

DETERMINATIONS:

A COMPOSITION FOR TENOR TROMBONE AND DIGITAL AUDIO

A THREE HOUR CREATIVE PROJECT

SUBMITTED TO THE GRADUATE SCHOOL

IN PARTIAL FULLFILMENT OF THE REQUIREMENTS

FOR THE DEGREE

MASTER OF MUSIC

BY

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I. Introduction

Background Information

There are fundamentally four aspects of sound that can be manipulated – pitch, timbre, volume, and time (rhythm). In order to represent a piece of music, more information has to be expressed than just a list of pitches, timbres, volumes, and durations. Such a list would include vertical sonorities, articulations, vibrato, sharpness of attack, or any of the many more quantities that musicians and composers can manipulate. Nevertheless, a list of only the four fundamental parameters, or, indeed, only some of them (e.g. just a list of pitches) can provide a composer with enough raw material to compose a piece of music. Computers also can manipulate these parameters, but require a set of rules – an algorithm – to control exactly what way the value of each parameter will be determined. When working with computer algorithms to facilitate musical composition, it is the job of the composer to devise a system that will map these musical parameters onto the numerical output of the computer algorithm.

In the 20th century, the serial techniques employed by Arnold Schoenberg foreshadow the computer-aided methods that would come later. The initial ordering of tone rows was determined by the composer, but the manipulations (transposition, inversion, retrograde, and retrograde inversion) performed on the rows hint at the sort of deterministic algorithm that can easily be performed by a computer. In the 1950s Iannis Xenakis noted that another way to achieve the uniform pitch distribution of serial music

was through stochastic (chance) methods - another area in which computers can easily perform more quickly than humans. As digital computers have become more common since the 1970s, the number of computerized composition systems has greatly increased, and the algorithms used have become more sophisticated.

Literature Review

Xenakis' book *Formalized Music* develops a notation for music that is taken from mathematics and outlines the Markovian processes used by many composers in their compositional algorithms.¹ Markovian chains formed the basis of the algorithms that Lejaren Hiller used to generate pitch, duration, and volume information for his work *Illiad Suite*, the first work composed entirely by computer.²

Roads surveys types of algorithms used by composers: linked automata, cellular automata, stochastic processes, chaos generators, pattern matching techniques and neural networks.³ These algorithms are used to generate data, but they are independent of parameter mapping done by the programmer. Rowe discusses several filters that will generate new musical material from an input list and discusses which parameters each of the filters manipulates.⁴ Although these transformations can be classified into the four broad categories mentioned above, each transformation has unique characteristics that

¹ Iannis Xenakis, *Formalized Music*, rev. ed. Harmonologia Series No. 6 (Stuyvesant, NY: Pendragon Press, 1992).

² Lejaren Hiller, "Music Composed with Computers – A Historical Survey," in *The Computer and Music*, ed. Harry B. Lincoln (Ithaca, NY: Cornell University Press, 1970), 42-96.

³ Curtis Roads, "Representations and Strategies for Algorithmic Composition," in *The Computer Music Tutorial* (Cambridge, MA: MIT Press, 1996), 853-909.

⁴ Robert Rowe, *Interactive Music Systems* (Cambridge, MA: MIT Press, 1993), 166-185.

will make it more useful for some purposes. Winkler also discusses objects that can generate new musical material. He further discusses techniques for analyzing music in order to produce the input to the objects that are able to transform it.⁵

After generating a set of notes (e.g. an arpeggio), this set of notes can be manipulated as a single unit. Langston describes software that manipulates units larger than just a single pitch. His IMG/1 is a software system that will compose incidental music in a specified style. IMG/1 will compose a chord progression with a specified rhythmic density, then compose a melody to play over the chords, all in a particular chosen style.⁶

⁵ Todd Winkler, *Composing Interactive Music: Techniques and Ideas Using Max* (Cambridge, MA: MIT Press, 1998).

⁶ Peter S. Langston, "IMG/1: An Incidental Music Generator," in *Computer Music Journal* 15, no. 1 (Spring 1991): 28-39.

II. Method

Determinations was composed using a combination of basic materials chosen by the composer, algorithmic techniques implemented using a computer, algorithmic techniques implemented by the composer, and freely-composed material that has no known algorithmic basis. The computer algorithms were implemented with Cycling '74's Max/MSP software. The sounds for the digital audio portion of the composition were assembled using MOTU's Digital Performer and Propellerhead Software's Reason. Notation was accomplished with Makemusic's Finale software.

The pitch set used in *Determinations* was chosen by the composer. Likewise, the overall form was decided upon by the composer based upon esthetic decisions not rooted in algorithmic thinking. Aspects such as timbre, register, tempo and the host of other details that make up a piece of music were choices that were also left to the intuitive sense of the composer. The computer-implemented algorithms were used to generate melodic material (both pitches and rhythms) and harmonic material.

III. Discussion

What follows will discuss the points outlined in the Method section. A description of the pitch materials that were chosen for *Determinations* and the overall form will address the decisions made by the composer. A description of the computer-based procedures used to determine the specific pitch material (both melodic and harmonic) will address the algorithmic components. Finally, a brief description of the role of Digital Performer and Reason software will complete the Discussion.

Basic Materials

The basic pitch material for *Determinations* has its origin in the technical constraints of the tenor trombone. The notes E and B-flat are the two principal pitches in the composition, the E arising from the lowest pitch on the instrument, with the slide completely extended, and the B-flat being a tritone above when the slide in all the way in. The tritone was divided using the simple sequence 3, 2, 1. So, starting from E and going up 3 semitones yields the note G, going up 2 semitones from G yields A, and going up 1 semitone from A yields B-flat. To complete the octave, a mirror image of this series was used: going up 1 semitone from B-flat yields C-flat, going up two semitones from C-flat yields D-flat, and going up 3 semitones from D-flat returns to E. The six-tone scale E, G, A, B-flat, C-flat, D-flat, (E) provides the primary pitch material for *Determinations*.

Since the tritone divides the octave into symmetrical halves, it implies no tonal relationship. The asymmetrical division of the tritone was used in order to provide some sort of tonal element to the piece. Since the sequence mirrors itself around the note B-flat; however, there is still ambiguity inherent in the pitch collection. This mirror point was exploited for melodic development, explained below.

Overall Form

The tritone interval is reflected in the structure of the piece through a broad tonal relationship. The piece is not traditionally tonal through the function of harmony, but the notes E and B-flat are reinforced as tonal centers through melodic repetition of these pitches. E can be considered the tonic, as it is the pitch that begins and ends the piece; while B-flat can be considered the dominant, that is, the pitch that the piece moves to, and then returns from.

In terms of large structure, *Determinations* is in five sections: an introduction, a section consisting of melodic material over a sustained chord accompaniment, a section consisting of melodic material over a repeated 16th-note accompaniment, a short cadenza, and a coda that recalls the introduction. The introduction establishes the note E as a tonic and B-flat as a dominant. In the next section, over the sustained chord, the tonal center switches to B-flat (in system 10), and remains on B-flat, except for a short phrase in E in the first half of system 17, until the coda. The piece ends on E.

The accompanying material in systems 6 through 12 starts on the pitches E and B-flat. As the section progresses, A is added, then G is added. The section ends with a sustained harmony built up of all the pitches of the lower half of the scale. In the

rhythmic section, systems 13 through 20, there are four parts, each using a different histogram to generate notes chosen from all 6 notes of the scale. As the section begins, the accompaniment is centered on E, while the soloist remains centered on B-flat. As the section progresses, the four lines change, one by one, to a harmony centered on B-flat.

Algorithmic Components

Patches were written in Max/MSP to generate strings of pitches using the scale described above. Melodic figures were generated from a patch that used a histogram to weight the probability of randomly selected scale degrees (see Figure 1). That is, a table was produced whereby each note of the scale over a two-octave range was assigned a number. This number represented the probability that that note would be selected. The higher the number assigned a certain note, the higher the probability that it would be selected. Four different tables were used to generate strings of note. The main difference between them was the probability that the note in the center of the range would be selected. These series of notes were used directly, without modification, in the rhythmic accompaniment in systems 13 through 20. The composer clicked on the “Scale centered on Bb” message in the patch to transpose the scale from E to B-flat (see Figure 1).

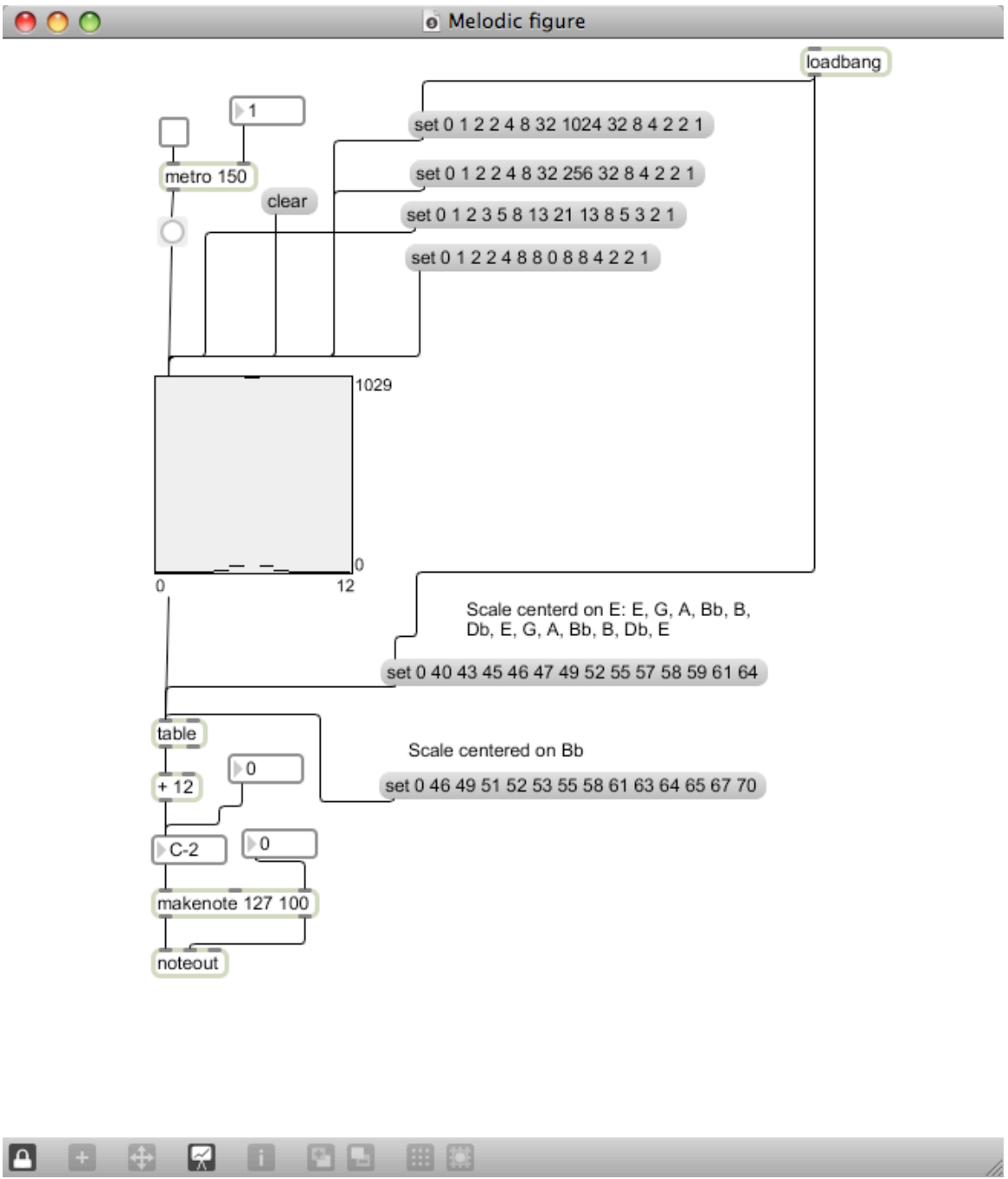


Figure 1: Max/MSP patch used to generate melodic material

Though this patch is slightly different, it also used a table to assign probabilities to certain notes, which are then selected at random. For the accompaniment patch, the composer could generate notes of the following sets: (E, B-flat), (E, A, B-flat), and (E, G, A, B-flat). All notes within a set had equal probabilities of being selected. The patch also contained logic to change attack times from 5000 ms to 200 ms over the course of 30 seconds and to assign notes randomly to either the left or the right channel.

One last algorithmic procedure was not implemented with the computer. Since the scale used in *Determinations* was symmetrical around both E and B-flat, this symmetry was exploited to generate new motives from transposed material. In the original scale, the note B-flat has intervals of a minor second, a minor third, and a tritone both above and below, producing all the pitches of the scale. Material that has been transposed from a tonic of E produces the symmetrical intervals of a minor third, a perfect fourth, and a tritone both above and below B-flat. The intervals of the original scale were sometimes used in transposed material. One example is in the first eight beats of system 14 (see Figure 5), where the first four beats are a motive transposed from an E tonic, and the second four beats are the same material transformed to the original scale.



Figure 5: Transformation of melodic material

Digital Performer and Reason

Reason was used as the primary sound generating software for *Determinations*. Trombone samples from the University of Iowa Musical Instrument Samples were used in several NN-19 samplers in Reason. A synthesized tone from a Subtractor synthesizer was also used, along with reverb and EQ effects. Digital Performer was used as sequencing software to generate data providing the Reason synthesizers with pitch, volume, and rhythmic information, as well as automation of some of these and other parameters. Digital Performer was also used to manipulate the sound of the trombone accompaniment in systems 6 through 12, pitch shifting the audio file generated from Max/MSP and Reason.

IV. Conclusion

This creative project focused on the composition of a work for tenor trombone and digital audio, integrating algorithmically determined, computer-generated melodic and harmonic materials. The use of computer music methods enabled the composer to expand upon the sound of the acoustic instrument as a source, surpassing its constraints in register and developing new timbres and phrase structures that are not possible acoustically. Though the materials were generated algorithmically, the composer maintained control of the work by selecting only material that was deemed appropriate, and combining it in non-algorithmic ways. The composition *Determinations* is the result of this effort.

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Appendix: Score of *Determinations*

Determinations

by Harold Walls

Performance notes:

Tempo is flexible throughout, but events should occur in the same order as they appear left to right in the score.

Vertical dashed lines denote events that should be synchronous.

Breath marks denote pauses. The duration is up to the performer, but they are not intended to be long pauses.

The CD is divided into 5 tracks:

Tracks 1 - 4 contain the digital audio for performance

Track 5 contains a midi realization of the piece with a synthesized solo part

During performance, tracks 1-3 run continuously without pause.

Score

Determinations

Harold Walls

Trombone

Digital Audio

2

* - cup mute, + - closed, ○ - open

3

Cue #1: Begin CD track 1

4

5

6 A

mf

0 s 5 s 10 s

7

Random order

8

f 54 s

Random Order

9

10

70 s

Random Order

11

84 s

Pitch Shift

12

ff *p*

13 **B** *accel.*

$\text{♩} = 100$

14 $\text{♩} = 100$

mf

15

mf

16

cresc. poco a poco

This system contains measures 16 and 17. The top staff is a bass clef with a melodic line of eighth notes, grouped by a slur and a comma. The bottom staff is a grand staff with piano accompaniment. A bracket highlights the piano part in both staves.

17

This system contains measure 17. The top staff continues the melodic line from measure 16. The bottom staff continues the piano accompaniment. A bracket highlights the piano part in both staves.

18

This system contains measure 18. The top staff continues the melodic line. The bottom staff continues the piano accompaniment. A bracket highlights the piano part in both staves.

19

ff

Thicker texture in digital audio

This system contains measure 19. The top staff continues the melodic line. The bottom staff continues the piano accompaniment. A bracket highlights the piano part in both staves. The dynamic marking *ff* is present.

20

fff

Cue # 2: Let digital audio play until sound stops, then cue to track 4

This system contains measure 20. The top staff continues the melodic line. The bottom staff continues the piano accompaniment. A bracket highlights the piano part in both staves. The dynamic marking *fff* is present.

C cadenza

21

ff

22

gliss.

f *mf*

Cue # 3: Begin CD track 4

23

mp *f*

15^{ma}