Collaboration Software for Music Analysis: A Case Study

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Abstract
While use of the Internet and Web have revolutionized many aspects of music collaboration, certain areas remain nearly untouched. Issues that hamper computer-supported collaborative music analysis are threefold. First, software for music analysis can be complex, requiring some users to develop advanced computer skills. Second, technologies that facilitate large-scale collaborative music analysis have not been developed. Finally, tools for analysis influence the processes used, ultimately shaping the end product. This paper examines these three areas in a case study analyzing UnfoldEntwine, an electro-acoustic composition by Diane Thome.

1 Introduction
Numerous applications have been developed to support collaboration in work and learning. These applications, known as groupware, are categorized by whether users are located in the same place or are at a distance and whether users are working at the same time or at different times. Asynchronous groupware includes technologies such as email, newsgroups and mailing lists, group calendars, and collaborative writing systems. Examples of synchronous or real-time groupware include chat systems, video communications, decision support systems, and multi-player games.

Issues in groupware often stem from areas where social systems are not easily translated to a virtual medium. For example, it is usually necessary to determine processes for control and hierarchy in a groupware voice-based chat system—having 100 participants all trying to talk at the same time hampers efficient exchange of information. It is also important for participants to be grounded in a project—that is, all group members should be able to identify the group’s present accomplishments and future goals (Gutwin, 1998).

Collaboration has been explored in both work environments and learning environments. With applications reaching beyond distance education, collaborative learning has created new models of learning both inside and outside of classrooms (Luce 2001). Collaborative learning can be used to create systems of “virtual apprenticeship” where less experienced participants benefit from the guidance and contributions of expert participants (Singley, et al. 2000).

1.1 Music Groupware
In the musical domain, groupware applications have focused on composition, performance, and education. For example, Faust Music On Line allows for real-time synthesis and interactive and collective composition (Jordá, 1998). Online jamming tools such as the TransJam Server exemplify synchronous distance collaboration, allowing participants to move between the roles of performer and observer (Burk, 2000). Collaborative multi-location performances made possible by Internet2, such as the World’s First Remote Barbershop Quartet and the musical “The Technophobe & the Madman,” recreate a traditional performer/audience hierarchy while separating audience members from performers and performers from each other. Synchronous educational events have conformed to the traditional teacher/student model of learning, with events such as master classes (Young, 1999).

Examples of music collaboration cited thus far have one important component in common: they model real-world interactions. These interactions can be considered examples of social systems. While specific interaction protocol needs to be developed for each project, the nature of this social interaction draws from existing common practice. For example, in a master class, the hierarchical nature of the teacher/student/audience relationship would likely be reflected in the floor controls. While the teacher could be free to interrupt the student while s/he is playing, an audience member would not be free to interrupt the teacher while s/he is commenting. For projects with established social systems, the fundamental challenges often come in the form of bandwidth issues and the need for higher-quality transmittable audio. While refinements to the collaborative interface or protocols are often necessary, adjustments could be made using real-world systems as a frame of reference.

1.2 Collaboration and Music Analysis
The process of music analysis poses special challenges to computer-supported collaboration. First, pedagogical processes often treat music analysis as a solitary experience. While the finished
product of an analysis is shared and discussed, the processes used to formulate the analysis are often undocumented. Second, it is not always necessary to prove a single analytic interpretation as “correct.” Conflicting interpretations are far from problematic, as they reflect diversity of perception in individual listeners.

These two elements raise important questions about collaborative music analysis: How do collaboration and the tools used for analysis affect processes? Does collaborative technology influence the exploration of a work? Will documentation and preservation of process influence the final result? What types of roles and interaction protocol are necessary for collaborative analysis?

2 Architecture

UM WorkTools is a web-based environment for collaborative research developed at the University of Michigan for inter-university research. WorkTools can be customized for different projects and includes resources for announcements, data and document sharing, discussion, and real-time chat. Moderators and participants do not need to know HTML or even a FTP client, to create and use a workspace or to upload files or other resources to a workspace.

![Figure 1. A view of the WorkTools interface.](image)

This environment was chosen because it was easy to configure and was also familiar to University of Michigan participants. Existing functionality could be appropriated to support music analysis tasks.

3 The Analysis

*UnfoldEntwine* was commissioned as a piece for dance by the University of Michigan for world premiere performance at ICMC '98. In her program notes for the piece, composer Diane Thome commented: "The sense of the unknown - the unforeseen - the invisible - was present in my mind throughout the compositional process motivating a trajectory of sonic events. The single stream of sound which opens the piece ultimately devolves, after a series of briefer digressions, into a realm of multiple, concurrent tributaries. The processes of unfolding, disclosing, interleaving and entwining which characterize the architecture of the work also suggested its title" (Thome, 1998).

Choreographer Jessica Fogel wrote "In gathering movement for the work, I free associated with the evocative title, and created a collage of dance phrases inspired by its two words. Some of the dance phrases are based on the literal unfolding of body parts, or of costumes, or, on a metaphorical level, of self. I also structured the dance so that the phrases of movement would unfold gradually over the course of the entire work. The word ‘entwine’ inspired movement based on games of cat’s cradles, as well as human knots, where the dancers get all tangled up and then undo themselves, as well as simple gestures such as braiding hair. We also developed material based on the entwining of limbs or phrases of movement with another dancer. In creating the dance, the idea emerged that the more one unfolds, the more one becomes entwined, and vice versa, as in any intimate relationship" (Fogel, 1998).

Observations and theories from participants in this analysis have been combined to create a narrative of the piece. Individual participants used various methods when commenting on the piece. These approaches include examination of timbre changes throughout the piece, examination of pitch content using set-class analysis and harmonic analysis, and examination of perceived pitch content as supported by graphical realizations of the work, specifically spectrograms and chromagrams.

The structure of *UnfoldEntwine* can be analyzed through examination of the placement and juxtaposition of “organic” and “synthetic” timbres. For this analysis, organic sounds as those whose timbres are associated with acoustic instruments, while synthetic sounds do not. The piece opens with a synthetic timbre that plays a prominent role throughout the piece, which we nicknamed “the helicopter.” The helicopter pulses at approximately 12 Hz, its speed varying slightly throughout the piece. At 15 seconds into the piece, the helicopter is joined by a pitched organic timbre at G♯4 (middle C–C4). This G♯ plays a very important role in the piece as this pitch is heard the most. Interplay between the helicopter and the G♯ intensifies as they adopt subtle elements of each other’s timbre through the next two minutes of the piece.

An organic F♯4 is added to the sustained G♯4 at 2:48 and is soon followed by an A4, forming set-class 3–2 [0 1 3]. This pitch cluster changes at 3:30, with the F♯4 replaced by an E4, with the sustained pitches of G♯4, and A4, set-class 3–4 [0 1 5]. This pitch shift is illustrated in Figure 2 by a chromagram, which displays pitch class content as a function of time (Wakefield and Pardo, 1999). In the following chromagram, frequencies are mapped to pitch classes,
with red to blue scale content indicating the presence of absence of the pitch class, respectively.

Figure 2: A chromagram displays shifts in pitch content between 3:00 and 3:30.

After these pitches are stated, the synthetic timbres move away from pitched content, becoming more percussive.

A new section begins at 4:30 by the introduction of swirling voice-like timbres that overpower the synthetic sounds. After 5:00, the helicopter and flute sounds mimic each other in turn. New organic flute-like content is introduced at 6:14, with gestures comprised of the third significant pitch cluster of B C# F#, set-class 3-9 [0 2 7]. These flute-like gestures are supported by a new synthetic percussive timbre that becomes prominent as the gestures become shorter and sparser. The helicopter returns at 8:17 serving as an introduction to a new section dominated by the pitch F#, which is also marked by the return of the percussive timbre.

At 10:20, a fourth significant pitch cluster is introduced comprised of C, F, and F#, set-class 3-5 [0 1 6]. This cluster is followed by solitary G#, which re-establishes its importance in the composition.

The final section of the piece is marked by increased movement in both organic and synthetic material. The section begins at 11:15, with sweeping non-pitched gestures that have greater intensity than the pitched gestures that marked the second section of the piece. The piece concludes with ascending and descending sonic tsunamis. These sweeping gestures are illustrated by a spectrogram as seen in Figure 3.

Another theory governing pitch selection is an unfolding of F# minor and F Major triads, which share the pitch of A. The pitch of G# can be interpreted as Ab, creating an F minor triad. This G# can be viewed as a link between major and minor.

4 Observations

The process of undertaking this analysis yielded a rich variety of rewards and frustrations. Observations can be divided into three categories: those related to interaction protocol development, those related to the WorkTools environment and those related to the process of analysis.

Issues concerning interaction protocol development stemmed from the asynchronous aspect of the process. Some messages were accompanied by requests for the production of supportive materials such as spectrograms and chromatagrams. As only one participant was responsible for producing these figures, development often depended on quick response. However, participants had not previously encountered these graphical realizations were aided by this system in that they did not have to learn the software used to generate them. Use of graphical realizations helped to provide a framework for supporting hypotheses.

The WorkTools environment made some aspects of efficient information exchange difficult. For example, it was not possible to track when and if messages had been read by participants. This often lead to confusion about whether discussion posts had been read and if so, why nobody had responded. Comments added to dormant discussion topics were easily overlooked. Another problem experienced by participants involved the interface for writing comments. Unfinished comments were not preserved when participants navigated to another WorkTools section before posting the comment.

Analytic challenges were related to differences in individual perception and interpretation with respect to musical aspects of the piece and meaning of participant comments. Compiling the observations raised questions of how conflicting opinions could be incorporated into a finished analysis. It was also difficult to interpret the weight and context of some comments—whether they were speculations or could

Figure 3: A spectrogram from 14:00 to the end of the piece illustrates the sweeping large-scale gestures.
be supported by various means.

Different paces of individual participants allowed for reversion of dormant topics. Renewed interest in these topics was exciting, as many of these topics would not have been documented outside of a computer environment, and could have easily been forgotten. Documents uploaded to the workspace could be linked to individual messages, allowing ideas to be supported by examples comprised of various media.

5 Future Directions

This case study has identified and explored several issues specific to collaborative music analysis. However, further exploration and development are critical to better understand how the tools for collaboration impact both analytic processes and results. Future work will involve the refinement of interaction protocol and the workspace functionality. Both the types of music analyzed and the number and background of participants will be expanded and varied.

References


