisions 33
Figure 2.1.4 *Fight or Flight*: sonification matrix 34
Figure 2.2.1 *PARADOX eleven*: Spatial Prisoner's Dilemma 40
Figure 2.2.2 *PARADOX eleven*: temporal structure 41
Figure 3.2.1 IPD Points Matrix 46
Figure 3.2.2 Screenshots from software developed over the duration of the candidature 47
Figure 4.2.1 *IPD Score Generator* GUI 53
Figure 4.2.2 *IPD Score Generator*: GUI finer detail 54
Figure 4.2.3 *IPD Score Generator*: Initialisation Panel 55
Figure 4.4.1 Toe Separator by Peter Atkins 73
Figure 4.4.2 Buckle by Peter Atkins 74
Figure 4.5.1 Ego Moon 2 by Annette Bezor 80
Figure 4.6.1 *Give in to Light*: score extract from the opening bars 128
Figure 4.7.1 Table comparing IPD strategies to their musical roles 130
Figure 5.1.1 *CONflict*: visual palette of 14 images 132
Figure 5.1.2 Description of Bann’s tuning: 18-tone just intonation 133
Figure 5.1.3 *CONflict*: screenshots of the global visual output, including the agents' selections 134
Figure 5.1.4 *CONflict*: installation photographs from Project 2 and Project 3 134
Figure 5.2.1 *Drowning*: overhead shot of installation and a close up of the hydrophones and piezo drivers 135
Figure 5.2.2 *Drowning*: diagrams showing set-up 136
Figure 5.4.1 Hand painted film-strip from 'Chartres' by Stan Brakhage 138
Figure 5.4.2 *Monuments*: screenshot 139
Figure 6.2.1 Modular structure of the ENSEMBLE Application 142
Figure 6.3.1 ENSEMBLE GUI 144
Figure 6.3.2 ENSEMBLE: video game in action with electric guitar and ebow 145
Figure 6.4.1 fr@gm3nT performance 149
Figure 7.0.1 Hackers GUI 153