Timeliner: Building a Learning Tool into a Digital Music Library

Mark Notess
University Information Technology Services
Indiana University
Bloomington, Indiana, USA
mnotess@indiana.edu

Margaret B. Swan
School of Library and Information Science
1320 E. 10th Street
Indiana University
Bloomington, Indiana, USA
mbswan@indiana.edu

Abstract: Timeliner is a pedagogical tool integrated into Variations2, the Indiana University digital music library. Timeliner enables students and instructors to create visual representations of the formal structure of musical works contained within the digital library. The tool incorporates content visualization and annotation features drawn from traditional multimedia design principles. This paper describes the Timeliner tool and its integration within Variations2. We then describe results from multi-method user studies that have informed the tool's design. Finally, we describe our plans for improving Timeliner and integrating other pedagogical tools in Variations2. The application of these ideas is not limited to music: pedagogical tools can be integrated into digital libraries for other disciplines as well.

Introduction

Digital libraries offer improved ease of access for educational content. For music in particular, digital libraries provide a significant advantage over traditional media (Dunn & Mayer, 1999). Rather than having to check out a usually inferior copy of an original recording, users can access a high-quality digital copy online. Beyond this initial ease of access is ease of navigation: digital music players make it easy to stop, rewind, and restart a recording, allowing faster, more convenient navigation than was possible with cassette tapes or even CD players. But computing technology provides a greater opportunity than mere improvement upon the traditional library model. By looking at the educational uses to which people put their retrieved materials, we find the computer offers useful integration of access tasks and usage tasks.

Isaacson (2003) captures the essential motivation for developing visualization and annotation tools in the domain of music.

> Music is a temporal art. Experienced in its essential form—that is, by listening to it—we perceive it as a continuous stream of aural stimulus. Our native cognitive abilities enable us, however, to take that raw sensory information and perceive, recall, and interrelate intricate melodic, harmonic, and rhythmic structures in it. That same aural medium is ineffective, however, when we want to keep a record of those perceptions, describe them, and share them with others (p. 1).

In the same article, Isaacson offers a survey of the ways a digital music library can support pedagogically-oriented visualizations of music. Among them he briefly describes a prototype of the Variations2 Timeliner tool as a mechanism for diagramming and annotating the sections of a musical work and the relationships between those sections.

This paper describes the Timeliner as it was finally implemented within the Variations2 software system and released for use during the Fall semester of 2003. After describing Timeliner, we summarize results of user studies we have conducted. These studies include both lab-based usability tests as well as real-world usage in music

classes. We conclude by outlining our future plans for pedagogical tool development and offering suggestions for how our work might apply beyond the discipline of music. The conference presentation based on this paper will include a short demonstration of the Variations2 Timeliner.

The Variations2 Timeliner

Variations2, the Indiana University Digital Music Library Project, is a large research and development project focused on providing a testbed for research related to digital music libraries (Variations2, 2004). Pedagogical tools for music theory instruction are a major part of the project. The components introduced with the first version of Variations2 were a search window, a streaming audio player, and a score viewer. In the second release, during the Fall semester of 2003, one of the new components was the Timeliner. Timeliner is integrated with the rest of the system: users can search for a musical recording, listen to it with the streaming audio player, and then select one or more tracks of the recording to diagram in the Timeliner window (Fig. 1).
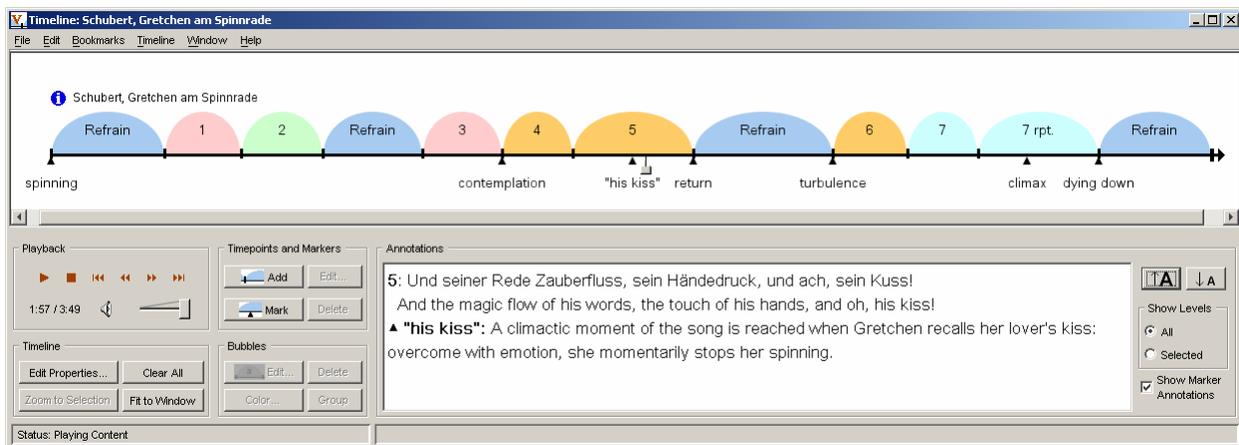

Figure 1: The Variations2 Timeliner window showing formal analysis of Franz Schubert's "Gretchen am Spinnrade"

A common design principle of content visualization and annotation tools alike is that they enable interactive representations of content in a temporal space (Mackay & Pagani, 1994). This temporal variable is also a core element of Timeliner; users create content representations in the form of musical "timelines" which are linked to synchronized audio playback. Time-based interactivity is further encouraged via the presence of a playback position indicator ("slider") that moves along the timeline. The temporal timeline space may be supplemented with a wealth of visualization elements such as bubbles, hierarchical bubble groups, colors, timepoints, measure numbers, and text labels. Bubble properties such as size, height, and individual color (or overall palette) may be adjusted to suit the task at hand, as can audio playback methods and background color (Fig. 2). Users can navigate the recording by clicking on a bubble. This allows rapid comparison of similar or dissimilar sections.

Temporal space considerations are also a common feature of complex annotation tools, as are related variables such as segmentation and positioning of points of interest (Yamamoto, et al., 2001). Timeliner users may similarly annotate their visualizations to distinguish certain sections of a musical work and note meaningful places in the work. Timeliner annotations take the form of written descriptions illustrating the musical events or processes that take place in a bubble or group of bubbles, or those that are associated with a timepoint or marker. Annotations are displayed during playback in the annotation pane. In figure above (Fig. 1), the slider is in the bubble labeled "5". Therefore the annotation pane displays the annotations associated with that bubble. However, the marker (small black triangle) is also nearby, so the annotation for the marker labeled "his kiss" is also displayed in the annotation pane.

Figure 2: Timeline example, with square, black & white, hierarchical "bubbles" showing a phrase-length analysis of the Beatles' "Being For the Benefit of Mr. Kite"

Beyond being a diagramming and annotation tool for individual use, Timeliner also supports the educational context. When users have finished creating a timeline, they can save the timeline as a data file for sharing with others. In support of instructional needs, a timeline—the diagram and all the labels, annotations, and timepoint time offsets—can be saved as a web page. This web page can be printed for submission as an assignment. Timeliner supports in-class use by faculty by providing the ability to enlarge the annotation display font or zoom in on a part of the timeline for an up-close view.

Timeliner works only with recordings cataloged in the Variations2 collection. This collection is currently rather limited, with just under 300 recordings in the collection. We add recordings to the collection to support pilot studies, or as we have time for cataloging.

User Studies

Multiple evaluations of Timeliner have been conducted to gauge how well it works for both student and faculty users. In addition to traditional usability lab sessions with representative music students, pilot studies integrated Timeliner into actual instructional usage.

Usability Lab Sessions

Two usability tests which focused on the Timeliner have been conducted thus far. The initial test was a formative evaluation conducted with six participants early in the development process. We used the results of this test to make numerous changes to the design of the tool. The second usability test, with seven participants, was conducted after Timeliner largely resembled its current form but prior to its actual release. We focus here on the results of that second test.

The user test required participants to work through three major tasks, two of which involved the Timeliner (the third task focused on other Variations2 features). The two timeline-related tasks are shown below (Tab. 1).

Task 1. Motivation: Next week's theory quiz requires that you analyze and diagram a Beatles song and turn it in before the end of class. You decide to use the Variations2 Timeline tool to practice for the quiz.
1. Create a new timeline for the Beatles song entitled "Norwegian Wood".
2. Diagram the structure of the piece by creating bubbles.
3. If appropriate, group a set of bubbles to show larger formal structure.
4. Use labels and/or colors to show relationships between the sections.
5. Add annotations to some bubbles to describe some musical feature of that section.
6. Print out the timeline you just created.

Task 2. Motivation: One of the pieces you have been working with is the Beatles song entitled "I Will". You open the timeline file, a work in progress, to continue diagramming the structure.
1. Adjust the timeline for "I Will" so that it more correctly reflects the structure of the song. You may want to change colors, labels, timepoints, etc.
2. Save the timeline after you are done making adjustments.
3. Print out the timeline you just saved.

Table 1: Timeline tasks from usability test.

Participants also filled out a demographic questionnaire and a user satisfaction survey. The test was followed by a debriefing interview. Participants were recruited from two music theory classes at the IU School of Music, one junior-level and the other graduate-level.

Results from the test indicated a good level of overall satisfaction with the Variations2 system. Satisfaction was measured by eleven 7-point Likert scale items, where 1 was negative and 7 positive (e.g., "Overall, I found Variations2 difficult/easy"). The mean satisfaction rating by all users across all items was 5.88. Participants expressed enthusiasm for using the Timeliner tool to complete music theory assignments and said it would be unquestionably useful. The most significant usability issues raised by the test pertained to initiating the Timeliner window. Participants were confused about how to start Timeliner from Variations2. We made changes to address this issue prior to releasing the software. A more minor issue was that some users were initially put off by the complexity of the Timeliner window. As this appeared to be a minor issue, we chose not to address this before release.

Pilot Instructional Usage

During the Fall semester of 2003, the Timeliner received pilot usage in three courses (Tab. 2). For each pilot, students had the opportunity to fill out a post-pilot survey that included our eleven satisfaction items along with some free response questions. In all, 66 surveys were returned. After the semester ended, we interviewed the course instructors with open-ended questions to get their perspective on Timeliner and their students' experience with it.

Pilot	Activity Description	Survey Responses	Mean Satisfaction
1	In a junior-level musical skills course for music majors, instructor asked students to use the Variations2 Timeliner to analyze a song in order to prepare a transcription of it. Students were required to hand in a paper copy of their timeline.	33/85[1]	5.33/7.00
2	In an undergraduate non-major music appreciation elective course, students analyzed a twelve-bar blues song using Timeliner and submitted their completed timelines as email attachments. Students completed the assignment during a class session held in a computer lab.	28/28[2]	5.22/7.00
3	In a graduate-level piano literature class, instructor prepared timelines for the required listening items during one week of the syllabus. Students had the option of using the pre-made timelines to aid their study.	5/25[3]	4.93/7.00
Notes: [1]Assignment was required, survey was optional. [2]Assignment and survey were required. [3]Both usage and survey were optional.			

Table 2: Three timeliner pilots, with user satisfaction ratings.

Overall results were similar to usability lab conclusions—a positive response despite an initial learning curve. For example, after a somewhat difficult in-class first experience with a Timeliner-based analysis assignment, fully half of the pilot 2 group (14 of 28) picked "7" (recommend) on the 7-point Likert scale when asked whether they would recommend future classes use the tool. Theory students (pilot 1), were more tentative in their endorsement. One reason may have been that their assignment—making a form diagram to accompany an transcription—did not necessarily seem relevant to them. Another reason is that, as music students, they were very aware of the limited amount of recorded music available in Variations2 and felt this would in turn limit the usefulness of the Timeliner. While not asked specifically about the Timeliner, 10 of 33 indicated a definite intention to use Variations2 again, and another 10 indicated probable use. Pilot 3 occurred while there were still some significant bugs in the software that prevented full use—hence the limited response rate and lower satisfaction rating. Overall, satisfaction ratings were slightly lower than those recorded in the usability session. In accordance with our previous findings of satisfaction ratings for Variations2, these results may suggest that satisfaction in

contextual uses is not necessarily predictable from lab-based ratings (Notess & Swan, 2003).

In their interviews, instructors indicated that Timeliner is particularly useful as an illustrative visualization tool when incorporated into classroom demonstration. One instructor noted,

> *[One advantage of Timeliner is] …Even just in front of a class, making a form diagram like that as a group. I think it's fun. They like watching when you group the bubbles…oooooooh! It's fun, I think, to do in front of the class with their input.*

Another instructor said he would like to use it in class but that his classroom was not equipped appropriately to allow him to use Timeliner. The small amount of recorded material in Variations2 was mentioned as a potential inhibitor for use by instructors as well.

One instructor offered perspective on what kinds of learning resulted from Timeliner use.

> *[After students used Timeliner] I noticed a deeper ability among the students to listen to the music. They were questioning how and why the piece sounded like it did. They were focusing more on the musical elements in a composition and tying it to a music time period…[Timeliner] creates a visual link to what the students are hearing. [We are] able to reach both auditory and visual learners at the same time, and we're also able to bring in those learners who function best by doing. I see us reaching all three learning style groups with this. I also believe that being able to see a visual representation of what you hear is very important for these students.*

One instructor explained why he created timelines to guide his students' listening in a graduate piano literature class.

> *So, theoretically they've done a theory sequence where presumably they've been exposed to things like sonata form; they have been exposed to harmonic and textural analysis, and rudiments of analysis and … are at some level familiar to them. By the same token they have probably heard some quantity of 20th century music and keyboard literature in general. But the regular and systematic tying together of the two, and the expectation that they should be able to do that in a fluent way, that in my experience is very often not the case.*

His belief was that, by having an annotated diagrammatic representation of musical form to use for navigation during listening, his students would more quickly gain fluency in discussing musical form at the professional level. This in turn would allow him to cover more challenging material in class.

All three instructors indicated that they had recommended (or intended to recommend) Variations2 use to their colleagues.

Conclusions & Future Work

After examining results from user tests and pilot usages, we can conclude Timeliner appears to offer promise of extending the benefits of a digital music library into discipline-specific pedagogical use. We have also realized that Timeliner can be quite useful independent of a digital library, so we are developing a stand-alone version of Timeliner that works with a local audio file. The stand-alone Timeliner will make it easy for faculty to create instructional timelines for classroom use using their own recordings. The stand-alone Timeliner can also be used in classrooms not having network connectivity.

Future plans for Timeliner development include possible interfacing of its visualization and annotation functions with other components of the Variations2 system such as scanned score images or encoded scores. Additional user evaluations will take place as each version is produced. Methods will include lab-based usability testing as well as further pilot projects in classroom use and continuation of instructor interviews.

An application of particular interest to us is distance learning. We are currently working with a distance version of a music appreciation course, hoping to have the distance students use Timeliner to improve their ability

to hear musical form. Because Timeliner is a Java application, the distance students will be required to install Variations2 in order to use Timeliner. Application installation is non-trivial in a day when many distance students assume everything will run within a browser window, so we are working on ways to simplify and better support the software installation process.

We are also developing other pedagogical tools attached to the Variations2 digital music library. One of these tools will allow for annotation of scores. In addition to providing standard drawing tools for lines, circles, text, etc., we are providing labeling tools that will make it easy for users to label chords, notes or segments following the analytical schemes used within the discipline (e.g., phrase labels, Roman numeral or figured bass harmonic analysis, non-chord tones).

Pedagogical tools for digital libraries are not limited to music. Generic text or free-form annotation in digital libraries has received extensive research attention (e.g., Marshall, 1997; Price, et al., 1998), but most efforts are directed at generic annotation of text-based documents. Tools for discipline-specific meaning construction within multimedia in educational contexts are still rare. Our experiences with Timeliner indicate such tools may well be worth pursuing. The development of such tools should begin, as we did, with a detailed examination of the kinds of analysis present in a discipline. By studying examples of analysis and annotation, we can determine the visual and annotative languages most useful for online pedagogical tools within that discipline. If we are successful, students and instructors will find it easier to learn and teach with digital content in a seamless workflow.

Acknowledgements

References

Dunn, J.W., & Mayer, C.A. (1999) "VARIATIONS: A digital music library system at Indiana University." *DL '99: Proceedings of the Fourth ACM Conference on Digital Libraries* (pp. 12-19), Berkeley, CA, August 1999. NY: ACM Press.

Isaacson, E.J. (2003) "Content visualization in a digital music library." Presented at the *Third International Workshop on Information Visualization Interfaces for Retrieval and Analysis (IVIRA)* at *JCDL 2003*, Houston, TX, May 31, 2003. http://variations2.indiana.edu/pdf/isaacson_ivira_2003.pdf (26 Mar. 2004).

Mackay, W., & Pagani, D. (1994) "Video mosaic: laying out time in a physical space." In *Proceedings of the second ACM international conference on Multimedia* (pp. 165-172), NY: ACM Press.

Marshall, C.C. (1997) "Annotation: from paper books to the digital library." In *Proceedings of the second ACM international conference on digital libraries* (pp. 131-140), NY: ACM Press.

Notess, M., & Swan, M. (2003) "Predicting user satisfaction from subject satisfaction." In *CHI '03 extended abstracts on human factors in computing systems* (pp. 738-739), NY: ACM Press.

Price, M.N., Schilit, B.N., & Golovchinsky, G. (1998) "XLibris: the active reading machine." In *CHI '98 conference summary on human factors in computing systems* (pp. 22-23), NY: ACM Press.

Variations2 (2004) *Variations2: the Indiana University digital music library project.* http://variations2.indiana.edu (24 Mar. 2004).

Yamamoto, Y., Aoki, A., & Nakakoji, K. (2001) "Time-ART: a tool for segmenting and annotating multimedia data in early stages of exploratory analysis." In *CHI '01 extended abstracts on human factors in computing systems* (pp. 113-114), NY: ACM Press.