Composing an Interactive Virtual Opera: The *Virtualis* Project

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An earlier version of this paper was presented at the third Creativity and Cognition Conference, Loughborough University, U.K., 10--13 October 1999, and published in the Proceedings (New York: ACM Press, 1999; ISBN: 1-58113-078-3).

ABSTRACT

Designing the computer-based interactive opera *Virtualis* has led the authors to develop new tools for working with music, especially in three-dimensional spaces as well as an interaction model based on physical forces rather than on the user's intentions. Though opera and computing are two dissimilar interactive situations, the software environment presented in this article is intended (1) to combine them through the generalization by computed artifacts of certain operatic functional relationships and (2) to offset the relative absence of the spectator from the classical performance of drama.

What Are Virtual Operas?

We define as virtual an opera not intended to be performed on a stage, but "running" on a personal computer [1,2], enabling some interactivity with its spectator. This new genre is not based on the simple transfer of existing operas into the framework of new computing technologies; it takes into account the shifting uses and meanings induced by multimedia computing, assuming they could arouse new writings [in many fields, including opera] [3]. We have been working on an interactive opera project, *Virtualis*, the purpose of which is neither the reconstruction of a physical opera hall nor the recreation of an opera piece

from the past. It is [an original] creation using new technologies, but above all including original models of interaction; thus it is not merely a sophisticated multimedia application [4].

Interactive operas fall within the category of a large evolution of different artistic genres owing their existence to multimedia computing. Hypertext literature, interactive comic strips, and interactive musical games [(such as the CD-ROM *Eva* by Peter Gabriel and *Puppet Motel* Laurie Anderson]) are good examples of this revival. Moreover, *Virtualis* is not the first work in its genre:

- In 1996, Tod Machover [5], at the Massachusetts Institute of Technology Media Laboratory, designed a digital opera entitled *The Brain Opera*, allowing members of the audience either present during the performance or connected through the Internet to interact by contributing to the music.
- Jean-Pierre Balpe, at the Université de Paris VIII, Paris, France, created a digital opera named *Blue-Beard* in 1999, enabling the generation of variations on the plot of the famous story inspired by Perrault's tale.

Opera and Interaction

If we compare the individual interaction that occurs in opera halls between the spectator and the stage with that lived by someone facing his or her computer, we can observe sharp differences between the two situations.

During opera performances, the spectator is subjected to a continuous composite flow [6] from the stage and the hall: sounds coming from the orchestra, the choir and the singers but reflected onto the walls before reaching his/her ears, images and lights coming from the stage, overhead subtitles, etc. Facing this flow, the spectator is absent from the stage, but feels drawn in from time to time when sudden consciousness of some fact, which we could name a singularity bursts into his or her perception. Let us note that these singularities, as soon as they are detected, are no longer singularities; they are rather somehow added onto the

knowledge representation of the ongoing opera, if we use IA concepts]. The irruption of singularities triggers various expressions, such as coughs, excessive silence, movements, etc., which are, in feedback, globally interpreted by musicians and singers who modify their play accordingly.

- On the contrary, when someone faces a computer, the relationship involves alterity, or "otherness," within a very controlled experience. The famous British scientist Alan Turing had grounded his work in theoretical computer science in the concepts of alterity and personification: a process is to be considered intelligent if it is able to converse correctly with a human being.

Opera *cum* Computing

We are currently considering how to put together these two worlds---how to design a computer-based opera. From our point of view, we have to take advantage of an element common to both opera and computers: the way in which people invest meaning in these devices:

- Opera is full of incredible conventions. For instance, when listening to *War and Peace* by Prokofiev, nobody seems surprised to hear Napoleon singing in Russian.
- The user of a computer sometimes relates to it as an oracle that communicates through icons and command lines, so that computer-controlled processes seem to have some sort of "spirit."

An interactive computer-based opera therefore has to combine two devices:

- powerful opera tools generalizing already existing conventions in traditional operas
- an interactivity model.

The Opera Tools in *Virtualis*

There are three elements in traditional opera that we would like to generalize and amplify using computers:

- the multimedia zoom: whereas opera glasses deal only with images, enabling observation of the singers and of the smartly dressed audience members, we conceived of designing a general zoom function, as applicable to the music as to the dramatic plot or the singer's gestures
- the mutual transparency of foreground and background: in opera this is limited to visual aspects; we would like to generalize it to musical sound and drama
- the hermeneutics of writing and reading: whereas the opera spectator can only "read" the performance passively, our intent is to enable writing and composition as well.

Let us now examine the computerized systems we have developed to deal with these elements.

The Multimedia Zoom

We have studied the possibility of an essentially musical multimedia zoom by developing a software environment called Alma (as a tribute to Alma Mahler), running on a Macintosh computer, which enables the visualization and manipulation of musical content. Starting from the GUIDO [7,8] description language, which closely resembles a score, since it includes such important structural information as slurs or chords (which do not exist in MIDI format, for instance), this tool enables the creation of mappings between musical structures and graphical [3D] ones, on several levels, from the detailed notes to the global form of the piece through intermediate structures, thus corresponding to the musical zoom principle. To achieve this, we have added to the music-to-3D "converter" a set of algorithms for pattern searching [9, plus reference to Melucci and Orio, see reference section at the end] (especially using melodic morphology).

Figures 1a and b respectively show the "entrance" to and the "inside" of the main melody (played by the piano as indicated on the ground), which is represented as a corridor following the melodic line (although any parameter could be displayed, since the user can enter any mathematic function linking musical and geometrical parameters).]

Figures 2a and b show the principle of the musical zoom; the same melodic entity (in this case the upper voice; the lower remains constant) is represented two levels of detail: Fig. 1a shows the note level [where notes appear one after the other]; Fig. 2b, the slur level where notes are grouped into melodic packages : the melodic profile is simplified to show the main movement.

The Dynamic Updating of the Foreground

Whereas the zoom principle enables focus on a particular point, in our case a musical entity, which is explored at different levels, we have conceived of the principle of dynamic updating of the foreground as an extension of the curtains, canvas and backdrops in the theaters. It consists not only in putting the emphasis on one object, the others being considered less important, but also in enabling a certain transparency: while handling the foreground object, the user can still see the background objects.

Once more, this principle is implemented from a musical point of view in the Alma environment. First of all, the musical line that is followed and analyzed is played more loudly than the others. Moreover, users wandering among musical objects and their "fences" can adjust the volume by altering their distance from the object.

Writing and Reading Hermeneutics

In the 1950s and 1960s, several composers explored the possibilities of open forms [10], that it, works that could be varied by the instrumentalists playing

them. The most famous are three pieces for piano: the *Troisième Sonate* by Pierre Boulez (1957), the *Klavierstück XI* by Karlheinz Stockhausen (1957) and *Archipel IV* by André Boucourechliev (1965--1971). Such works were mainly of interest to musicians, due to the possibility to really play with the music. But for audiences, it was not possible to grasp the potential for renewal within these works during one performance.

Multimedia computing enables the combination of open forms and interaction, not only through hypertext or graphical links (such as clickable images), but also in a musical framework, by exposing users to the variations of the work.

We are currently working on adaptating a system of musical variations to the Alma environment, using some works created by Baboni-Schilingi [11] at the Institut de Recherche et de Coordination Acoustique/Musique (IRCAM) in Paris. The purpose is to vary a structure, after analyzing and extracting from it all possible patterns; the program then enables one to modify the degree of overlap of the initial structure [with] the extracted patterns, thus generating rather accurate variations on the initial idea.

An Interactivity Model

The Different Types of Interactivy

An interactive opera puts alterity onstage, being in this way similar to Turing's test. Therefore, in *Virtualis,* it will be possible in a way to produce a certain alterity by actualizing virtual entities, situations, characters and musical fragments, etc.

This raises the question of correlating the tools described in the previous section and the interactivity model [12]. It would be tempting to use these tools as a means of expressing of a certain intention, before connecting this intention to the actualization of the drama. This approach is classic in the field of cognitive sciences, but we have chosen a different one.

A Physical Model of Interaction

In *Virtualis*, there is a level called "the monologues of the story," which corresponds to an interactive actualization of musical and narrative contents. We are currently developing an interaction model based on equivalents of physical models of forces and force fields between the various objects.

This "story" is composed of a set of short dramatic moments M_i, involving two singers, a woman and a man. The idea is to determine everything according a model of simple forces, equivalent to such attraction forces as universal gravitation or electricity. As shown in Fig. 3, the two characters move about in a defined zone in the center of the screen. During each dramatic moment M_i, they are submitted to external forces that create force fields.

To evaluate the impact of each force and force field on the characters, we assign to each of them a set of variables equivalent to a mass or an electric charge. For instance, one of these charges corresponds to a value on a resignation/daring axis, from –100 to 100. A force field representing a kind of "force of renewal" appearing during a M_i moment will affect the character according to this dimension.

To vary not only the positions of the singers on the screen (to achieve that requires that numerous pictures be dynamically loaded by the application), but also the musical and textual contents, a certain number of variations were pre-recorded by two singers. They included synonyms [of words in the lyrics] as well as musical variations. Synonyms are organized on semantic axes, which functionas vectors. The choice of a given synonym is proportional to the scalar product between the semantic axis vector and the external force vector.

The user may wonder whether this system is really interactive, since physical forces seem to rule all aspects of this multimedia application. Let us note, however, that the user can freely move the characters, then modify the intensity of the forces and then alter in feedback what is sung and the progression of the music.

Last, but not least, let us note the consequences of this physical model for multimedia programming, which has been evolving for several years from script lists to object-oriented programming, as shown by the new versions of Lingo by Macromedia. Models based on physical forces simplify the entities used, since they mainly use real-time numeric resolution of equations whose solutions are the various positions of the objects. The number of cases to be handled and programmed therefore decreases, but the challenge is to prevent from becoming monotonous for users.

Conclusion

In the *Virtualis* interactive virtual opera project, we have shown that its artistic development cannot be separated from a scientific approach dealing with multimedia computing, and especially with an interaction model. The model we have chosen is based on physical-force simulation. Our future work will involve model and software improvements, but above all the evaluation of the project by musicians and non-musicians.

References and Notes

1.
A. Bonardi and F. Rousseaux, "Towards Digital 'Music Actions,'" *Proceedings of the ICMC 99 Conference* (San Francisco: The International Computer Music Association, 1999) p. 116.
2.
A. Bonardi and F. Rousseaux, "Virtualiser l'opéra virtuel," *Proceedings of the ReViCo 99* (Paris: Ecole Nationale Supérieure des Télécommunications de Paris, 1999) p. 23.
3.

L. Berio and U. Eco, "Eco in ascolto---Entretien avec Luciano Berio," in *Musique: texte*, *les cahiers de l'Ircam---Recherche et Musique No. 6* (Paris: Ircam, 1994) p.[98]

4.

The collaboration between the Computer Science Department in the Université de Reims and the Music Department in La Sorbonne has been very fruitful in this respect.

10.

U. Eco, *L'opera aperta* (Milan: Bompiani, 1962) p. 6.

5.

T. Machover, The Brain Opera Project (1996), <http://brainop.media.mit.edu/>.

6.

I. Moindrot, *La représentation d'opéra---Poétique et dramaturgie* (Paris : Presses Universitaires de France, 1993) p. 7.

7.

H. Hoos, K. Hamel, K. Flade and J. Killian, "GUIDO Music Notation---Towards an Adequate Representation of Score Level Music," *Proceedings of the JIM98 Conference* (Marseille: LMA Publication No. 148, CNRS, 1998) p. B3-1.[WHAT DOES GUIDO STAND FOR?->it is not an acronym, it is the first name of Guido d'Arezzo]

8.

H. Hoos, K. Hamel and K. Renz, "Using Advanced GUIDO as a Notation Interchange Format," *Proceedings of the ICMC 99 Conference* (San Francisco: The International Computer Music Association, 1999) p. 395.

9.

J. Baboni-Schilingi, *Composition par modèles interactifs, systèmes génératifs et applications informatiques* (Paris: Formation doctorale Musique et Musicologie du XX siècle, Université Paris-Sorbonne, Ecole des Hautes Etudes en Sciences Sociales, Mémoire de DEA, 1998), p. 47.

11.
Baboni-Schilingi [9].
12.
C. Elliott, "Modeling Interactive 3D and Multimedia Animation with an Embedded Language," forthcoming in the *IEEE Transactions on Software Engineering* 1999, <http://www.research.microsoft.com/~conal/papers/ds19>.[URL DOES NOT WORK]

R. Leibowitz, *Histoire de l'opéra* (Paris: Buchet-Chastel, 1957) p. 52. [NO REFERENCE IN TEXT?->reference added]

M. Melucci, N. Orio, "The Use of Melodic Segmentation for Content-Based Retrieval of Musical Data," *Proceedings of the ICMC 99 Conference* (San Francisco: The International Computer Music Association, 1999) p. 120.
T. Winkler, *Composing Interactive Music: Techniques and Ideas Using Max* (Cambridge, MA: MIT Press, 1998) p. 109

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