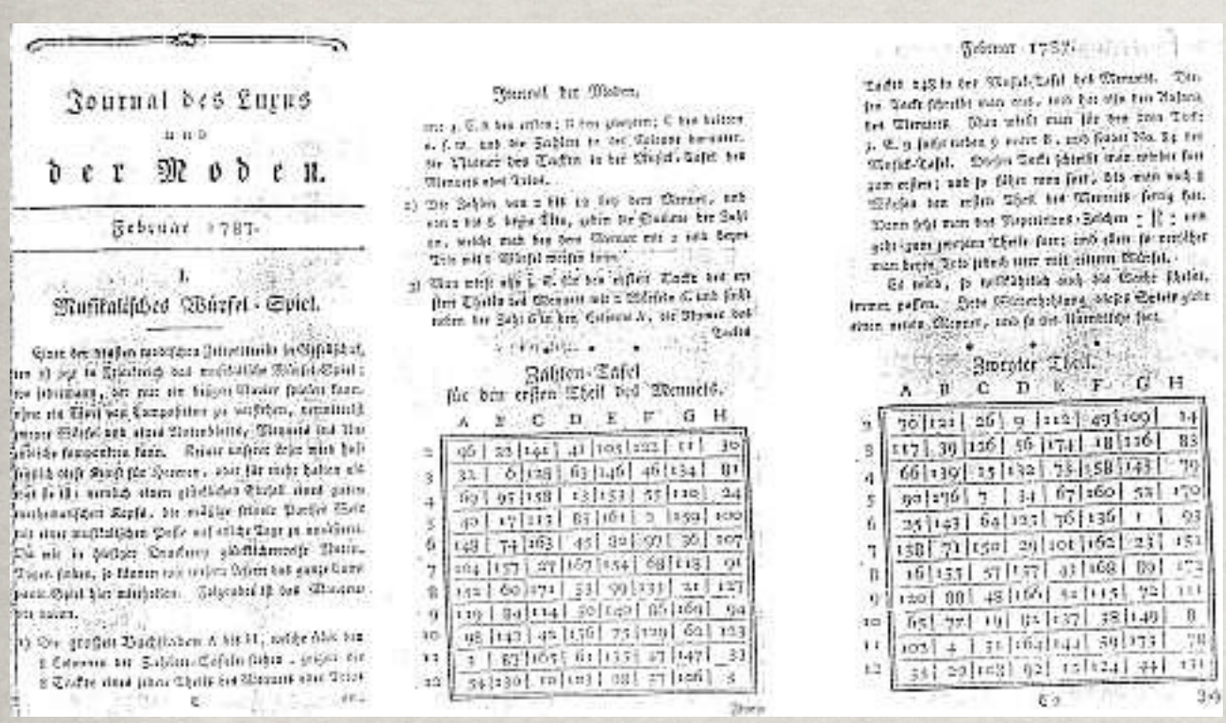
THEMATIC TRANSFORMATIONS IN THE TRANSFORMATION ENGINE

What is Algorithmic Music Composition?

- "**Algorithmic composition** is the technique of using algorithms to create music." - Wikipedia
- An Algorithm is a series of operations for accomplishing a task, with the following characteristics:
  - Finiteness - the method must not take forever.
  - Definiteness - Each step must have significance...
  - Input - the method must have valid materials on which to operate
  - Output - the method must produce at least one result
  - Effectiveness - the method must always produce the same output from the same input...
  - (adapted from Gareth Loy, Musimathics, Vol. 1)

- "Many algorithms that have no immediate musical relevance are used by composers as creative inspiration for their music. Algorithms such as fractals, L-systems, statistical models, and even arbitrary data (e.g. census figures, GIS coordinates, or magnetic field measurements) are fair game for musical interpretation." - Wikipedia

Algorithmic Music Examples



Journal des Luxus
und
der Moden.

Februar 1787.

I.

Musikalisches Würfel-Spiel.

Zahlen-Tafel
für den ersten Theil des Menuets.

	A	B	C	D	E	F	G	H
2	96	22	141	41	105	122	11	30
3	32	6	128	63	146	46	134	81
4	69	95	158	13	153	55	110	24
5	40	17	113	85	161	2	159	100
6	148	74	163	45	80	97	36	107
7	104	157	27	167	154	68	118	91
8	152	60	171	53	99	133	21	127
9	119	84	114	50	140	86	169	94
10	98	142	42	156	75	129	62	123
11	3	87	165	61	135	47	147	33
12	54	130	10	103	28	37	106	5

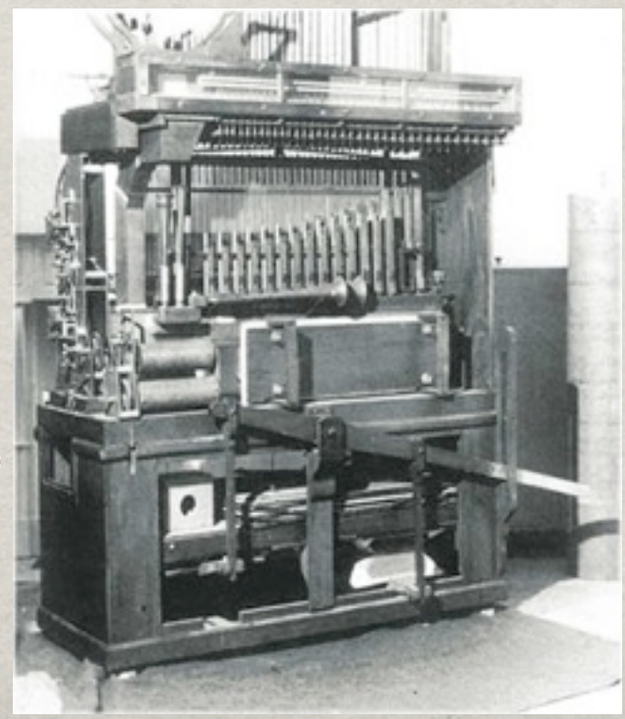
Februar 1787.

Zweyter Theil.

	A	B	C	D	E	F	G	H
2	70	121	26	9	112	49	109	14
3	117	39	126	56	174	18	116	83
4	66	139	15	132	73	158	143	79
5	90	176	7	34	67	160	52	170
6	25	143	64	125	76	136	1	93
7	138	71	150	29	101	162	23	151
8	16	155	57	177	31	168	89	172
9	120	88	48	166	92	115	72	111
10	65	77	19	82	137	38	149	8
11	102	4	31	164	144	59	173	78
12	54	80	159	81	18	124	44	131

- Mozart's *Musikalisches Würfelspiel* (1787)

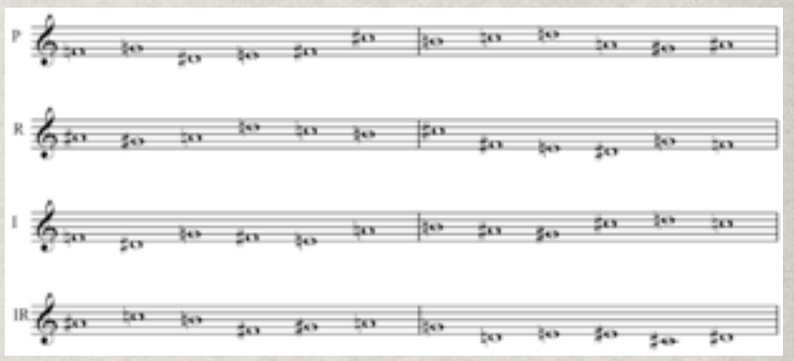
- Guido's Hand - (ca. 1026)



- Winkel's *Componium* (ca. 1820)

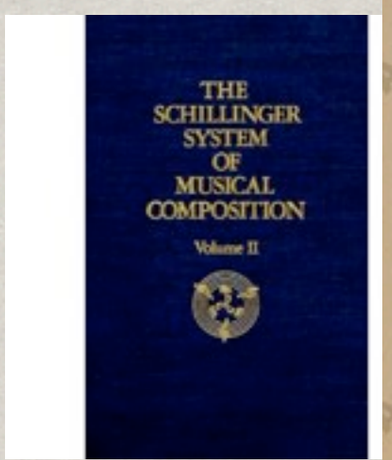
Algorithmic Music Examples

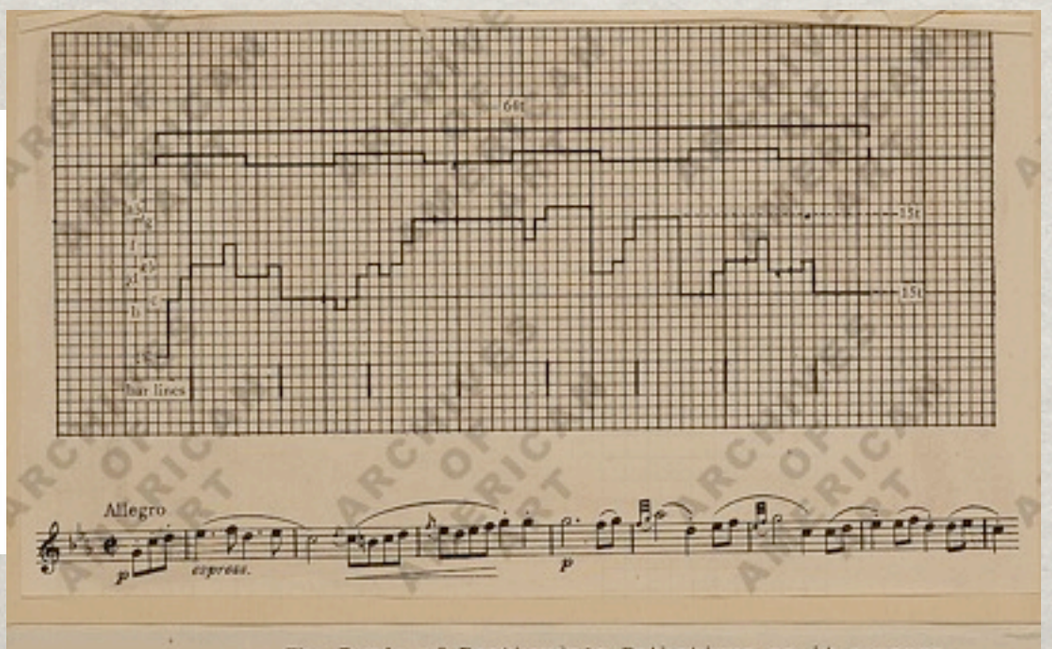
- Serial Music - mid 20th Century, especially later developments



Stravinsky, tone rows from *Requiem Canticles* (1966)

- George Gershwin, *Porgy and Bess* (composed under Schillinger's influence)
- Joseph Schillinger, *The System of Musical Composition*, (1949)





Algorithmic Music Examples

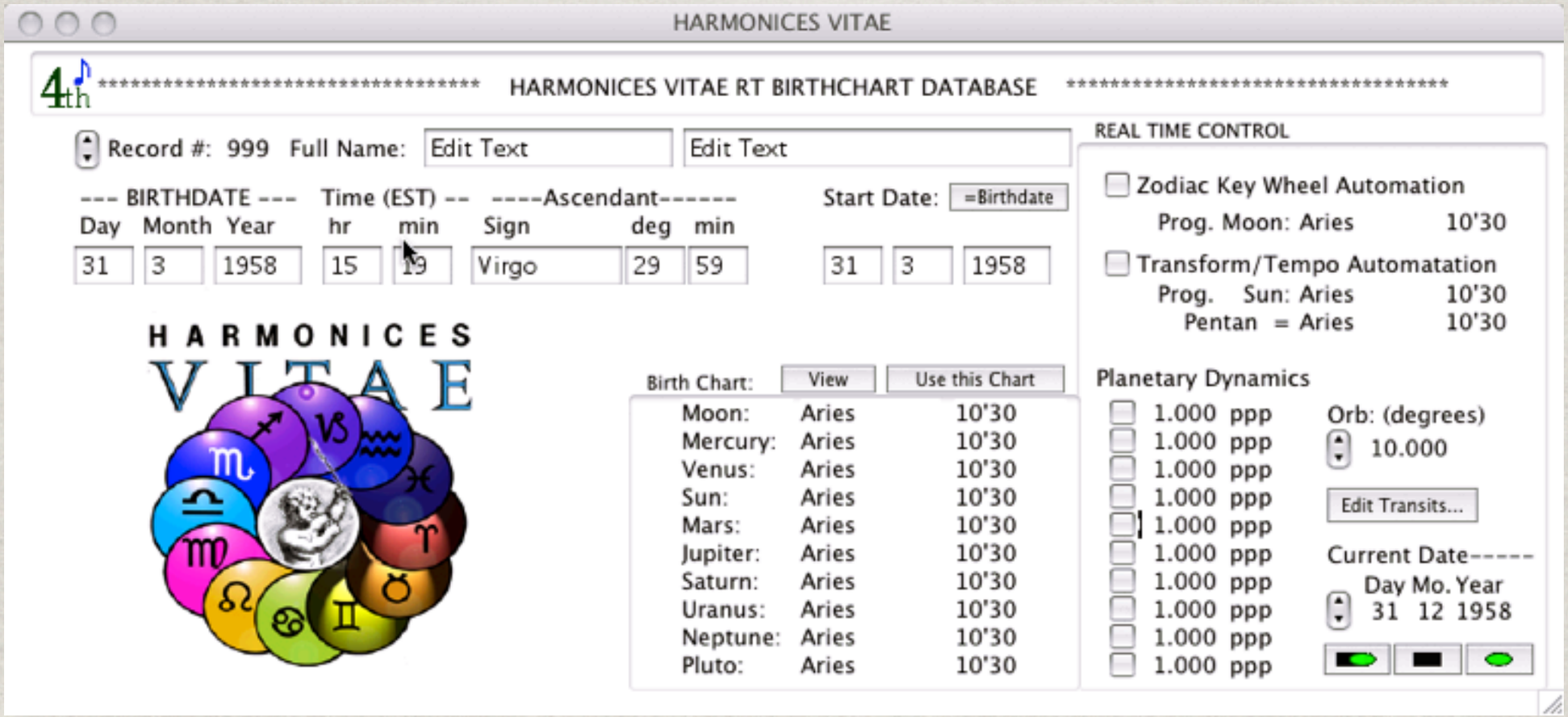
- L. Hiller, *Illiac Suite for String Quartet*, 1956
- Gottfried Michael Konig - *Project 1 (serial music computer program) (1964)*
- Iannis Xenakis - *Formalized Music: Thought and Mathematics in Composition* (1971)
- Brian Eno - pieces composed with the Koan Generative System
- Microsoft's patent 5753843 (1998) "A system and process for comprising a musical section in response to a user's interaction with a multimedia presentation is disclosed. The system includes a composition engine, performance engine, and arbitrator..."

Recent Work in Algorithmic Composition

A sampling of titles from the 2009 International Computer Music Conference

- **Hierarchical Markov Modelling for Generative Music** - Chris Thornton, Dept. of Informatics, University of Sussex, Brighton, England
- **Melody Extrapolation, A GTTM Approach** - Satoshi Tojo et al, Japan Advanced Institute of Science and Technology
- **A Symbolic Sonification of L-Systems** - Adam James Wilson, Center for Research in Computing and the Arts, UCSD
- **Perceptually Motivated Sonification of Moving Images -** Jean-Marc Pelletier, School of Media, Keio University, Kanagawa, Japan
- **Lyric-Based Rhythm Suggestion** - Eric Nichols, Center for Research on Cognition, Indiana University
- **Ecosystem Models for Real-time Generative Music** - Oliver Brown, Monash University, Clayton, Australia
- **Artistic Research in "Embodied Generative Music" -** Gerhard Eckel, et al, University of Music and he Performing Arts, Graz, Austria

Harmonices Vitae (1999)



- Generated music based on the planetary motions as they relate to an individual's birthchart
- Each planet in an individual's birthchart was represented by a particular instrument:
  Jupiter - Brass, Saturn - Bass, Mars - Drums, etc.
- Instrumental dynamics were calculated by traditional astrological methods for planetary intensity
- Planetary motions were calculated at the rate of one year of life = one minute of music.

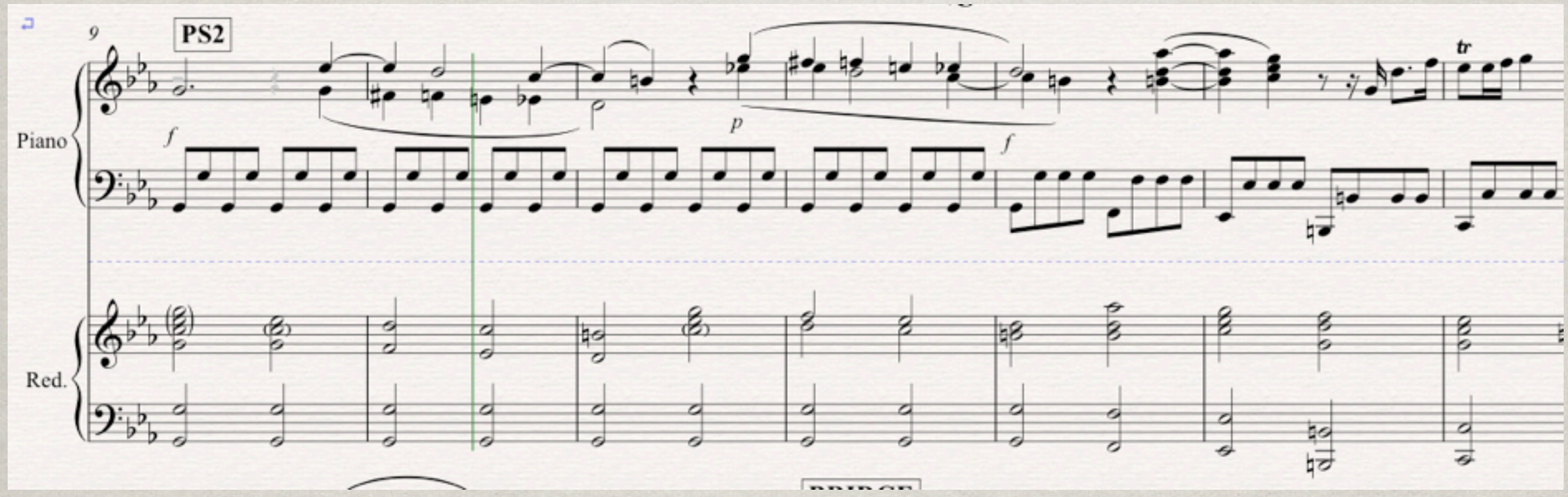
Schenkerian Synthesis in Harmonices Vitae

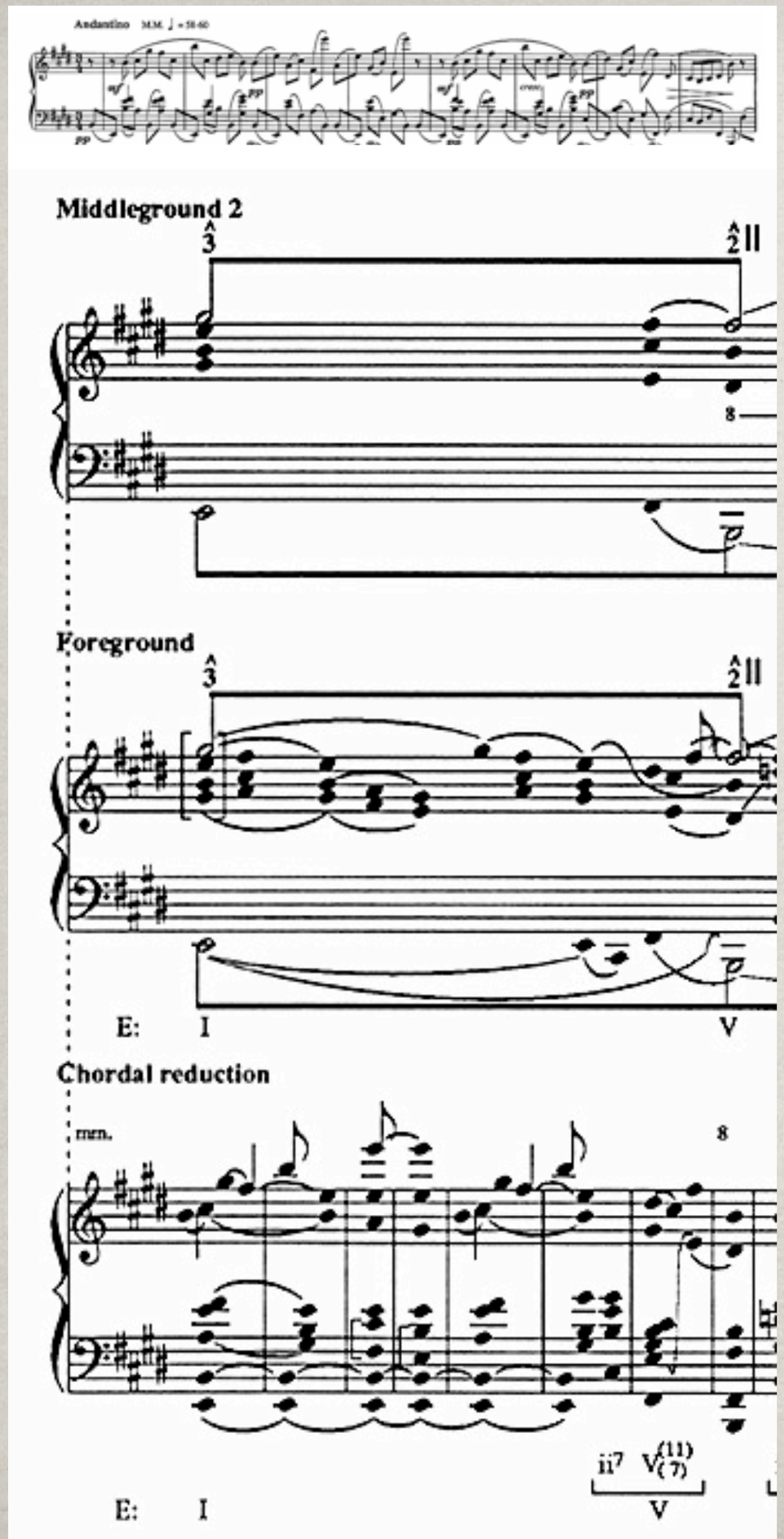
- Deeper musical structure was calculated based on the notion of "Schenkerian Synthesis"
  - Apply Schenker's analytical technique in reverse:

    Instead of analysing an existing piece to obtain foreground and background structures, we synthesize foreground and background structures to create a piece.

- In Harmonices Vitae:
  - Transiting Planet data called up foreground structures (i.e. motifs, themes) from a pre-composed library.
  - Moon progressing through the signs of the Zodiac called up background structures (i.e Voice Leading) from pre-composed voice leading sequences.

Mozart, k457, voice leading reduction





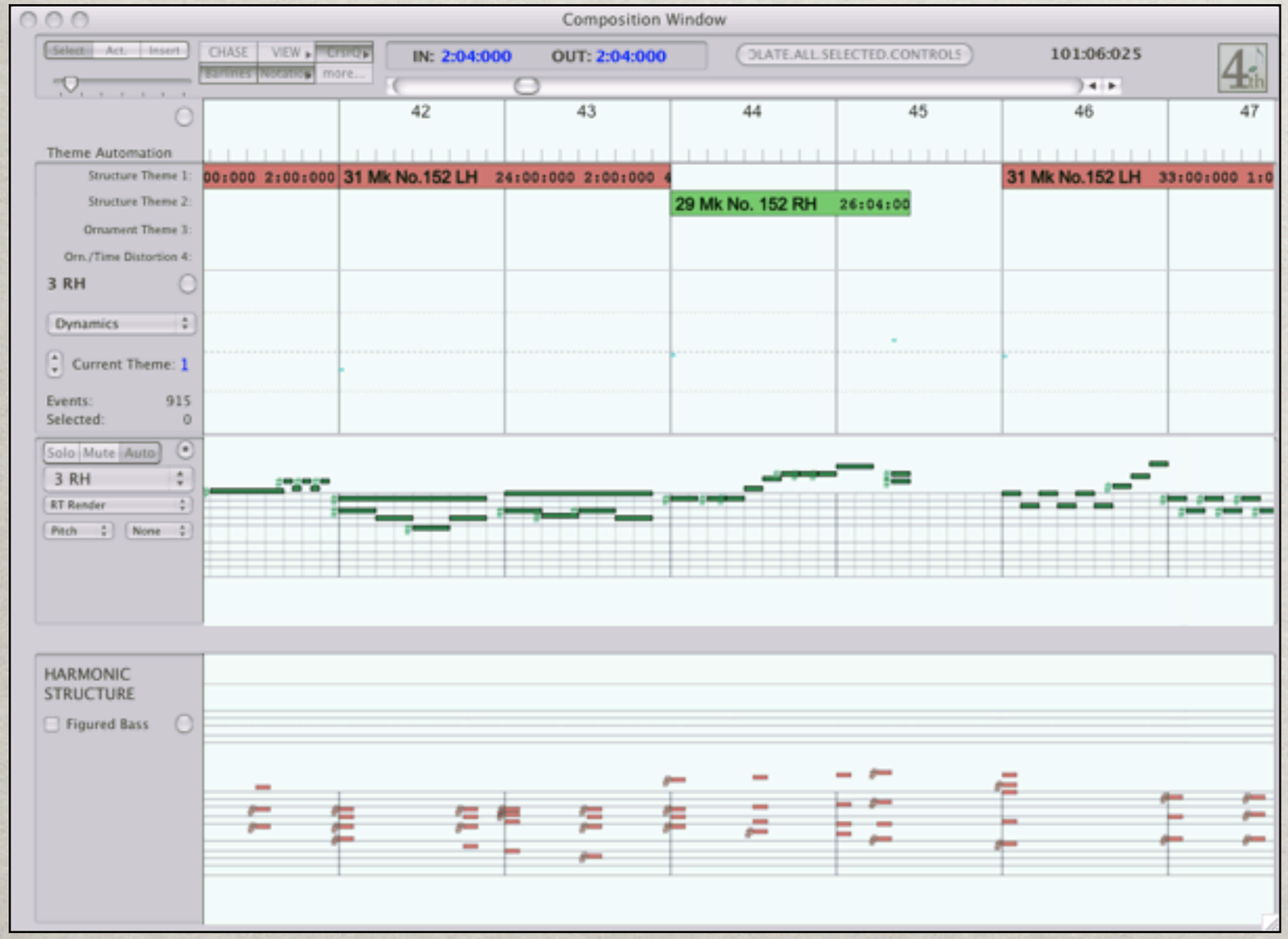
Scriabin, Prelude, op. 15, no. 4 Schenkerian analysis and voice leading reduction

from:

Neumeyer and Tepping, *A Guide to Schenkerian Analysis* (Prentice-Hall, 1992)

The Transformation Engine

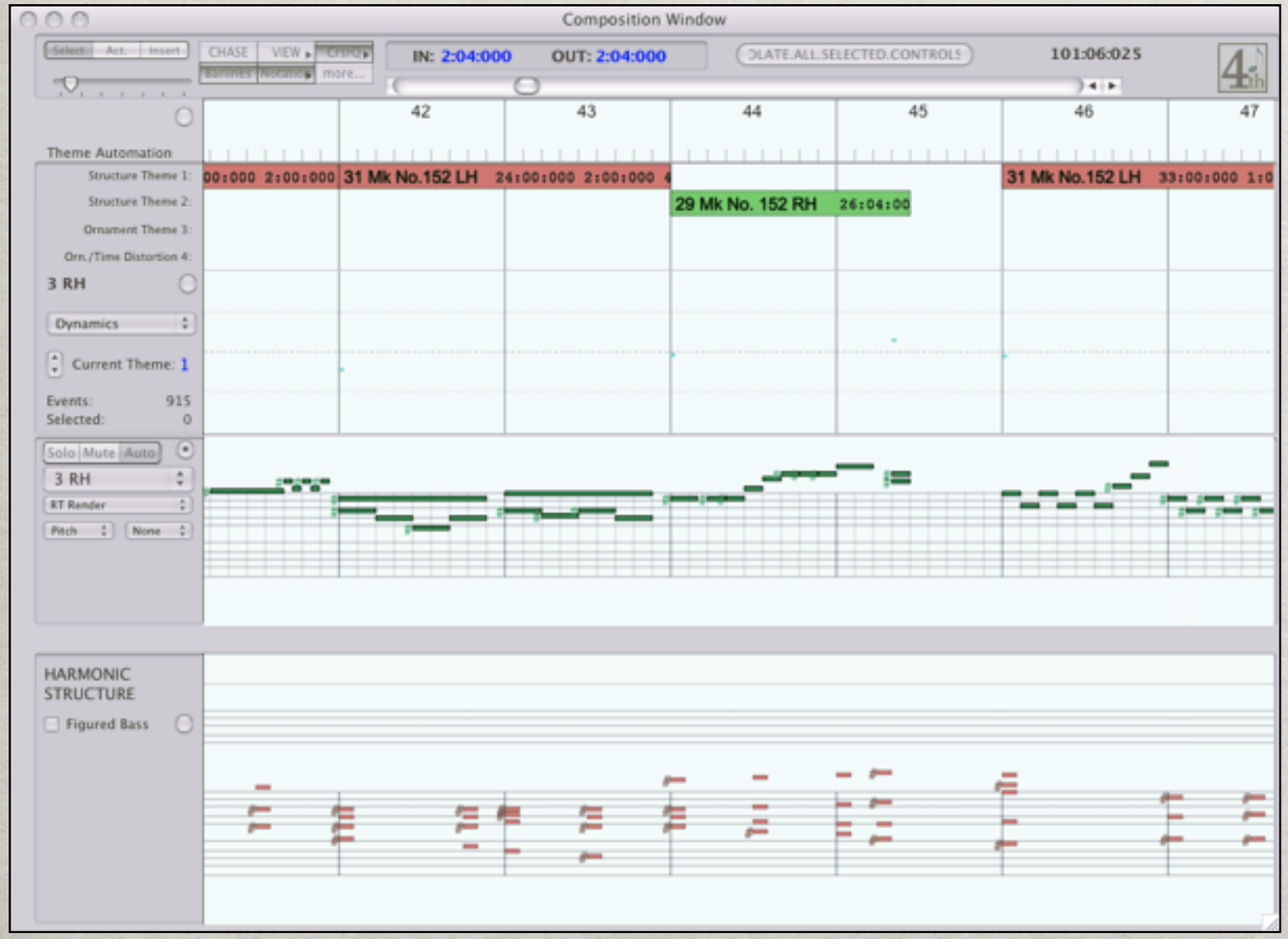
- *The Transformation Engine* is a software program which enables users to apply compositional transformations to musical information in realtime. Its aim is to extend and enhance the abilities of composers of instrumental music in the Western tradition of motivic and thematic composition



- This is a timeline representation of the musical composition, familiar from such programs as *Apple Logic* or *Final Cut Pro*. Time proceeds from left to right along the horizontal axis of the window, indicated by bar numbers across the topmost pane.

The Transformation Engine

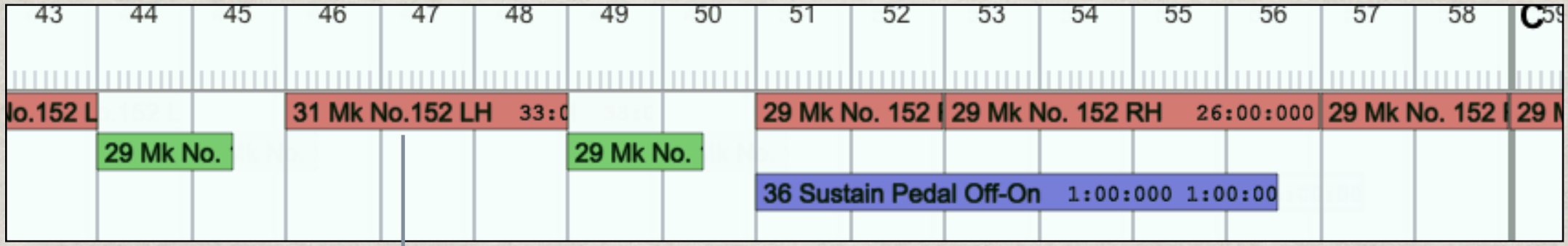
- *The Transformation Engine* is a software program which enables users to apply compositional transformations to musical information in realtime. Its aim is to extend and enhance the abilities of composers of instrumental music in the Western tradition of motivic and thematic composition

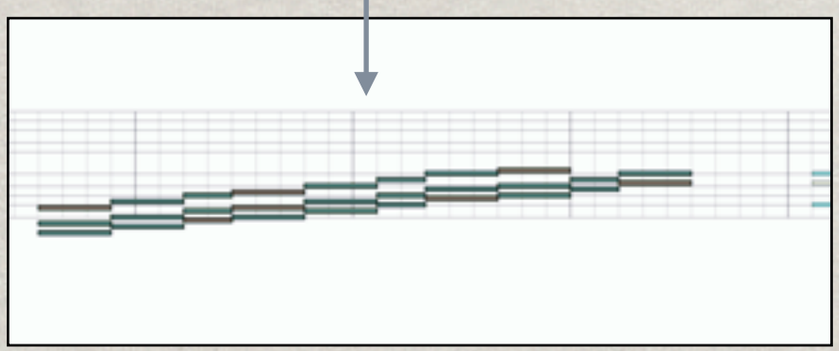


- An important and fundamental feature is that it allows for the artificial separation of Thematic Structure from Harmonic Structure.

REPRESENTATION OF THEMATIC STRUCTURE

- *Themes,* the *Engine's* fundamental musical unit, are displayed in several parallel tracks as colored rectangular blocks presenting both a simplified graphic representation of the musical content and a summary of the principal controls.



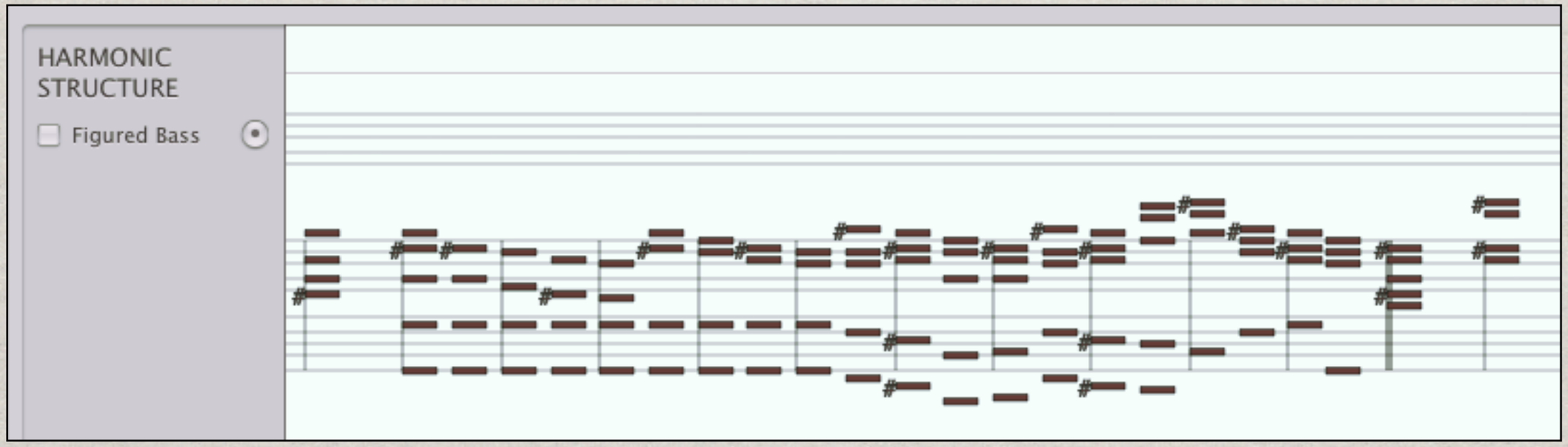


(Bartok, Mikrosmos No. 152, Left Hand, m. 33)

- *Each colored block is a pointer to a MIDI recording of the data for the theme it represents.*

Representation of Harmonic Structure

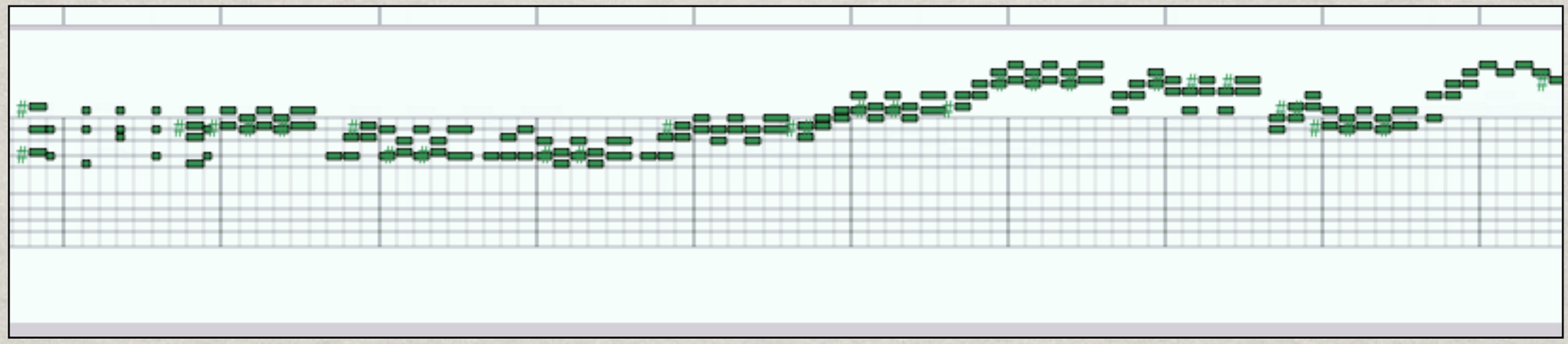
- Harmonic Structure is displayed in a schematic musical notation in a track along the bottom of the window.



Harmonic Structure of Mozart, k.457, mm 8-21

Representation of Musical Resultant

- The "resultant" is the combination of a theme with a harmonic structure. It is displayed in a schematic musical notation in the central pane of the window.



Global Pitch Transformations

- Harmonization and Re-voicing
  - many modes/scales available
    - Ionian, Dorian, Phrygian, etc
    - Octatonic, Whole-tone, Bitonal
    - Jazz chords, e.g. Dom.7 #9
    - Blues scale
    - etc.

Individual Track Pitch Transformations

- Controls
  - Tessitura
  - Pitch Width - including inversion
  - Voicing
  - Doubling
  - Repeated Notes

- Embellishments
- Resultants of two or more Themes

Types of Transformation

- Temporal Transformations
  - Articulation
  - Time Scaling - (diminution and augmentation)
    - Temporal Distortion

1:02:00, 1.120 - syncopated long and normal

3:00:00, 2.120 - alternating double-time and normal

29:00:000, 2.000 - alternating 1/8s & triplet 1/8s

28:00:00, 1.000 - triplet lilt

Applications

- Traditional Composition
- Algorithmic Composition
- Analysis - Resynthesis

Application to Composition

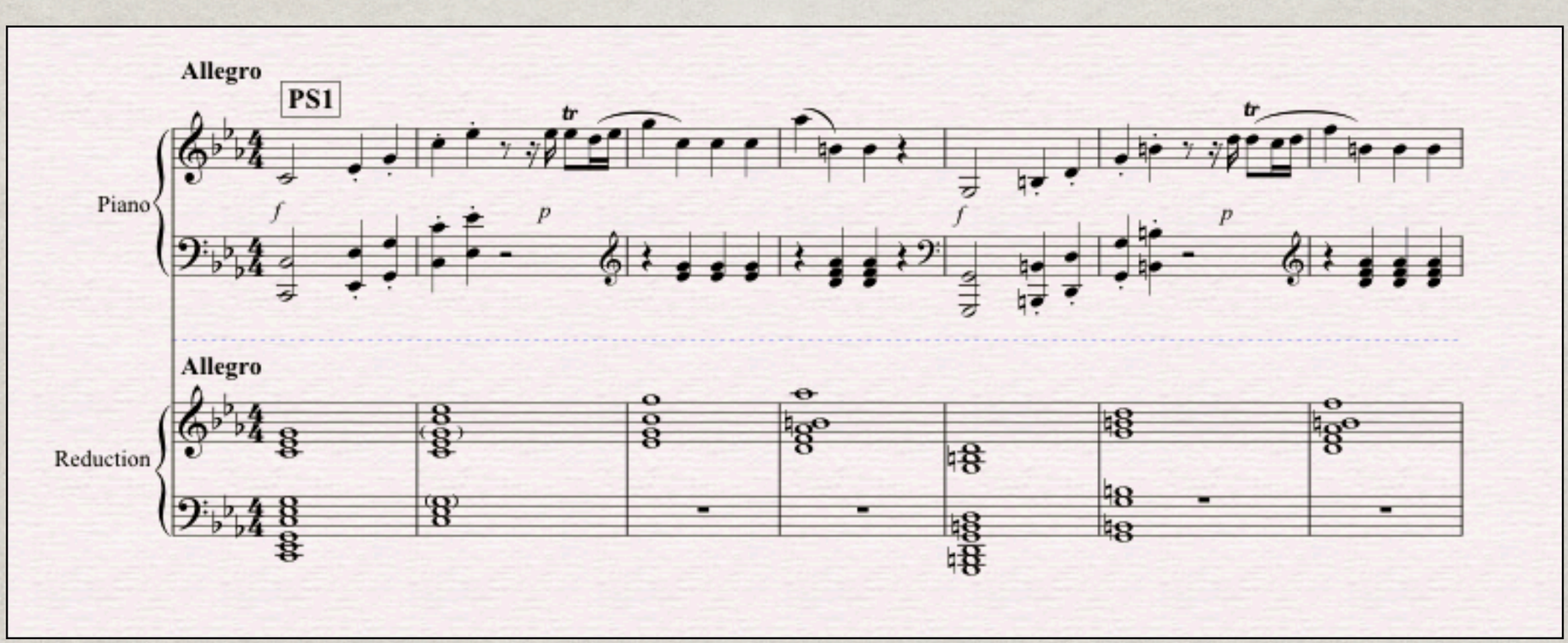
- 3. Hyper Rondo mm 0 - 65
- 2. Largo mm 36 ff
- 1. Moderato mm 94 ff

Analytical Application

- Mozart Piano Sonata Hybrid
- Harmonic Structure from k.457
- Thematic Structure from k.311

K.457 - HARMONIC ANALYSIS

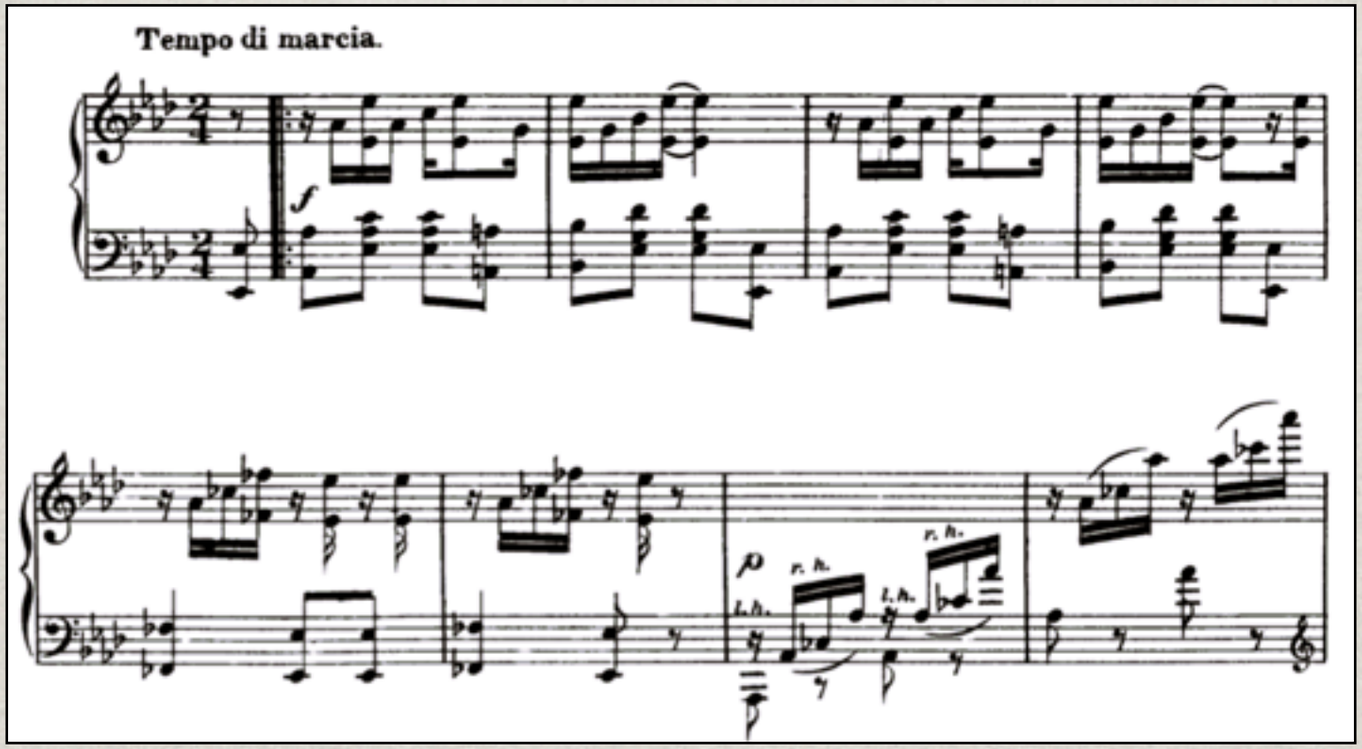
- Harmonic Structure
  - voice leading reduction
    - how much to reduce?



K.457, EXPOSITION - THEMATIC ANALYSIS (SIMPLIFIED)

Measure #	Theme	Comment	Key
1-8	Principal theme 1 (PS1)	I-V, V-I	C minor
9-18	Principal theme 2 (PS2)	prominent pedal on I^{6-4}, V^7 8 measures, plus two measure codetta	C minor
19-22	Bridge	begins with repetition of PS1	C minor (I) to V of E-flat
23-35	Second Subject 1 (SS1)	lyrical, wide range of note durations; extended with unusual C-flat harmony (bVI of E-flat)	E-flat Maj.
36-58	Second Subject 2 (SS2)	RH and LH in call/answer; German 6th in m.44, 49	E-flat Maj.
59-66	Closing Subject 1 (CS1)	4 measures long, with elaborated repeat	E-flat Maj.
67-74	Closing Subject 2 (CS2)	ends with stretto on PS1	E-flat Maj.

Hybrid #1 - "Maple Leaf Rag"

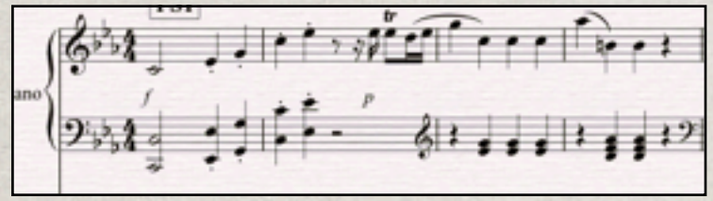


- regular phrasing (2+2+2+2...)
- clearly separated "theme sections"
- simple harmonic language
- most passages built from broken chords

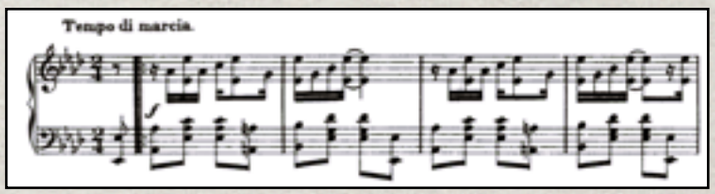
BASIC PROCEDURE

- following Thematic analysis of k.457, substitute appropriate "themes" from Joplin's MLR
- this procedure carried out independently for left and right hands
- tweak Tessitura of LH and RH separately to follow principal tones of Bass and Melody

PS1

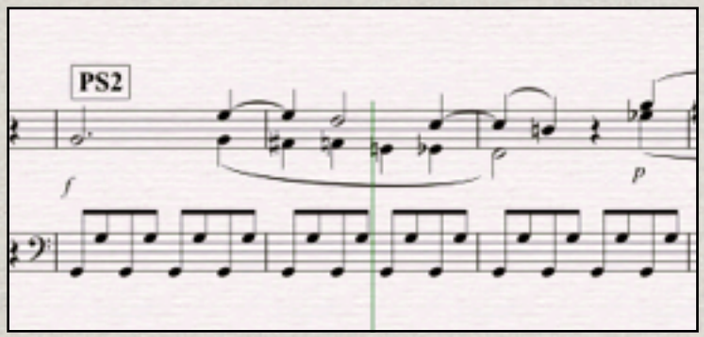


becomes

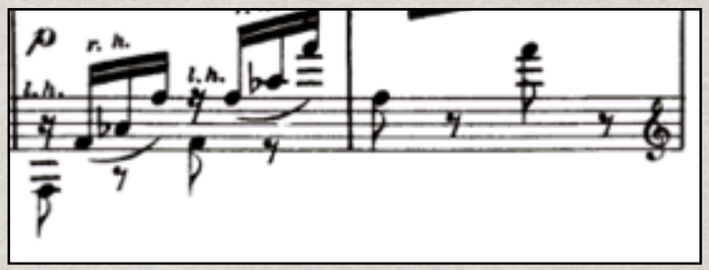


MLR, m-1-4

PS2

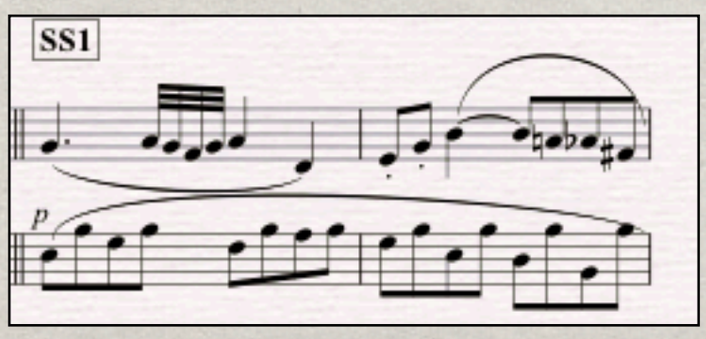


becomes



MLR LH, m-8-9

SS1

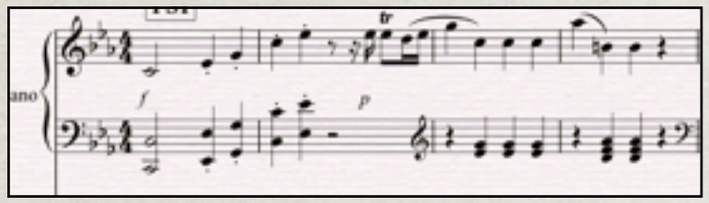


becomes

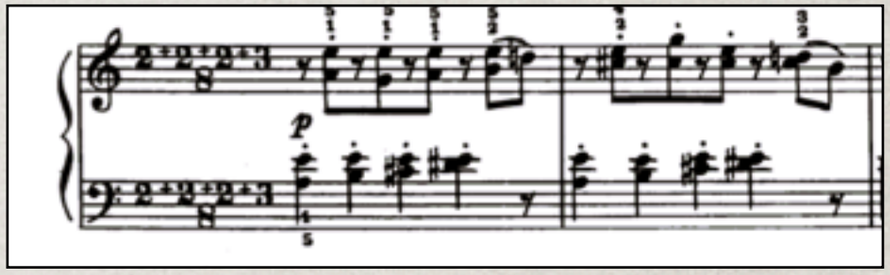
MLR, m-82-83 (TRIO)

MikroKosmos 152 SUBSTITUTIONS

PS1

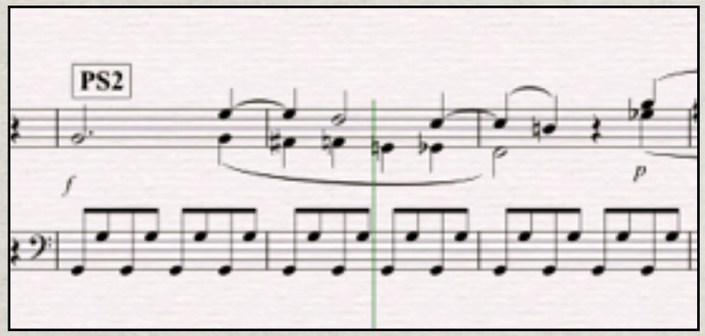


becomes

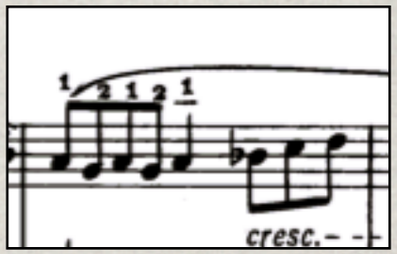


MK 152, m-1-4

PS2

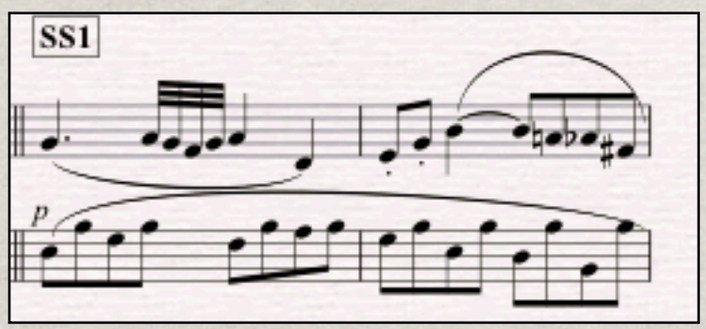


becomes

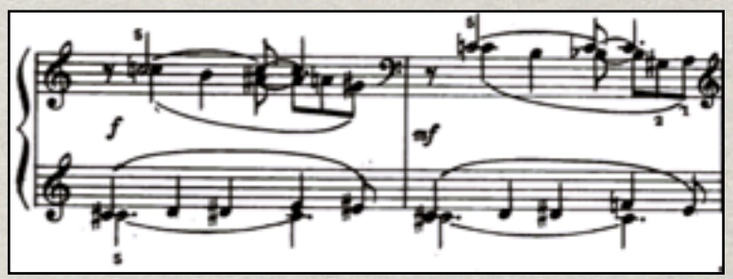


MK 152, m.27

SS1

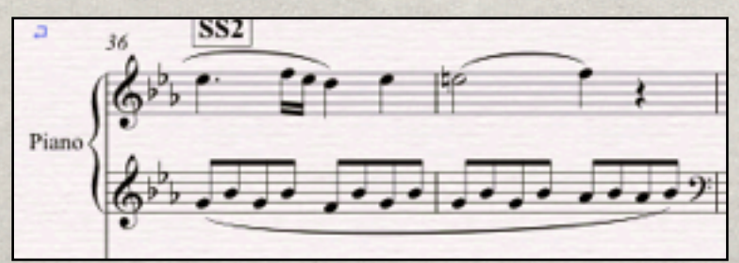


becomes

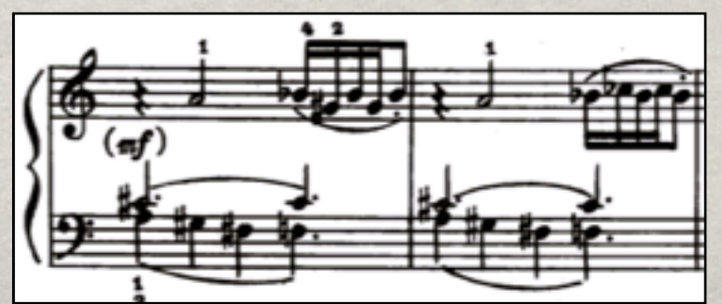


MK 152, m16-17 NB - LH in doubled note values

SS2



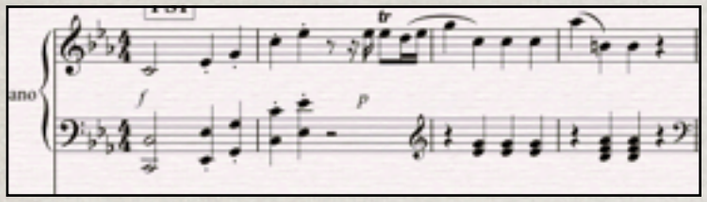
becomes



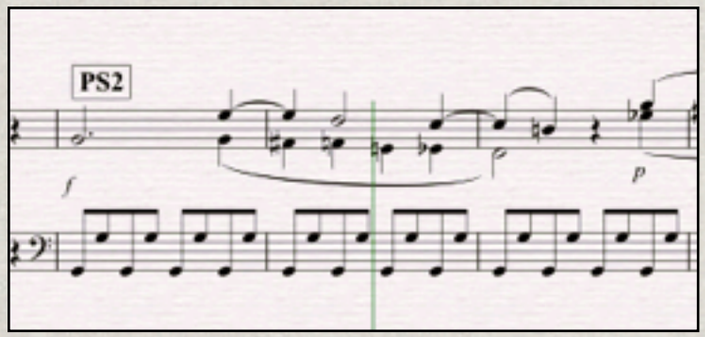
MK 152, m.25

Hybrid #3 - k.311

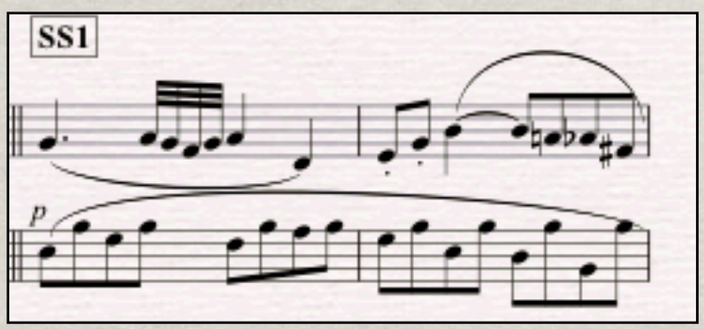
PS1



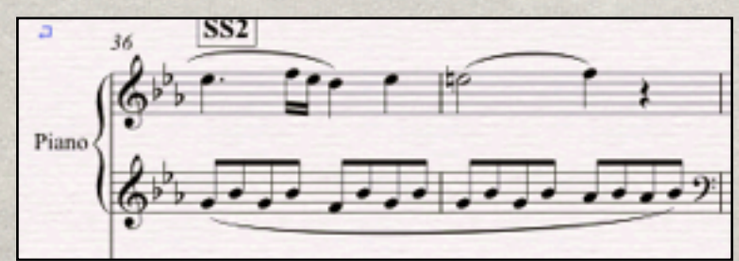
PS2



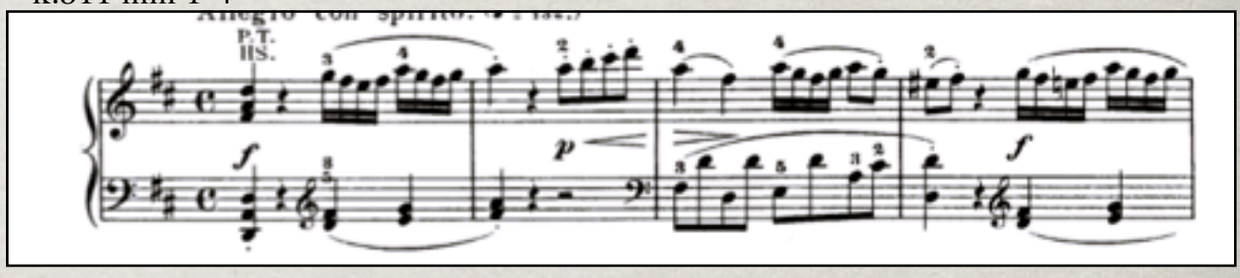
SS1

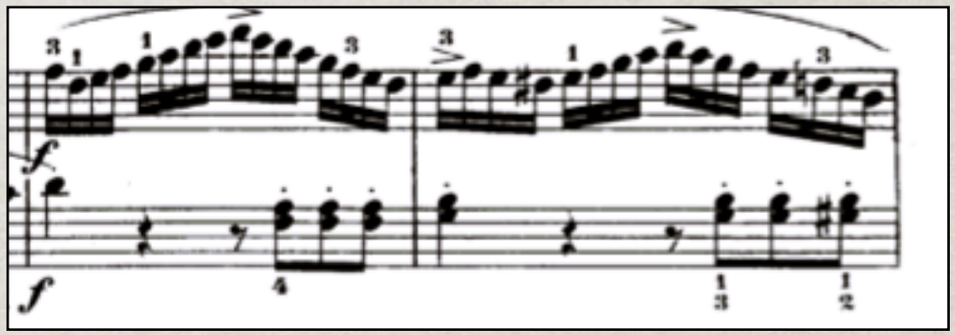


SS2



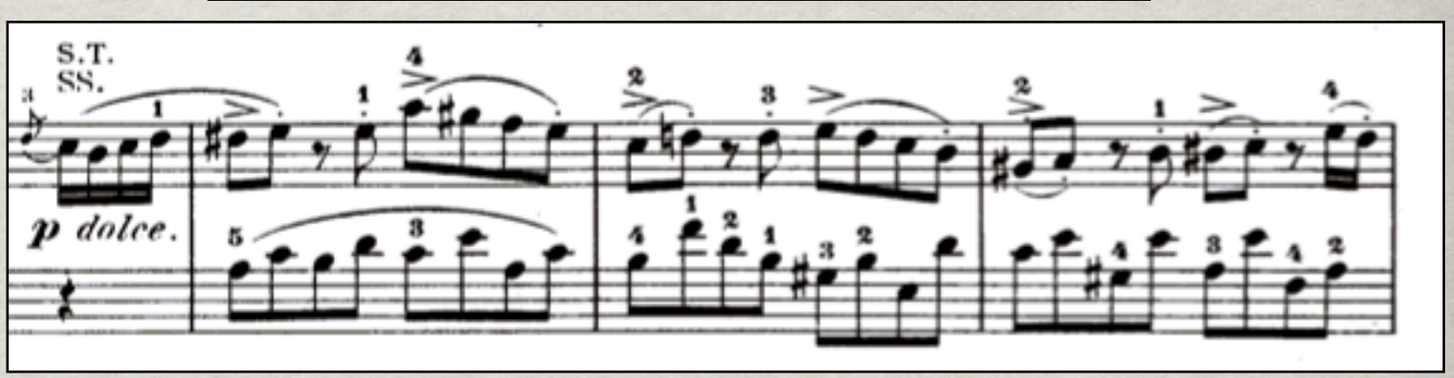
k.311 mm 1-4

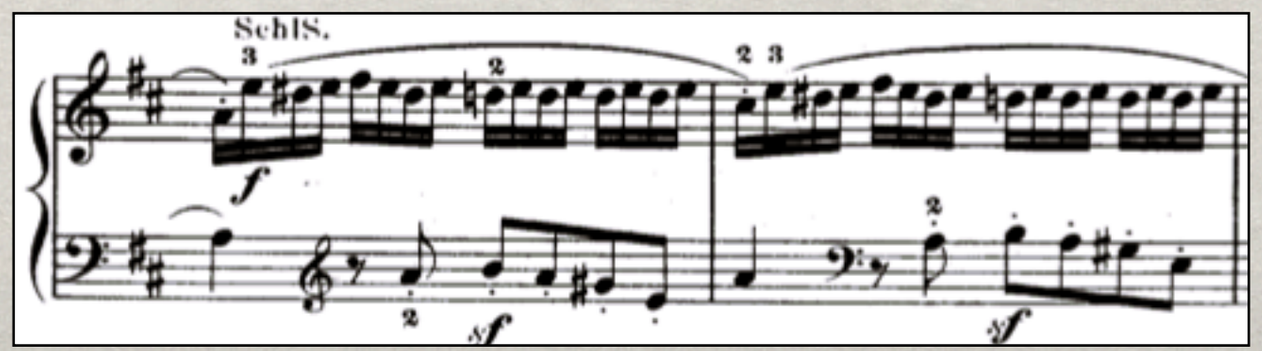




m12-13

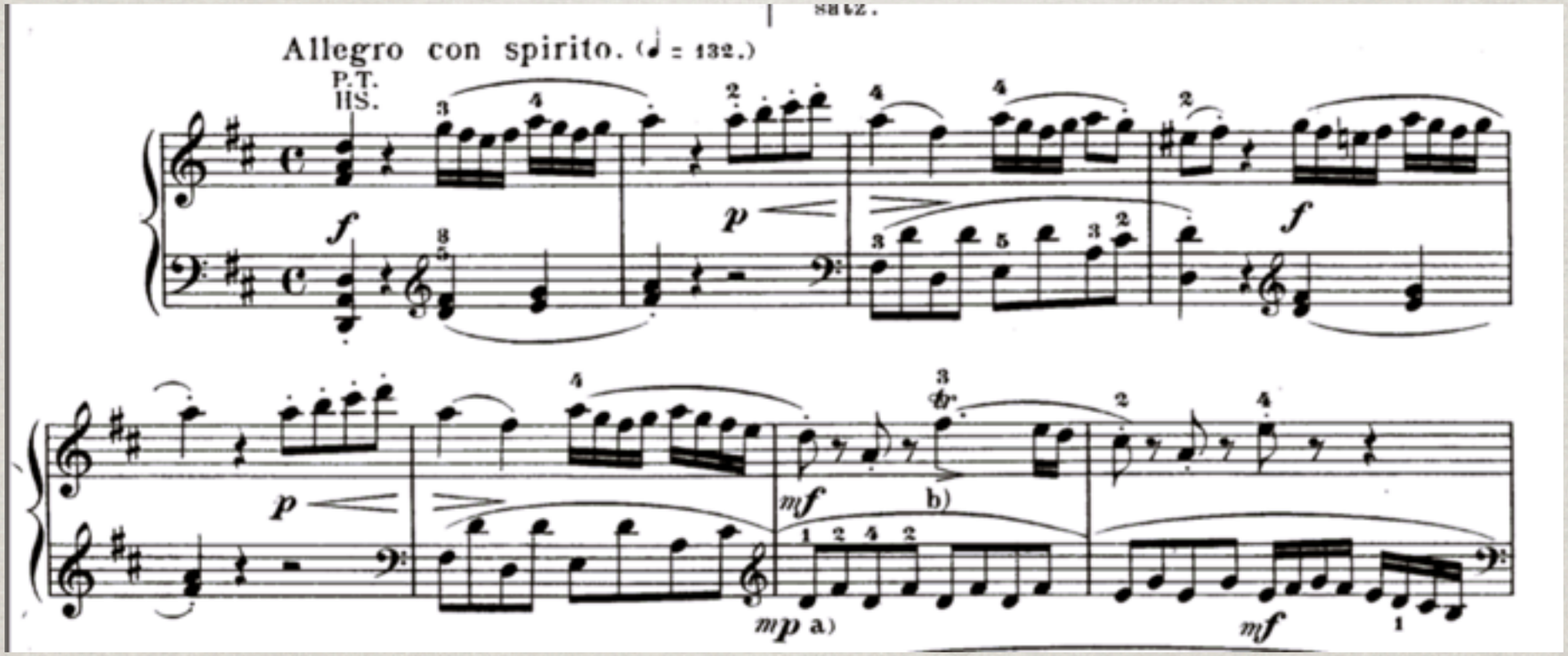
m17 ff





m 24-25

Hybrid #3 - k.311



- stylistically consistent with HS
- voice leading problems more evident
- shorter sonata has fewer and less elaborated themes