Sound of Rivers: Stone Drum: a Multimedia Collaboration, with Sonified Data, Computer-Processed Narration, and Electric Violin

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ABSTRACT

Sound of Rivers: Stone Drum is a multimedia collaboration, between choreographer Nicole Bradley Browning, animator and video artist Amber Marjorie Bushnell, poet and narrator Mark Gibbons, and composer and electric violinist Charles Nichols, with dancer Allison Herther and narrator Stephen Kalm. The piece illuminates research by scientist Mark Lorang, into how fish and insects navigate the ecosystem of floodplains, by the sound of rivers. The project began with three floats down the Middle Fork Flathead River, where audio and data were recorded, on and in the river, and at the field station. The data were used to ramp amplitudes of bandpass filterbanks, to process recordings above and below water, and to drive a bowed-string physical model. Poetry was written, based on an explanation of the scientific research, and choreography, animation, computer-processed narration, and an electric violin part were composed around the structure of the poem. The piece was performed live with a narrator, dancer, video artist, and electric violinist, and later developed into a fixed media piece.

1. BACKGROUND

Sound is an environmental cue, that fish and insects can hear and associate with direction and some physical dynamic process. Just as if you were placed in the floodplain of a river blindfolded, you could point to the direction of the river, because you could hear it, and assess where the sound is coming from.

Some species of stoneflies live most of their lives in the subsurface of gravel-bed river floodplains, up to several kilometers away from the surface channel, yet they must migrate to that surface channel, to complete their life cycle. The hypothesis of this research, underway at the Flathead Lake Biological Station, is that stoneflies can hear the river, and hence know which way to go. Many different kinds of aquatic habitat (riffles, rapids, runs, pools) have distinct soundscapes, due to various levels of turbulence, degrees of bedload transport, and types of sediment. Hence, rivers with complex combinations of such habitats, sediment types, and flow regimes, have complex soundscapes. One would expect that, because fish have ear bones, they evolved with the ability to use this ubiquitous physical cue to their environment, in ways that are beneficial to their survival. And, one would expect the same for aquatic insects that live in the river. We know a quiet street, from a busy intersection, so the same must be true for an aquatic organism, be it a fish or a bug. So, the fundamental hypothesis is that rivers create unique sounds, that organisms use as cues to their physical environment.

The sound of rivers is something any human can perhaps relate to. The babbling of a brook may be calming and soothing, but the roar of a rapid may well be frightening. The sound of gravel banging and clanging along the river bottom during a flood may be awe-inspiring as to the river's physical power to shape a landscape. Physical limnologist Mark Lorang, from the Flathead Lake Biological Station, is using these sounds to monitor dynamic behaviors of a river, by using fiber optic cable to pick up sounds too faint for the human ear to hear, and hydrophones to characterize habitat in ways that other measures of flow hydraulics cannot ascertain. He and fellow scientist Diego Tonolla, from the Leibniz-Institute of Freshwater Ecology and Inland Fisheries, were able to demonstrate the differences in soundscapes, from various river types, such as bedrock canyons, multi-channel floodplains, and meandering systems. More importantly. they were able to show that rivers channelized by heavy-handed human alterations were characterized by essentially no soundscape; the music died, because the complexity of channel and turbulence it creates was gone [1, 2].

2. PREPARATION

At the invitation of scientist Lorang, composer and computer-musician Charles Nichols joined a research team from the Flathead Lake Biological Station, on two of three floats down the Middle Fork Flathead River. During these floats, he recorded audio above the river, while scientists Chris Gotschalk and Diego Tonolla recorded audio and data in the river, from the rafts. At the same time, scientist Rob Maher recorded audio and environmental data at the edge of the forest, and engineers Scott Colton and Stephen Doll recorded audio along the river bank, at the Middle Fork Flathead River research station: see Figure 1.

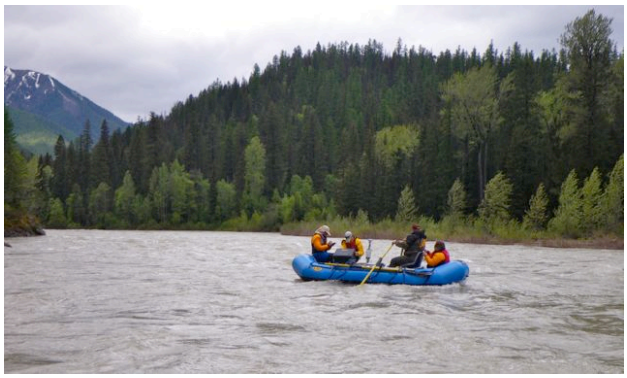

Figure 1. Scientists Chris Gotschalk, Diego Tonolla, and Mark Lorang, and composer Charles Nichols, on the Middle Fork Flathead River. Photo by Giles Shearing.

With support from a National Science Foundation Experimental Program to Stimulate Competitive Research (EPSCoR) grant, through the Montana Institute on Ecosystems, at the University of Montana, Nichols assembled a team of artists, including choreographer Nicole Bradley Browning, animator Amber Marjorie Bushnell, poet Mark Gibbons, dancer Allison Herther, narrator Stephen Kalm, and videographer Parker Nitopi, with the plan to develop, perform, and document a multimedia collaboration based on the research of Lorang.

The process started with Lorang writing descriptions of his research into the highly complex, dynamic, and diverse ecosystems of rivers and their floodplains, and his hypothesis that insects, specifically the stonefly, navigate the subsurface of gravel-bed river floodplains by the sound of rivers. From this springboard, Mark Gibbons wrote two poems, based on Mark Lorang's writings, one that relates the genesis of music to our fixation with the sound of water, vividly translating these sounds into historic musical references.

Next, the collaborative team of choreographer Browning, animator Bushnell, and composer Nichols met to brainstorm the aesthetic and structure of the piece, the motion and staging of the dance, the organization and projection of the animation, and the instrumentation and textures of the music, and how these would relate to the poem. While individually developing these three components of the piece, the creative team met periodically to update and critique, and posted video, images, and audio, to update and guide the evolution of the work.

3. DEVELOPMENT

3.1 Poem

After reading Lorang's scientific research and discussing his hypothesis about the migration of the stone fly in relation to the sound of water, poet Mark Gibbons returned to the source, to experience the sounds of water in creeks and rivers. Inspired by both the sounds and images he rediscovered on the Clark Fork River and Petty Creek, Gibbons began writing. He knew man had to come into the poem, so the fisherman in him came to the poem. While sound obviously dominates, it was the death of Dave Brubeck that brought actual musicians into the poem. Gibbons' poem was inspired by the experience of going to water, listening to it, watching it, reading Lorang's work, and allowing his memories and tastes in music to enter the poem.

3.2 Choreography

The choreography is divided into three sections, representing River: under the river, Animal: in the river, and Human: with the river, with Animal comprised of Insect, Fish, and Bird. The dancer interacts with a large cyclorama, a sheet of elastic and reflective fabric, stretched across the entire width and depth of the stage. At the back of the cyc is a skirt sewn into the fabric, that allows the dancer to insert themselves into the sheet. The dancer is at times under the fabric, pushing and grasping at the cloth, and at other times attached to the sheet, twisting, stretching, billowing, and plucking at the expanse: see Figure 2.

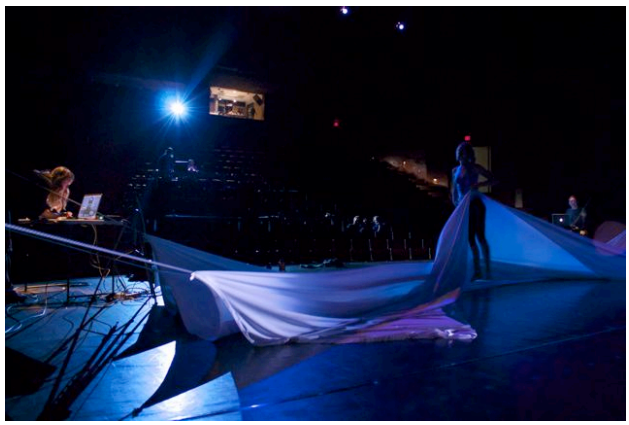

Figure 2. Video artist Amber Bushnell, choreographer Nicole Bradley Browning, lighting designer Mark Dean, dancer Allison Herther, and electric violinist Charles Nichols, rehearsing *Sound of Rivers: Stone Drum*. Photo by Amelia Hufsmith.

3.3 Video

The projection and animation is divided into three parts. First, on a screen that fills the back of the stage is a circular panel that contains striations, rippling in response to a live audio feed from the music, and a colored shadow based on a live video feed of the dancer, pulsing according to the amplitude of the music. Around the panel, also

projected on the back of the stage, is intricate digital animation composed in real-time, of hand-drawn river plants, insects, and animals, that grow and move in symmetrical patterns, throughout the piece. These river elements were chosen specifically to reflect the health of the floodplain ecosystem, and are interwoven to illustrate their interconnectedness in the natural environment. Projected from above, onto the cyc that the dancer interacts with, are animations built from insect and bird wings, and fish scales, that grow in density and modulate in color, as they pass over the reflective surface.

To animate the illustrations, Bushnell used Adobe After Effects Expression, a coding language based on JavaScript. Bushnell controlled parameters of the animation with Expression, resulting in a randomized collaboration with the computer, creating life-like movement for the river elements. To scale the projections, to the screen at the back of the stage, and on the cyc stretched across the stage, Bushnell used the video mapping software MadMapper, along with the VJ video mixing and processing software Modul8. Combining the two applications, she positioned the fall of the projections, gave live cues to the animations in coordination with the narrated poem and performed music, and created live interactive layers that responded to the sound design.

3.4 Music

The music is divided into three textures. The piece starts with processed spoken text, recordings of the poet reciting his poem, that have been stripped of their harmonic spectrum, stretched in time, shifted in pitch, and granulated into jittery textures. These soundfiles, based on key words of the poem, echo the live narrated text and cascade in parallel along the sides of the auditorium, through a quadraphonic sound system encircling the audience. The second texture is generated from bandpass filterbanks, built from spectral analyses of recordings taken on the floats and at the field station, that filter recordings taken above and under the water, into surging harmonies, that ebb and flow. These harmonies accompany bowed-string physical model synthesized sound, that uses the data of river depth to drive pitch, river velocity for amplitude or loudness, wind speed from the North for bow pressure, and wind speed from the East for bow position, creating a sonification of the environmental data. Finally, Charles Nichols performs live, on electric violin, passages that combine the scales and rhythmic motives of the music and instrumentalists mentioned in Mark Gibbon's poetry into original melodies, processed with multiple layers of phaser and delay effects, that sweep and echo in the four channel sound system.

3.4.1 Sonified Data

Inspired by composer Jonathan Berger's work, integrating data sonification into expressive electroacoustic music [3], Nichols began experimenting with mapping data streams, collected by the research scientists on the floats and at the field station, to synthesis parameters.

For the primary background texture, Nichols programmed instruments in CsoundQt, that ramped the gains of bandpass filterbanks, according to the data recorded during floats down the Middle Fork Flathead River. The octave band and one-third octave spectral analyses, from a hydrophone mounted on the raft, and from hydrophones dropped into wells around the floodplain, recording from 20 Hz to 20 kHz, up to 90 dB, were used to filter underwater and above water audio recordings. The collision of gravel and sand particles, sediment moving on the river bottom, in the underwater recordings of the river, made for ideal noise sources, processed by the data controlled filterbanks. These audio sources, along with the composer's recordings of Rattlesnake Creek, pinged the undulating filterbanks, as the data swept the bandpass gains, producing ringing harmonies. For added musical interest, the base frequency, that the filterbanks were built upon, was occasionally shifted, with slow glissandi.

For one of three foreground textures, Nichols programmed additional instruments in CsoundQt, that mapped environmental data to waveguide bowed string physical model synthesis parameters. Specifically, river velocity was used to control bow speed, river depth was mapped to pitch, and wind velocities from the East and North were applied to bow position and pressure. Nichols tuned the scale of these variables, to optimize the musical expression of the resulting synthesized sound. The results are simple melodies, with natural sounding fluctuations of loudness and timbre.

These synthesized bowed-string melodies were further processed, with the same digital effects that were applied to the live electric violin, effectively integrating them into the collective timbral palette.

3.4.2 Computer-Processed Narration

The first foreground texture is the result of processing a recording of the poet narrating his work. Action words, describing the movement of the river, and onomatopoeia, of the sounds of rivers, were cropped from the recording, as source material. These sources were analyzed, stripped of their harmonic spectra, time stretched, pitch transposed, and resynthesized, with the SPEAR application. The resulting soundfiles are noisy shadows of the originally recorded text. Nichols further processed these noisy sources with granular synthesis, using the Common Music grani instrument in the Grace application, varying the grain density and spread, to create a palette of jittery textures. When the narrator speaks a descriptive word, varied pairs of insectoid versions of the text cascade from the front of the hall and back, surrounding the audience with a musical interpretation of the poem.

3.4.3 Electric Violin

The electric violin part also was composed in response to the poetry. In his writing, Gibbons mentions luminary Jazz musicians Dave Brubeck, Duke Ellington, Lionel Hampton, and Charles Mingus, as well as Pop icon Frankie Valli. As a point of departure, Nichols used pitch collections from the melodies of *Take the A Train*, *Koto Song*, and *Silence is Golden*, and rhythmic material from

Flying Home and *Moanin'*, to compose material for the violin part.

The electric violin is heavily processed with GuitarRig effects, controlled with a pedal board. The violin techniques and effects used reflect the atmospheres evoked by the poetry. Artificial harmonics and multiple sweeping phasers elicit a glassy watery texture, while pizzicato and ping-pong delays produce a bubbling character. Octave doubling is used to transform the violin into a bass instrument, when Mingus is mentioned in the poem.

As described earlier, the data driven bowed string physical model synthesis also is processed with the same effects, creating a dialog between a live and computer-generated violin, later in the piece.

4. PERFORMANCE

For the performance, Allison Herther danced Nicole Bradley Browning's choreography, while baritone Stephen Kalm narrated Mark Gibbon's poetry. On each side of the stage, Amber Bushnell assembled the digital animation in real time, while controlling the processed video, and Charles Nichols performed electric violin, while controlling the computer music. The animations of bird and insect wings and fish scales were projected onto the cyc skirt, while the interactive video panel and live coded animation were projected on a screen behind the dancer. The interactive video panel was filled with a live shot of the dancer, with shading that intensified and striae that fluttered, in response to the music: see Figure 3.

Figure 3. Electric violinist Charles Nichols, narrator Stephen Kalm, and dancer Allison Herther, performing *Sound of Rivers: Stone Drum*. Photo by Todd Goodrich.

The piece was performed in four premieres, opening the Dance in Concert series, at the Montana Theatre of the University of Montana, May 8-11, 2014.

5. FIXED MEDIA

With the intent of translating the multimedia performance into a fixed media piece, Amber Bushnell and Charles Nichols collaborated to condense the multilayer projection and various audio elements, into one quadraphonic video. Using as a structural foundation the original recording used to produce the computer-processed narration, Nichols composed a fixed-media version of the music. Around a recording of Mark Gibbons reciting his poem, Nichols layered the computer-processed narration, water recordings filtered with environmental spectra data-driven bandpass filterbanks, data-driven wave-guide bowed string physical model synthesis, and electric violin performance. Similarly, Bushnell assembled her colorful digital animation of river elements, around and in a centered circular panel. In the panel, a video of Allison Herther dancing Nicole Bradley Browning's choreography is centered at the bottom, and a mirrored video of a different performance is reflected above. Also in the panel are variations on the rippling striations and pulsing shadings, that respond to the amplitude of the music: see Figure 4.

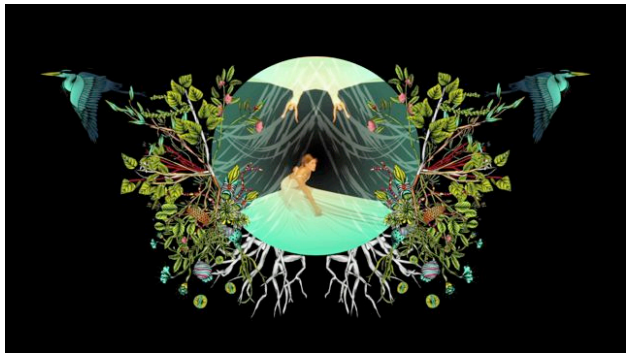

Figure 4. Video of Allison Herther dancing, surrounded by processed video and animation by Amber Bushnell, in the fixed media version of *Sound of Rivers: Stone Drum.*

The fixed media version of the piece has been presented at the Society of Electro-Acoustic Music in the United States annual conference, at Wesleyan University, March 2014, the New York City Electronic Music Festival, June 2014, and the Festa Della Musica Europea, at the University of Rome Tor Vergata, June 2014.

6. CONCLUSIONS

A wide-shot video of the live performance is posted at https://www.youtube.com/watch?v=3IEqF6kKyUo, and a stereo video of the fixed media version is posted at https://www.youtube.com/watch?v=9Rtm6EA29Bw.

Acknowledgments

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7. REFERENCES

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