Archaeologist of Sound

With near-obsessive determination, audio historian Patrick Feaster tracks down remnants of long-vanished voices and noises—and in some cases resurrects them against the odds

Found sound. Wax cylinders Feaster discovered on Smithsonian shelves (*top right*) were recorded at the 1889 World's Fair in Paris, where Thomas Edison was demonstrating the phonograph (*above*).

WASHINGTON, D.C.—In a quiet storage room three floors above the din of the exhibit halls at the Smithsonian Institution's National Museum of American History, sound historian Patrick Feaster is in nirvana. Donning latex gloves, he shows a visitor some of the ancient audio treasures he had discovered among a stack of more than 200 carefully wrapped glass plates, hollow wax cylinders, and flat metal records.

The collection dates from the 1880s, just after Thomas Edison invented the phonograph, when the idea of capturing and playing back a human voice or the toot of a trumpet seemed nothing short of magical.

Inventors during that early era experimented with glass, cardboard, cardboard covered with wax, tin foil, and mixtures of paraffin and wax as their recording mediums. They shouted into a mouthpiece, causing a vibrating needle to cut grooves into a record; some used photoengraving and variable beams of light to imprint a pattern.

And now Feaster, a friendly but intense 40-year-old with a slender build and a photographic memory for anything phonographic, had first crack at helping bring back to life the lost sounds of 130 years ago. His 2-month stint in the "nation's attic" had turned up undreamed-of finds, including long-lost cylinders recorded at the 1889 World's Fair in Paris and what may be the first-ever sound recording on a disk. Archives and artifacts, however, are only part of Feaster's chosen work. Just as important, he says, is his mission of using modern technology to resurrect long-vanished voices and sounds—some of them never intended to be revived.

Listening backward

Feaster has been obsessed with sound recordings for as long as he can remember. Growing up an only child in Valparaiso, Indiana, in the 1970s, Feaster became fascinated with his parents' vinyl 33-rpm records and started making paper cutouts of his own LPs at age 4. (His mother still has a few.) When his father started frequenting outdoor auctions and swap meets in search of parts for restoring a 1930 Model A Ford pickup, Patrick tagged along, marveling at the old phonographs and records that were on display.

In 1993, Feaster joined the master's degree program in history at Indiana University, Bloomington, but switched to the folklore and ethnomusicology department, where he found an outlet for his love of 19th and early 20th century recorded sound. The research for his 2007 thesis on how the phonograph affected the performances of Victorian musicians, vaudevillians, and orators could have filled several books, recalls his adviser and collaborator, Richard Bauman.

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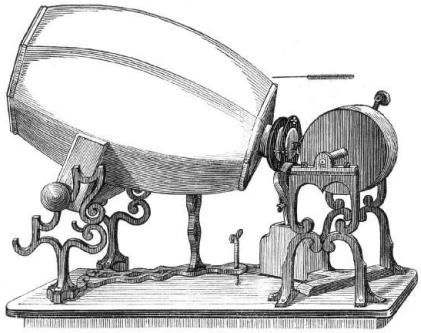
By then, Feaster and colleagues David Giovannoni, Richard Martin, and Meagan Hennessey had formed FirstSounds.org, a group devoted to finding and disseminating the earliest sound recordings. The team had been nominated for a Grammy for its CD *Actionable Offenses*, a compilation of bawdy wax-cylinder recordings from the 1890s. Another CD, *Debate '08*, reissued 22 recordings by presidential candidates William Howard Taft and William Jennings Bryan during the 1908 campaign—the first time sound bites were used in a presidential election, Feaster says.

In 2007, FirstSounds embarked on a much more daring quest: unearthing and playing back transcribed sounds that predate by 17 years Edison's phonograph and his needle-cut tin foil records. It began over beers at an Italian restaurant near Union, Illinois—the site of a large antique phonograph show—when Feaster and his colleagues began brainstorming about what might be the world's oldest sound recordings. Feaster mentioned the Parisian typesetter and amateur inventor Édouard-Léon Scott de Martinville, who in the 1850s designed and built a machine that used a horn and stylus modeled on the human ear to pick up vibrations from the air and trace them onto paper coated with soot (see figure, above). The inventor had no interest in playing the sounds back; rather, he hoped that people could learn to read the "phonautograms" and mentally reproduce words, songs, and theatrical recitations exactly as originally performed.

Feaster had come across Scott's work while reading over Edison's papers. He also remembered a rare, self-published book in which Scott, who claimed credit for the idea of recording sound, mentioned having deposited several phonautograms at institutes in Paris. Might those ghostly 150-year-old tracings—undulating scratchings resembling a cardiogram—still be legible, or even playable?

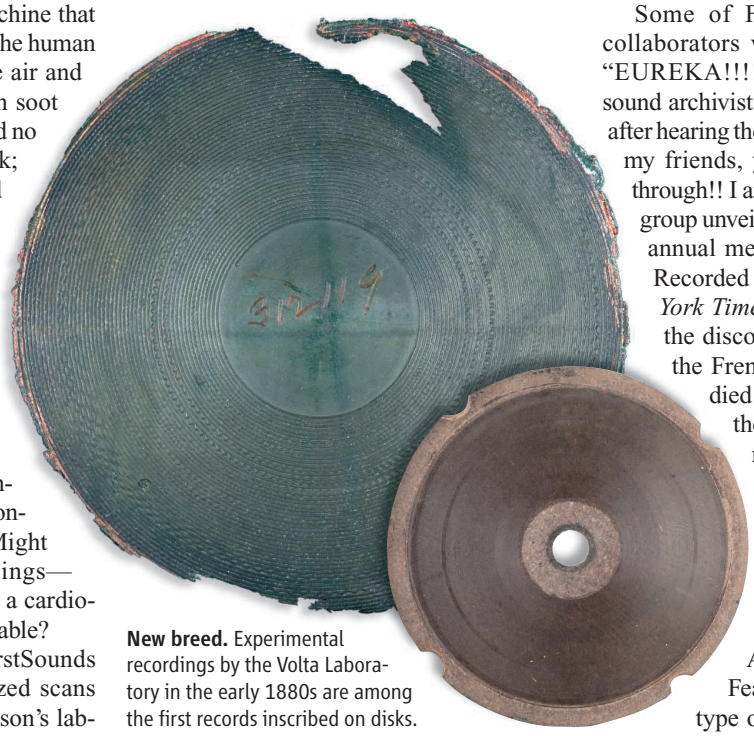
To test that possibility, the FirstSounds team took high-resolution, digitized scans of similar phonautograms that Edison's laboratory had made in 1878 to help New York City officials reduce the din of the newly built elevated railway on Manhattan's Sixth Avenue. After processing the scanned images, FirstSounds sent them to two physicists at Lawrence Berkeley National Laboratory in California who had developed software that reproduces sound from high-resolution scans of the grooves of wax cylinders and disk records too fragile or misshapen to be played with a stylus. Adapting the software, the Berkeley Lab scientists, Carl Haber and Earl Cornell, succeeded in playing the Edison phonautogram. After 133 years, the ghostly rumblings of a New York City train track rang out once more.



Before Edison. French "phonautograph" from the 1850s (*above*) traced sound waves onto paper (*right*) for sight-reading, not playback.

Sound from soot

In late 2007, Giovannoni of FirstSounds flew to Paris and took digital scans of some of Scott's phonautograms the team had tracked down in the French patent office. At first, the wiggly lines seemed unplayable. The traces seemed a mess, and there was no way to tell how fast Scott had turned his hand-cranked machine or how the speed had varied. On some of the other phonautograms Giovannoni examined in early 2008, however, Scott had included what turned out to be a Rosetta stone: a second trace due to the vibration of a tuning fork, its frequency noted on the sheet. By getting the vibration of the tuning fork right and holding it steady, Feaster and his colleagues realized, they could decipher the primary sound print as well.



New breed. Experimental recordings by the Volta Laboratory in the early 1880s are among the first records inscribed on disks.

Haber and Cornell at the Berkeley Lab had produced a raw audio file from some of the tracings, but variations in the speed of Scott's cranking caused the sound to waver unintelligibly, Feaster recalls: "I stayed up into the wee hours of the morning adjusting the [sound of the] tuning fork to a consistent frequency, and bit by bit the recording gradually resolved itself." About 5:30 a.m., listening through headphones plugged into his computer, Feaster heard the muffled strains of what sounded like a young girl in 1860 singing the French lullaby *Au Clair de la Lune*. Later that morning, he e-mailed his parents: "After a few hours of audio restoration work last night, I was (I believe) the first person now living to hear a vocal music performance from before the American Civil War."

Some of Feaster's FirstSound collaborators were less restrained. "EUREKA!!" sound archivist Réné Rondeau e-mailed him after hearing the sound file. "Congratulations, my friends, you have made THE breakthrough!! I am beyond stunned." When the group unveiled the file a month later at the annual meeting of the Association for Recorded Sound Collections, *The New York Times* ran a front-page story on the discovery, and TV crews mobbed the French patent office. Scott, who died believing he might never get the credit he deserved, posthumously got his due.

Follow-up work revealed further surprises. In early 2009, Giovannoni scanned a trove of Scott's phonautograms that Feaster's research had turned up at the French Academy of Sciences in Paris. Feaster had adapted a different type of software, designed to convert optical film soundtracks into digital audio files, to play them.

One of the newfound phonautograms—a passage from *Aminta*, a pastoral drama by the 16th century Italian poet Torquato Tasso—also included a trace from a tuning fork. But when Feaster played back the recording, it was too fast. "It sounded like the Chipmunks—unquestionably wrong," he recalls. "I wondered if I'd miscalculated

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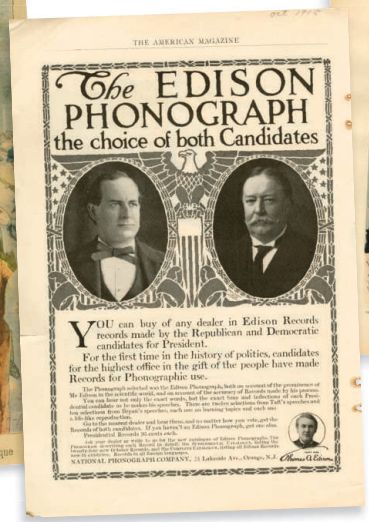

Spinning the news. The 1908 Bryan-versus-Taft race marked the first use of sound recordings in a U.S. presidential campaign, to satirists' delight.

somewhere." Scott's notes on the sheet suggested that he had dictated the recording himself. Feaster concluded that Scott's marking of "500" for the tuning fork's frequency must refer to the number of half-cycles, not the full oscillations researchers measure today. In that case, the recording would be an octave lower than he had been assuming. Returning to *Au Clair de la Lune*, he slowed the playback down to the proper speed. The "girl's" voice became that of a man—almost certainly Scott himself.

In 2009, Feaster traveled to Paris to examine some of the phonautograms Scott had deposited at a French scholarly society in 1857. There he met Laurent Scott, a descendent of the inventor. Through headphones attached to Feaster's laptop, Laurent heard his great-grandfather's voice for the first time.

Inspired by the success with Scott's phonautograms, Feaster began exploring other visual recordings that he could attempt to convert into sound. "Today, we can listen—with a little work—to virtually any waveform we can see on paper," he says. Two years ago, in some of his most far-ranging efforts to date, he applied his software to the musical notation found in a 10th century manuscript of the Enchiriadis treatise, a medieval work on music theory. The result was a 7-minute sound file that Feaster calls "the closest thing you're likely to hear to a 1000-year-old phonautogram." Feaster has also applied software to "play" other historic musical notations—"as though a sound synthesizer were being programmed directly by medieval monks," he says.

Online
sciencemag.org
Links to sound files and other material.

Scouring the attic

In comparison, Feaster's sleuthing at the Smithsonian Institution seems almost contemporary. The little-publicized Smithsonian collection of 1880s recordings is the largest repository of its kind in the world. When Feaster first visited it in December 2010, an old catalog card with the obscure inscription "WJH—damaged record" caught his eye.

He leapt to the conclusion that "WJH" might be William J. Hammer, Thomas Edison's agent at the Paris Exhibition of 1889. That was the world's fair for which the Eiffel Tower was built and the first time that most Europeans heard Edison's talking machine. If Feaster's hunch was correct, the records could contain the only sounds known to exist from the 1889 fair.

But when Feaster returned to the Smithsonian in October 2011 on a 2-month fellowship, he found that a renovation several years earlier had forced the collection to be moved to several temporary storage units. He and Smithsonian curators Carlene Stephens and Shari Stout combed the shelves for anything resembling a box of wax-cylinder records.

In the next-to-last cabinet, Feaster found a closed wooden box stamped "WJH—Newark, N.J." Inside were 28 hollow wax cylinders, some broken, many discolored, each on its own wooden peg. A torn piece of paper describes 16 of the recordings. Among the inscriptions: "Violin recorded on Eiffel Tower, Nov. 6, 1889." The 12 untitled cylinders may include recordings Hammer is reported to have made of native American Indians visiting the fair as part of the Buffalo Bill show, officials from Africa speaking in their native tongues, and prominent French politicians of the day.

Because the records are so fragile—some literally held together by a core of string—it will take time and patience to remove them from the pegs and find out whether any sound can be coaxed out of the 122-year-old grooves, he notes. But the condition of the cylinders looks promising, Giovannoni says.

One of Feaster's latest discoveries sprang from a painstaking perusal of the laboratory notebooks of 1880s sound pioneers in the Washington, D.C.–based Volta Laboratory, which included Alexander Graham Bell, his cousin Chichester Bell, and Charles Sumner Tainter. In 1881, Tainter described his attempts to record sound on a flat metal record incised with a spiral pattern of grooves and then play it back with a magnet after filling the grooves with a mixture of iron filings and wax. As part of the ultimately unsuccessful work, he cut two ridges along the narrow circular edge of the same record. On one ridge he recorded the word "potato"; on the other, a trilled "r."

Then Feaster had a eureka moment. One of the records he examined in the Smithsonian collection bore an odd, two-ridge pattern on its edge. He had a match. "There's no doubt in my mind that this is the record that Tainter had referred to," he says, cradling a metal record in gloved hands. If so, it is the earliest known recording on disk.

When Feaster isn't contemplating sounds from past generations, he's thinking about those from the newest—in particular his son Perrin. Before Perrin was born last February, Feaster and his wife, Ronda Sewald—a sound archivist whom he met in graduate school—recorded him in the womb and sang to him, putting their own lyrics to a catchy but unknown tune the couple had heard on a century-old wax cylinder. (Their wedding, in June 2006, featured a wax-cylinder processional, vows recorded and played back on a 1906 Edison wind-up phonograph, a century-old recording of Felix Mendelssohn's "Wedding March" as the recessional, and a Victrola-shaped cake.) In the delivery room, the couple banned cameras during the birth but kept the sound recorders rolling. "Perrin is likely to have strong feelings, one way or the other, about old records," Feaster says.

–RON COWEN

Ron Cowen is based in Silver Spring, Maryland, and writes about physics, astronomy, and the history of technology.

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