Creating Integrated Music and Video for Dance: Lessons Learned and Lessons Ignored

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ABSTRACT
In his demonstration, the author discusses the sequential progress of his technical and aesthetic decisions as composer and videographer for four large-scale works for dance through annotated video examples of live performances and PowerPoint slides. In addition, he discusses his current real-time dance work with wireless sensor interfaces using sewable LilyPad Arduino modules and Xbee radio hardware.

Keywords
Keywords: dance, video processing, video tracking, LilyPad Arduino.

1. INTRODUCTION
Over the past five years, I have composed music and video as part of a series of collaborations with choreographer Elizabeth Shea and scenographer/lighting designer Rob Shakespeare, both my professional colleagues at Indiana University. During that period, we created four large-scale works, two some twenty minutes or more in duration. While our first work had a small amount of actual video, it did incorporate video tracking which in turn affected the music in real time. Each successive work incorporated interactive music and video in varying ways—full-time live processing of the dancers' images, fixed video, infrared tracking and keyed projections, etc.

The aesthetic problems created and the problems solved in having competing visual and aural stimuli for an audience to synthesize has been a journey of discovery and occasional confusion. The collaborative language that three artists from different disciplines create to work together when exploring a combined medium none is fully experienced in is one that continues to evolve. I would like to share examples from each of these works, which are quite different from each other, and discuss the pro and cons of each approach, how each influenced the subsequent work…or how these lessons were ignored in favor of a completely different approach.

2. FOUR WORKS FOR DANCE
2.1 Coming to Light
Completed in 2006, *Coming to Light* is a 22-minute work for eight dancers with video projection and video tracking. The projection created by scenographer Rob Shakespeare used four keyed data projectors to create the illusion of a panning virtual camera capturing a sunset with moving light appearing through a window, casting moving shadows on the dancer and the stage [1]. In addition, composer Jeffrey Hass used video tracking to trigger audio samples, with brightness and target velocity affecting density and intonation.

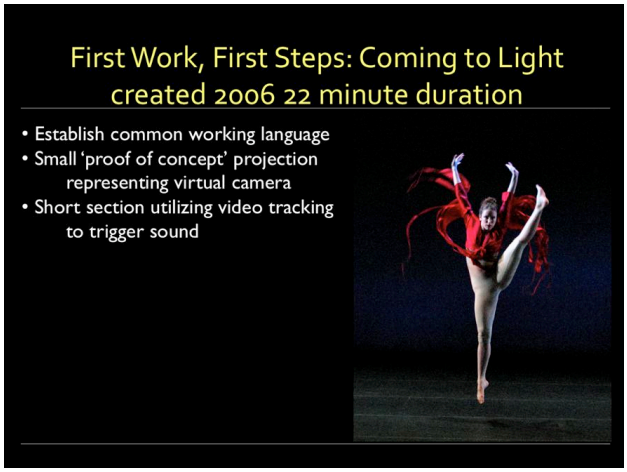

Figure 1. Slide 2 Coming to Light.

Successes in this work included the artists finding a common working language to develop ideas incorporating technology that fit a common artistic vision. Staging to accommodate the two technical aspects affected the overall choreography and the challenge of making that work in the context of a larger work was successfully met.

Lessons learned were how intensive the work for even short renderings of 3-dimensional projection can be…therefore difficult to incorporate on a large scale. Additionally, triggering musical gestures via grid-based video tracking without visible reference points for the audience to relate to aural events (i.e. a way to see the dancers 'hit' the grid locations) made this early attempt less effective than hoped.

2.2 Dancing Till the Cows Come Home
This 11-minute 2007 work by Elizabeth Shea and Jeffrey Hass utilized full-time video processing of the eight live dancers projected on a full-stage screen (cyclorama) behind them. Hass used Mark Coniglio's *Isadora* software [2] to generate twenty difference 'scenes' throughout the work and used a DAW (MOTU's *Digital Performer* [3]) to send MIDI control data to Isadora, synchronizing the pre-recorded audio tracks with dynamic video processing parameter changes. In addition, the composer provided live "VJ'ing" of some scenes with a control surface.

Successes included capitalizing on collaborative techniques learned in the first work to more quickly conceive of choreography, music and video in a unified artistic vision.

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Learning from the video tracking ambiguity of the first work, a clear connection between the actions of the dancers and the subsequent effect on the visual and/or aural presentation was made. Finally, by composing the music and programming the video processing simultaneously, it was possible to exploit close relationships between them—to create a visual rhythm tied closely to the aural rhythms.

In certain scenes, the physical rhythms of the dancers drove the visual rhythm and density of the projection—the more active they became, the more proportionally active the interactive projection became. A minor but important lesson was learned about combining live video with projection—we quickly learned that the camera needed to be placed on a catwalk shooting down onto the stage to avoid having the processed projected image picked up from the cyc and reprocessed.

The overall effect demanded that the viewer make constant choices of whether to follow the full-stage video with the processed dancers' images or the dancers themselves. The aurally intense nature of the music also placed additional demands on the audience attention. Lessons learned in this regard were addressed in the next two pieces.

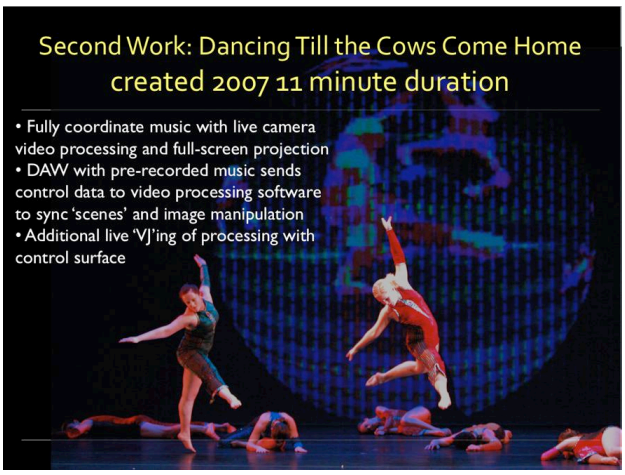

Figure 2. Slide 15 Dancing Till the Cows Come Home.

Figure 3. Slide 16 Dancing Till the Cows Come Home.

2.3 The Nature of Human

The Nature of Human, completed in 2008 is a 20-minute, three-movement work for nine dancers, with movements based on "mind, body and spirit" respectively. *1. Mindstorms* experimented with the use of real-time infrared mattes to produce a silhouette of the dancers against the rear cyc, which was backlit with IR LED's. The silhouette was picked up by an IR camera in the hall and fed into the Isadora application, where it was inverted to a luminous image and projected back onto the dancers from a carefully calibrated projector. Various patterns and graphics were added to the projected inverse silhouettes using a masking technique. One of the goals of scenographer Rob Shakespeare was to create "virtual shadowless light." The composer had sonified data from synaptic activity and used it not only for the music, but also envelope-tracked the peak amplitudes and converted them into bright flashes which were also projected onto the dancers' bodies. Finally, for part of the movement, panels of infrared translucent fabric were hung to give a three-dimensional feel, as shown in the Figure 4 lower-right image.

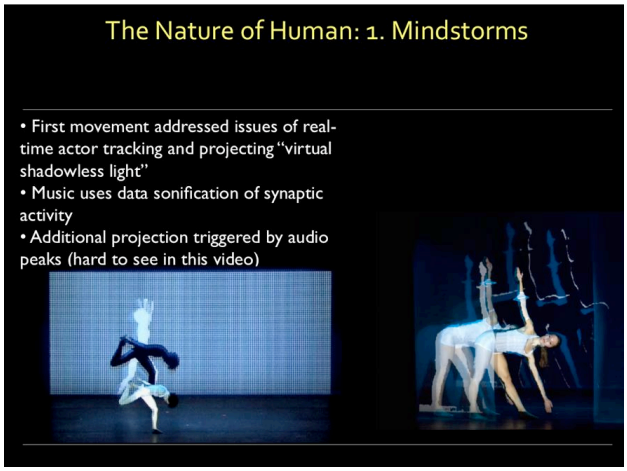

Figure 4. Slide 20 The Nature of Human.

2. Magnetic Resonance Music utilized full-screen fixed video incorporating some pre-recorded sequences of choreography that was then mirrored by the real-time dance itself. The intent was to bring the projected image into the same world as the dancer and not create a competing visual distraction. Figure 5 below shows two instances where the actual dance and the projection intersected.

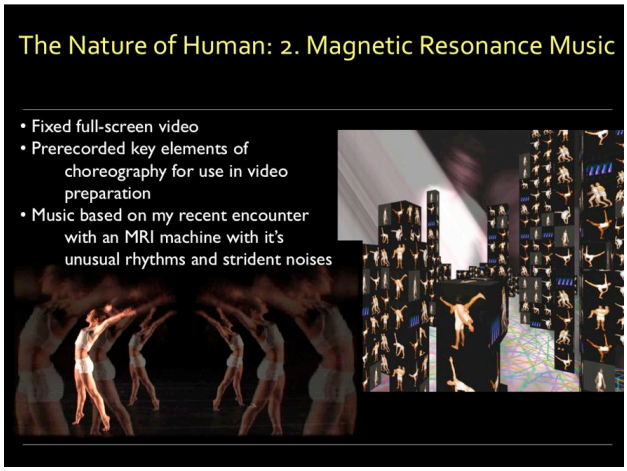

Figure 5. Slide 28 The Nature of Human.

Lessons learned were again numerous. In the first movement, we quickly discovered that the lag created primarily by the composite video-to-Firewire converter meant the image projected onto the dancer ended up trailing when the dancer moved quickly. The choreographer Liz Shea took advantage of

this, however, by designing sequences where the dancer deliberately interacted with her 'shadow.' A higher-quality converter diminished lag time, but did not eliminate it. Additionally, eliminating all sources of infrared in a theatre is a daunting challenge. IR leaks caused visual noise and other interference to the silhouettes, particularly around the edges of the image. Putting IR filters on all stage lighting and mounting a matte in front of the projector helped reduce this problem.

Movement 2's full-screen projection behind the dancers again created competing visual elements for the audience, but constructing the choreography to be used in the video as well as on-stage at the same time unified the elements to a greater degree than in *Dancing Till the Cows Come Home.* Sequences where dancers were asked to perfectly coordinate with their on-screen counterparts were limited primarily to solos, which helped, as we had learned how difficult this is for live dancers to synchronize consistently, particularly when they are not facing the screen. Below is the final moment, with the dancers mirrored by the video.

Figure 6. Slide 30 The Nature of Human.

2.4 Unstrung

Unstrung was the fourth and last collaboration to date between choreographer Liz Shea and composer Jeffrey Hass. Written in 2009, the eight-minute work is for solo dancer, live processed violin (with violinist on-stage) and minimal projection. While the composer had explored various techniques of interaction between projected image and dancer in previous works, limiting the work to a solo dancer and single instrumentalist allowed for the possibility of greater live interaction between the two. The 'story' behind the work traces the path of the dancer from confinement to freedom. Wishing to keep the focus primarily on the dancer and violinist, the projection was scaled down compared to previous works and complimented the story with evolving string motifs.

MAX/MSP [4] was used for live processing of the violin, which gave the violinist great freedom in interpretation. This allowed the two artists to visually cue each other and play off the activity and intensity of each other.

The progress made in finding a musical language incorporating real-time processing that responded well to interaction with physical movement was necessary for our next step, which is to use wireless sensor data from the dancer to modify both aural and visual elements. Finding simultaneous musical and choreographic gestures that create a sense of unity of purpose was an important artistic step to take before adding the additional technological elements with movement tracking. Having learned both the advantages and disadvantages of using large numbers of dancers in a piece, it was clear that certain more sophisticated and subtle interactions work best with a solo dancer.

2.5 What's Next

The next dance collaboration will involve both musical and video processing driven by a network of physical sensors and video tracking. I have in the past several months created a basic extremely lightweight wireless sensor package that is easily sewn on a dancer's costume. Each set of wearable hardware consists of two bend sensors, a LilyPad ADXL335 3-axis Accelerometer, a LilyPad Arduino 328 Main Board, and LilyPad Xbee board, and Xbee Series 2 wireless radio, all powered by a light polymer lithium ion battery.

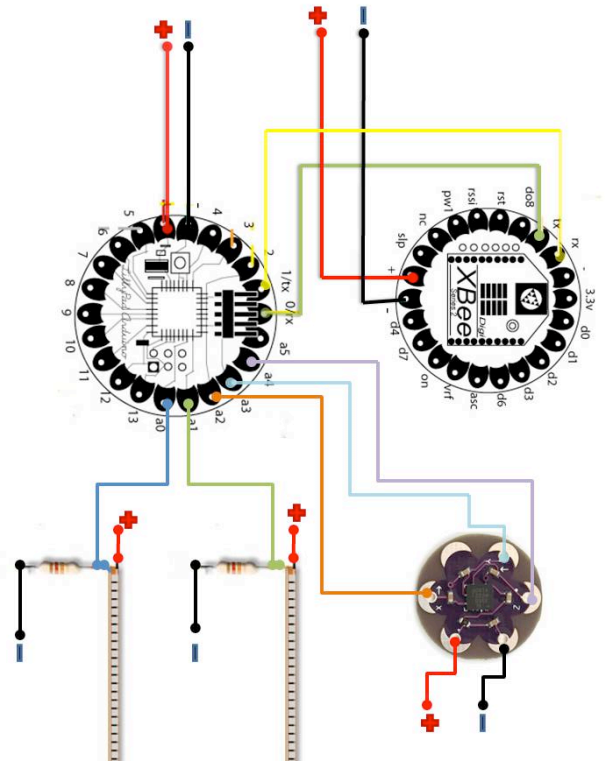

Figure 7. LilyPad wearable sensor system schematic [5].

Data is transmitted wirelessly to an Arduino Pro board with an Xbee shield and matching Xbee Series 2 radio, communicating with MAX/MSP and Isadora via USB. The Arduino board has the ATmega chip removed and acts simply as a serial pass-through device for the base station Xbee. Current work involves adding a multiplexing board to the LilyPad to increase the number of sensors accommodated by a single unit (Sparkfun Analog/Digital MUX BOB-09056).

The LilyPad Arduino has been programmed via Sketch [6] to perform a 20-second calibration and scaling of the sensors when requested. It numbers the data packets sent out so that missing or bad packets can be detected and compensated for.

The goal for the current project is to take all of the lessons learned, beginning with standard and IR video tracking, plus live video processing and visible interactions between musician and dancer, and to now add sensor movement data into the mix. Utilizing live video from the dancer(s) and simultaneous sensor

data, all sorts of decision trees for both audio and live video processing can be fashioned and immediately fed back into the process. Learning from past experience, triggered events will be noticeably related to physical actions, generated video will visually compliment rather than distract from the dancer, choreography will be developed in close coordination with the musical effects of the dancer's actions, and above all, the technology may inspire, but will ultimately serve the artistic purpose of the creation, not the other way around.

3. ACKNOWLEDGMENTS

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4. REFERENCES

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[2] Isadora. http://www.troikatronix.com. Retrieved April 16, 2010.

[3] Digital Performer. http://www.motu.com. Retrieved April 16, 2010.

[4] MAX/MSP. http://www.cycling74.com. Retrieved April 16, 2010.

[5] Figure courtesy of Ed Dambik, Indiana University Advanced Visualization Lab, Bloomington, Indiana.

[6] Arduino Sketch. http://arduino.cc/en/Main/Software. Retrieved April 16. 2010.