Realtime Performance Strategies for the Electronic Opera *K…*

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Abstract

With K…, Philippe Manoury has created a large-scale opera that effectively combines realtime electronics with operatic singers and full orchestra. The commitment to this process is due to the composer's belief that a realtime interactive system is the best method for integrating electronics and acoustic music without losing expressivity. This presentation will investigate the coordination of the composer, technicians, musicians, software, and hardware prerequisite to the realization of this opera.

1 Introduction

Philippe Manoury's electronic opera *K…,* after Kafka's *The Trial*, was premiered in the spring of 2001 at the Opéra-Bastille in Paris and was restaged in the spring of 2003. This opera is one of the first large-scale classical opera to incorporate electronics in a central way. While the technological components of this opera are not new, the scale of their conjunction is noteworthy.

The opera's acoustic and electronic components were composed concurrently at Ircam by Manoury with the support of musical assistant, Serge Lemouton. The opera combines fourteen operatic singers, a large orchestra, a forty voice virtual choir, and the realtime disposition of an of electronic sounds, effects, samples, and spatialization. The electronics were generated, sampled, processed and actualized in the two years proceeding the premiere (November 1998 – January 2001). In performance, the implementation of the electronic portions of the opera is through an iterative process involving the triggering of approximately 2000 events by a musician in the orchestra pit playing a clavier. The computer generates and transmits the electronic materials of the opera in realtime and implements score following as a safeguard against error by the clavier player.

Manoury's reason for the use of a realtime system is central to his belief that realtime is the only agendum for preserving expressivity when combining electronic and acoustic instruments. The element of tempo is an issue when human musicians are forced to slave to a pre-composed electronic track. With a static electronic tape, musicians lose an interpretive dimension realized through small adjustments in tempi. These adjustments are a means of personal expression and vary according to the size of the performance space, the mood of the music and the nature of the musician's responses to it. These micro tempo changes are possible with a realtime based performance strategy.

2 About *K…*

The opera's Prologue is a sonic depiction of a nightmare of the central character, Josef K. In this purely instrumental scene, there is a strong component of electronics which depict K.'s turmoil. The story begins with Josef K. being awakened one morning by two warders telling him of his arrest. Progressively K. becomes increasingly obsessed with his upcoming trial, although a trial never actually takes place in the opera. During the course of the opera K. tries ineffectually to enlist help or make changes in his situation. K. never learns why he has been arrested and so never knows whether or not he is guilty.

The technology involves the inaugurating in realtime of synthesized and sampled sounds. These sounds are either pre-recorded samples, live samples, synthesized elements, or spatialized events. Synthesis technology used in the opera includes pafs (phase aligned formants – a process used to synthesize vowel formants that change over time [Puckette, 1995]), noise, and psola (pitch synchronous overlap add – a technique that allows the decomposition of a periodic signal into pitch period waveforms which can then be overlapped or added to change pitch while maintaining formant structure [Schnell et al, 2000]). Among the transformation techniques used were harmoniser, reverberation, and the leslie effect. More than 500 samples are played throughout the opera

3 A Realtime System

The system can be divided into the areas of input, monitoring, triggering, processing, connections and output, with each step involving adjustments by human technicians or musicians. With the exception

of the short duration of an electronic event, there is no time in the opera where the technology runs by itself. Continuous human interaction allows for the adaptation of the technological components to the natural performance rhythms of the conductor, singers, and orchestra players. While the clavier player is responsible for the initialization of each event, there are two sureties against his failure.

3.1 Inputs

Inputs to the spatialization portion of the system are from three wireless microphones. The microphones, connected to a transmitter hidden in the costumes of the performers, are sent to a receiver in the sound booth and then sent to channels 1, 2, and 3 of the Yamaha 02R Digital mixer. Signals 1 and 2 (the voices of K and the priest) are sent to the adc (analogue to digital converter) on the SGI for live processing. All wireless microphone signals are also sent to other channels for amplification without processing - either to the set of loudspeakers closest to the stage (loudspeakers 1, 2, 5, and 6), or to the loudspeaker near the orchestra pit (loudspeaker 16). The latter routing is used to produce a more focused sound that appears closer to the place where the singer is located.

Amplification is used for the main character, Josef K. in three scenes: Scene 3 in the bank, Scene 4 in the courtroom, and Scene 11 in the cathedral. In all of these scenes there is a strong component of electronics. Amplification is used in order to maintain a balance between voice, orchestra, and electronics. Three other characters use amplification for the same reason: the Bank Director, the Judge, and the Priest in Scenes 3, 4, and 11 respectively.

3.2 Monitoring

In the audience the composer operates a Yamaha 01V Midi Mixer to control the levels of the electronic parts in realtime. The composer manually adjusts the levels of eight parameters during performances. These parameters are overall level, spatialization, noise, transformations, samples, synthesis, reverberation, and amplification of live sounds. Parameters are sent continuously from the midi mixer via two midi lines to the machine room. In the machine room the signal goes to a booster to augment the midi signal, and then to a midi merge to combine the signal with the signal from the clavier. Next is a midi to serial conversion and then the signal is sent into the SGI via the serial port.

From the audience Lemouton monitors the Sony Laptop displaying the GUI for the SGI. The laptop is connected to the SGI in the machine room via an ethernet cable. In case of human (the clavier player) or computer error, Lemouton is responsible for problem solving.

Both the conductor and the clavier player have small audio monitors with independent volume control that deliver a mono signal of the electronic portion of the opera. This is obtained from a patch in the computer that produces a stereo mix. This is sent to the stereo outs of the SGI and journeys from the machine room to the orchestra pit via the Opéra-Bastille's built in audio system.

3.2.2 Intercom

Before the performance can start and preceding each act, all involved must signal their readiness to begin. This is done through an intercom system connecting the assistant conductor, the musical assistant, the lighting director, the stage manager, and the clavier player. The intercom system is built into the Opéra-Bastille and allows the stage manager to direct the production by enabling him to be in contact with circles of participants in the performance of the opera.

3.3 Triggering

Following the conductor as any musician in the orchestra, the clavier player plays single notes at preset points in the score (see Figure 1. for an example of the clavier score). The rhythm of the notes the clavier musician plays is essential and matches exactly with the acoustic elements of the opera.

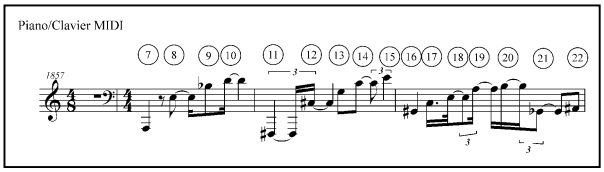

Figure 1. Clavier score excerpt from Scene XIC – circled numbers indicate electronic event numbers

While the exact notes played on the electronic keyboard are never heard, there are two important reasons for the pitches on the clavier to vary. First, a keyboard player would be less engaged if the same pitch was played 2000 times. And more importantly, the computer, in carrying out score following, is monitoring what pitch is played, and the time elapsed in milliseconds from the beginning of a section to the onset of that particular note. This means that the probability of accuracy increases if the note pitches are varied so as to give unique pitches at least every fifteen steps. With the algorithm for score following the computer can monitor the timing and pitches and determine if the event currently playing is at the correct time. If the clavier player misses a note, the computer will advance to the correct event number in a section.

3.4 Processing

Processing is rendered by a dual CPU SGI computer running jMax, Ircam's proprietary version of Max/msp. jMax or Java Max runs on the Linux operating system and allows the separation of GUI

from working engine [Déchelle, et al, 1999]. The SGI executes the synthesis and spatialization patches working up to 80% of the computational power of each CPU. Monitoring functions, or the GUI interface, are Java based and is carried out on the laptop computer. Thirty qlists containing spatialization and synthesis events are read and carried out by the Jmax patches on the SGI.

3.5 Connections

The hardware and the types of connections used in the opera can be viewed in Figure 2. Links are through ethernet, aes/ebu, midi, fiber optic, or wireless connections.

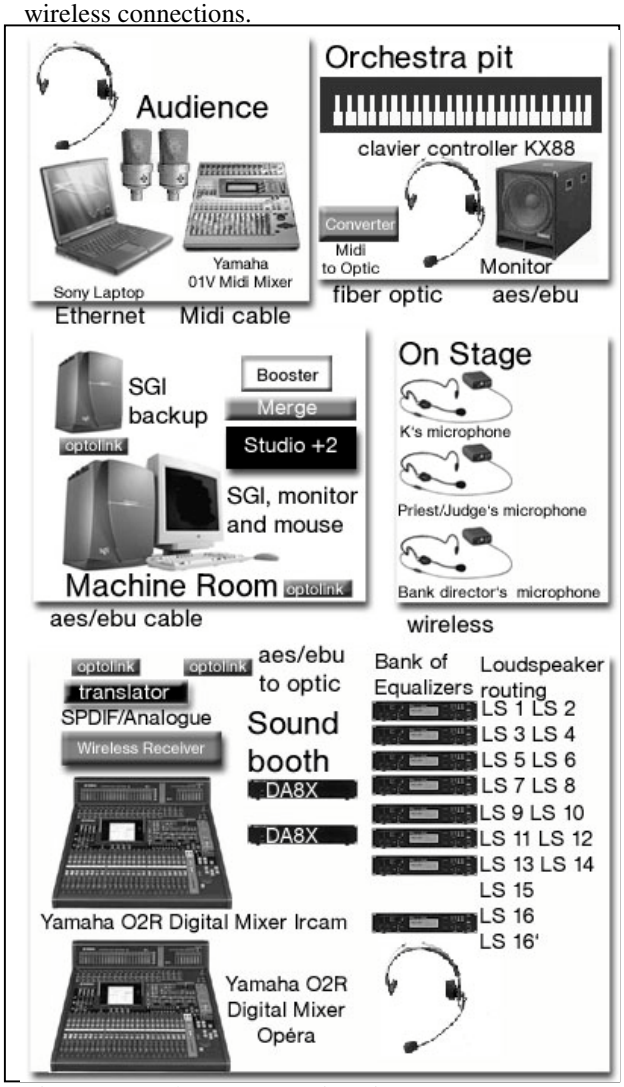

Figure 2. Hardware connections in *K…*

The Opéra-Bastille installed a fiber optic system in the grand hall for *K…*'s 2001 premiere. This system was used in *K…* to pass a midi signal from the clavier in the orchestra pit to the digital mixer in the sound booth. This permitted the transmission of the signal over the required long distance without degradation or drop out.

There is another system in the Opéra-Bastille used to pass audio signals from the stage to the sound booth for monitoring and archive recordings. This system was initially tested for use with *K…* but was found to be unreliable for sending a midi signal.

A second SGI in the machine room with the same hardware, sound cards, software, libraries and samples, is ready in case of a problem with the primary computer. The backup system has never been used.

3.6 Output

There are sixteen loudspeaker channels used in the opera *K…*, although thirty loudspeakers are actually employed. Spatialization patches in the SGI send a signal to the digital mixing board. Signals are routed to two dacs (digital to analogue converters) and then sent to a bank of eight equalizers and then sent to the Opéra-Bastille's amplifiers.

There are amplifiers and loudspeakers hidden in the walls throughout the grand hall in the Opéra-Bastille. The amplifiers are connected to loudspeakers or sets of loudspeakers. This assignment of speakers is hardwired and dependent on the placement of the loudspeaker in the hall. For example, there is only one loudspeaker 1, which is located in the wall on the left in the front of the hall. But, there are six of loudspeaker 13 at the back of the hall on the left, with two each on three levels of balcony. See Figure 3. for an overhead view of the speaker layout in the Opéra-Bastille.

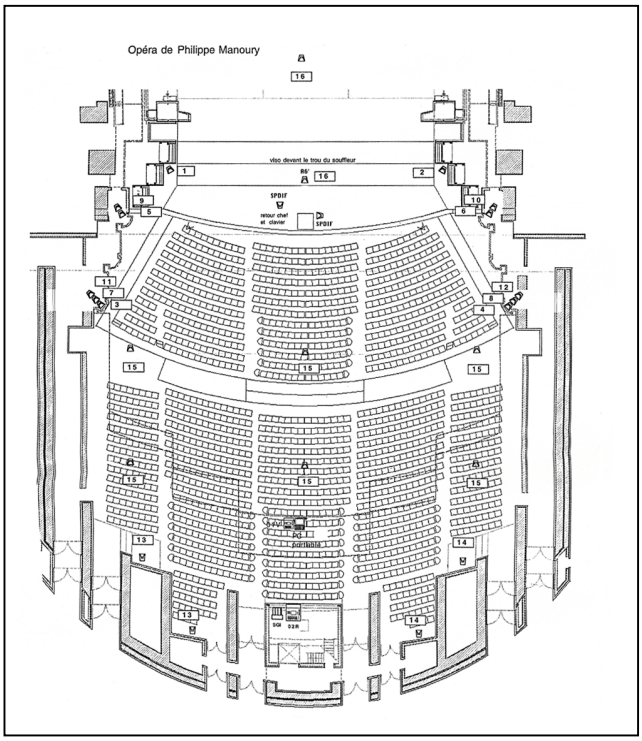

Figure 3. Loudspeaker layout in the Opéra-Bastille.

Loudspeaker 1 and loudspeaker 2 were visible during the performance of *K.…* This was because their usual location was considered too close to the audience. In their original location, these two

loudspeakers would have given the front audience members too large a proportion of the electronic part of the opera. A petition to the director of the Opéra-Bastille secured the necessary special dispensation to move the two loudspeakers from their usual location in the wall under loudspeaker 5 and loudspeaker 9, to a location more removed from, and visible to, the front audience members.

4 Realtime Spatialization

Realtime spatialization is one of the components of the opera that dramatically shifts the reception of the work. Spatialized sound is not just another timbre in the orchestra, but gives an immersive dimension that is unusual in the context of a modern classical opera.

The concept of sonic trajectory is important to Manoury. Through his use of fleeting and sweeping trajectories, the listener's focus changes from the nature of the sound to its motion. The launching of twenty-eight preset pathways such as zigzags, rotations, and spirals, are algorithmically timed to the dimensions of the Opéra-Bastille. See Figure 4. for the layout of one of the spatial pathways. All parameters for each pathway, such as length of time for intensity panning, distance cues and reverberation, are preset. During an all night rehearsal of spatialization cues at the Opéra-Bastille, these parameters were determined by ear by Manoury and Lemouton.

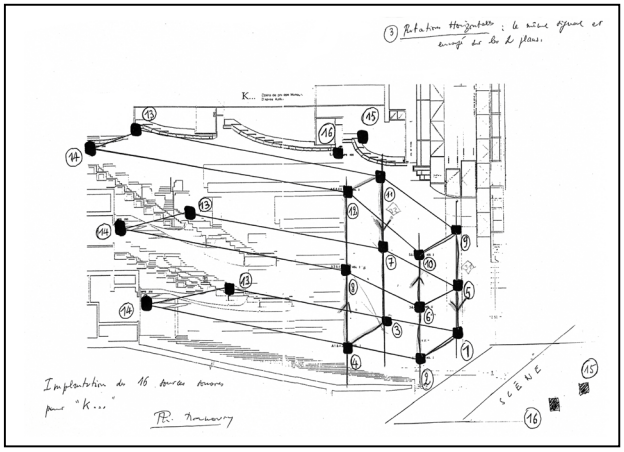

Figure 4. Forward rotation pathways used in K… at the Opéra-Bastille

Manoury also uses spatialization to simulate a virtual cathedral. In Scene 11, when Josef K. goes to a cathedral, the voices of K. and the priest are spatialized in realtime. At dramatic moments, such as when the priest first calls out Josef K.'s name, the priest's voice acquires a trajectory as it moves rapidly around the hall. Also, by changing the level of the sound, the amount of reverberation and the spectral content in the voices of the two singers and the other electronic sounds, the audience has the experience of being in a massive, reverberant space such as a cathedral.

5 Conclusions

Opera is expensive and its production protracted, with large sets, costumes, movement, singers, orchestra, and lighting. Manoury's addition of electronics increases the substance of this artform. But, there is also an increase in the audience's engagement with the opera. Although he creates an extremely varied palette of sonic materials, Manoury maintains the independence of each element while at the same time fusing them into one sonic universe. The composer successfully combines the elements so as to stimulate the listener to find new relationships with sound. Accordingly, we have reason to carefully study the strategies involved in this extensive realtime performance system to better comprehend this emergent form of opera.

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