

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

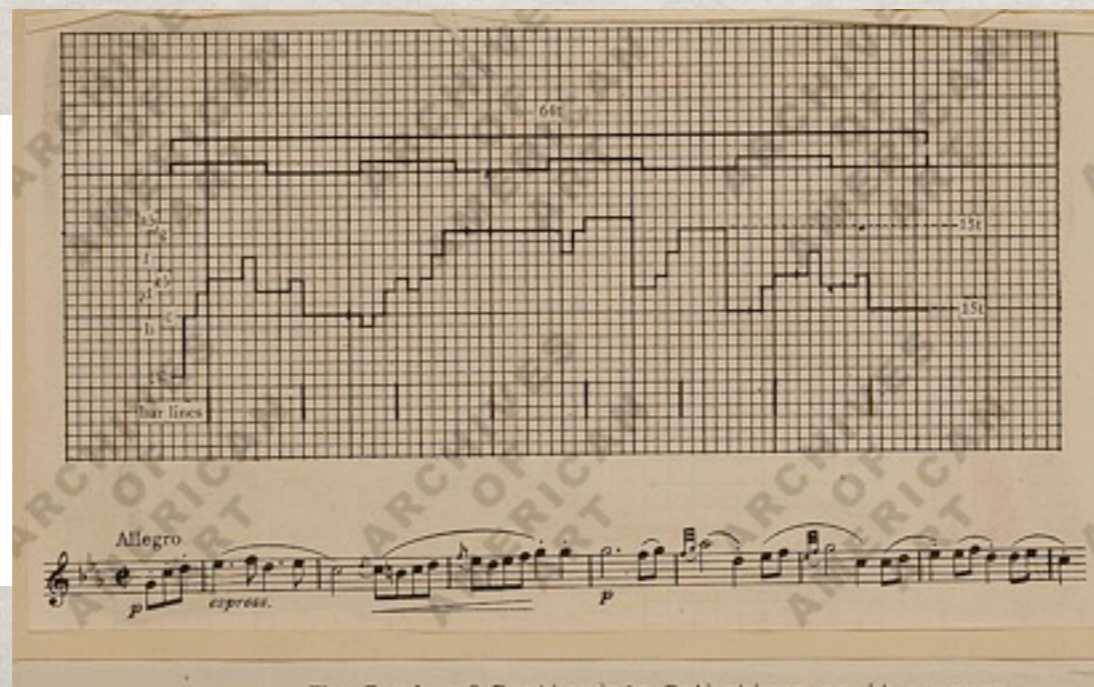
ALGORITHMIC MUSIC EXAMPLES

- 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 König - *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 the Performing Arts, Graz, Austria

HARMONICES VITAE (1999)

4th ***** HARMONICES VITAE RT BIRTHCHART DATABASE *****

Record #: 999 Full Name: Edit Text Edit Text

--- BIRTHDATE --- Time (EST) -- ----Ascendant----- Start Date: =Birthdate

Day	Month	Year	hr	min	Sign	deg	min		Day	Month	Year
31	3	1958	15	19	Virgo	29	59		31	3	1958

HARMONICES VITAE

Birth Chart:	View	Use this Chart
Moon:	Aries	10'30
Mercury:	Aries	10'30
Venus:	Aries	10'30
Sun:	Aries	10'30
Mars:	Aries	10'30
Jupiter:	Aries	10'30
Saturn:	Aries	10'30
Uranus:	Aries	10'30
Neptune:	Aries	10'30
Pluto:	Aries	10'30

REAL TIME CONTROL

Zodiac Key Wheel Automation
Prog. Moon: Aries 10'30

Transform/Tempo Automatation
Prog. Sun: Aries 10'30
Pentan = Aries 10'30

Planetary Dynamics

1.000 ppp Orb: (degrees)
 1.000 ppp 10.000
 1.000 ppp
 1.000 ppp Edit Transits...
 1.000 ppp
 1.000 ppp
 1.000 ppp
 1.000 ppp
 1.000 ppp
 1.000 ppp

Current Date-----
Day Mo. Year
31 12 1958

- 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

The image displays a musical score for Mozart's K457, specifically a voice leading reduction. The score is presented in two systems: "Piano" and "Red.". The "Piano" system shows the original piano accompaniment, featuring a treble clef with a key signature of two flats and a bass clef with a key signature of two flats. The music includes dynamics such as *f* (forte) and *p* (piano), and a trill (tr) in the final measure. The "Red." system shows the voice leading reduction, consisting of block chords in both staves. A vertical green line is drawn through the score, indicating a specific measure. A small box labeled "PS2" is located in the upper left corner of the Piano system. A blue dashed line separates the two systems.

Andantino MM. 1-10-40

Middleground 2

Foreground

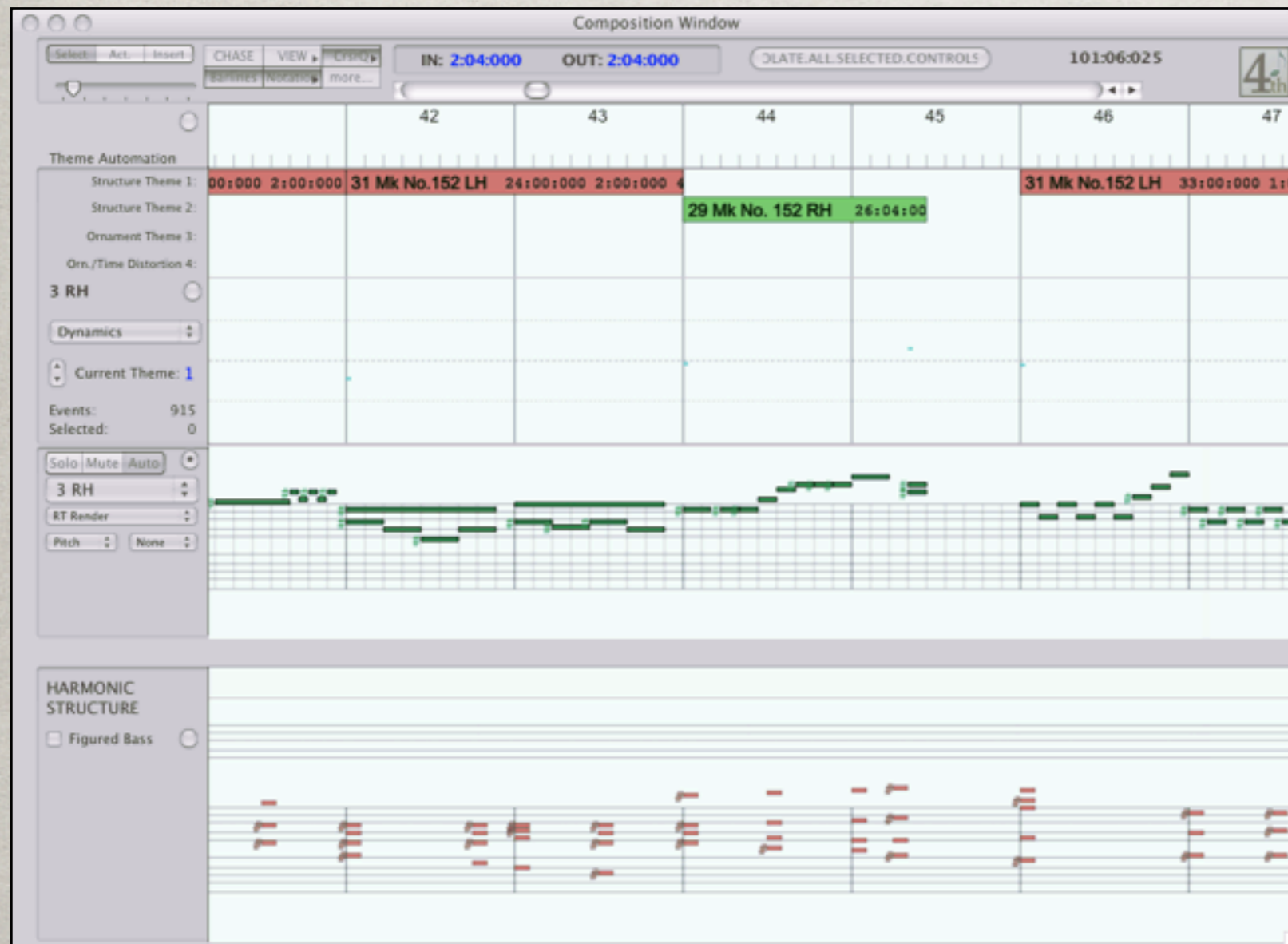
Chordal reduction

SCRIABIN, PRELUDE, OP. 15, NO. 4 SCHENKERIAN ANALYSIS AND VOICE LEADING REDUCTION

from:
Neumeyer and Teppig, *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

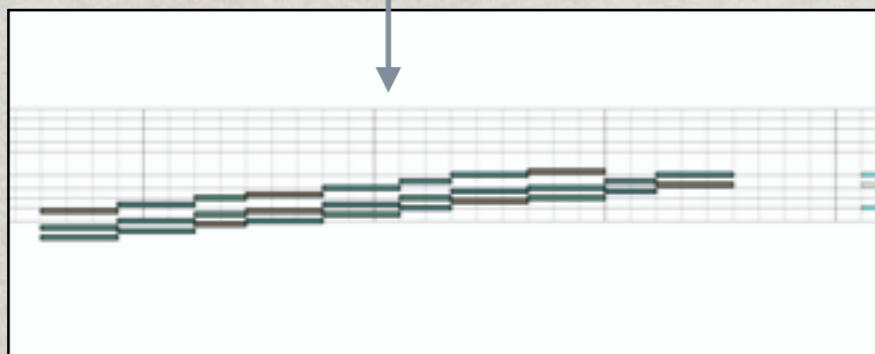
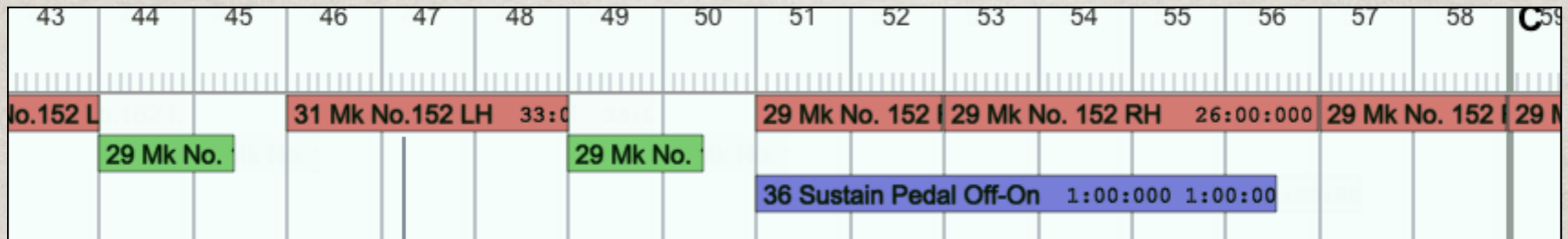
- ✿ *The Transformation Engine* is a software program which enables users to apply compositional transformations to musical information in realtime. Its aim is to extend and enhance the abilities of composers of instrumental music in the Western tradition of motivic and thematic composition

The screenshot displays the 'Composition Window' of the Transformation Engine software. The interface includes a menu bar (Select, Act, Insert), a toolbar with buttons for CHASE, VIEW, and CSPP, and a status bar showing 'IN: 2:04:000' and 'OUT: 2:04:000'. A timeline at the top shows measures 42 through 47. Below the timeline, there are several tracks for automation, including 'Structure Theme 1', 'Structure Theme 2', 'Ornament Theme 3', and 'Orn./Time Distortion 4'. The 'Structure Theme 1' track shows a red bar labeled '31 Mk No.152 LH' with time markers '00:000 2:00:000' and '24:00:000 2:00:000'. The 'Structure Theme 2' track shows a green bar labeled '29 Mk No. 152 RH' with a time marker '26:04:00'. The 'Orn./Time Distortion 4' track shows a '3 RH' control. Below the automation tracks, there is a piano roll view showing green notes and stems. At the bottom, there is a 'HARMONIC STRUCTURE' section with a 'Figured Bass' checkbox and a piano roll view showing red notes and stems.

- ✿ 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.

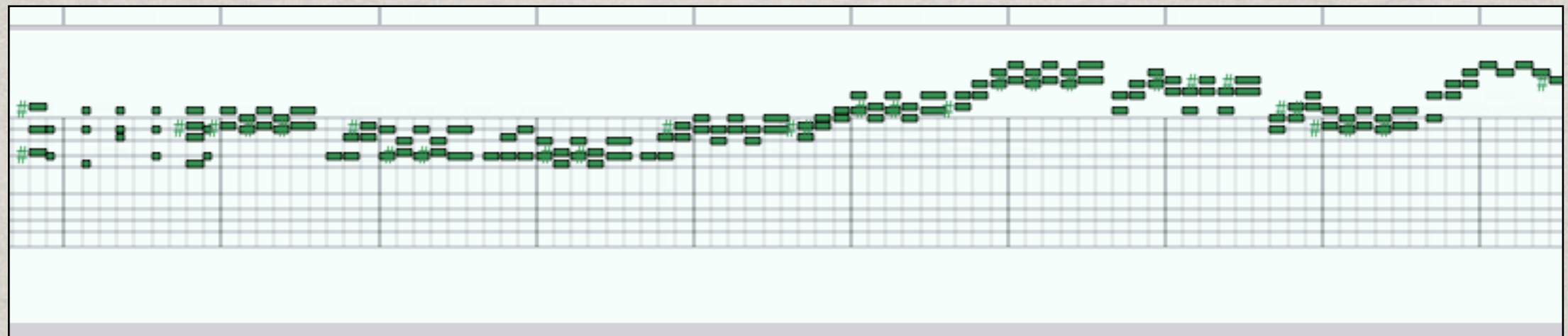


The image shows a software interface for displaying harmonic structure. On the left, there is a control panel with the text "HARMONIC STRUCTURE" and a checkbox labeled "Figured Bass" which is currently unchecked. To the right of the control panel is a musical staff with two staves. The notation consists of horizontal bars and vertical lines, representing the harmonic structure of the music. The notation is displayed in a schematic style, with some notes and accidentals visible.

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



- 29:00:00, 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?

The image displays two musical staves for the piece K.457, marked 'Allegro' and 'PS1'. The top staff is the original piano score, featuring a treble clef with a melodic line and a bass clef with a harmonic accompaniment. The tempo is 'Allegro' and the key signature is two flats. The score includes dynamic markings such as *f* (forte) and *p* (piano), and trills (*tr*) in the upper voice. The bottom staff is a harmonic reduction, showing the chordal structure of the piece in a simplified manner, with notes grouped into chords and stems. The tempo is also marked 'Allegro'.

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”

Tempo di marcia.

The image displays a musical score for the piano piece 'Maple Leaf Rag'. It is written in 2/4 time and marked 'Tempo di marcia'. The score is presented in two systems. The first system contains four measures, and the second system contains four measures. The music is in G major, indicated by one sharp (F#) in the key signature. The notation includes treble and bass clefs, a common time signature, and various musical symbols such as notes, rests, and dynamic markings like 'p' (piano) and 'r.h.' (right hand). The piece is characterized by its regular phrasing and simple harmonic language.

- ✿ 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

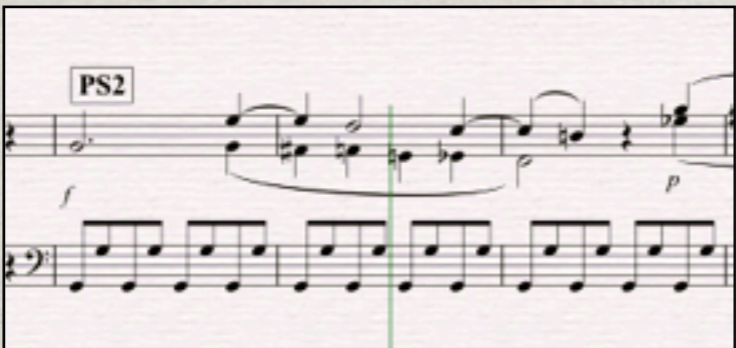


becomes



MLR, m-1-4

PS2



becomes



MLR LH, m-8-9

SS1



becomes

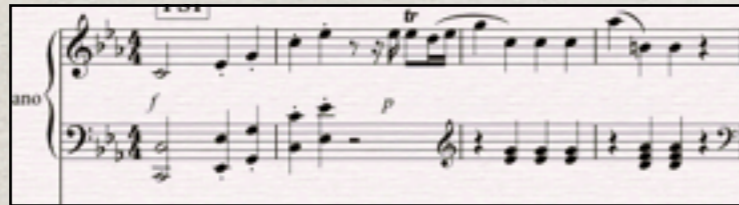


MLR, m-82-83 (TRIO)

MIKROKOSMOS 152

SUBSTITUTIONS

PS1



becomes

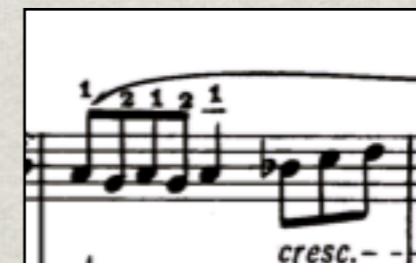


MK 152, m-1-4

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

Musical score for PS1, measures 1-4, piano part. The score is in G major, 4/4 time, and begins with a forte (f) dynamic. The right hand features a melodic line with grace notes, while the left hand provides a rhythmic accompaniment.

PS2

Musical score for PS2, measures 5-8, piano part. The score continues the piano part from PS1, marked with a forte (f) dynamic. The right hand has a melodic line with a crescendo leading to a piano (p) dynamic at the end of the phrase.

SS1

Musical score for SS1, measures 9-11, piano part. The score continues the piano part from PS2, marked with a piano (p) dynamic. The right hand features a melodic line with a slur, and the left hand has a rhythmic accompaniment.

SS2

Musical score for SS2, measures 12-13, piano part. The score continues the piano part from SS1, marked with a piano (piano) dynamic. The right hand has a melodic line with a slur, and the left hand has a rhythmic accompaniment.

k.311 mm 1-4

Musical score for k.311 mm 1-4, full score. The score is in G major, 4/4 time, and begins with a forte (f) dynamic. The right hand features a melodic line with grace notes, while the left hand provides a rhythmic accompaniment. The tempo is marked 'Allegro con spirito'.

Musical score for k.311 mm 12-13, full score. The score continues the full score from k.311 mm 1-4, marked with a forte (f) dynamic. The right hand features a melodic line with a slur, and the left hand has a rhythmic accompaniment.

m12-13

m17 ff

Musical score for k.311 mm 17-20, full score. The score continues the full score from k.311 mm 12-13, marked with a piano (p) dolce dynamic. The right hand features a melodic line with a slur, and the left hand has a rhythmic accompaniment. The tempo is marked 'S.T. SS.'.

Musical score for k.311 mm 24-25, full score. The score continues the full score from k.311 mm 17-20, marked with a forte (f) dynamic. The right hand features a melodic line with a slur, and the left hand has a rhythmic accompaniment. The tempo is marked 'Schl.'.

m 24-25

HYBRID #3 - K.311

Allegro con spirito. (♩ = 132.)

P.T.
HS.

f *p* *f*

p *mf* *mf*

mp a) *mf* b)

8142.

The image shows a musical score for a piece titled "HYBRID #3 - K.311". The score is in 2/4 time and consists of two systems of piano and violin parts. The tempo is "Allegro con spirito" with a metronome marking of quarter note = 132. The key signature has two sharps (F# and C#). The first system includes performance instructions "P.T." and "HS." above the piano part, and dynamic markings *f*, *p*, and *f*. The second system includes dynamic markings *p*, *mf*, and *mf*, and fingering instructions "a)" and "b)". The score is numbered "8142." in the top right corner.

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