NoteAbility: A Music Notation System That Combines Musical Intelligence With Graphical Flexibility

Keith A. Hamel
School of Music
University of British Columbia
6361 Memorial Road,
Vancouver, B.C., V0T 1Z2 Canada
hamel@uxig.abc.ca

Abstract
One of the most difficult problems in the design of a comprehensive music notation system is to mediate between graphical flexibility and notational intelligence. Most existing systems are either highly automated (thereby being efficient, yet graphically inflexible) or they are graphically-oriented (thereby being highly flexible, but lacking mastery enabling editing features.) NoteAbility is a new notation system being developed for NeXTstep computers that is designed to offer a high level of notational intelligence along with sophisticated formatting and editing facilities within a flexible graphical environment.

1 Background
There have been numerous advances in the design of music notation and printing software over the past five years, and there are now a significant number of programs that are able to accurately reproduce music scores and produce publishable-quality printing. (Yacowitz, 1992), [Hewlett and Sellidge-Field, 1994] and [Belkin, 1994] all provide overviews and assessments of many of these programs. Despite the availability of this software, many musicians still find that these systems are either inadequate for their needs or unnecessarily awkward or inefficient at performing certain tasks, especially as the music being represented increases in complexity.

2 Designing a Music Notation System
The difficulty in designing a comprehensive music notation system stems from the vast range of musical styles and idioms that need to be accommodated, and from the high degree of variability that must be supported at every level of the representation. Transcribing streams of music (i.e. notes with rhythmic position and durations) onto a staff is only a small part (and the easiest part) of creating a score. The real challenge lies in the methods and mechanisms by which a default representation can be transformed into something the user wants, rather than something the software wants.

When designing a music notation system, it is important to remember that music notation is graphics, not music or sound. However, music notation usually has a direct relation to music, and therefore, should include a representation of the music-syntax (i.e. the structure of measures, beats, voices, notes, etc.). The translation of this music-structure into graphical objects creates music notation, and this translation forms the basis of most music notation systems. In addition, a music notation system must also allow graphical variability that is independent of the music structure, and it is in this area that some programs fall short.

In essence, one can view a music score both as a representation of a music structure, and as an abstract collection of graphical objects (noteheads with stems, beams, dynamic markings, etc.). The view of the score as a music structure is necessary when the rules of CommonMusic Notation (CMN) are applied or when standard editing commands (e.g. part extraction, transposition, etc.) are invoked. The view of the score as a collection of graphical objects is necessary in order to customize the appearance of the score, to contrast the conventions of CMN or to represent music outside the domain of CMN (e.g. much contemporary music). Most existing music notation systems conceive of a score as being primarily one or the other. Those that view music as a collection of graphical images (e.g. NoteWizare™) are highly flexible, but don’t adequately support the editing of the music structure. Those that view a score primarily as a music structure (e.g. Torec™, Finale™) are often limited in the degree of graphical flexibility permitted or in the ease with which graphical alterations can be made.

NoteAbility™ is a new notation system, being developed for NeXTstep computers, that attempts to give equal weight to both views of a music score. It stores the underlying music structure and thereby supports all the standard score editing procedures, yet it also persists images to be freely adjusted and modified regardless of their position within
the music structure. In effect, editing can be performed either at the structural level or at the graphical level.

3 Representation of the Music Structure

NoteAbility is a page-oriented editor, with each page divided into a variable number of systems, and each system containing a variable number of staves. Along each system there is a rhythmic spine which typically represents the beat and subbeat positions of each measure in the system. All images (with a few exceptions) have three associations to the music structure: they are connected to a staff, they have a beat position within the score and they belong to a voice. The association to the staff binds the image to vertical adjustments of that staff while the beat position binds the image to horizontal adjustments of the rhythmic spine. The voice association is used for certain editing procedures such as part extraction, but since voices are independent of staves, images associated to a particular staff can belong to any voice.

The example below lists the music structure of a series of music elements and shows the results of changing the rhythmic spine.

<table>
<thead>
<tr>
<th>Image</th>
<th>Staff</th>
<th>Beat Positions</th>
<th>Voice</th>
</tr>
</thead>
<tbody>
<tr>
<td>rest</td>
<td>1</td>
<td>0.00</td>
<td>1</td>
</tr>
<tr>
<td>note</td>
<td>1</td>
<td>0.50</td>
<td>1</td>
</tr>
<tr>
<td>dynamic</td>
<td>1</td>
<td>0.56</td>
<td>1</td>
</tr>
<tr>
<td>chord</td>
<td>1</td>
<td>1.00</td>
<td>1</td>
</tr>
<tr>
<td>slur</td>
<td>1</td>
<td>1.05 - 1.18 - 1.50</td>
<td>1</td>
</tr>
<tr>
<td>crescendo</td>
<td>1</td>
<td>2.20 - 2.82</td>
<td>1</td>
</tr>
<tr>
<td>note</td>
<td>1</td>
<td>2.25</td>
<td>1</td>
</tr>
<tr>
<td>note</td>
<td>1</td>
<td>2.50</td>
<td>1</td>
</tr>
<tr>
<td>note</td>
<td>1</td>
<td>2.75</td>
<td>1</td>
</tr>
</tbody>
</table>

Figure 1 - Association of images to rhythmic spine

4 Complexity in the Music Structure

The music structure in NoteAbility can accommodate complex rhythmic groupings, complex chord structures and any number of voices. The program formats this material according to CHN conventions for chord formation, accidental placement and tuplet organization. When necessary, the user can modify the placement of noteheads and accidentals and re-format chords and tuplet groupings.

Figure 2 - Complexity of voices, chords, accidentals and tuplets

5 Graphical Flexibility

It is impossible to predict how a composer or editor may choose to represent a particular musical passage or how they might want to alter or customize the appearance of the score. A notation program can begin with a default representation (and in many instances, there is no need to alter this representation,) but the program must allow the appearance of images to be modified easily and in quite radical ways in order to accommodate the needs of individuals.
In order to support a high degree of graphical flexibility, NoteAbility permits the appearance and placement of images to be altered regardless of their position within the music structure and independent of CMN conventions. Some examples of graphical flexibility follow:

Any image can appear at any points size regardless of the staff size or the size of any connected images. The dimensions of all images can be altered freely and all attributes of notes (e.g., rhythmic value, note head type, etc.) can be modified regardless of the beat position and duration of the notes, (or regardless of how much "musical sense" it seems to make).

![Diagram of musical notation](image1)

Figure 3 - Flexibility of image size, image dimensions and note attributes

Notes and rests may be shifted to different places in the score (i.e., their location in the music structure can be altered), or they can remain at the same beat position and be offset graphically from the rhythmic spine. In figure 4, both measures contain the same music structure, and on playback they sound identical. However, in the second measure, the notes have been dragged away from their original rhythmic positions to demonstrate the independence between music structure and graphical placement.

![Diagram of musical notation](image2)

Figure 4 - Independence between music structure and graphical placement

There are both graphical and structural classes of some images. Certain images (e.g., clefs, key signatures, time signatures and barlines) are integral components of the music structure, and as such, are automatically altered when the music structure is modified. There are, however, graphical versions of these objects that have no affect on the music structure. The graphical versions are used as cautionary symbols or in situations where the user does not want to alter the underlying music structure. If desired, the graphical version can be used to contradict the music structure. There are also classes of notes and beams that are more graphical than regular notes and beams. These images are used for grace note passages and to represent unconventional notations. In figure 5, the first measure contains clefs, a time signature and a key signature that are graphical and independent of the music structure, and the second measure contains graphical notes and beams.

![Diagram of musical notation](image3)

Figure 5 - Graphical classes of some images

ICMC Proceedings 1994

305

Music Notation
Any notes or rests in the system can be beamed together regardless of their best position, staff association or voice number, and the format of the beams (i.e. the rhythmic values of the subbeams) can be altered independent of the rhythmic values of the notes in the beam. In the figure below, the second and third measures were identical until the beams were edited. The subbeam groupings in the third measure no longer reflect the durations of the beamed notes.

Figure 6 - Flexibility in beam groupings and beam format.

6 Conclusion
By combining structural and graphical representations of a score, NoteAbility permits either the underlying music structure or the graphical surface of the score to be edited where appropriate. This design allows standard score editing procedures to be performed easily and accurately without restricting the flexibility and variability of the graphical images.

References

For more information about NoteAbility contact:
Cuisa, 3208 West Lake St., Suite 133, Minneapolis, MN 55416, USA
(612) 822-1604
info@cuisa.com

Music Notation 306 ICMC Proceedings 1994