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Water Cycle Music: Turning Data Into Sound

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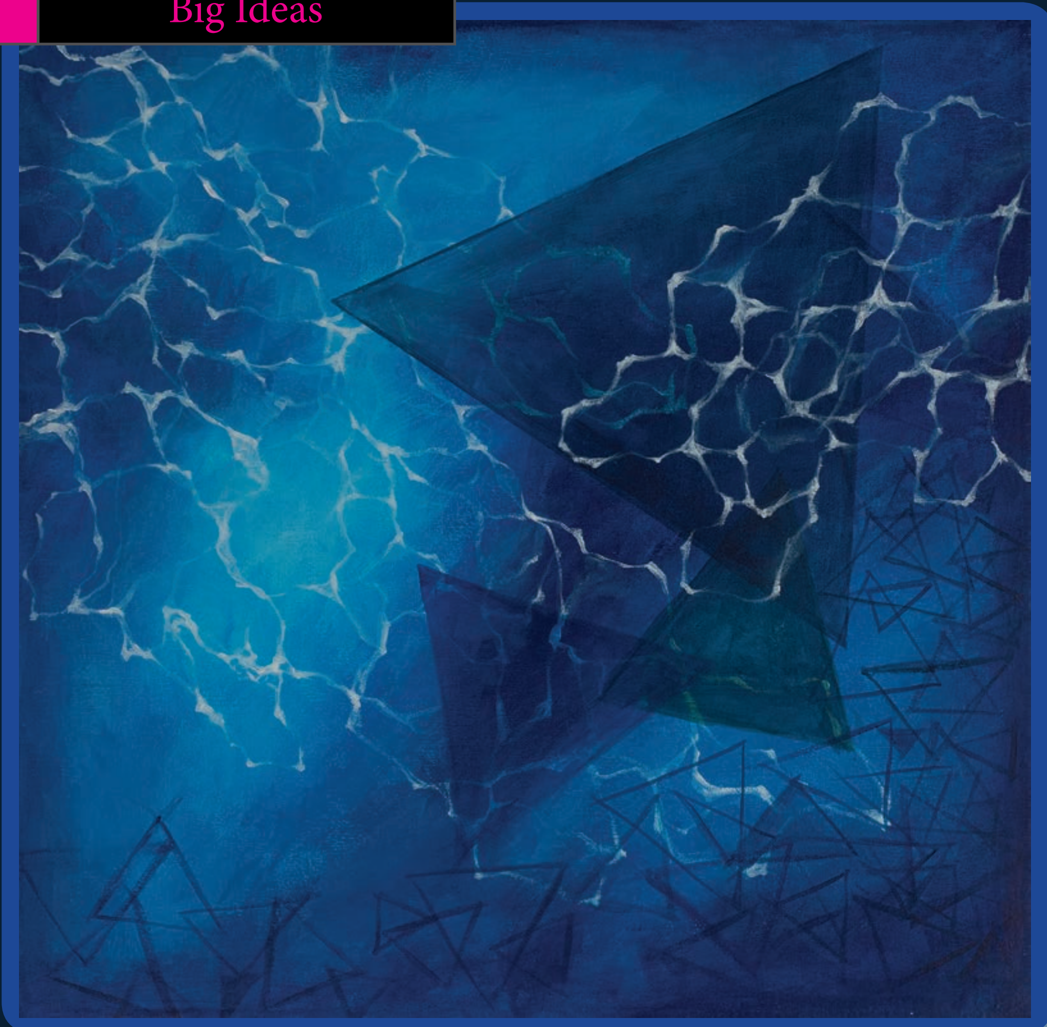

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Turning Dat

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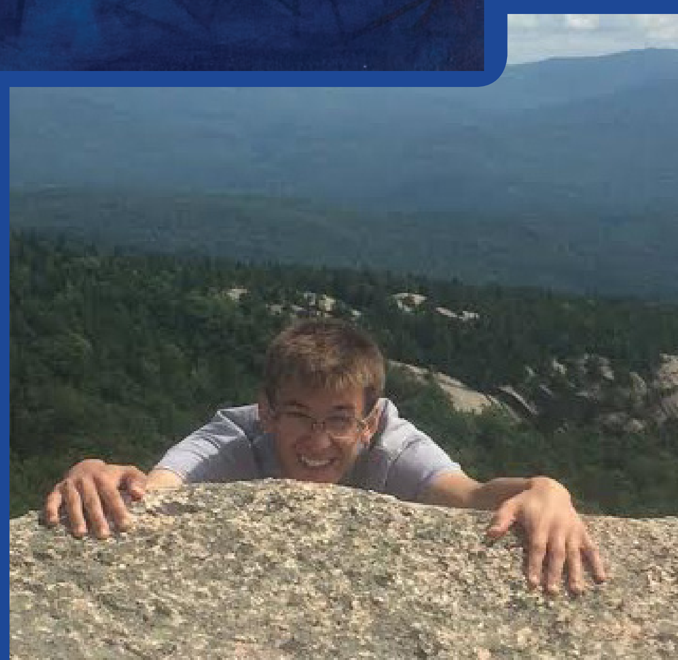
Since the creation of the world's first-known line chart in 1786, scientific data has been overwhelmingly represented and disseminated to the public in visual formats. Tables, charts, and graphs fill up scientific papers and PowerPoint presentations across the world, and more often than not these representations offer little in the way of artistic expression, but rather present scientific data and findings in a rather bland manner. The arts and humanities, which have been closely interwoven with the sciences since the times of the ancient Greeks, have been almost completely ignored in modern scientific communications. While science can give us a powerful understanding of



Above: Torrin Hallett at Hubbard Brook.

Right: A V-notch Weir used to measure streamflow.

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how the world works, the arts and humanities are also needed to more meaningfully convey and communicate those findings to the general public.

Communicating scientific facts and data through music is one exciting possibility for the merging of the arts and sciences. But how do you aurally represent data in a way that is true to the data and allows the data to be easily interpreted while still creating a pleasing musical piece? That was my challenge when, in June 2016, I arrived at the Hubbard Brook Experimental Forest in Woodstock, NH as part of a Research Experience for Undergraduates program that was investigating ways to represent data as sound. I had just completed my third year at Oberlin College and Conservatory where I was studying music composition, horn performance, and mathematics. The music I had been writing was meant to be played by living musicians as opposed to computers, and this concept of turning data into sound was completely foreign to me.

Meanwhile, scientists and musicians at Hubbard Brook had already begun their Waterviz project, creating both real-time aural representations of water cycle data as well as aural representations of pre-existing water cycle data going back to 2010. All of these pieces had been created by Marty Quinn, a musician and the owner of the Design Rhythmics Sonification Research Lab, who has been involved in data sonification for the past two decades.

After listening to Quinn's sonifications, I decided to work with Hubbard Brook's water cycle data set from 2015. This had 8670 data points taken at hourly intervals for ten different variables, and I was tasked with making my own unique, aural representation of these data. As I was getting started, I made a few calls to my school colleagues who studied in Oberlin's Technology in Music and the Related Arts program and purchased Max/MSP, a visual programming language that seemed like it had some potential for data sonification. Max/MSP allowed me to input the data values for each variable and scale them to appropriate ranges that were usable by the program. The scaled values for each variable could be assigned to a sound or instrument, and the magnitudes of the data values defined that sound's or instrument's pitch and volume. I chose a sound that I thought was representative of each variable and decided how the data would influence it.

To represent streamflow, I used the notation program Finale to write and record a tranquil clarinet melody. The streamflow rate controlled the clarinet's volume. If the stream flowed fast enough, cymbals would also start playing, hitting more frequently with higher streamflow. I wrote and recorded a more spritely countermelody for the flute whose volume is controlled by solar radiation. I used a vibraphone to represent rain and a celesta to represent snow, with heavier precipitation triggering more and higher pitches being played by those instruments.

For wind speed, I created a droning sine wave that sounded louder and played at higher octaves with higher wind speed. The panning of this drone was controlled by wind direction. I also chose a sine wave to represent temperature. It oscillated up and down with temperature changes. I used a rolling timpani, or kettledrum, to represent air pressure, with its pitch going up and down along with the pressure.

A pan flute chord represented soil water storage levels, adding higher pitches to the chord as the soils became more saturated. A piano played a chromatic scale that went up and down with changes in humidity. A synthesizer represented evapotranspiration, the water vapor evaporated into the air from the soil and transpired into the air by trees. This synthesizer sounds like something breathing, mimicking the trees and soils "respiring" water vapor into the atmosphere.

The end result was a fourteen-and-a-half minute piece that plays the entire year's data, with a new hourly data point heard once every 100 milliseconds. A recording of this piece will join Quinn's other sonifications on Hubbard Brook's Waterviz website, www.waterviz.org.

In addition to the full piece, I also made recordings of each variable individually cycling through its entire range to act as an aural key or legend. Finally, I made recordings of several hydrological events such as rainstorms, snowmelt, and periods of extended high and low streamflow. These recording excerpts were synchronized to stacked graphs of all the variables with a line moving across them in step with the data, allowing the listener to see the data in a more familiar graphical format while they are listening to the piece.

I hope that my aural representation of data and others like it can help increase the number of people in the general public who are accessing and interacting with scientific data. The current prevailing methods of data representation (charts and graphs) make it very difficult for visually-impaired people in particular to consume scientific data. The ability to represent data both visually and aurally also provides a greater variety of ways for sighted people to interact with data. I anticipate that sonic representations presented in tandem with graphs will act as a bridge for the scientific community to this newer method of data representation.

Hopefully, more data sets will be presented in the future in more aesthetically pleasing ways, as opposed to seemingly cumbersome lists of numbers or unoriginal graphs. This will encourage members of the non-scientific community to spend more time interacting with the data, which can lead them to develop their own conclusions about it. The collaboration of artists and scientists in communicating scientific findings can allow for the exciting prospect of a world where the humanities and sciences are closely intertwined and working together for everyone's benefit.