

**From Experiments in Music Intelligence  
(Emmy) to Emily Howell:  
The Work of David Cope**

CS 275B/Music 254

# Experiments in Musical Intelligence: Motivations

1990-2006

# Emmy (overview)

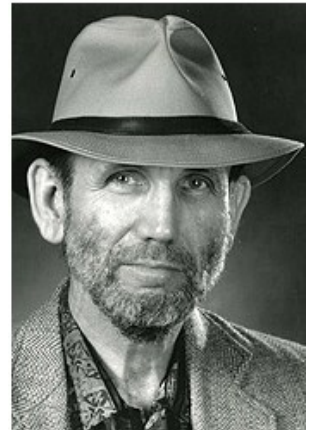
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## ▶ History

- ▶ Work began around 1985 (on a Mac in Lisp)
- ▶ Originally employed augmented transition network (ATN); linguistic model
- ▶ Developed its own grammar: **SPEAC**

## ▶ Main steps

- ▶ Encoding (basis = MIDI)
- ▶ Classification by **genre**
- ▶ Parsing of encoded works into **signatures**
- ▶ Storage of signatures in genre-specific, **composer-specific** lexicons
- ▶ Generation of new pieces in specific genre and style



# Formative influences



David Cope at work in his California home. Photograph: Catherine Karnow for the Observer

*Observer*, 2010: “You pushed the button and out came hundreds and thousands of sonatas...”

<http://www.guardian.co.uk/technology/2010/jul/11/david-cope-computer-composer>



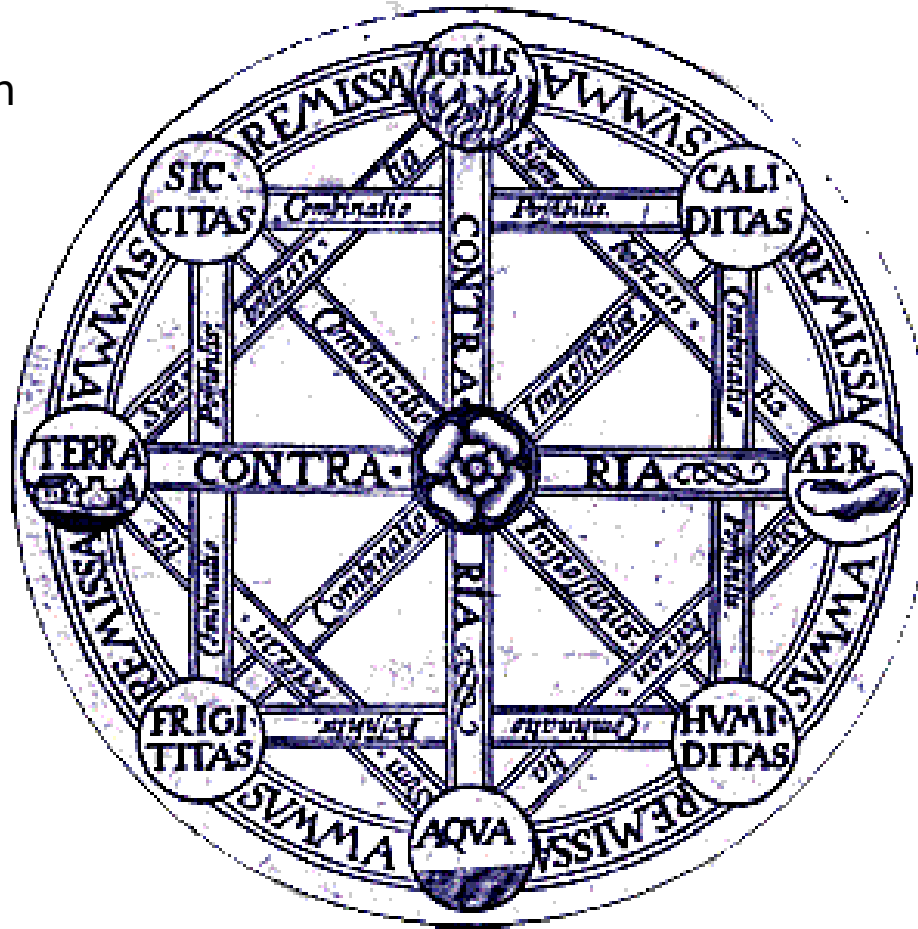
Wind chimes (L)  
Rhythmicon (top)  
Aeolian harp (below)

Aleatoric  
instruments



# Process: Ars combinatoria

Leibniz:  
Math dissertation  
1690



Rationale for  
**binary logic**  
"of the universe"

# Aleatoric possibilities of musical automata (c. 1785)



## Musikalische Würfelspiele

### Wolfgang Amadeus Mozart: Musikalisches Würfelspiel

Anleitung so viel Walzer oder Schläfer mit zwei Würfeln zu componiren so viel man will ohne musikalisch zu seyn noch etwas von der Composition zu verstehen (KV Anh. 294d, posthum 1793)

1. Walzerzeit

	Tafel 1	Tafel 2	Tafel 3	Tafel 4	Tafel 5	Tafel 6	Tafel 7	Tafel 8
11	58	32	141	41	928	123	11	311
12	32	8	128	83	148	48	134	81
13	928	35	158	13	153	33	110	24
14	48	12	111	85	161	2	159	100
15	140	74	163	45	80	37	34	167
16	114	157	27	167	154	68	118	81
17	152	68	171	33	85	133	21	127
18	118	84	114	90	148	88	189	84
19	158	142	42	158	75	129	62	153
20	1	87	163	81	138	47	147	33
21	154	180	10	101	38	37	186	6

Nominations: 8 6 9 10 8 6 12 8

2. Walzerzeit

	Tafel 1	Tafel 2	Tafel 3	Tafel 4	Tafel 5	Tafel 6	Tafel 7	Tafel 8
22	78	121	158	1	112	45	108	14
23	117	39	126	68	174	78	118	81
24	68	138	13	132	73	82	148	78
25	98	178	7	34	87	168	62	120
26	25	140	64	125	76	138	1	33
27	188	71	180	28	101	162	23	161
28	18	158	157	175	45	168	85	172
29	120	88	148	186	51	115	72	111
30	65	77	19	62	132	35	148	8
31	182	4	131	184	144	33	173	71
32	35	30	188	82	12	124	44	131

Nominations: 7 10 4 7 8 7 3 8



Benutzung – folgende Funktionen sind deaktiviert/eingeschränkt:

- Vorlesen einzelner Tafeln
- Laden, speichern, drucken und der MIDI-Export von erwählten Blöcken
- Es kann nur eine der 379.748.833.683.341 Kombinationen eingelesen in Notes dargestellt und über abgespielt werden.
- Der Artikel zur Geschichte der Musikalischen Würfelspiele ist nicht gelinkt.



Home
Speichern
Würfeln
Spiele
Vorlesen
Instrumente
Hilfe
Geschichte
Instrumente
Notenblatt
Druck

<http://www.schott-music.com/wuerfelspiele/tabelle.htm#>

# Musical dice games



Sample dice game:

96	22	141	41	105	122	11	30
32	6	128	63	146	46	134	81
69	95	158	13	153	55	110	24
40	17	113	85	161	2	159	100
148	74	163	45	80	97	36	107
104	157	27	167	154	68	118	91
152	60	171	53	99	133	21	127
119	84	114	50	140	86	169	94
98	142	42	156	75	129	62	123
3	87	165	61	135	47	147	33
54	130	10	103	28	37	106	5

70	121	26	9	112	49	109	14
117	39	126	56	174	18	116	83
66	139	15	132	73	58	145	79
90	176	7	34	67	160	52	170
25	143	64	125	76	136	1	93
138	71	150	29	101	162	23	151
16	155	57	175	43	168	89	172
120	88	48	166	51	115	72	111
65	77	19	82	137	38	149	8
102	4	31	164	144	59	173	78
35	20	108	92	12	124	44	131

# Process: Augmented transition network (Cope)

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Once upon a time there was a \_\_\_\_\_ (adj.) \_\_\_\_\_  
(noun). \_\_\_\_ (pronoun) lived in a giant \_\_\_\_\_ (noun).  
One day a \_\_\_\_\_ (noun) came along. \_\_\_\_ (pronoun)  
wanted to know whether \_\_\_\_\_ (pronoun) could  
\_\_\_\_\_ (verb) in the \_\_\_\_\_ (noun).

- *nouns*
- *adjectives*
- *pronouns*
- *verbs*



# Computer implementation (Emmy)

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- ▶ Select a repertory (one composer, one genre)
- ▶ Encode several pieces (one genre, one composer)
- ▶ Parse them into five elements of musical grammar (**SPEAC**)
  - ▶ **Statements**
  - ▶ **Preparations**
  - ▶ **Extensions**
  - ▶ **Antecedents**
  - ▶ **Consequents**
- ▶ Discover and store “signatures” (identify “earmarks”):  
**recursive procedure**

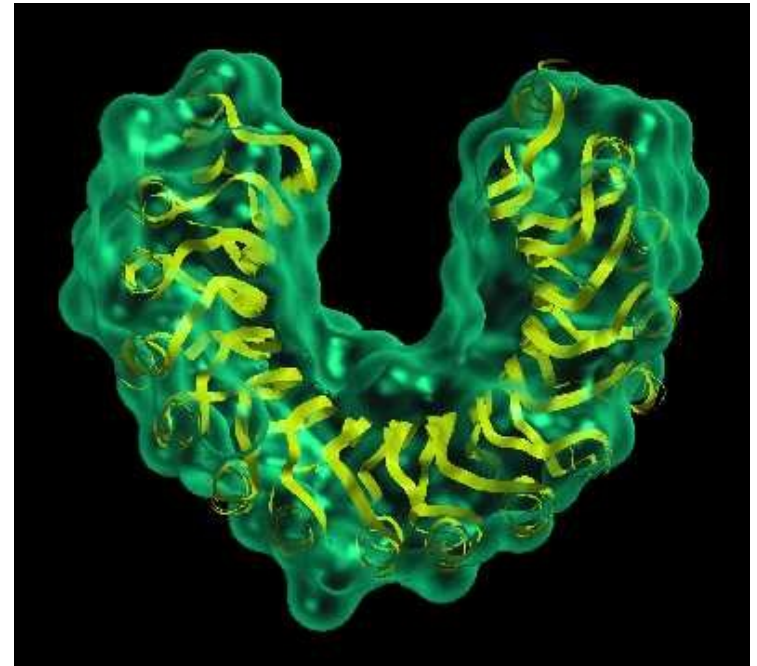
# EMI's grammatical parts (c. 1990)

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- SPEAC
  - **Statements**
  - **Preparations**
  - **Extensions**
  - **Antecedents**
  - **Consequents**
- BEAD model (genetic algorithms/lattices)

“recombinant music” (IEEE)

**Structural encodings  
enabling fluid sequencing**



# Signature properties

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- ▶ Are relatively **short** (2-5 events)
- ▶ Are shorter than themes
- ▶ Are stored *with approach and departure info*
- ▶ Are described by intervallic relationships
- ▶ Are **not** described by key or mode



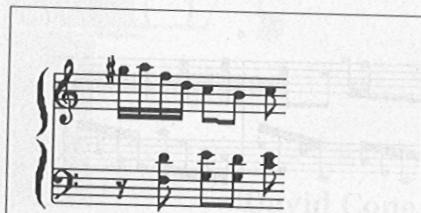
# Signature specification (pattern matching)

## ► Appropriate motives

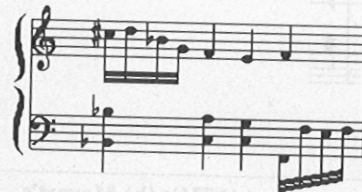
- No. of events = 2-5
- recurrence
  - ☐ > 3 times
  - ☐ Less than ubiquitously
  - ☐ Not pervade all pieces

## Signatures

Sample signatures



(a)



(b)

Figure 4. Two versions of a Mozart signature from (a) K. 330 and (b) K. 547a.

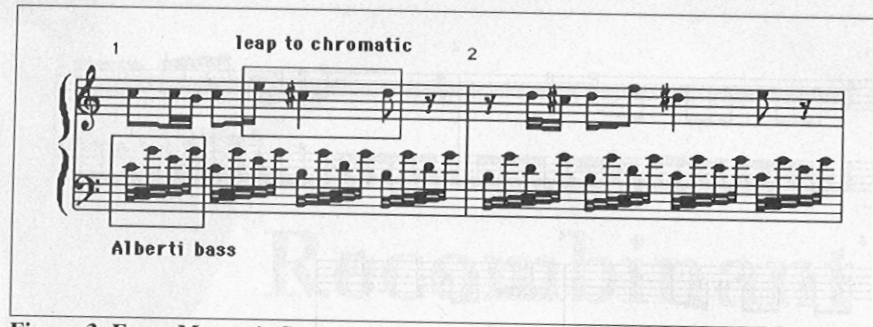


Figure 3. From Mozart's Sonata K. 279, first movement (1774).

Recursive process of identification


# Signatures

Composer specific

Genre specific

Movement specific

Texture specific



The image displays two musical excerpts, (a) and (b), each consisting of a piano and a violin part. Excerpt (a) is from Mozart's Sonata K. 283, second movement (1774), and excerpt (b) is from Mozart's Sonata K. 330, third movement (1778). Both excerpts are in 2/4 time. Excerpt (a) shows measures 1 through 4, with the piano part featuring a steady eighth-note accompaniment and the violin part playing a melodic line. Excerpt (b) shows measures 1 through 8, with the piano part featuring a steady eighth-note accompaniment and the violin part playing a melodic line. The notation is in standard musical notation with treble and bass staves.

(a)

(b)

Figure 1. From (a) Mozart's Sonata K. 283, second movement (1774); (b) Mozart's Sonata K. 330, third movement (1778).

# Lexicon (stores)

- **Individual** signature information
- **Approach** (“preparations”) information
- **Departure** (“extensions”) information
- **Relationship** information

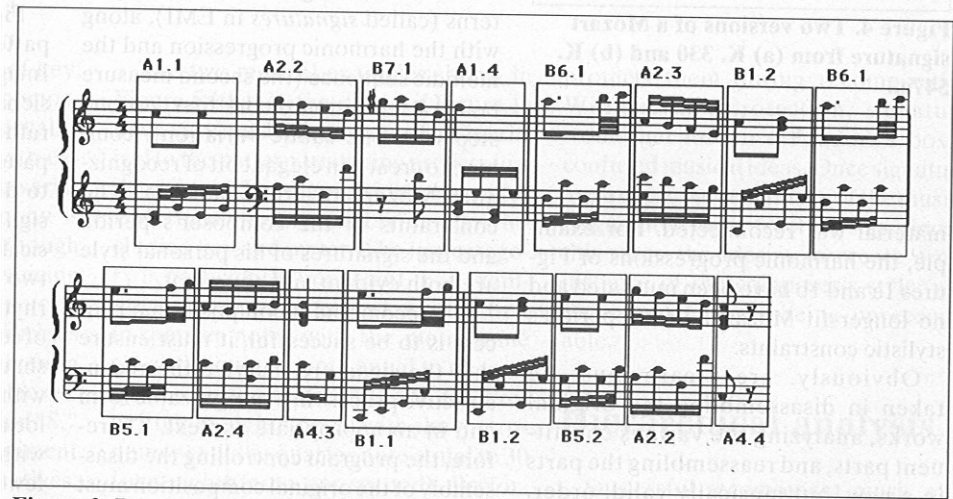


Figure 2. Random recombinant music and its analysis. “A” here refers to Figure 1a, “B” to Figure 1b; the numbers represent the location, first by the measure number and then by the beat number.

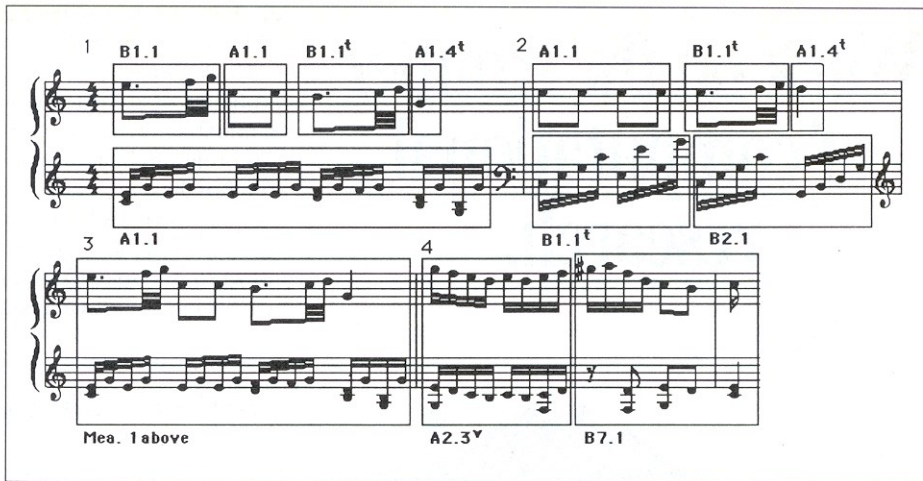
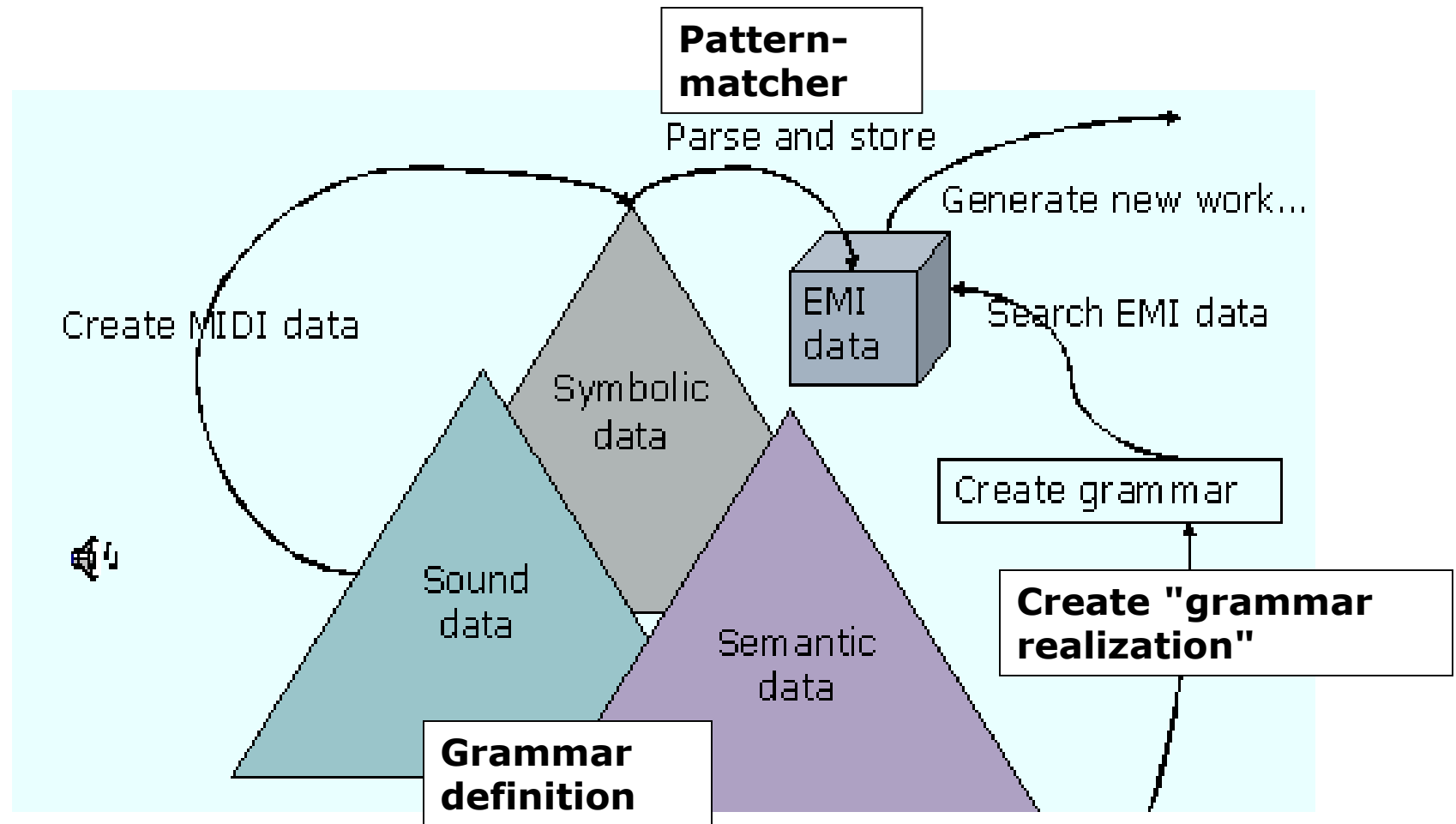


Figure 6. EMI's recombination of segments in Figure 5, with signature (B7.1) and suggested sources (t = transposition; v = variation).

Composer = Mozart  
Genre = Piano sonata  
Movement type = Allegro



# Experiments in Musical Intelligence







# Ways of experiencing Emmy

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- ▶ Listening to MIDI performances
- ▶ Listening to live performances
- ▶ Viewing the notated music (no longer easy)
- ▶ Performing the music

<http://artsites.ucsc.edu/faculty/cope/mp3page.htm>

# Reactions to EMI

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## Cons: From MIDI files

- ▶ “Mechanical”
- ▶ Too fast
- ▶ Too slow
- ▶ Too soft
- ▶ Too loud
- ▶ “Not human”

## Pros: From live concerts

- ▶ That’s by a computer?

# From Emmy to Emily Howell

2010—

# *Computer Models of Musical Creativity*

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- ▶ Initiates process of **signature capture from interactive** user responses
- ▶ Develops **its own lexicons**
- ▶ Models **broader processes** of grammatically-founded processes including
  - ▶ Speech
  - ▶ Poetry
  - ▶ Lyrics

# Hidden Structure

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- ▶ Takes comprehensive view of 20<sup>th</sup>-century analytical concepts
- ▶ Makes them available for compositional algorithms
  - ▶ Post-tonal music
  - ▶ Generative algorithms
  - ▶ Style- and genre syntheses:
    - ▶ Mozart in Bali

# Emily Howell

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- ▶ Debuted in March 2010
- ▶ Represents the second incarnation of Emmy
- ▶ Composes modern, original music

<http://www.miller-mccune.com/culture-society/triumph-of-the-cyborg-composer-8507/>

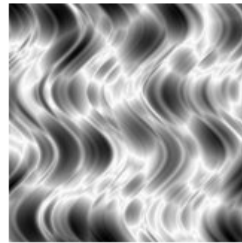
[Ryan Blitstein=former student of this class]

# Pieces by Emily Howell

- ▶ *From Darkness, Light*
- ▶ *Land of Stone*
- ▶ *Shadow Worlds*

<http://www.centaurrecords.com/>

Latest release:



**Variations on a Theme by Emily Howell** by David Cope (Apr 9, 2013)

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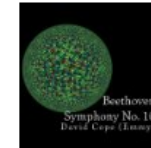
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