Exploring New and Emerging Models for Nonlinear Performative Works

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Nonlinear music, parametrical discontinuity, discrete, non-contingent, non-compressible, sequential structure, multilinear structure, nonlinear narrative, referential structure, spectrogram, parametrical disjunction, Charles Ives, Igor Stravinsky, Arnold Schoenberg, Olivier Messiaen, Karlheinz Stockhausen, Pierre Boulez, Pierre Schaeffer, Iannis Xenakis, Luciano Berio and Earle Brown, James Tenney, John Zorn.

Abstract
This dissertation seeks to define and classify musical nonlinear structures and to explore the possibilities they might afford for the creation of new musical works. It provides a comprehensive framework for the discussion of nonlinear structure in musical works and provides a detailed overview of the rise of nonlinearity in music during the 20th century.

Nonlinear events are shown to emerge through significant parametrical discontinuity at the boundaries between regions of relatively strong internal cohesion. The dissertation situates nonlinear structures in relation to linear structures and unstructured sonic phenomena and provides a means of evaluating Nonlinearity in a musical structure through the consideration of the degree to which the structure is integrated, contingent, compressible and determinate as a whole.

It is proposed that nonlinearity in music can be classified as a three dimensional space described by three continuums: the temporal continuum, encompassing sequential and multilinear forms of organization, the narrative continuum encompassing processual, game structure and developmental narrative forms and the referential continuum encompassing stylistic allusion, adaptation and quotation.

The contribution of cultural, ideological, scientific and technological shifts to the emergence of nonlinearity in music is discussed and a range of compositional factors that contributed to the emergence of musical nonlinearity is examined. The evolution of notational innovations from the mobile score to the screen score is plotted and a novel framework for the discussion of these forms of musical transmission is proposed.

A computer coordinated performative model is proposed, in which a computer synchronises screening of notational information, provides temporal coordination of the performers through click-tracks or similar methods and synchronises the audio processing and synthesized elements of the work. It is proposed that such a model constitutes a highly effective means of realizing complex nonlinear structures in performance.

The use of spectrograms of recorded musical works is proposed as a potential means of evaluating nonlinearity in a musical work through the visual representation of parametrical divergence in pitch, duration, timbre and dynamic over time. Spectral and structural analysis of repertoire works is undertaken as part of an exploration of musical nonlinearity and the compositional and performative features that characterize it.

A creative folio comprising 29 original works that explore nonlinearity is presented, discussed and categorized, utilising the proposed classifications. Spectrograms of these works are employed where appropriate to illustrate the instantiation of parametrically divergent substructures and examples of structural openness demonstrated by different performances.

Exploring new and emerging models for non-linear performative works

FIGURES AND TABLES

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Creative Folio

Compact Discs

Lindsay Vickery PhD Creative Folio CD1: Block-Form works

1	shifting planes (2005)	13:33	Ensemble Scintilla Divina	Scintilla Divina Festival 2005
2	offRamp (2002)	08:23	HEDKIKR	from the album *HEDKIKR: hies* (2002)
3	exit points (2003)	06:31	Grit	Lunchtime Concert, Western Australian Academy of Performing Arts
4	still-life with visitations (2002)	10:49	The Collective	Scale Variable Concert,Lawrence Wilson Gallery
5	kreuz des suedens I-V (2003)	12:46	Ensemble Scintilla Divina	Scintilla Divina Festival 2003
6	Hunting Pack (2011)	08:24	Decibel	Pretty Things, Perth Institute for Contemporary Arts
7	Night Fragments (2011)	16:57	Caitlin Cassidy and Decibel	Decibel: Voice from a Dark Place, Perth Institute for Contemporary Arts

HEDKIKR: Darren Moore - Drums and Lindsay Vickery - Tenor Saxophone

Decibel: Caitlin Cassidy - Mezzo-Soprano (7), Cat Hope - Flute/Alto Flute (7), Lindsay Vickery - Clarinet/Bass Clarinet (7), Tristen Parr - Cello (6, 7), Stuart James - Keyboard (5,7) and Joshua Hogan - Cimbalom

Lindsay Vickery PhD Creative Folio CD2: Collage Works

1	entropology (2002)	9:00	Magnetic Pig	Totally Huge New Music Festival 05 (2002)
2	Hey Jazz Fans! (2003)	5:57	Lindsay Vickery	from the album *HEDKIKR: hies*
3	<as viewed from above> (2001)	5:22	Lindsay Vickery	Lunchtime Concert: Western Australian Academy of Performing Arts
4	delicious ironies 1 (noir) (2002)	6:01	Melissa Madden Gray and HEDKIKR	Studio Recording
5	delicious ironies 2 (mcj) (2005)	6:20	Matthew Jones	Studio Recording
6	delicious ironies 3 (dr woo) (2010)	8:28	Lindsay Vickery	transformations concert 15 May 2010
7	splice 2002)	6:21	Lindsay Vickery	Studio Recording
8	echo-transform 1 (2010)	8:27	Lindsay Vickery	transformations concert 15 May 2010
9	Improbable Games (2010)	11:22	Decibel	Studio Recording
10	reconstruction of a shifting path (2011)	9:09	Mark Gasser	The Mechanical Piano: Western Australian Academy of Performing Arts

Magnetic Pig: Jessica Ipkendanz - Violin, Lindsay Vickery - Alto Saxophone, Robyn Sarti - Vibraphone, Philip Waldron - Double Bass and Emily Green-Armytage - Piano

HEDKIKR: Melissa Madden Gray - Voice, Darren Moore - Drums and Lindsay Vickery - Tenor Saxophone

Decibel: Cat Hope - Alto Flute, Lindsay Vickery - Bass Clarinet, Tristen Parr - Cello

Lindsay Vickery PhD Creative Folio CD3: Multilinear, Polystructural and Subtractive Structure

1	between the lines (2002)	6:51	HEDKIKR	from the album *HEDKIKR: hies* (2002)
2	parallel trajectories (2003)	9:19	Ensemble Scintilla Divina	Scintilla Divina Festival 2003
3	Tectonic (2008)	17:04	Cloud Chamber Orchestra	Tectonic: A Program of Works by Lindsay Vickery Art Gallery of Western Australia
4	éraflage (2007)	8:18	Ensemble Scintilla Divina	Scintilla Divina Festival 2007
5	corridors, stairways, night and day (2009)	9:45	Lindsay Vickery	Sound Spectrum : LIVE new electronic music
6	antibody (2009)	14:19	Decibel	from the album *Decibel: Disintegration | Mutation*
7	ghosts of departed quantities (2010)	10:12	Decibel	from the album *Decibel: STASIS ECSTATIC*

HEDKIKR: Darren Moore - Drums and Lindsay Vickery - Tenor Saxophone

Decibel: Cat Hope - Alto Flute (6), Bass Flute (7), Lindsay Vickery - Clarinet (6),Bass Clarinet (7), Aaron Wyatt - Viola, Tristen Parr - Cello and Stuart James - Keyboard (6), Piano (7)

Lindsay Vickery PhD Creative Folio CD4: Polytemporal Structures

1	interXection (2002)	8:23	HEDKIKR	Studio Recording
2	whorl (2003)	6:28	Grit	Lunchtime Concert: Western Australian Academy of Performing Arts
3	Particle + Wave (2004)	6:42	resonator	Studio Recording
4	zwitschern (2005)	6:46	Ensemble Scintilla Divina	Scintilla Divina Festival 2005
5	transit of venus (2009)	9:25	Decibel	from the album *Decibel: Disintegration | Mutation*
6	delineate 1 (2010)	5:52	Callum G'Froerer	International Trumpet Seminar, Chosen Vale, New Hampshire
7	The Talking Board (2011)	7:44	Decibel	Camera Obscura, Perth Institute for Contemporay Arts
8	partikulator (2011)	7:21	Lindsay Vickery	Shock of the New: The Velvet Lounge, Perth
9	Questions written on Sheets of Glass (2011)	3:40	Lindsay Vickery	The Mechanical Piano, Western Australian Academy of Performing Arts

HEDKIKR: Darren Moore - Drums and Lindsay Vickery - Microphone

Decibel: Cat Hope - Double Bass (5), Bass Flute (7), Lindsay Vickery - Bass Clarinet (7), Aaron Wyatt - Viola (5,7), Tristen Parr - Cello (5,7) and Malcom Riddoch (7) Processing and Spatialisation

DVD

1. PhD Recordings

VickeryAntibody20091118.m4a	WA Academy of Performing Arts	decibel
VickeryAntibodyDistintegrationMutation2011.m4a	Studio	decibel
VickeryAsViewedfromabove20000613.m4a	Korzo Theatre Den Haag, NETHERLANDS	Lindsay Vickery
VickeryAsViewedfromAbove20000809.m4a	University of Western Australia, Perth	Lindsay Vickery
VickeryAsViewedfromAbove2000LTC.m4a	WA Academy of Performing Arts, Perth	Lindsay Vickery
Vickeryasviewedfromabove20040923.m4a	Lasalle College of the Arts, SINGAPORE	Lindsay Vickery
VickeryBetweentheLines20021208.m4a	Artswatch, Louisville Kentucky USA	HEDKIKR
VickeryBetweentheLines20021211.m4a	Cantebury House, Ann Arbor, Michigan USA	HEDKIKR

VickeryBetweentheLines20030314.m4a	Spectrum Gallery, Perth	HEDKIKR
VickeryBetweentheLinesStudio2003.m4a	Studio	HEDKIKR
VickeryBetweentheLinesTake120030402.m4a	Studio	HEDKIKR
VickeryBetweentheLinesTake220030402.m4a	Studio	HEDKIKR
Vickerycorridorsstairwaysnightandday 20090815.m4a	SPECTRUM PROJECT SPACE, ECU	Lindsay Vickery
Vickerycorridorsstairwaysnightandday 20090908.m4a	WA Academy of Performing Arts	Lindsay Vickery
Vickerycorridorsstairwaysnightandday20090701.m4a	The Octagon, University of WA	Lindsay Vickery
VickerydeliciousIronies(3)20010305.m4a	WA Academy of Performing Arts, Perth	Lindsay Vickery
Vickerydeliciousironies(anak2)20100515.m4a	WA Academy of Performing Arts	Lindsay Vickery
Vickerydeliciousironies(cyphers)desk20080621.m4a	Art Gallery of Western Australia	
Vickerydeliciousironies(December1952Redux)20090326.m4a	WA Academy of Performing Arts	Lindsay Vickery
Vickerydeliciousironies(drwoo)20100515.m4a	WA Academy of Performing Arts	Lindsay Vickery
Vickerydeliciousironies(kds)20071107.m4a	Lasalle College of the Arts, SINGAPORE	Fusion Chamber orchestra
Vickerydeliciousironies(kds)desk20080621.m4a	Art Gallery of Western Australia	Dan Russell and Tristen Parr
Vickerydeliciousironies(mcj)Studio2005.mp3	Studio	Matthew Cellan Jones
Vickerydeliciousironies(noir)20020411.m4a	Victorian College of The Arts, Melbourne	GRIT
Vickerydeliciousironies(noir)20020413.m4a	WHATISMUSIC? Festival, The Ninth Ward, Melbourne	
Vickerydeliciousironies(noir)20020714.m4a	Art Gallery of Western Australia	
Vickerydeliciousironies(noir)20051013.m4a	Univ University of Western Australia, Perth ersity of WA	
Vickerydeliciousironies(noir)Studio2002.m4a	Studio	
Vickerydeliciousironies(noir)StudioDM2002	Studio	HEDKIKR
Vickerydeliciousironies(noir)StudioMMGLV2002.m4a	Studio	
Vickerydeliciousironies(ragingbelle)1.m4a	Studio	Gemma Horbury
Vickerydeliciousironies(ragingbelle)2.m4a	Studio	Gemma Horbury
Vickerydeliciousironies(ragingbelle)3.m4a	Studio	Gemma Horbury

Vickerydeliciousironies(ragingbelle)4.m4a	Studio	Gemma Horbury
Vickerydeliciousironies(ragingbelle)Studio2002.m4a	Studio	Gemma Horbury
Vickerydeliciousironies(shmil)20100515.m4a	WA Academy of Performing Arts	Lindsay Vickery
Vickerydeliciousironies(sichuan)20020411.m4a	Art Gallery of Western Australia	Magnetic Pig
Vickerydeliciousironies(sichuan)Studio2002.m4a	Studio	Clocked Out
Vickerydeliciousironies(vox)Studio2002.m4a	Studio	Melissa Madden Gray
Vickerydelineate120100515.m4a	Kurongkurl Katitjin Gallery, ECU	Lindsay Vickery
Vickerydelineate120100617.m4a	Chosen Vale, Enfield, New Hampshire, USA	Callum G'Froerer
Vickeryechotransform120100515.m4a	Kurongkurl Katitjin Gallery, ECU	Lindsay Vickery
Vickeryechotransform120100515.m4a	WA Academy of Performing Arts	Lindsay Vickery
VickeryEntropology20020411.m4a	Art Gallery of Western Australia	Magnetic Pig
Vickeryeraflage120070818.m4a	Scintilla Divina Festival Jena, Germany	Ensemble Scintilla Divina
Vickeryeraflage20080621.m4a	Art Gallery of Western Australia	Cloud Chamber Orchestra
Vickeryeraflage220070818.m4a	Scintilla Divina Festival Jena, Germany	Ensemble Scintilla Divina
VickeryExitPoints20040419.m4a	WA Academy of Performing Arts	GRIT
VickeryExitPoints20040424.m4a	The Hellenic Centre, Perth	GRIT
VickeryExitPoints20051013.m4a	Callaway Auditorium, University of WA	Guapo
Vickeryghostsofdepartedquantities20100624.m4a	Australian National University, Canberra	decibel
Vickeryghostsofdepartedquantities20120119.aif	WABE, Berlin	decibel
Vickeryghostsofdepartedquantities20120127.aif	Biberach, Germany	decibel
VickeryghostsofdepartedquantitiesStudio2012.m4a	Studio	decibel
VickeryHeyJazzFans20020204.m4a	Studio	Lindsay Vickery
VickeryHeyJazzFans20040419.m4a	The Hellenic Centre, Perth	Lindsay Vickery
VickeryHeyJazzFans20040424.m4a	WA Academy of Performing Arts	Lindsay Vickery
VickeryHeyJazzFans20040923.m4a	Lasalle College of the Arts, SINGAPORE	Lindsay Vickery

VickeryHopeTalkingBoard20110921.m4a	Decibel - Camera Obscura PICA	decibel
VickeryHopeTheTalikingBoard20120127.aif	WABE, Berlin	decibel
VickeryHopeTheTalkingBoard20120129.aif	Biberach, Germany	decibel
VickeryHuntingPack20110620.aif	Decibel - Pretty Things PICA	decibel
VIckeryImprobableGames20101201.wav	Createworld	decibel
VIckeryImprobableGames20101203.mp3	MSA Conference Dunedin	decibel
VickeryImprobableGames20110128.m4a	Albany Entertainment Centre	decibel
VickeryImprobableGames20110129.m4a	Karri View Winery Denmark	decibel
VickeryImprobableGames20110130.m4a	Painted Tree Gallery	decibel
VickeryImprobableGames20110131.m4a	Nannup Town Hall	decibel
VickeryImprobableGames20110514.m4a	Peking Spring: Street Theatre ANU Canberra	decibel
VickeryImprobableGames20110515.m4a	Sydney Conservatorium	decibel
VickeryImprobableGames20110923.m4a	ABC Studios, Perth	decibel
VickeryInterXection20020804.m4a	Perth Institute of Contemporary Arts	HEDKIKR
VickeryInterXection20030314.m4a	WA Academy of Performing Arts, Perth	HEDKIKR
VickeryInterXection20040424.m4a	Spectrum Gallery, Perth	HEDKIKR
VickeryInterXectionA20031203.m4a	Queensland University of Technology	HEDKIKR
VickeryInterXectionB20031203.m4a	Queensland University of Technology	HEDKIKR
VickeryInterXectionStudio2002.m4a	Studio	HEDKIKR
VickeryKreuzdesSuedens20020913.aif	Scintilla Divina Festival Jena, Germany	Ensemble Scintilla Divina
VickeryKreuzdesSuedens20040424.m4a	WA Academy of Performing Arts	GRIT
VickeryNightFragments20110328.m4a	Perth Institute of Contemporary Arts	decibel
VickeryoffRamp20021208.mp3	MadLab Columbus Ohio, USA	HEDKIKR
VickeryoffRamp20021211.m4a	Cantebury House, Ann Arbor, Michiga,n	HEDKIKR

	USA	
VickeryoffRamp20021213.m4a	The Rotunda, Philidelphia	HEDKIKR
VickeryoffRamp20030314.m4a	Spectrum Gallery, Perth	HEDKIKR
VickeryoffRamp20031203.m4a	Queensland University of Technology	HEDKIKR
VickeryoffRampStudio2003.m4a	Studio	HEDKIKR
VickeryParallelTrajectories20020913.m4a	Scintilla Divina Festival Jena, Germany	Ensemble Scintilla Divina
VickeryParallelTrajectories20040419.m4a	The Hellenic Centre, Perth	GRIT
VickeryParallelTrajectories20040424.m4a	WA Academy of Performing Arts, Perth	GRIT
VickeryParallelTrajectories20080621.m4a	Art Gallery of Western Australia	Cloud Chamber Orchestra
VickeryParallelTrajectories20100223.m4a	WA Academy of Performing Arts, Perth	Resonator
Vickeryparticleandwave20051013.m4a	Callaway Auditorium, University of WA	Guapo
VickeryparticleandwaveStudio2004.m4a	Lasalle College of the Arts, SINGAPORE	Fusion Chamber Orchestra
VickerypartikulatorStudio2012.aif	Sound Spectrum, The Velvet Lounge Perth	Lindsay Vickery
VickeryQuestionswrittenonSheetsofGlass20111027.aif	The Mechanical Piano WAAPA Auditorium, Perth	Lindsay Vickery
Vickeryreconstructionofashiftingpath20110916.m4a	Piano Tapestry - THNM Festival STC Perth	Mark Gasser
Vickeryreconstructionofashiftingpath20111027.aif	The Mechanical Piano WAAPA Auditorium	Mark Gasser
VickeryShiftingPlanes20050911.m4a	Scintilla Divina Festival Jena, Germany	Ensemble Scintilla Divina
VickerySplice(BTL)Studio2003.m4a	Studio	HEDKIKR
VickerySplice(MrLucky)20040921.aif	Lasalle College of the Arts, SINGAPORE	Danielle Micich
VickerySplice(offRamp)Studio2003.m4a	Studio	HEDKIKR
VickerySplice(Scratch)20040419.m4a	Club Zho, Perth	Lindsay Vickery

VickerySplice(Scratch)20040424.m4a	WA Academy of Performing Arts, Perth	Lindsay Vickery
VickerySplice20020204.m4a	University of Western Australia, Perth	Lindsay Vickery
VickerySplice20030314.m4a	WA Academy of Performing Arts, Perth	Lindsay Vickery
VickerySplice20040419.m4a	The Hellenic Centre, Perth	Lindsay Vickery
VickerySplice20040923.m4a	Lasalle College of the Arts, SINGAPORE	Lindsay Vickery
VickerySpliceStudio2003.m4a	Studio	Lindsay Vickery
VickeryStilllifewithVisitations20020914.aif	Lawrence Wilson Gallery, Perth	The Collective
VickeryTectonic(LSCamera1)20071107.m4a	Lasalle College of the Arts, SINGAPORE	Fusion Chamber Orchestra
VickeryTectonic(LSCamera2)20071107.m4a	Lasalle College of the Arts, SINGAPORE	Fusion Chamber Orchestra
VickeryTectonic20080621.m4a	Art Gallery of Western Australia	Cloud Chamber Orchestra
Vickerytransitofvenus20090602.m4a	Spectrum Gallery, Perth	Trumpet Trio
Vickerytransitofvenus20090910.m4a	Callaway Auditorium, University of WA	resonator
Vickerytransitofvenus20100223.m4a	WA Academy of Performing Arts, Perth	decibel
Vickerytransitofvenus20120124.wav	Logos, Gent	decibel
VickerytransitofvenusDistintegrationMutation2011.m4a	studio	decibel
VickerytransitofvenusStudio2011.wav	studio	decibel
VickeryWhorl20040424.aif	WA Academy of Performing Arts, Perth	GRIT
Vickerywhorl20071107.m4a	Art Gallery of Western Australia	Cloud Chamber Orchestra
Vickeryzwitschern20050911.aif	Scintilla Divina Festival Jena, Germany	Ensemble Scintilla Divina
VickeryzwitschernLS.m4a	Lasalle College of the Arts, SINGAPORE	Fusion Chamber Orchestra

2. PhD Scores (.pdf format)

Between the Lines (2002). Tenor Sax And Drums (betweenthelinesScPhD.pdf)

Entropology (2002). Violin, Alto Saxophone, Double Bass, Vibraphone and piano (entropologySC.pdf)

éraflage (2007). Flute, Harp, String Quartet, Double Bass And Percussion
(eraflageScPhDSc.pdf)

ExitPoints (2003). Soprano Saxophone, Violin, Viola, Double Bass, Piano
(ExitPointsSc.pdf)

Hey Jazz Fans! (2003). Alto Saxophone and Interactive Electronics
(HeyJazzScPhD.pdf)

interXection (2002). Drums, Microphone and Ring Modulator
(interXectionsc.pdf)

Kreuz des Suedens (2003). Violin And Cello
(kreuzdessc.pdf)

offRamp (2002). Tenor Sax And Drums
(offRampSc.pdf)

Parallel Trajectories (2003). Chamber Orchestra
(parallelScPhDSc.pdf)

particle+wave (2004). Soprano Saxophone, 2 Sundanese Gamelan Instruments (or Three Instruments) and Independently Controlled Click-Tracks
(particle+waveScPhDSc.pdf)

Shifting Planes (2005). Clarinet, Harp, Theorbo And String Quartet
(shiftingplanesJenaScPhd.pdf)

Still-life with Visitations (2002). Chamber Orchestra
(stilllifeScPhd.pdf)

Tectonic (2008). Chamber Orchestra and Electronics
(TectonicScPhDSc.pdf)

whorl (2004). Saxophone, Celeste, Percussion (or Three Instruments) and Independently Controlled Click-Tracks
(whorlScPhDSc.pdf)

zwitschern (2005). Clarinet, Violin And Theorbo and Independently Controlled Click-Tracks
(zwitschernScPhDSc.pdf)

3. PhD Video (.mov format)
Screen-Score Screen Captures

Transit of Venus (2009) Explanation of the Mobile Score
(scoreexplanationTransitofVenus.mov)

Antibody (2010) Explanation of the Mobile Score
(scoreexplanationAntibody.mov)

ghosts of departed quantities (2010) Explanation of the Mobile Score
(scoreexplanationghostsofdeparted.mov)

Improbable Games (2010) Explanation of the Mobile Score
(scoreexplanationImprobableGames.mov)

Night Fragments (2011) Screen capture of Flute Mobile Score
(NightFragments_Fl.mov)

The Talking Board (2011) Explanation of the Mobile Score

(scoreexplanationTheTalkingBoard.mov)

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(2008HopeVicFreedomandStructure.pdf)

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(2005VicWesternElectric.pdf)

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(2004VicProblemofObjectivity.pdf)

Burtt, J., Lavers, K., and Vickery, L. (2004). Representations of recombinant memory in interactive performance works, Proceedings of Qi + Complexity Consciousness reframed Conference, Beijing China
(2004VicRecombinant.pdf)

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(2002VicRobosax.pdf)

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(2001VicTheWesternEdge.pdf)

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(2011VicthescreenedscoreICMC11.pdf)

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(2010VicStockhausenMSA10.pdf)

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(2010VicSomeNLmusicalmodelsECUSS.pdf)

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(2010VicMobileScoresACMC10.pdf)

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(2010HopeVicAestheticsScreenScoreCW10.pdf)

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(2010composerscoreperformercomputerECUSS.pdf)

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(2008VicExploringNewSymbiotica.pdf)

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(2004VicRecombinantCR04.pdf)

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(2004VicNewStructKAM.pdf)

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(2004VicHigherorderACMC04.pdf)

Statement of original authorship

The work contained in this thesis has not been previously submitted to meet requirements for an award at this or any other higher education institution. To the best of my knowledge and belief, the thesis contains no material previously published or written by another person except where due reference is made.

Signature

Date 29 DEC 2011

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1. Introduction

The term nonlinear, literally “not in a straight line”, has come to be applied to a broad range of musical structures that are characterised by incongruities caused through disruption in their apparent linear continuity.[1] In the most prosaic terms, it might be said that music is always linear, it “never exists as a whole at any given moment, but rather unfolds in a linear manner over time” (Hanoch-Roe 2003 p. 146). However, the experience of music, its apparent temporal flow, together with the atemporal analytical consideration of the relationships between its constituent parts, often proves significantly more complex. The notion of a nonlinear model in music, reflects the circumstance that disruptions, such as episodes of interruption, disjunction, fragmentation, or dislocation, may give rise to structures that may appear impossible to frame within a consistent or stable, linear form.

In the literature, the inability of nonlinear models of structure to “privilege any order of reading or interpretation” (Žižek 2000 pp. 37) is ascribed to a range of factors. Kramer minimally characterises nonlinearity in music as the result of the generation of each event independent of all others (1981 p. 554), suggesting that both the degree of disjunction and provenance of musical materials may play a role in the emergence of a nonlinear event. However, structure emerges, in all music, not as a consequence of an individual event, but “through the division of the musical timespan into sections” and “the individuality of these sections is brought about through a balance between change and continuity” (Kuhl and Jensen 2007 p. 266). In this sense, disjunction is necessary for the emergence of structure in both linear and nonlinear works. Therefore, the particular role played by disjunctive ruptures within the context of a work, is key to any definition of nonlinear structure.

Fitzell states that in nonlinear works the “directionality of events defies meaningful expectation” (2004 p. 6). This suggests that the interrelatedness or independence of events, both in relation to each other and in relation to the continuity of the work as a whole, contribute to a sense of nonlinearity: that in nonlinear structures, disjunctions not only function to delineate substructures, as they do in linear works, but also to disturb the temporal flow of the work through their lack of contingency.

[1] Perhaps the most comprehensive examination of nonlinearity in music was made by Jonathan Kramer (see Kramer 1973, 1978, 1981, 1988, 1995 and 1996).

Berio, on the other hand, identifies the absence of expectation as a key quality. While still providing a definition based on the absence of contingency between substructures, he describes the nonlinear work as “an agglomeration of events, without any prearranged center; events which nonetheless find, locally and sometimes surprisingly, their connections, their necessities, and, occasionally, their beauty” (2006 pp. 97-98). Berio’s definition suggests that the number of independent substructures present in a work contributes to a sense of nonlinearity, that the “agglomeration of events” resists reduction or compression into the kind of greatly simplified schematisation found in linear forms.

Thomas Delio proposes a more comparative definition, implying that nonlinearity emerges from the relationship between a particular instantiation of a work and its potential other manifestations. He states that a “structure is open if it presents no single fixed view of reality, but instead reinforces those variable conditions under which each unique consciousness becomes manifest” (1981 p. 359). Similarly, Galia Hanoch-Roe foregrounds the conceptual and atemporal implications of nonlinearity stating that such works are brought into being through listening “just as in a picture or an architectural space. The succession of events is a mere exposition of something that in its nature is simultaneous” (2003 pp. 148-9). Both of these definitions point to the indeterminacy or variability of the ordering of substructures as a key indicator of nonlinear structure.

These definitions of musical nonlinearity raise a number of questions in regard to the formation of a robust understanding of what constitutes nonlinear structure in a musical work. If nonlinearity can be identified at a minimal level in an “independent musical event” as proposed by Kramer:

- what range of circumstances might lead to the emergence of such an event?;
- is it possible to define the degree of disjunction that results?; and
- does the degree of disjunction, by itself, play a role in the emergence of a sense of nonlinearity?

Since disjunction is a key indicator of all forms of music structure, it would appear that the determination of nonlinearity in a structure is a matter of degree, therefore

- what boundaries define nonlinear works upon a continuum between linear forms and the complete absence of form[2]?

These questions will be principally addressed in chapter two of the dissertation through the investigation of four factors as key to the determination of nonlinearity in a musical work:

- integration - the degree to which of musical substructures are discrete;
- contingency - the degree to which substructures in a work imply temporal continuity;
- compressibility – the degree to which it is possible to simplify the structure though schematization; and
- determinacy - the degree to which the structure is repeatable.

Works by Mozart, John Cage and Lejaren Hiller, Earle Brown, Béla Bartók, Olivier Messiaen and Brian Eno are discussed in relation the establishment of the boundaries demarcating both linear and nonlinear structures and nonlinear structures and the absence of form.

Although nonlinear structure has been seriously discussed since the 1950s, no comprehensive taxonomy or categorisation of such works has ever been adopted. A variety of terms, often denoting the same type of structure and often not mutually exclusive, are used in the literature, these include: Block Form[3], Montage[4], Mosaic[5], Mobile[6], Polyvalent[7], Moment Form[8], The Open Work[9], Multilinearity[10],

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2 Examples of formless sound might include, for example, naturally occurring environmental sounds.

3 Henry 1919, Strickland 1991 pp. 124-140, Watkins 1994 p. 255, Taruskin 1996 p. 1452, Cross 1998 p. 21, Beard 2001, Koozin 2002 p. 32, Fitzell 2004 pp. 43-44, Adlington 2006 p. 121, Brackett 2010 p. 59.

4 Andriessen and Schonberger 2006 p. 161.

5 Messiaen 1966, Healey 2008 p. 183, Keym 2008 p. 190.

6 Selz 1966 p. 72, Morgan 1975 p. 9.

7 Coenen 1994 p. 218.

8 Wörner 1973 p. 46, Morgan 1975 p. 8, Kramer 1978 p. 18, Pasler 1982 p. 68, Maconie 1990 p. 63, Cross 1998 pp. 60-63, Albaugh 2004 p. 3.

9 Eco 1989 p. 19.

10 Deleuze and Guattari 1987 p. 296, Landow 1992 pp. 66-67, Aarseth 1997 p. 43, Capper and Wright 2002 p. 575, Tofts 2003, Hawkes, Law and Murphy 2000 p. 16, Bolter 2001 p. 128, Reiser 2002 p.152, Vandendorpe 2009 p. 147 and Hesse-Biber 2010 p. 593.

Spatial Music[11], Multilayered Form[12], Superposition[13], Palimpsest[14], Game Structure[15], Developmental Nonlinearity[16] and Quotation[17]. The range of terminology reflects variations in perspective, ideology and sometimes technique, between theorists, as well as shifts in critical thought over time. Chapter three seeks to classify the possible categories of nonlinear structure and to place the varied terminology within a consistent framework. To this end, interlinked continuums of classification are proposed, accommodating the existing terminology for the evaluation of nonlinear works within three principal perspectives:

- the Temporal Continuum – categorizing works according to the temporal disposition of their constituent structures, upon a continuum bounded by sequential and multilinear structure;
- the Narrative Continuum – categorizing works according to their use of disjunctions in processual, algorithmic and developmental narrative as a means for emphasising disjunction;
- the Referential Continuum– categorizing works according to their use of quotation, adaptation and stylistic Allusion as a means for emphasising disjunction.

Works by Ives, Stravinsky, Schoenberg, Messiaen, Stockhausen, Boulez, Xenakis, Earle Brown, Berio and John Zorn are explored as exemplars of these categories and classified according to this model.

Over the last century, the term nonlinear has been applied to the structure of a broad range of musical works. Arguably the emergence of nonlinearity as a structural technique was a logical consequence of the increasing complexity of formal experimentation during the Modernist era. The frequent application of terms that imply disruption of linearity such as interruption, reordering, disjunction,

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11 Morgan 1976 and 1980, Kramer 1996 p. 76, Salzman 2001 p. 159, LaBelle 2006 p. 192, Iverson 2011.

12 Morgan 1976 p. 153.

13 Healey 2008 p. 178.

14 Derrida (1974), Kristeva (1980), Sarup 1993 p. 33 Genette (1997).

15 Sward 1981 p. 244, Butor and Pousseur 1971, Xenakis 1992 p. 123, Havryliv 2005 p. 24, p. 107, Heile 2006 p. 47, Anderson 2007.

16 Pasler 1982, Kramer 1988 pp. 48-49.

17 Burkholder 2001, Schnittke 2002 p. 87-90.

fragmentation, juxtaposition, permutation, and stratification in discussion of work by composers in the early years of the twentieth century such as Mahler, Ives Debussy and Stravinsky are indicators of the increasing prevalence of a nonlinear aesthetic.[18]

Composers work within the context of the ideologies and frameworks that bind societies. The last hundred years saw challenges to existing linear notions of stability, and the grand narrative of progress. This period of rapid change and evolution of cultural, ideological, scientific, technological and aesthetic understandings greatly opened the field of nonlinear possibilities available to the composer.

Chapter four provides an overview of the development of compositional techniques employed by composers in the creation of nonlinear works. A number of the critical cultural, ideological, scientific and technological shifts are considered. The discussion encompasses the work of a diverse range of composer including: Ives, Busoni, Russolo, Schoenberg, Webern, Cowell, Varésè, Messiaen, Cage, Stockhausen, Ligeti and Xenakis, Tenney, Rosenboom, Grisey, Murail, Rissett, Lachenmann, Berio, Aaron Cassidy, Schaeffer, Denis Smalley, John Oswald, Richard David James and Yasunao Tone. It charts the emergence of "mobility" in the musical score and indeterminacy of notation in works by Cage, Earle Brown, Feldman, Boulez, Cornelius Cardew and Haubenstock-Ramati. Technological solutions such as the "screen-score", computer interactivity computer coordination of live performers are discussed, in relation to the works of Kagel, Emmanuel Ghent, Gerhard Winkler, Jason Freeman, David Kim-Boyle, Marek Chołoniewski, George Lewis, Lawrence Casserley and Evan Parker, William Hsu and John Butler. The implications of these developments for the investigation of new models of nonlinear structure are also considered.

Chapter five explores the possibility of the spectrogram as a tool for the analysis of nonlinear Structure. Structure is principally identifiable through the presence of

[18] Examples include: "Extended" Sonata Forms (See Newlin (1947), Rosen (1988), Hepokoski (1993), (2001) and (2002), Darcy (1997) and Schmidt-Beste (2011)); Ives pluralistic use of polystylism (Cowell (1969), Whitesell (1994), Cooney (1996), Thurmaier 2006); Debussy's exploration of permutative fragmentation in *Jeux* (1913) (See Kramer (1978) p. 189, Meyer (1989) p. 304, Pasler (1982) p. 64; and Stravinsky's development of independent rhythmic cells, polyrhythmic ostinati and nondevelopmental "blocks" (See Boulez, P. (1991) pp. 55-110, Taruskin (1996) pp. 1486-1497 and Code (2007)).

parametrical disjunction between substructures that comprise relative parametrical continuity. The spectrogram allows the visual identification of changes in pitch, duration, amplitude and timbre over time and therefore is potentially capable of detecting discontinuities between substructures based upon these parameters, potentially providing an opportunity to examine the degree of integration, compressibility and contingency in a work. Through inspection of multiple spectrograms of the same work it is also possible to examine the degree to which the structure of a work is variable and indeterminate. In order to explore these possibilities, works by Stravinsky, Pierre Schaeffer, James Tenney and Stockhausen are analysed employing this method.

The Spectrograms in this dissertation were created using Chris Cannam's *Sonic Visualiser* software distributed by Queen Mary, University of London (Cannam et al 2010). In order to maximise the key parameters of pitch, duration, amplitude and timbre, a Y Axis (frequency) resolution of 0 Hz to 3520Hz and an X axis (duration) of roughly 1 second per millimeter are employed unless otherwise noted. Spectrograms exceeding 24.61 cm (equivalent to works exceeding four minutes and 6.1 seconds) are proportionally reduced to fit vertically on the A4 page. In cases where several recordings of the same work are compared found in chapter six, the frequency resolution may be altered to allow a number of spectrograms to be displayed on the same page. In such cases the same temporal resolution is used for each spectrogram, so that they are proportional in length to the durations of the works analysed.

The following parameters were used in the generation of the spectrograms: maximum Bin size of 32768 (giving the finest resolution in frequency), the maximum Window Overlap of 93.75% (to compensate for the reduced time resolution of the large window size), and the Normalize Visible Area function (allotting the brightest available colour to the frequency bin with the highest value within the visible region of the spectrogram). These values were judged to provide a resolution that resulted in the best compromise between pitch, timbre and amplitude resolution versus time, for the purposes of evaluating substructural discontinuities. The images were exported from the software's spectrogram layer to Portable Network Graphics (.png) file, using the default green-yellow-red colour spectrum setting: where green indicates frequencies with low energy and red indicates frequencies with high energy.

The final chapter is an exegesis, charting the development of my own explorations into the formal possibilities of Block-Form, Collage, Permutation, Multilinear, Polytemporal, Polystructural and Erasive nonlinear models. The relationship and connection between current work and earlier compositional concerns is addressed showing the development upon the implications of previous work, as well as new nonlinear models in more explicit and focused terms. The creative folio comprises 29 works encompassing a range of forces, both in size and diversity, from solo to chamber orchestra. The creative folio exhibits a gradually evolving means of coordinating nonlinear performance through the mobile score, guided improvisation, the click-track, the real-time score and coordinated processing of live audio that resulted in the development of a computer coordinated performance model. The categories of nonlinear formal model defined in chapter three are applied to the works in the creative folio, allowing for the classification and assessment of the developments made in their course of its composition.

In this dissertation, structure is discussed principally from the standpoint of standard musical analysis, namely the description of manipulation of musical parameters to give rise to structure. Other lines of enquiry, including philosophical[19] or psychological[20] frameworks, afford important avenues for further investigation of nonlinearity in music, but are only broadly examined.

In consideration of the centrality of structure to this discussion, several terms are defined specifically, namely: structure, model and form.

Structure is defined as an overarching term, reflecting the understanding that any sounding music (as opposed to conceptual or non-cochlear[21] forms of music) inherently comprises sonic events that have structural implications. Structure is considered here as a continuum comprising three subdivisions: linear structures

[19] Both Fitzell (2004) and Kramer (1988) develop a concept of nonlinearity through a discussion of phenomenology, in particular Edmund Husserl's *The Phenomenology of Internal Time-Consciousness* (1964 [1928]).

[20] Arthur Bregman's Auditory Scene Analysis (1990) and the work that has followed it, provide tools for evaluating nonlinearity in psychological terms. Recent developments in neuroscience even suggest the existence of a "structure tracking" region of the brain (Levitin and Vinod 2005 p. 571).

[21] See Kim-Cohen 2009.

encompassing all linear models and forms, nonlinear structures encompassing all nonlinear models and forms and finally structures that exhibit a complete absence of form due to lack of integration, compressibility, contingency and determinacy.

The term model refers in this text to a construct informed by ideological and technical considerations. For example, a developmental model of structure draws on ideological assumptions that accept that thematic materials may be modulated and varied without dissipating their identity and compositional techniques that allow for these modifications. A nonlinear permutational model, on the other hand, assumes that the identity of a work is not dissipated by the rearrangement of its internal substructures.

Models, in this definition, give rise to formal structures, the most specific of the three terms, that may define a particular class derived from a structural model, for example a developmental model gives rise to sonata form, and also a specific instance of this form, for example the first movement of Mozart's *Piano Sonata No. 16* K. 54. This is an important distinction in the case of nonlinear works, as while sonata form might be attributed analytically to the first movement of Mozart's *Piano Sonata No. 16* in the abstract, that is from the score, with the assumption that it will retain this precise form in all cases, a work conceived according to a permutational model, for example Stockhausen's *Klavierstuck XI* can only be described in a general way in the abstract, that is, as a model because its actual form is variable, indeterminate. It can only be described with precision formally in specific instances of individual performances. The hierarchical relationship between the terminologies for musical structure used in this dissertation is illustrated in figure 1.

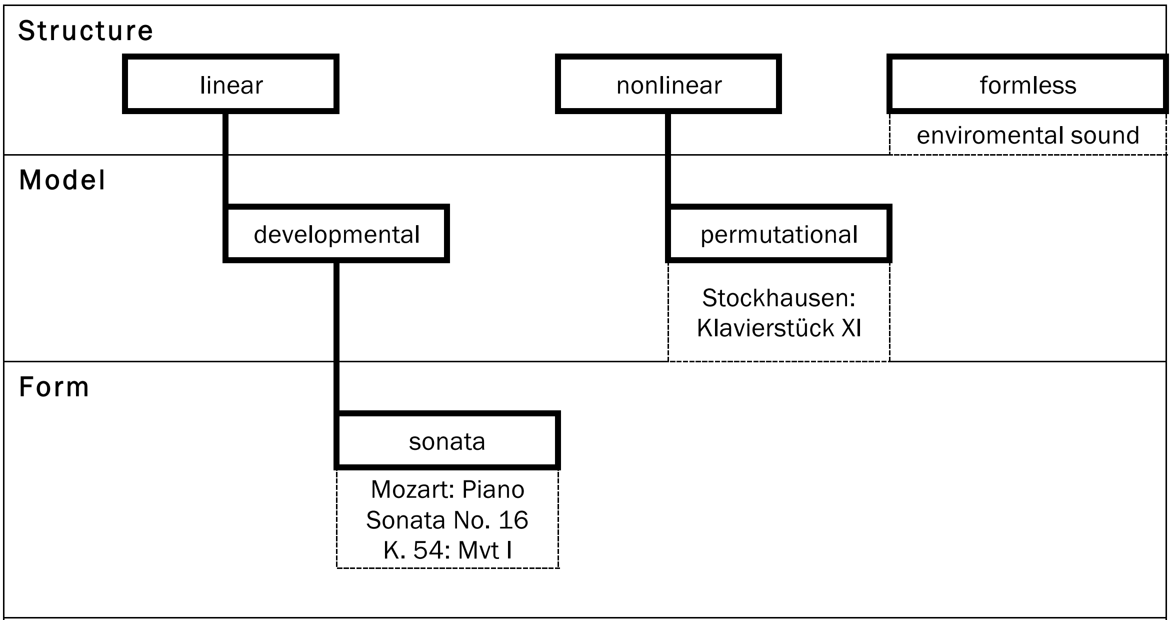

Figure 1. The hierarchical relationship between the terminologies for musical structure used in this dissertation.

The musical works discussed in this dissertation are delimited in order to provide examples that may be evaluated and interpreted structurally. The examples discussed are limited to works that are:

- composed, to the degree that the contents of their performance is at least minimally prescribed, as opposed to freely improvised;
- coordinated and/or defined through notated traditional, graphic, textual score and/or audio cues;
- intended to be performed by instruments, voices and/or electronics;
- of a fixed or variable duration, but intended for performance in a concert format as opposed to an open-ended format such as installation and sound art.

Over fifty works (excluding the author's own) are cited in the dissertation in relation to nonlinear structure. Charles Ives *The Unanswered Question* (1908) is the earliest of only nine works from the first half of the 20th Century; the remaining examples are drawn relatively evenly from the 1950s until the present. The works discussed are listed in Table 1 below. Those highlighted in bold are discussed in greater detail. The rationale for inclusion of these works principally emphasises primary examples of novel nonlinear models and techniques, and secondarily their significant successors.

1908	***Ives: The Unanswered Question***
1912	**Ives: *Putnam's Camp***
1913	Debussy: *Jeux*
1920	**Stravinsky: *Symphonies of Wind Instruments***
1927	**Bartók: *Az éjszaka zenéje***
1942	Cage: *Credo in US*
1944	**Messiaen: *Regard de l'Onction Terrible***
1946	**Schoenberg: *String Trio Op. 45***
1948	**Schaeffer: *Étude aux Chemins de Fer***
1951	Cage*: Imaginary Landscape No. 4*
1952	**Brown: *December 1952***/Cage: *Imaginary Landscape No. 5*
1953	Feldman: *Intermission 6*
1954	Earle Brown: Folio and Four Systems
1956	**Stockhausen: *Klavierstück XI***
1957	John Cage: *Winter Music*
1959	**Xenakis: *Duel***/Stockhausen: *Refrain/* Messiaen: *Cantéyodjayâ*
1960	Foss: *Time Cycle/*Stockhausen*: Kontakte/*Pousseur: *Repons*
1961	**Stockhausen: *Klavierstück IX/*Tenney: *Collage #1 "Blue Suede"***
1962	*Xenakis: Strategie*
1963	Boulez: *Third Sonata/***Kagel: *Prima Vista***
1964	*Stockhausen: Mixtur*/Kagel: *Match*
1967	***Brown: Event-Synergy II***
1969	**Berio: sinfonia**/Stockhausen: *Momente*/Birtwistle: *Verses for Ensembles*
1974	*Zorn: Klarina*
1976	Cage: *Apartment House 1776*
1977	Rasmussen: *Berio-Mask: A Palimpsest*
1979	Xenakis: *Palimpsest*
1983	Birtwistle: *The Mask of Orpheus*
1984	Zorn: *Cobra*
1987	**Lewis: *Voyager***
1991	Winkler: *Hybrid I*
1992	**John Zorn: *Speedfreaks***
1993	Takemitsu: *Archipelago S.*
1994	**John Oswald: *Z*** /Sciarrino: *Sonata V/Adams: John*'s *Book of Alleged Dances*
1997	**Tone: *Solo for Wounded CD***
1998	Benjamin: *Palimpsest I*
2001	**Winkler: Hybrid II/Chołoniewski: Passage/ Richard David James (Aphex Twin): *Gwarek2***
2004	**Freeman: *Glimmer***
2006	**David Kim-Boyle: *tunings***

Table 1: **Works cited in the dissertation. Examples in bold are discussed in greater detail.**

Throughout their progress, both the theoretical and creative work have been subject to academic and public evaluation and critique. This has included twenty conference presentations and journal articles and over a hundred public performances of the creative works, which are documented on the accompanying DVD. The most successful performances are collected on four compact disks.

2. Nonlinear Musical Organisation

The first part of this discussion seeks to identify the circumstances that determine or contribute to the functioning of a musical structure in a nonlinear manner. The notion of form in music is dependent upon hierarchical strategies for representing musical structure that involve the reduction of larger spans of musical time into schematically represented substructures. It follows that this strategy can potentially generate schema that can be evaluated upon a continuum from simple to complex structure. At the point of greatest simplicity, musical substructures are reduced to a schema that captures a small necessary number of formal divisions. At the point of greatest complexity, a schema approaches a Borgesian level of absurdity, where the representation of musical substructure is irreducible - a so-called "one-to-one" map of the world.[22] Music, at the point of greatest complexity can be considered formless. It is argued here that nonlinear structures fall between these two poles and may be identified by four factors that determine or contribute to their distinction both from linear structures and from formless structures.

The second part of this discussion explores application of these four factors in the evaluation of works that, it is argued, exemplify nonlinear structure and examples at the boundary between linear and nonlinear structure and nonlinear structure and formlessness.

2.1. Factors in the Evaluation of Nonlinear Structure

Nonlinear structures may be distinguished from linear structures by the presence of strong discontinuity between their internal substructures. This implies that such substructures are discrete rather than integrated with one another. Discrete substructures are characterised both by the internal contrast and independence of their constituent musical materials from prior and succeeding substructures, and the strength of the disjunctive boundaries severing them from prior and succeeding substructures. The degree to which substructures in a work are discrete or lacking in integration is the first factor in identifying nonlinearity in a musical structure.

[22] A map "that was the same scale as the empire, and coincided with it point to point" (Borges 1975 p. 131).

The emergence of substructures from the fabric of musical discourse derives, in all music, from shifts in the level of continuity from one moment to the next. These shifts are marked by perceptible changes, discontinuities, between “form-bearing” musical parameters.[23] In order for such a shift to imply a boundary between two substructures, the discontinuity must be significant in relation to the preceding substructure, and both the preceding and succeeding substructures must evidence relatively strong internal cohesion.[24]

The use of disjunction to mark structural divisions is a common practice in musical composition. In sonata form, for example, continuity is often broken by disjunctions such as a quickening of harmonic rhythm, a cadence in a new key, and a short silence, to mark the boundary between substructures. However, a high level of homogeneity and contingency between the substructures is usually maintained through relative continuity in other parameters such as meter, tempo and the proximity of the modulation. Figure 2 illustrates this process.

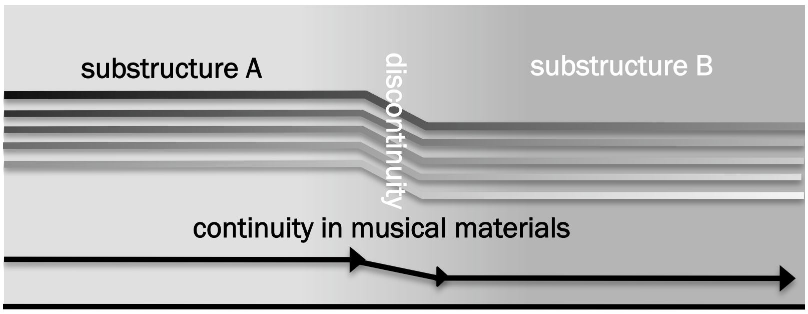

Figure 2: The emergence of substructures through weakening of the continuity of musical materials in a linear work.

When the degree of discontinuity between two substructures is raised to a critical degree, the impression of homogeneity and stability, the sense of temporal flow between the two musical substructures, breaks down. Borrowing a term from music

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23 McAdams proposes the parameters “timbral brightness, pitch, duration, dynamics and spatial location” as possessing form-bearing capacities (McAdams 1989 p. 195). The potential for referential and/or narrative musical materials to bear form will be discussed below.

24 “Musical form is constituted through the division of the musical timespan into sections of a certain size; that the individuality of these sections is brought about through a balance between change and continuity; and that this play of variation inside a frame of overall unity is grounded on the tendency of the human mind to create coherence in event structure” (Kuhl and Jensen 2007 p. 266) also see Snyder (2000) p. 194.

perception, several critics have called this an absence of "belongingness"[25]: the two substructures cannot be reconciled as belonging to an unfolding continuity. Figure 3 illustrates this process.

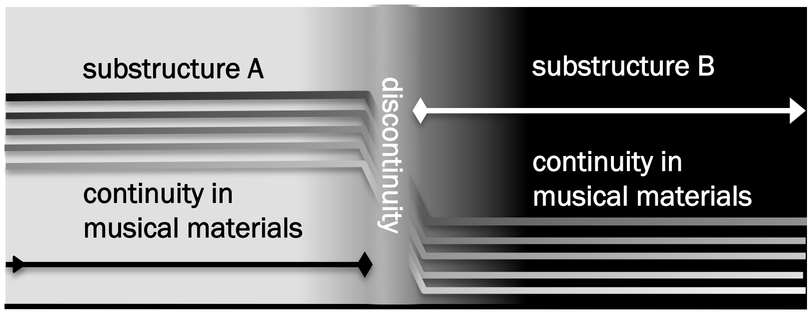

Figure 3: The emergence of substructures through weakening of the continuity of musical materials in a nonlinear work.

In a nonlinear event, disjunction between substructures reaches a critical point and continuity cannot be maintained across the rupture. Pierre Boulez described this process as "anesthetizing the frontiers" between musical substructures, leading to a situation in which "listening time is no longer directional but time-bubbles, as it were" (Boulez 1986 p. 178). The nonlinear event is the minimal phenomenon indicating nonlinearity. It is a necessary characteristic of nonlinear structures.

Substructures that "anesthetize the frontiers" between musical substructures can, however, be found in linear works: the dramatic ruptures in the musical fabric of the final movement of Beethoven's Ninth symphony are an example. The emergence of nonlinear formal structure also depends on the evaluation of the degree of contingency between its substructures, the cumulative effect of how much they "follow on" from one another and the degree to which they are contextualised by other substructures, in addition to external understandings and expectations.

Consider the following example, a structure comprised of five substructures, each parametrical divergent. The parametrical divergences allow for an ordering of the substructures in such a way that the parametrical shifts are made consistently in the same direction, for example: gradually louder, faster and higher in register. A consecutive ordering might suggest that the relationships between the

[25] See Fitzell (2004) p. 25 and Lalitte et al. (2004). The concept of "belongingness" from Bregman (1990) pp. 196–203, further elaborated in Handel (1993) pp. 377–381.

substructures are linear: that each new substructure is the consequence of the previous one. If the same five substructures are rearranged in order to minimise the continuity between them, the contingency between substructures is reduced creating a nonlinear structure. This arrangement is illustrated in figure 4.

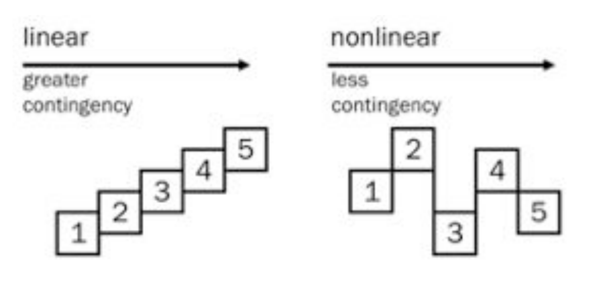

Figure 4. The effect of reordering of subsections that are parametrically consecutive.

This suggests that the factor of contingency in a structure is somewhat independent of the degree of discreteness of the substructures themselves, although substructures that exhibit greater disjunction arguably weaken contingency in consecutively ordered substructures and increase the lack of contingency in a non-consecutive ordering.

The number and duration of discrete, non-contingent substructures also impacts the degree of contingency. In the simplest forms, there are a relatively small number of discrete substructures. Sectional forms such as binary, ternary and rondo, are all generally considered linear structures, as a consequence of the contingency provided by a small number of substructures that are contextualised as departures away from and then returns to, an opening, predominant substructure which may also be longer in duration or repeated more frequently (in rondo form for example).

In contrast, nonlinear structures may exhibit weakening of contingency through lack of dominance, through number of occurrences, and proportion of duration, of one subsection over the others. The degree of contingency in a musical structure is the second key factor to the evaluation of nonlinearity.

In larger and more complex linear works the ordering of, and relations between, substructures may still be compressed into simple schema by grouping or nesting them into higher (and longer) substructural layers. This class of linear structures includes developmental forms such as sonata form. In such works a minimum of contingency between the musical materials of the substructures allows them to be evaluated as belonging to an overarching continuity.

As the number and heterogeneity of substructures increases, the ability to place them into an overarching unified structure or to group them into less complex layers decreases. In nonlinear works the degree to which the subsections can be reduced to simpler schematic formulae is diminished in comparison to linear sectional and developmental forms. This issue can be termed “compressibility”.

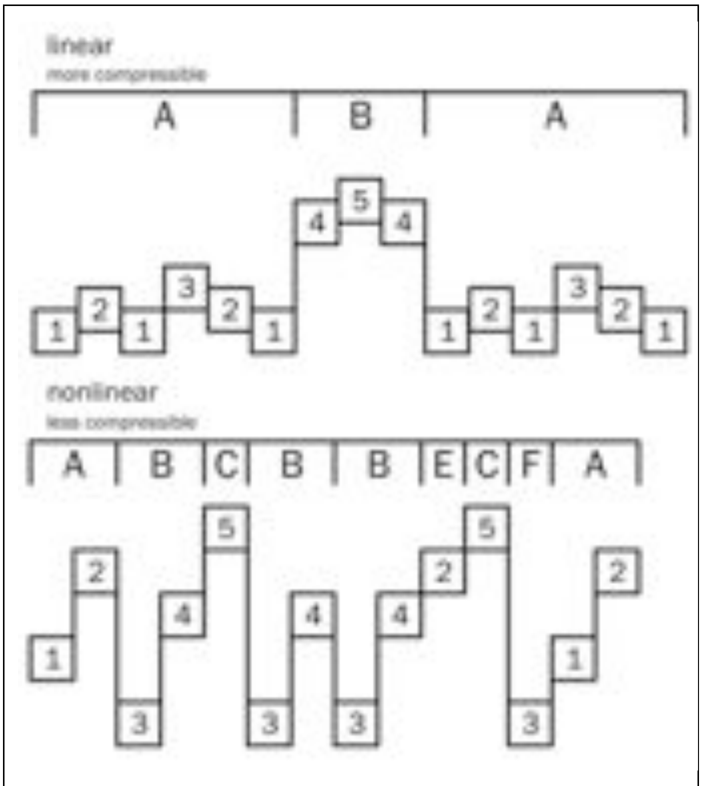

Figure 5. The effect of grouping upon the factor of compressibility.

Figure five illustrates the importance of the issue of compressibility, schematising two structures with the same number (13) and variety (5) of discrete subsections. In the first example, the ordering of subsections allows for grouping into only three principal formal blocks. In the second ordering the thirteen subsections can only be grouped into nine principal formal blocks. Compressibility is the third factor necessary for the evaluation of nonlinear structure.

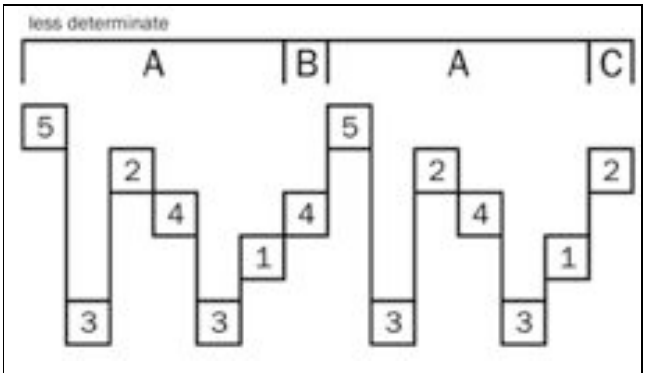

Figure 6. The effect of indeterminacy of ordering upon structure.

In a subset of nonlinear structures, so-called mobile or open models, substructures may be reordered in each instantiation of the work. In such examples, the potential for multiple orderings is a factor in reducing the importance of compressibility, as a formal schema applied to one particular version of the work cannot hold for all possible cases. Figure 6 illustrates how a reordering of the example in Figure 5 can result in an entirely different grouping of the same subsections. Indeterminacy of formal structure is a quality of all mobile works.

The issues discussed above suggest that nonlinear structures can be evaluated by

- a high degree of non-contingency and discreteness in comparison to linear works;
- an intermediate degree of compressibility: less compressible than linear works, but not entirely formlessly incompressible;
- (in the case of mobile works) the degree of indeterminacy of their substructural ordering.

The situation of nonlinear formal structures upon a continuum of formal complexity may be evaluated against three factors: the degree of integration, contingency and compressibility, and in the case of mobile structures an additional factor of determinacy, as illustrated in figure 7.

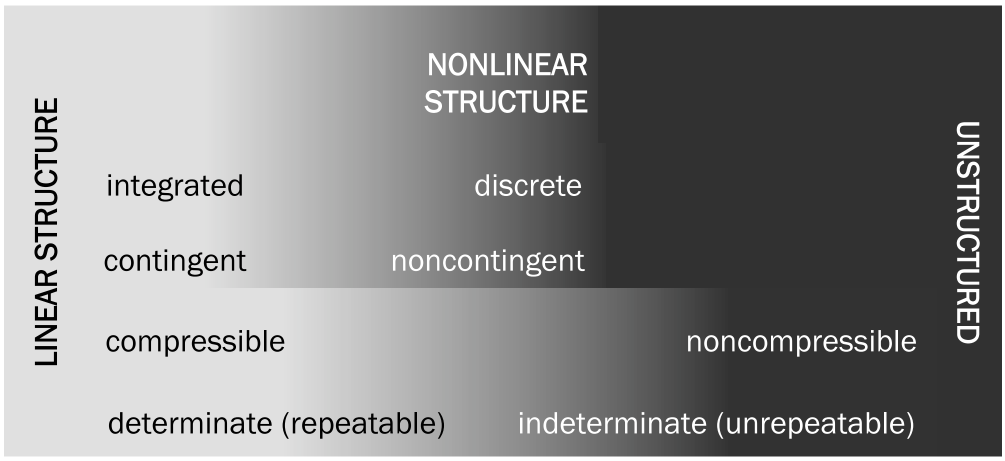

Figure 7: Factors for the evaluation of nonlinear formal structure

The positioning of nonlinear structure upon a continuum of formal complexity, presumes the presence of a boundary along the continuum at which linearity gives way to nonlinearity, and a boundary at which structure itself gives way to formlessness. The following section explores several examples of such boundary works.

2.2. Defining the Boundaries of Nonlinear Structure

Earle Brown's (1926-2002) work *Event-Synergy II* (1967)[26] is not the earliest example of mobile form, but provides a relatively simple and clear example of a nonlinear structure as defined in this dissertation. In this work, 19 performers are divided into two ensembles (designated A and B) each with an independent conductor. The instrumentation of the work is shown in figure 8. The conductors, via hand signals, indicate to the performers which of four "events" they are to play. The conductors spontaneously determine the order and duration of the events and indeed the duration of the work as a whole, during the performance. They may also freely cue other indications such as tempo, dynamic and fermata.

A	Flute	Oboe	Cor Anglais	Bb Clarinet	Bass Clarinet	Bassoon	String Quartet
B	Flute	Oboe	Eb Clarinet	Bb Clarinet		Bassoon	String Quartet

Figure 8. The orchestration of Group A and B in Earle Brown's *Event Synergy II* (1967).

Figure 9 shows excerpts of the score from each of the four events, as well as the seating arrangement for the ensemble. Event 1 and Event 3 (examples a. and b. respectively) are further divisible: Event 1 into five sections and Event 3 into four subsections. These subsections are performable in any number or order.

[26] A performance of this work on the 26th of March 2009 by students of the Western Australian Academy of Performing Arts with Anthony Pateras and myself conducting is included in the support materials DVD.

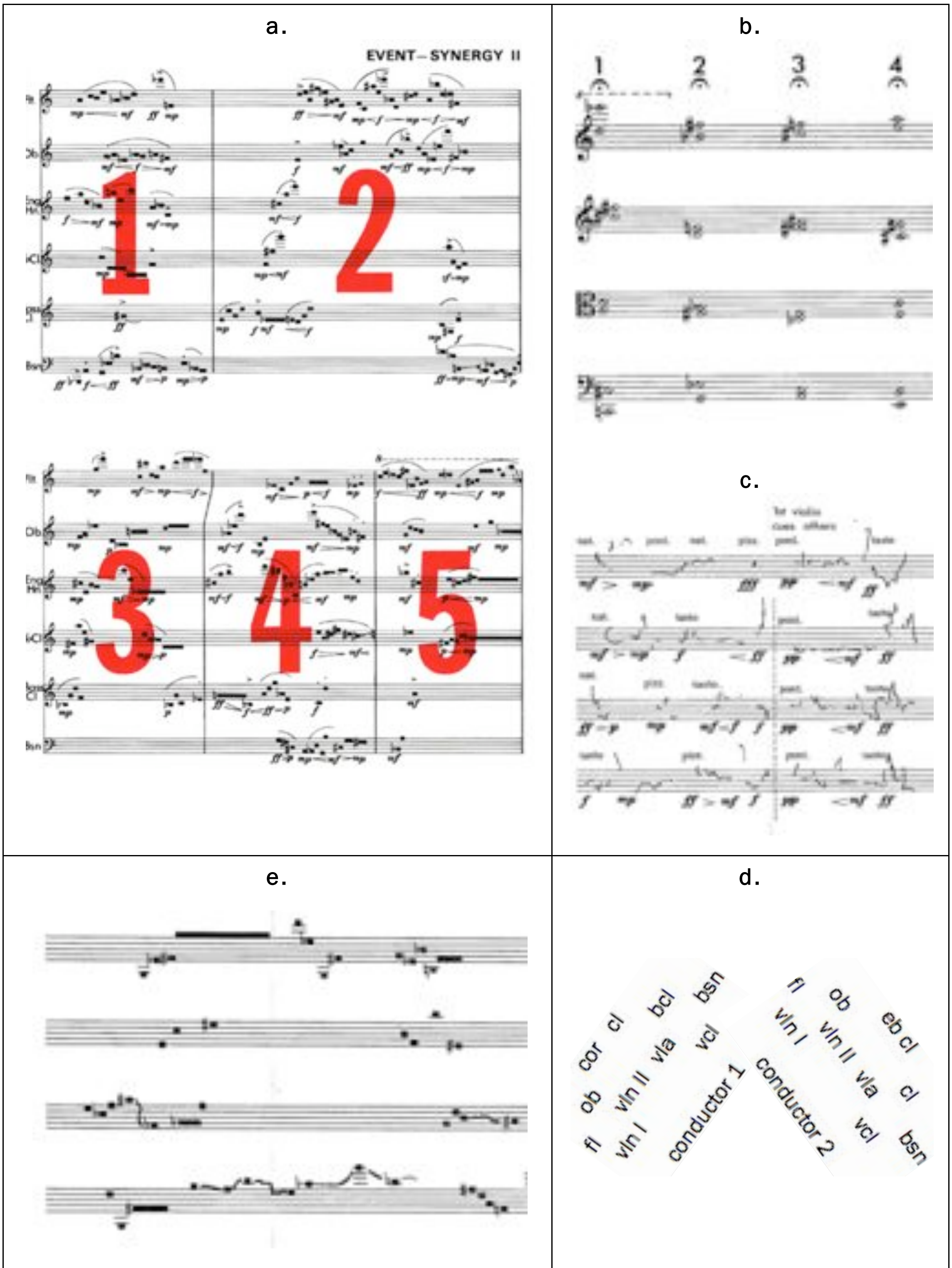

Figure 9: Score Excerpts from Earle Brown: *Event – Synergy II* (1967). Event A1 (Winds), b.) Event B3 (Strings), c.) Event B2 (Strings) d.) Seating Arrangements for the Ensembles A and B and e.) Event B4 (Strings) (Score excerpts © 1967 Universal Edition)

The musical material in each of the four events is distinct. The parametrical variety of the events is summarised in Table 2. In addition to the parameters listed, the conductors are afforded significant flexibility not only in deciding the order and tempo of the events, but also to ““over-ride” the indicated dynamic values and raise or lower the over-all loudness” (Brown 1962).

Event	Texture	Dynamic	Articulation	Orchest-ration	Pulse	Clef
1	Contrapuntal	rapid changes (*p*-*f*)	Legato with some accents and staccatos	Fixed	Yes	Yes
2	Extended techniques	rapid changes (*pp*-*ff*)	Glissandi and other graphical indications	Free	No	No
3	Chords	none	none	Fixed	No	Yes
4	Solo	none	Some glissandi, accents and staccatos	Free	No	No

Table 2: The parametrical variety in Events 1, 2, 3 and 4 of Earle Brown’s *Event Synergy II* (1967).

The spatial disposition of the ensembles provides a further distinction between the materials performed by each group. The discrete nature of the four events ensures disjunction between materials in any particular iteration of the work. The level of both integration and contingency in the work is therefore low.

Event-Synergy is an “open” work, in the sense that the final structure of any performance is primarily dependent upon the decisions taken by the conductors. The possible number of instantiations of the work, considering that it does not have a fixed duration, is extremely large within the boundaries set by the composer, namely the materials, the performers and the number of conductors. Because of the indeterminacy of structure it is only possible to schematically represent the work’s structural model in a notional realization of the work. Such a schematization is illustrated in Figure 10.

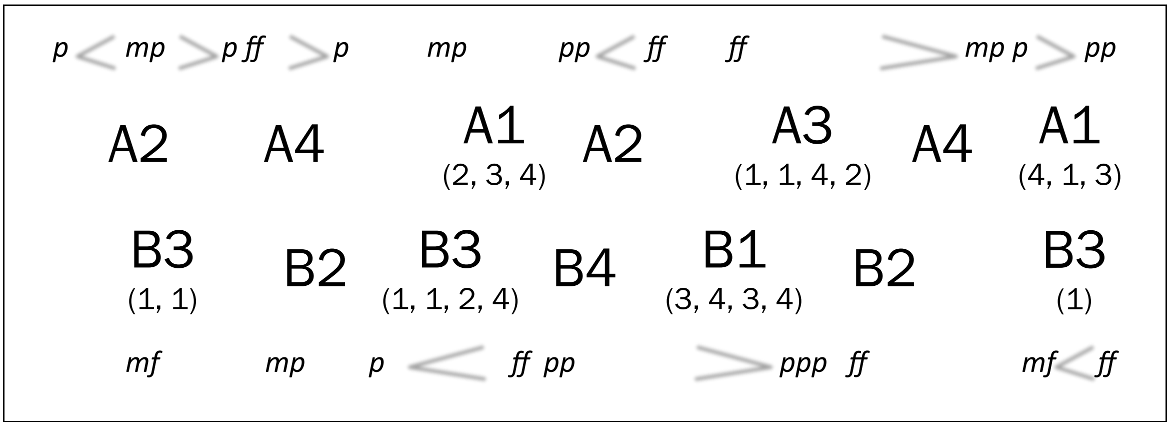

Figure 10: A schematic representation a notional realisation of the structural model of Earle Brown: *Event – Synergy II* (1967).

Event – Synergy II conforms to the definition of a nonlinear structure proposed in the previous section, through the discrete nature of its substructures, and the discontinuity between them. The structural model entails indeterminate ordering of its substructural components in performance, however given the prescribed nature of the materials, orchestration and the rule set governing the work, the compressibility and determinacy of *Event-Synergy* might be regarded as moderate in comparison to utter lack of structure.

2.2.1.The Structured/Unstructured Boundary

The example of *Event-Synergy* draws attention to the outer boundary of the continuum of formal complexity – between structured and unstructured nonlinearity. In defining this boundary, composer Brian Eno's (1948-) experience of listening to a recording of chance environmental events that were arbitrarily captured on tape, is pertinent. Although something of a "thought experiment" given that this "work" has never been publically available, it focuses on the role of determinacy in evaluating nonlinearity.

According to Eno,

> I recorded whatever sounds there happened to be: cars going by, dogs, people, (cut it down to three and a half minutes and then) kept running it over and over. I tried to learn it, exactly as one would a piece of music: oh yeah, that car, accelerates the engine, the revs in the engine go up and then that dog barks, and then you hear that pigeon off to the side there. This was an extremely interesting thing to do, first of all because I found you can learn it. Something that is completely arbitrary and disconnected as that, with sufficient listenings, becomes highly connected. (Toop, 1995 p. 129)

The structure described by Eno presumably comprises discrete, noncontingent, and only marginally compressible substructures, three of the identified distinguishing features of a nonlinear structure. However, as a recording, the capability to repeat the structure very precisely determinacy is maximised. The sounds alone might be considered unstructured, but the high degree of determinacy of the recording of the sounds draws it within the boundary of structure rather than formlessness.

This example emphasizes the important role that technology has played in the issue of nonlinearity: before the advent of recording this technique for capturing a segment of unstructured sound was impossible. It is also something of a perverse example, in that the obsessive listening strategy needed to render “completely arbitrary and disconnected” sonic events as “highly connected” is not a normative behaviour. The issue is pertinent as repetition is the only link such a work retains with the notion of structure. Increasing familiarity with the sonic materials promotes the formation of connection and contingency between the discrete events.

Theorist Holger Shulze comments on Eno’s observations:

> we simply cannot bear to be surrounded by anything that is literally meaningless and generated by chance. We forget its aleatoric genesis and find ourselves involved in a mental game, a heuristic fiction.
>
> (Schulze 2003 p. 63)

2.2.2.The Linear/Nonlinear Boundary

The boundary between linear and nonlinear structure is perhaps best explored through the comparison of two works from opposing sides of this “border”. Béla Bartók’s *Az éjszaka zenéje* (The Night’s Music) from the *Szabadban* (Out of Doors 1926) and Olivier Messiaen’s *Regard de l’Onction Terrible* (Contemplation of the Awesome Anointing) from *Vingt regards sur l’Enfant-Jésus* (Twenty Contemplations of the Christ Child 1944) are piano works, of similar length, that share an “arch” (ABCBA) formal structure.[27] Despite the external formal similarities between the works, the composers’ approach to the musical materials comprising their subsections is markedly varied.

The Night’s Music, Bartók’s first excursion into what would become one of his signature musical styles (Curcio 2009 p. 64), can be divided formally into five sections: the outer two eponymous exemplars of nocturnal “nature sounds and noises”, the second and fourth usually referred to as a “Chorale” or “song of

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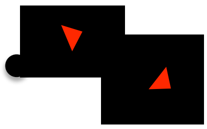
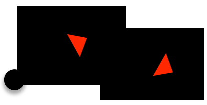
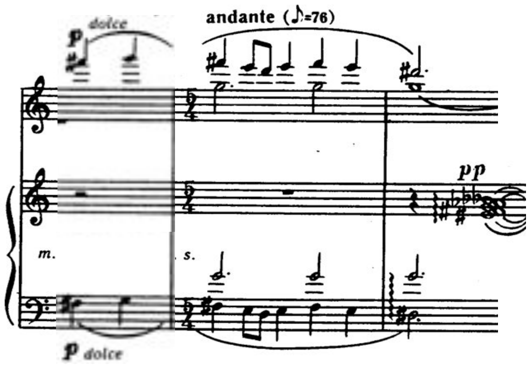
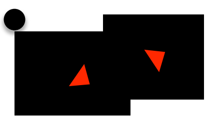
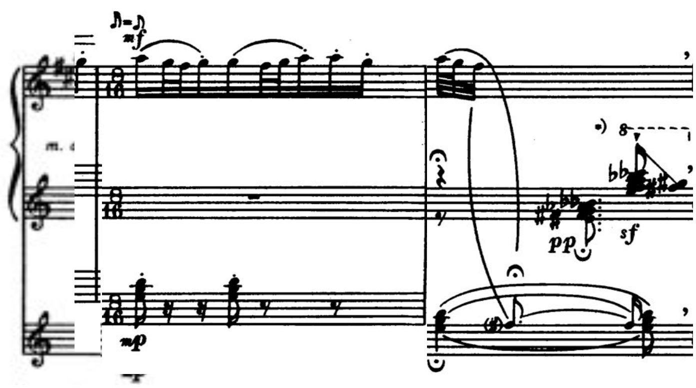
[27] See discussion of *The Night’s Music* as “a preliminary study of (Bartók’s) five-part 'arch form'” in Gillies 1994 p. 178 and Messiaen’s exploration of non-retrogradable form in Healey 2008 p. 168-172.

loneliness" and a central section featuring a synthetic "peasant flute" melody.[28] The opening phrase of each section is given in Table 3. Although no attempt here is made at a thorough analysis, it is clear even from the fragments presented in the Table that there are relationships between the five sections – if only in the complimentary exploration intervallic shapes at the head of each melody: eschappé, mordent and cambiate.

SECTION A bars 1-17 "nature sounds and noises"  Eschappé	
SECTION B Bar 18-37 "Chorale", "song of loneliness"  Mordent	
SECTION C bars 38-48 "peasant flute"  Cambiate	

[28] These descriptors are used by Somfai (1984 p. 5) and Tallián (1981 p. 144).

SECTION B bars 49-60 “Chorale”, “song of loneliness”	
SECTION A bars 61-65 “nature sounds and noises”	

Table 3. The Arch Form structure of Béla Bartók’s *Az éjszaka zenéje* (The Night’s Music) from *Szabadban* (Out of Doors 1926) (Score excerpts © 1927 Boosey and Hawkes).

Somfai, who does provide a thorough analysis of *The Night’s Music* in his article “Analytical Notes on Bartók's Piano Year of 1926” (1984), comes to the following conclusion, regarding the growth of the work from the seeds of the “hidden melody” (the central stave of section A in Table 3).

> One should mention as an almost reflex presence of the organic thinking in Bartók's composition that the hidden melody of the ostinato foreshadows quite clearly the polymodal chromatic line of the third and fourth phrases of the Chorale melody. (Somfai 1984 p. 10)

Messiaen in contrast, builds *Regard de l’Onction Terrible* with sections that are entirely distinct and discrete. Healey describes Messiaen’s approach as derived from his exploration of non-retrogradable rhythms – rhythmic palindromes that remain identical when reversed.

> The movements in non-retrogradable form demonstrate Messiaen’s application to the structural domain of a technique designed for small-scale use. (…) The eighteenth of the Vingt Regards is a perfect example of the symmetry produced by this form. (Healey 2008 p. 172)

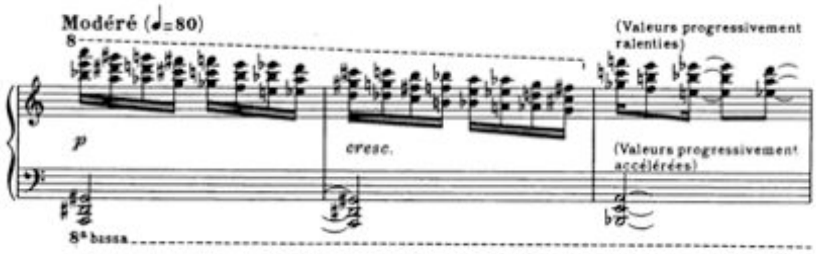
Non-retrogradable rhythms create peculiarly discrete structures. To paraphrase T. S. Elliot, their “end is in their beginning” and this means their identity is bound to their symmetry and must always terminate in a boundary beyond which they cannot pass. Figure 11 shows three measures from Olivier Messiaen’s *Quartet for the End of Time* displaying non-retrogradable rhythms.

[redacted]

Figure 11: Non-retrogradable rhythms from Olivier Messiaen's *Quartet for the End of Time* (1941). Palindromic durational sets establish their own boundaries through symmetry, because of the finality of the conclusion of the mirrored set of durations. (Score excerpts © 1942 Durand).

Healey identifies palindromic formal structures in a number of Messiaen's works including movements of the *Visions de l'Amen* (1943) and *Vingt regards sur l'Enfant-Jésus* (1944) (2008 p. 168).

The three sections vary in the range of pitch classes that they employ and their registral compass. The first and fifth sections are fully chromatic and cover seven octaves from A^0 to A^7. They consist entirely of 016 trichords that chromatically traverse a range of two and a half-octaves. These superimposed chromatic scales employ "chromatic durations"[29] - one descending with durations of increasing length, and the other ascending with durations of decreasing length. The two scales are retrogrades of one another (transposed by a tritone) and the fifth section is also a retrograde of first. The three parametrically divergent substructures that give rise to the arch form structure of *Regard de l'Onction Terrible* are shown in Table 4.

SECTION A "chromatic durations" bars 1-23	

[29] For an account of Messiaen's development of the "chromatic durations" technique see Sholl (2008) p. 73.

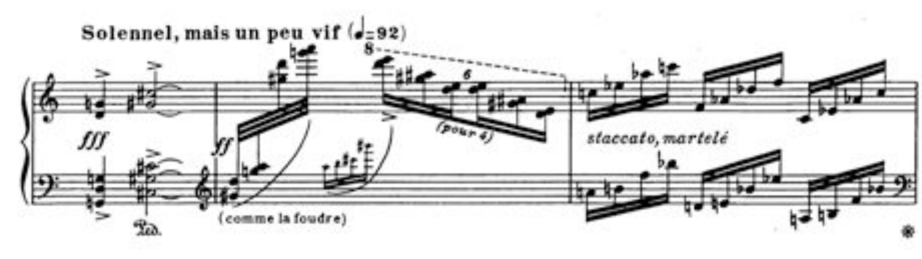
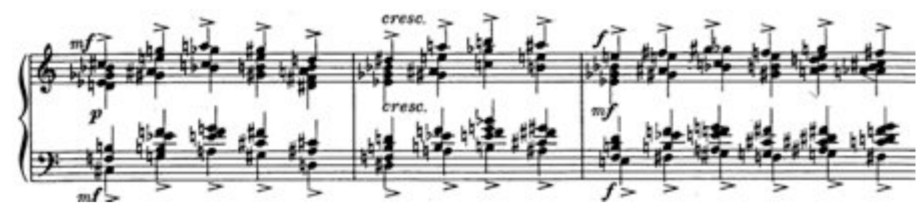
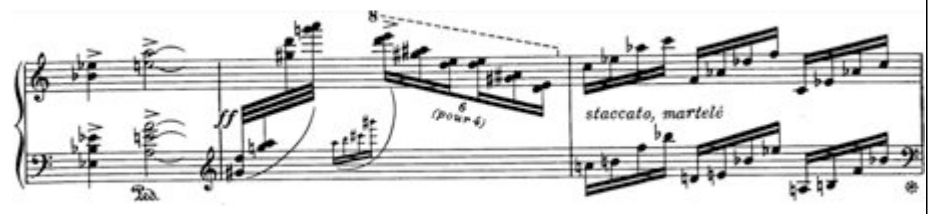
SECTION B “rocket-like groups” bars 24-90	
SECTION C “chorale” bars 91-97	
SECTION B “rocket-like groups” bars 98-177	
SECTION A “chromatic durations” bars 178-196	

Table 4. The arch form structure of Olivier Messiaen’s *Regard de l’Onction Terrible* (Contemplation of the Awesome Anointing) from *Vingt regards sur l’Enfant-Jésus* (Twenty Contemplations of the Christ Child 1944). (Score excerpts © 1947 Durand).

The second and fourth sections are based on Messiaen’s fifth mode of limited transposition[30] (see figure 12) and have a range of slightly more than seven octaves from Bb^{0} to B^{7}. They comprise two types of material: melodies of five-note “quintal” chords alternating with a variety of arpeggiations that Healey refers to as “rocket-like groups” (2008 p. 168). The third, central section is based on Messiaen’s “Theme of Chords”[31] (figure 13), seven to ten-note chords of equal duration, and occupies less than 3 octaves from C#^{2} to B^{4}. The section is fully chromatic, including all twelve notes of the chromatic scale.

[30] Rogosin (1996) p. 119

[31] In the preface to *Vingt regards sur l’Enfant-Jésus,* Messiaen notes three recurring themes that appear in various movements of the work: the “Theme of God”, the “Theme of the Star and the Cross” and the “Theme of Chords”. See Messiaen (1947) p. i

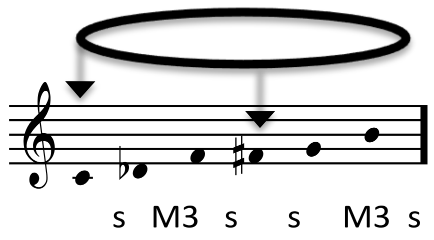
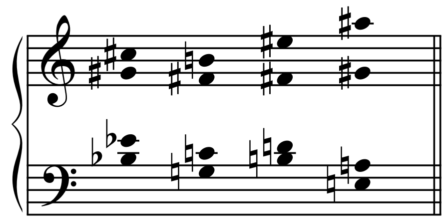
	

Figure 12: Messiaen’s fifth mode of limited transposition comprising an arrangement of semitones and major thirds, symmetrical around C and F#.	Figure 13: The “Theme of Chords” from Messiaen’s *Vingt regards sur l’Enfant-Jésus* (Messiaen 1947 p. I).

Both the Bartók and Messiaen examples are highly determinate and also readily compressible into quite simple formal schemes. It is feasible to envisage other possible avenues for contextualizing these works, for example: they both exhibit programmatic aspects[32] that might lead to different conclusions about the relationships between their substructures. However the discrete nature of the three kinds of musical materials found in *Regard de l’Onction Terrible*, resists attempts on a purely musical level to assign an overarching continuity or contingency to the formal structure of the work. For this reason, and in comparison to the Bartok example, *Regard de l’Onction Terrible* can be considered to have a nonlinear formal structure and *The Night’s Music* to have a linear structure. These two works occupy opposing sides of the border between linear and nonlinear structure.

Figure 14 places these five examples upon the continuum of formal complexity illustrating how each one is evaluated in relation to integration, contingency, compressibility and determinacy. Brown’s *Event Synergy II* is a well-defined example of a nonlinear structure with clearly discrete and non-contingent substructures and a intermediate degree of compressibility and determinacy in the structure overall. The environmental sounds from which Eno extracted his recording bear all the hallmarks of formlessness, with the exception of a very determinate and relatively compressible “structure” (as it is a very short recording). Bartók’s work comprises a highly compressible and determinate formal structure (arch form) and relatively integrated and contingent formal substructures, and is therefore best described as a linear substructure. Messiaen’s similar arch form work is also highly compressible

[32] See Bartók: Weissmann (1950) p. 15 and Schneider (2006) pp. 81-87; and Messiaen: Bruhn (1998) pp. 391-6 and Burger (2009).

and determinate in formal structure, however the internal substructures are discrete and non-contingent enough for the entire structure to be regarded as nonlinear.

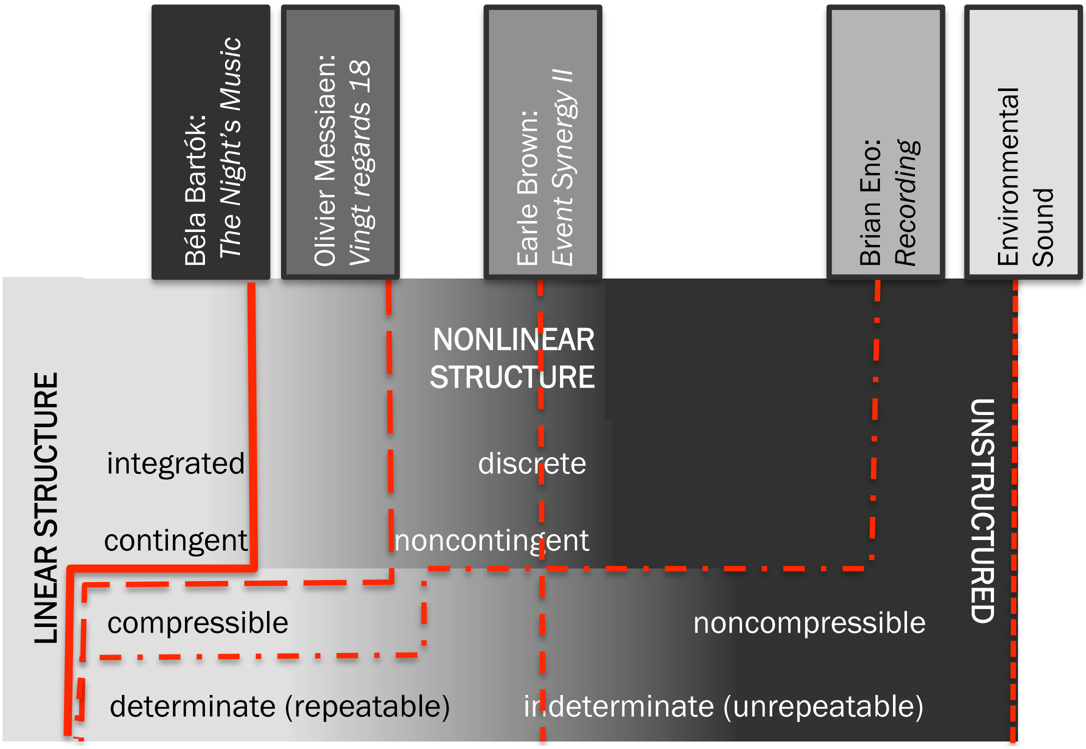


Figure 14: Examples by Bartók, Messiaen, Brown, Eno and "environmental sound" upon the continuum of formal complexity in relation to integration, contingency, compressibility and determinacy.

This chapter provides four factors for consideration in the evaluation of nonlinearity in musical works the: degree of integration determined by parametrical disjunction between substructures; the degree of contingency determined by parametrical relationships between substructures; the degree of compressibility determined by the degree to which the structure can be reduced to a minimum number of discrete substructures; and determinacy determined by the degree to which a structure is repeatable.