Music Learning - Compositional Thinking

Gary Greenberg
Northwestern Computer Music
School of Music, Northwestern University
Evanston, Illinois 60208
(312) 491-3895/5431

ABSTRACT

This paper discusses work being done at the Northwestern University School of Music using the computer to develop compositional approaches to earning about music. Deluxe Music Construction Set, a music notation program, is used to enhance traditional approaches to working with a piece of music. Compositional tools written in Object LOGO are used by students to re-construct and manipulate a piece, then to compose their own compositions using the piece as a model. Working at the computer enables students to address important musical issues directly, without previous composition or keyboard experience.

I. ISSUES AND CONCERNS

Compositional processes have traditionally been an important part of a musician's training. When musical styles were relatively stable, stylistic composition brought musicians up to date and prepared them for involvement in contemporary musical life. As musical styles diversified and mutated, composing as an approach to earning about music became increasingly difficult. One approach to dealing with the growing variety and complexity of music has been to codify aspects of a style into compositional rules. These rules have provided a starting point for using the computer as a personal tool that checks the student's work for errors and that can provide assistance when the student encounters a problem. One concern about this type of computer-assisted instruction is whether learning how to follow a set of rules properly actually promotes the intended musical insight and experience. Equally important, one might wonder about the broad consequences of perpetuating an approach to earning about music that, except for certain music specialists, is becoming increasingly irrelevant to many who are genuinely interested in expanding their own musical knowledge.

Rather than use the computer to support an approach to earning about music based on an existing "paper and pencil" technology, computer music composition provides a model for how the computer can be an integral part of the learning process itself. At the computer, the composer must describe explicitly the musical events to be created. The composer then compares the computer's response with his/her intentions, reflecting on new insights and musical possibilities suggested by the performance. The ongoing evolution of musical ideas and understanding is the result of the composer's reaction to the feedback provided by the computer. As the composer, students are able to work more like composers, relying on their own evolving musical expertise as a framework for their decisions. Rather than follow a set of seemingly arbitrary rules, students themselves are ultimately responsible for their work.

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2. MUSICAL RESOURCES

2.0 Practical Concerns

Today's affordable personal computers and commercially available software that can play a
digital synthesizer via MIDI interface make it possible to support a compositional approach to
learning about music without the resources of a sophisticated computer music studio. At
Northwestern University's music students are able to use the University's Macintosh Lab, a network
of 28 Macintosh SE computers, with digital synthesizers and sound equipment provided as part of a
grant from the United States Department of Education's Fund for the Improvement of
Postsecondary Education (FIPSE) and with funds provided by the Deans of the School of Music.
This makes it possible for an entire class to meet together for hands-on experience and to use the lab
for out-of-class assignments and projects. The hardware and software can be easily replicated in
student dormitories or by individuals at home, providing students with a variety of options for
where they can work.

2.1 Music Notation

Deluxe Music Construction Set (DMCS), a music notation program that supports eight
channels of MIDI, is used to enhance traditional approaches to dealing with music. It relieves
the need for keyboard skills and requires only basic score reading ability to be able to work effectively
with a piece of music. Students learn how to use DMCS gradually over the course of analysis and
compositional assignments. At the computer, the student can work more like an experienced
musician, selecting sections of a piece to play and making adjustments to tempo and dynamics to
bring out specific features of the piece. DMCS enables students to easily make changes and
adjustments in the score and to try a variety of "what if" situations.

2.2 Compositional Tools

A music programming environment written in Object LOGO (Kramoski, 1986) provides
compositional tools that students can use to rearrange and manipulate a piece, thereby to compose their
own composition using the piece as a model. The music environment is modeled after Music
LOGO, developed by Jesse Hausberger at MIT (Hausberger, 1990), for the clarity of its musical
approach. LOGO, a friendly version of LISP, is easy to use and was developed with educational
concerns in mind. An interpreted language, LOGO allows for real-time exploration and
eperimentation of ideas. A MIDI implementation developed by Stephen Hain at Corel Software
provides access to a digital synthesizer for higher quality sound. The hierarchical organization
supported by LOGO procedures is especially appropriate for capturing aspects of musical
structure. It also allows one to make changes at any structural level without having to rewrite the
entire piece. Working with a higher-level programming language makes it easy to modify the music
environment or its compositional tools to suit students' evolving needs. While students only need to
know how to use a few music primitives and compositional tools, how to write procedures and
save/load their work on diskettes, they can quickly learn new programming skills to address musical
issues as they emerge. They can continue to use the environment as a musical resource on their
own or in other courses where the environment now supports the first quarter of a three-quarter
computer music sequence (Greenberg, 1988) and an introduction to compositional programming
(Greenberg, 1988).

3. TWO PROJECTS

3.0 A Compositional Model for Learning

The compositional approach to learning about music being developed begins with an encounter
with a piece that raises musical issues. Then, the computer is used to support analytic activities and
to explore and develop issues raised during class discussion. Having looked at the piece from
different perspectives, students develop a model that is used as a basis for composition. The
following are two example projects being developed for the first year of a two-year Musicianship

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3.1 Exploring Musical Process: J.S. Bach, Invention #13

Baroque counterpoint is a subject usually reserved for more advanced courses. However, aspects of baroque music, specifically the role of imitation, can be easily supported by the computer. The Inventions of J.S. Bach provide a good source of examples with which to work. Students can begin by listening to a number of Inventions and extract general features shared by the pieces in order to establish a model for what an Invention is. Then, students are ready to focus attention on a single piece for closer examination and analysis. Invention #13 is a piece one might decide to work with.

One of the most important features of the opening is the imitation between the upper and lower voices. The piece begins with two statements of the first theme in the upper voice, echoed each time an octave lower. Then, a second theme is stated three times in the upper voice, moving down by step. Each time the second theme is stated, it is echoed a Perfect 11th higher. The step-wise descent in the upper and lower voices continues more quickly with half of the second theme repeated three times, each time echoed a Perfect 11th (P5) below in the lower voice. Finally, the opening theme returns, but now it returns in the lower voice and is echoed an octave higher by the upper voice. Students can create a listening exercise that describes in words the processes that begin the piece. They can then turn to the music itself for more details to complete their description.

<table>
<thead>
<tr>
<th>Upper Voice</th>
<th>Lower Voice</th>
</tr>
</thead>
<tbody>
<tr>
<td>REPEAT 2 times (First Theme E(6)</td>
<td>First Theme E(1)</td>
</tr>
<tr>
<td>REPEAT 2 times (Second Theme E(3)</td>
<td>Second Theme E(4)</td>
</tr>
<tr>
<td>(shaped by step)</td>
<td></td>
</tr>
<tr>
<td>REPEAT 3 times</td>
<td>Half Second Theme G(9)</td>
</tr>
<tr>
<td></td>
<td>Half Second Theme E(1)</td>
</tr>
<tr>
<td>(continue descent to E(7)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Lower Voice</td>
<td>Upper Voice</td>
</tr>
<tr>
<td>-------------</td>
<td>-------------</td>
</tr>
<tr>
<td>REPEAT 2 times (Other First Theme G(6)</td>
<td>Other First Theme G(6)</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Students can make this hearing of the opening explicit by orchestrating it using DMCS. For example, they might change metre with each of the first three themes and then bring back the opening time when the first theme returns.</td>
<td></td>
</tr>
</tbody>
</table>

Students can now test their model by creating a computer description of the opening of the piece. First, students teach the computer how to play each of the thematic units by writing a
LOGO procedure. The Play music primitive takes a list of pitches and a list of durations as inputs and plays the first pitch with the first duration, then the second pitch with the second duration, and so on until one of the lists is empty. Integers are used to represent pitches and relative durations (Bamberger, 1986). To simplify the problem and focus on the musical processes of the description, the accompaniment to the thematic material is ignored.

```
To J3B.FirstTheme
   Pitch [1,1,2,8,7]
To J3B.SecondTheme
   Pitch [1,1,2,1,2,3]
End
To J3B.OtherFirstTheme
   Pitch [2,3,2,1,7,2,1]
To J3B.OtherSecondTheme
   Pitch [1,1,2,3,7,1]
End
```

Students can then use these melodic fragments as inputs to the Echo music primitive. Echo needs an input for the NAME of the procedure that plays a theme, the INTERVAL updown at which to answer the theme, the NUMBER of times to repeat this echo, and then the INTERVAL updown to move between each echo.

```
To Echo echoTheme EchoInterval NUMBEROfEchoes StartingStartingEchoes
```

Students use their procedures that play the thematic material from the opening of the Invention win with the Echo procedure to test their description of the piece.

```
To Opening
   ECHO "J3B.FirstTheme" 1 2 0
   ECHO "J3B.SecondTheme" 1 2 1
   ECHO "J3B.OtherSecondTheme" 1 3 1
   ECHO "J3B.OtherFirstTheme" 1 2 0
End
```

The Opening procedure generates a good approximation of the first eight measures of Invention #1. This description can now be generalized by a single procedure named Invention13 that maintains the musical processes and relacionality of the opening, but has placeholders for the specific thematic material as inputs.

```
To Invention13 EchoTheme SecondTheme HalfSecondTheme OtherFirstTheme
   ECHO "Opening" 1 3 2
   ECHO "OpeningTheme" 1 3 1
   ECHO "OpeningTheme" 1 3 1
   ECHO "OtherFirstTheme" 1 2 0
End
```

Recreating the opening of the Invention is now simply a matter of giving the procedure Invention13 the proper procedure names as inputs.

```
I Invention13 "J3B.FirstTheme" "J3B.SecondTheme" < a LOGO command
     _ "J3B.HalfSecondTheme" "J3B.OtherFirstTheme" < the command line continues
```

The challenge for students is to now create a new invention using their own thematic material as inputs to the invention13 procedure. They soon discover that Invention13 by itself does not guarantee an effective opening. To develop a better understanding of the model they are working with they need to look more closely at the original piece. One way of gaining further insight is to simplify the upper and lower voices to determine the structural melodic pitches of the processes described in the Invention13 procedure. Students work in DMCS where they can play the piece and their reduction together. Using dynamics and instrumentation, they can hear either the piece or its reduction in the foreground and confirm for themselves the analytic implications of their reduction. Students can reduce the opening of the piece to block chords or include a roman numeral analysis to clarify the harmonic progression that supports the melodic process.
The melodic and harmonic reductions provide the student with structural pitches to ornament, and with a harmonic progression to elaborate. Using this as a framework for creating their own thematic materials, a student might write the following procedures:

To MyFirst
P5 [4 1 6 7]
End

To MySecond
P5 [5 1 2 3]
End

To MyOtherFirst
P5 [5 4 2 3]
End

To MyHalfSecond
P5 [7 4 2 3]
End

These new procedures can be used as inputs to Invention13 to generate the opening of a new piece.

Invention13  "MyFirst" "MySecond" "MyHalfSecond" "MyOtherFirst"

The student might hear that something sounds awkward when the procedures MySecond and MyHalfSecond are ECHOed in Invention13. These procedures can be edited and the problem notes moved up or down until they sound better when used with Invention13. The student can also compare these procedures with the harmonic and melodic reduction and notice that the third note of MySecond and no second note of MyHalfSecond violate the intended harmony of the reduction. Working by ear as well as with analytic insights, the student can try alternative procedures:

Invention13 can be used to determine which version sounds better:

Invention13  "MyFirst" "MySecond" "MyHalfSecond" "MyOtherFirst"

Having debugged the opening of the piece, the student can write a procedure to begin his/her Invention:

To MyInversion
Invention13 "MyFirst" "MySecondBetter" "MyHalfSecondBetter" "MyOtherFirstBetter"
End

Throughout the project, students are compelled to use analytic insight and their own musical experience as a basis for making decisions. While every piece created is very much each student's own work, what is particularly interesting is how all of the compositions in a class are related to
each other as variations on the same musical processes. Students are now ready to look at the piece as a whole to discover the consequences of the processes they are now quite familiar with. Knowing the opening of this piece well also makes them curious about the processes that initiate other inventions. In addition, students can use the computer to invent their own musical processes and relationships as a framework for original compositions.

3.2 Exploring Musical Structure: Anton Webern, Variations for Piano, Op.27 #2

Contemporary music provides exciting new possibilities for music education. While students' lack of familiarity with new music can make it difficult for them to deal with pieces in a significant way, this unfamiliarity can be taken advantage of to engage students more actively in the process of learning about a piece. The second movement of Anton Webern's Variations for Piano Op. 27, for example, is a piece that most students have probably never heard. Their initial reaction to it might well be one of confusion and possibly disinterest.

Rather than starting with the piece as a whole, one can break it up into melodic fragments or tuneblocks using LOGO. These tuneblocks can be played at the computer by typing the tuneblocks names in any order, any number of times. This approach builds on the work of Jonne Bamberger at MIT using tuneblocks to explore intuitive models of music (Bamberger, 1977; Bamberger and Brody, 1984).

Before students hear the piece itself, their first project is to use all of the Webern tuneblocks at least once to create a piece they like. This gives students the opportunity to work with the material of the piece on their own terms and in a context where there are no right or wrong answers. Students often find it useful to begin by grouping similar tuneblocks together. They realize, for example, that both Ted and Liz play chords. Tom, Kip, and John all have grace notes. Kip and Liz are the loudest tuneblocks and that Jane and Tom both repeat a note. These observations help students simplify the problem of dealing with the fifteen tuneblocks as they develop their own strategies for building a tune. Some students might see the similarities they discover between tuneblocks to structure their pieces around variations, while other students might create a tune by connecting different types of pitch contours they have identified into extended melodies. Students are usually surprised at how each piece achieves a unique character and how tuneblocks that they used in one way, function quite differently in another student's piece.

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Once students are well-acquainted with the tunelocks, they are provided with the original piece in Object LOGO as a model to reconstruct using the tunelocks. Hearing the tunelocks; they have come to understand in their own way now in a very different musical context forces them to reconsider many of their initial assumptions and imperatives. In addition to capturing the simple repetition, students use procedures and orchestrations to reflect their hearing of the piece's structure.

With a procedural description of the first half of the movement, students can use the categories and relationships they developed while working on their own piece to experiment with the structure of the original. For example, they can listen to what happens when related tunelocks are substituted for each other. They might switch Ted and Liz, which both play chords.

Or, they might have Tim, Kip, and Jon, which all play grace notes, exchange places.

They could also explore what happens when the repeated A's in June or Tom are repositioned in the piece.

Now that students are familiar with the piece, they can work with it in standard music notation using DMCS. While this new representation may not be congruent with their image of the piece.
that has evolved from using the tuneblocks. It provides a different perspective for working with the piece. One thing that is not immediately obvious, even with notation, is the canon between the upper and lower voices. Even less obvious is the canon’s twelve-tone melody. To change the way students hear the piece from a succession of melodic fragments to the ongoing imitation between two voices, they can use dynamics and orchestration in BMCS to help them hear the two separate lines.

This new description of the piece can be captured in an Object LOGO procedure that requires a list of twelve pitches as an input which is applied to the rhythmic structure of the piece to generate the canon. The procedure WebemVar will recreate the opening of the piece when given Webern’s opening row.

? WebemVar [10 9 1 11 2 0 6 5 4 0 7 3]

Students can then use this procedure to create their own variations on the Webern by experimenting with new themes (serial or not) and by listening to how this influences the coherence of the piece.

? WebemVar [10 9 0 11 2 8 3 6 1 7 5 4]

Webern’s Variations for Piano is a piece that would normally be difficult for first-year music students to deal with. As the computer, students can become engaged in meaningful musical activities that encourage them to hear and to think about the piece in different ways. Instead of being told information about the piece that may seem arbitrary or irrelevant, by manipulating the music themselves, students are able to come to a personal understanding of the piece.

4. SIGNIFICANCE

By enabling students to become involved with a piece through meaningful musical activities, the computer makes it possible for them to establish a new relationship with music. Rather than follow a set of seemingly arbitrary rules, the compositional approach described in this paper makes students ultimately responsible for working through their own models of music and for making the musical issues they encounter their own. The approach has great potential for engaging non-musicians in learning about music without prerequisite keyboard and notation skills. As students become increasingly self-sufficient in using the computer to work with a piece of music, we may gain new insights into the nature of music learning by the issues and problems that students spontaneously take on for themselves.

REFERENCES


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