The New Age of Sound: How Bell Telephone Laboratories and Leopold Stokowski Modernized Music

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A decade-long collaboration between Bell Telephone Laboratories and the conductor Leopold Stokowski laid the foundations for a vibrant future of artistry through sound recording.

On April 10, 1940, *The New York Times* ran the headline "Sound Waves 'Rock' Carnegie Hall…Tones Near Limit That the Human Ear Can Endure." "The loudest musical sounds ever created crashed and echoed through venerable Carnegie Hall last night as a specially invited audience listened, spellbound, and at times not a little terrified," read the paper (Anonymous, 1940, p. 25).

The evening before, the psychoacoustician and the Acoustical Society's first president Harvey Fletcher stood at a control panel in Carnegie Hall while recordings of the Philadelphia Orchestra playing under the direction of his long-time collaborator, the avant-garde conductor Leopold Stokowski, were piped into the auditorium. They were demonstrating "enhanced" music, in which the dynamic range of the recordings had been drastically expanded during production for a dramatic effect that could literally bowl over an unprepared listener. At Stokowski's command, the sound level shifted across a range of nearly 100 dB; at its loudest, the wall of sound emanating from three loudspeakers positioned on the stage was comparable to the output of 2,000 musicians. "When he wanted a stupefying volume of tone, that in Carnegie Hall seemed to shake the building, he got it instantly," reported the *Times*.

But the demonstration was not merely a show of power. Although the music was played through three enormous loudspeakers sheathed in a curtain of fabric, the performance sounded as if it were really happening on stage, with the bass coming from one side and the violins from another. This remarkable auditory illusion stereophonic sound was the careful work of Fletcher and his team of engineers from Bell Telephone Laboratories.

How this collaboration between Fletcher, a pioneer of psychoacoustics, and one of the century's greatest conductors came to be is no less fascinating than the sonic experiments they presented to an awed public. It is a story of big personalities and bigger ambitions, of grand plans for telephony and sound recording, and nothing less than the future of music itself. It begins with a brash young organist who wouldn't stay behind his instrument.

Bringing Up a Conductor

The son of a cabinet maker, Leopold Stokowski (**Figure 1**) was born in 1882 in inner-city London. At 13, he was admitted to the Royal College of Music, and at 16, he was elected to the Royal College of Organists (Chasins, 1979). By his midtwenties, Stokowski grew tired of his role as an organist and sought a coveted conductor position. Despite having absolutely no experience at the helm of an or-

Figure 1. *A portrait of young Leopold Stokowski dated March 18, 1918. From the George Grantham Bain Collection, Library of Congress.*

chestra, it was through the persistence of his well-connected future wife Olga Samaroff (née Lucy Mary Olga Agnes Hickenlooper; **Figure 2**) that he received an interview and soon an offer from the Cincinnati Symphony Orchestra in 1909. At that time, Samaroff's renown as a pianist far exceeded Stokowski's reputation; she had produced her own concert debut at Carnegie Hall in 1905, which was followed by well-advertised and attended tours in North America and London (Samaroff Stokowski, 1939). Surely the weight of her recommendation must have provided some assurance to the Cincinnati Board as they gambled on their risky new hire.

Luckily for the Cincinnati Board, Stokowski was an immediate success. His style was bold and unmistakable; he favored the vigorous "free-bowing" technique, desynchronizing the strokes of the string players for a bigger, more textured sound and unforgettable visual effect (several videos illustrate Stokowski's conducting style, e.g., Stravinsky's *Petrushka Suite*, goo.gl/vW9cyv; Bach's *Ein Feste Burg* and *Little Fugue* in G minor, goo.gl/RTAUC5). It is especially insightful to watch Stokowski conduct during a rehearsal, orating his directions for tone and volume (goo.gl/gRZFPc). The public adored the young dynamo.

Figure 2. *A portrait of the couple Leopold Stokowski and Olga Samaroff. Samaroff was a respected pianist who used her considerable influence to arrange Stokowski's first two conducting positions. From the George Grantham Bain Collection, Library of Congress.*

But Stokowski's relationship with his supervisors grew turbulent. Stokowski dreamed of growing the symphony; he wanted more concerts in more cities with more musicians. The board rebuffed him every time, and after several well-publicized showdowns, Stokowski was released from his contract and he headed for Germany in 1912. Again, Olga finessed a new opportunity for Stokowski, whom she had married the year before. On her way to meet him in Munich, Olga took a stopover in Philadelphia. There, she negotiated with the Philadelphia Orchestra and signed a contract on behalf of her husband, who was already overseas. He sent his acceptance by telegram. It was there, with the Philadelphia Orchestra, where Stokowski first became fascinated with recording technology.

Recording Enters the Electronic Age

In 1917, Stokowski and his players traveled by ferry to Camden, New Jersey, to record two of Brahms' *Hungarian Dances* for the Victor Talking Machine Company. Like most recordings before 1925, the method of sound capture involved no electronics or amplification (for a historical review, see Brock-Nannested, 2016). Acoustic horns shaped like funnels captured and converted pressure waves in the room to mechanical energy driving a stylus, which etched a wax disc. The process had severe consequences for the sound quality; only very powerful, or very proximal, sound sources would make it clearly onto the final product, compromising dynamic range and balance. High-frequency sounds were severely attenuated, yielding recordings devoid of pleasing harmonics and resonances. Unsurprisingly, Stokowski found the character of these recordings disappointing (indeed, the recordings have a tinny quality and the dynamic range is compressed by the presence of a persistent hiss; listen for yourself at goo.gl/549Gpc). Sixty years later, Stokowski recalled, "It was not good. But I didn't close my mind to the idea of recording. I wanted to make it better… to project music in the fullness of its eloquence to as many people as we can all over the world" (Gould, 2001).

In 1925, Victor unrolled their electrical recording system and invited Stokowski and his symphony back to make the first orchestral recordings on the new technology. The new "orthophonic" recording system used condenser microphones placed around the room instead of acoustic horns. The microphone and amplifier setup greatly expanded the upper limit of the frequencies that could be committed to the record from 2.5 Hz to 6 kHz (Bell Telephone Laboratories, 1946). Even better, the orchestra could play in their regular positions instead of clustered around the horns. Although the system was still prone to "surface noise," an artifactual, persistent hiss in the 3- to 5-kHz range, the orthophonic system was a quantum leap beyond the old acoustic method.

Stokowski was spellbound. The American music critic Roland Gelatt (1977, pp. 253-256) recalled that the young conductor was "not content merely to conduct and leave all else to the engineers. Microphone placement, the seating arrangement of his orchestra, sound reflectors, monitoring panels—the entire paraphernalia of recording intrigued him." It was a fuss for the engineers but a watershed moment in his artistry. Just as he had "Stokowski-ized" (to use the parlance of his sometimes detractor Toscanini) so many concertos and sonatas, so too would he leave his mark on electronic recording.

Bell Telephone Laboratories Targets the Music Industry

In 1928, while Leopold Stokowski was enjoying a meteoric ascent in the classical world, the physicist Harvey Fletcher established himself as the director of acoustics research at Bell Telephone Laboratories (Fletcher, 1992). Fletcher, the son of a pioneer who had walked from Missouri to Utah behind a canvas wagon, completed his doctoral work in physics under the auspices of Robert Millikan, who won the 1923 Nobel Prize for work related to Fletcher's dissertation on measuring the charge of electrons. After joining Bell Telephone Laboratories, Fletcher's collaborator on acoustics research died suddenly, leaving him in charge of an endless experimental to-do list (Knudsen and King, 1964). The aim of the project was to develop telephone technology that would make a remote talker seem only a meter away, and to do so, Fletcher became a pioneer of psychoacoustics. He set about relating the physical correlates of sound to perceptual correlates, like loudness and intelligibility, through systematic study. After several years, it was clear that the illusion of total immersion in an acoustic environment couldn't be accomplished with a single microphone, so he began investigating stereophonic, or binaural, recording.

The Bell Telephone Laboratories Director of Research (and vacuum tube innovator) Harold D. Arnold sensed an opportunity; if Fletcher's work could inform the development of technology for *speech* transmission, so too could it lay the groundwork for high-quality recording and reproduction of music. It was one thing to measure the frequencies and sound level changes found in music, which Fletcher had already begun to investigate; it was another to understand how distortion changed the aesthetic and perceptual qualities of music. The scholar Robert McGinn (1983) proposed that the interest was threefold. First, Arnold anticipated that radio stations would eventually begin broadcasting a greater range of frequencies and volumes, and he wanted Bell Telephone Laboratories to be prepared with the necessary changes in sound recording and transmission circuitry. Second, he was willing to bet that higher quality music would find a market in consumers. If radio never caught up to transmitting a sufficiently rich signal, then music could be distributed by wire. Third, Arnold saw it as a chance to spread the enjoyment of music and culture to the masses, a cause no less weighty than the others in his eyes.

To study the technology of music recording and transmission, the laboratory would need access to a skilled professional orchestra; that way, the subjective experiences of listeners would be determined by the technical aspects of the experiment and not the quality of the musicianship. Arnold arranged for several prominent musical directors, including Stokowski, to tour the laboratories. A few weeks after the visit, Stokowski headed to a performance in Europe with a copy of Fletcher's *Speech and Hearing* in tow for the long boat ride.

Stokowski and the Scientists

Nearly a year after his first visit and a few days after a disappointing live broadcast on NBC radio marred by poor sound quality, Stokowski wrote to Arnold and Fletcher. Although Stokowski was much maligned by his critics for being an egotist first and a musician second, he may not have entirely disagreed. "I always want to be first. I'm what's known as egocentric," he once said (Stokowski, 1943, p.189). Robert McGinn proposed that he was motivated by higher principles to reach out to the Bell Telephone Laboratories group. "If this hypothesis is valid, Stokowski's overture to and collaboration with Bell Telephone Laboratories should be understood in the context of his dissatisfaction with the sonic quality of existing radio broadcasting and records, not as merely another attempt to gratify his insatiable ego" (McGinn, 1983, p. 47).

Stokowski invited the researchers to set up shop at the American Academy of Music where rehearsals were held, and the Bell Telephone Laboratories team accepted. Amplifiers and elaborate circuits moved from Murray Hill, New Jersey, into the Academy in Philadelphia. Soon, Harvey Fletcher was conducting listening tests and Stokowski was helping him position the condenser microphones around the room to find their optimal locations for a binaural recording. "Listening monaurally gives me the sensation of the music being choked and crushed together," opined Stokowski. "Binaurally, the music sounds free" (Fantel, 1981, p. TG25).

Nearly every rehearsal in the 1931-1932 season was captured on a record. But these were no ordinary recordings. Arthur C. Keller, part of Halsey Frederick's group at Bell Telephone Laboratories that was investigating how to reduce the "surface noise" on traditional records, had recently created a new kind of moving coil stylus for cutting grooves into disks. It was made of sapphire, and instead of moving from side to side along the surface of a disc as it etched, it cut vertically. This drastically reduced the amount of wear and tear on the disc as it played and kept the phonograph needle on track (Keller and Rafuse, 1938). Several of the records had dual tracks etched by parallel styluses, and in 1979, when the original recordings were unboxed and shared with the public in a limited release, it was discovered that these two tracks were, in fact, stereophonic recordings made from two separate microphones in the practice room (McGinn, 1983). The spectral fidelity and dynamic range of these experimental records were so unparalleled for their time, and it was nearly three decades before consumer technology caught up to Arthur Keller's invention (many of the original recordings can be found online at bit.ly/2kTHfza). In the view of electronics columnist Hans Fantel, these records were not only the clearest of their time but served as a defining benchmark for all future recordings. "It was in the course of this project that the precise attributes and definitions of fidelity in sound reproduction were first formulated" (Fantel, 1982, p. D23).

Just as the engineers sojourned into the daily lives of professional musicians, Stokowski ventured into the realm of scientists. For him, the amplifiers and microphones that crowded the auditorium were more than foreign visitors. They were the future of nothing less than musical expression and emotion. At the 1932 meeting of the Acoustical Society of America, Stokowski gave an extemporaneous address to the assembled crowd of physicists, psychologists, and engineers (Stokowski, 1932).

> *What are we trying to do? We who are dealing in sound. The ultimate aim is to send, to project, the finest quality of music that we can to as many people in the world. We have to find the means to do that. At present, they are imperfect and limited, but as we work new horizons, new possibilities, open up before our eyes* (Stokowski, 1932, p. 11).

Perfecting the technology to capture sound, with all its color and liveliness, was only part of the plan. In his speech, Stokowski described the technology that would decades later propel Milli Vanilli to infamy.

> *What if performers only looked as if they were singing, when other, more talented musicians were supplying the audio? Now, if we divorce those two, if we find the best elements of sound, the best singers….and give you that, by wired transmission as ideally as we can, if we separately find actors and actresses…if we synchronize these two groups the problem will be solved* (Stokowski, 1932, p. 12).

Stokowski also foresaw that electronics gave the composer godlike control over sound.

> *For example, in the electrical instruments we now have we are able to intensify any harmonic we wish, to give any timbre. That was not possible in the old instruments. That is one possibility. But there is another. Instead of taking those concentric harmonics above the fundamental, we can take eccentric sounds above the fundamental and intensify those in various degrees so that we shall be able to create an entirely new timbre* (Stokowski, 1932, p. 13).

Now that sound was a signal to be manipulated, a medium to be sculpted, the highs could be higher, the lows lower, and the crescendos more thunderous than an orchestra of hundreds. Purposeful distortion liberated the creator. Listeners would reap these strange fruits, ushered into a new sonic age.

Experiments at the Academy of Music

During the 1931-1932 season at the Academy of Music, the Bell Telephone Laboratories team conducted exploratory research that solidified the foundations for Stokowski's vision. Harvey Fletcher, Arthur Keller, and a team of engineers, including Edward Wente, inventor of the condenser microphone, and Herman Affel, coinventor of the modern coaxial cable, made efficient use of their residency in Philadelphia. The main findings from this period on auditory perspective and the physical characteristics of orchestral music were published in a symposium of six papers in *Transactions of the American Institute of Electrical Engineers* (Affel et al., 1934; Bedell and Kerney, 1934; Fletcher, 1934; Scriven, 1934; Steinberg and Snow, 1934; Wente and Thuras, 1934; also see Jewett, 1933 for an overview).

To understand the requirements of any system that would reproduce the sounds of an orchestra in high fidelity, the Bell Telephone Laboratories team quantified the frequency transmission range needed to produce the sounds of each instrument in the symphonic orchestra without noticeable distortion to a skilled listener. The thin, wispy quality of a piccolo survived recording and playback so long as frequencies in the range of 500 to 10,000 Hz were preserved, but the pure sound of a violin required a wider bandwidth ranging from 40 to 13,000 Hz to transmit. This range was perhaps surprisingly broad; consider that the typical range of notes a violin can produce spans from 196 to 2,637 Hz (for more about violin acoustics, see Gough, 2016) . Of course, Fletcher's team had the insight that clear reproduction of music wasn't simply a matter of matching the highest and lowest notes that could be played from an instrument. Whenever a sound changed quickly, a theoretically infinitely wide bandwidth would be needed to convey that transition faithfully. Thus, the range of sounds that should be recorded and transmitted by an ideal system should match the *human ear* and not be tailored to the sounds that need to be reproduced (Fletcher, 1934). However, although those with normal hearing can, in theory, detect pure tones from 20 to 20,000 Hz, Fletcher reasoned that the extreme limits were not critical to preserve for his purposes: "In music these frequencies usually are at such low intensities that the elimination of frequencies below 40 cps and above 15,000 cps produces no detectable difference in the reproduction of symphonic music" (Fletcher, 1934, p. 10).

With the same systematic approach, the researchers tackled the question of amplitude: what range of power must a system for reproducing orchestral music have to sound lifelike? Fletcher reported that "if this discussion were limited to the type of symphonic music that now is produced by large orchestras," a dynamic range of 70 dB would suffice (Fletcher, 1934, p.10). But he recognized that this limit was not imposed by any fundamental quality of music but more practically by "the capacities of the musical instruments now available and the man power that conveniently can be grouped together under one conductor." Fletcher marveled at how the early prototypes of the Bell Telephone Laboratories engineers, which could both amplify and attenuate sound in recordings, enabled the Philadelphia Orchestra to surpass these technological barriers with aesthetically pleasing results.

Figure 3. *"Oscar," a mannequin used for binaural recording experiments by Bell Telephone Laboratories personnel. Oscar was present for recording experiments during the 1931-1932 season at the Academy of Music. Reprinted from Rankovic and Allen (2009).*

> *As soon as a system was built that was capable of handling a much wider range, the musicians immediately took advantage of it to produce certain effects that they previously had tried to obtain with the orchestra alone, but without success because of the limited power of the instruments themselves* (Fletcher, 1934, p. 10).

The Bell Telephone Laboratories researchers were also busy characterizing the physical requirements necessary for auditory perspective. They recognized two ways to produce this effect. One method involved head receivers, in which a dummy head with two microphones positioned by the ears recorded right- and left-hand audio tracks that could be played back to the listener over headphones. Fletcher and his colleagues Snow and Hammer had worked extensively on this method of mannequin recording and had constructed "Oscar," a department store mannequin with microphones in either cheek (for a review, see Paul, 2009) for both scientific study and demonstrations to the public (**Figure 3**). Indeed, Oscar was present in the audience at several of the Philadelphia Orchestra rehearsals (Hammer and Snow, 1932)!

The other method of producing auditory perspective used loudspeakers. To reproduce the experience of listening to music in an auditorium at some distant room, the problem is one of producing an exact duplication of the pattern of vibrations in the air at the recording site at every corresponding point in the receiving site (Fletcher, 1934). This idea becomes more complicated when the recording and receiving room shapes do not align well, but it provided a theoretical framework in which to pose the problem.

This line of research involving loudspeakers occupied the researchers during their residency in Philadelphia. In one perceptual study, the engineers Steinberg and Snow asked how many microphones and loudspeakers were necessary for a percept of auditory perspective. Using one of the rooms at the Academy of Music, microphones were set up at the left, center, and right sides of the stage and hidden behind a curtain. Words were uttered from various positions on the stage, and naive participants indicated where they thought the talker was located. The best performance came from a three-speaker setup, where each of the left, center, and right microphone inputs were played through a separate loudspeaker (Steinberg and Snow, 1934). This gave reasonable lateral and depth localization, although the accuracy of the participant's guesses was far from perfect. Interestingly, whenever the quality of the left and right transmissions was mismatched, listeners showed a pronounced bias toward the most natural side, apparently weighting the cues provided by level differences in accordance with the perceived reliability of the source. Steinberg and Snow's (1934, p. 17) summary of this experiment shows a practical attitude toward their findings, "The application of acoustic perspective to orchestral reproduction in large auditoriums gives more satisfactory performance than probably would be suggested by the foregoing discussions." In other words, this will do the trick.

The Grand Unveiling of Stereophonic Sound

On the evening of April 27, 1933, Harvey Fletcher welcomed a distinguished crowd at Constitution Hall in Washington, DC. Under the auspices of the National Academy of Sciences, an audience of presidential advisors, senators, and congressional representatives gathered for a musical performance. On the stage were three loudspeakers. Stokowski was stationed at a control panel in the hall (**Figure 4**). His musicians remained in their rehearsal room in Philadelphia awaiting their cue.

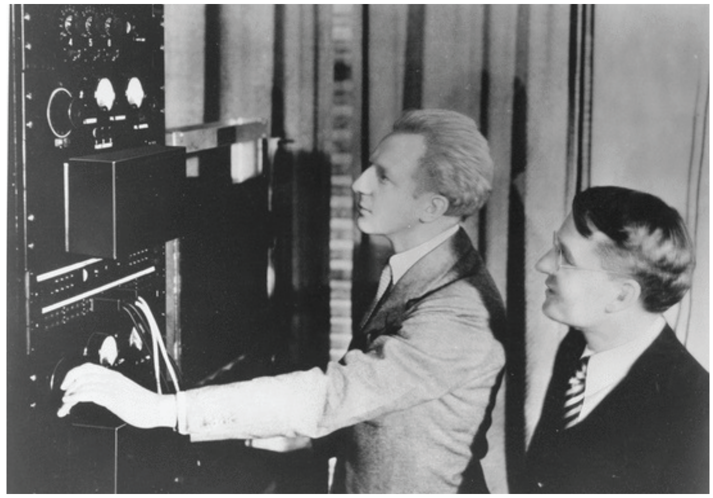

***Figure 4.** Leopold Stokowski (**left**) and Harvey Fletcher (**right**) at Constitution Hall in Washington, DC, on the evening of their wire transmission demonstration. From the Bell Telephone Laboratories Archive.*

In the first act of the show, the audience listened to a scene wired from Pennsylvania to Washington. On the left-hand side of the stage in Philadelphia, a handyman constructed a box with a hammer and saw. From the far right, another worker proffered suggestions to his friend. "So realistic was the effect that to the audience the act seemed to be taking place on the stage before them. Not only were the sounds of sawing, hammering, and talking faithfully reproduced, but the auditory perspective enabled the listeners to place each sound in its proper positions, and to follow the movements of the actors by their footsteps and voices," wrote an observer (Fletcher, 1992, p. 184). Next, a soprano sang *Coming Through the Rye* as she weaved across the stage in Philadelphia. At Constitution Hall, the phantom of her voice "appeared to be strolling on the stage" (Fletcher, 1992, p. 184).

The show ended with an unforgettable duel in the dark between two trumpet players separated by more than a hundred miles. The two traded licks from their opposite posts in Constitution Hall and the Academy of Music in Philadelphia. But the audience was none the wiser. "To those in the audience there seemed to be a trumpet player at each side of the stage before them. It was not until after the stage was lighted that they realized only one of the trumpet players was there in person" (Fletcher, 1992, p.184). The crowd was left in awe.

This was not simply a show of tricks. It was the grand public unveiling of Fletcher's ambitious and laborious project, stereophonic sound. To calibrate the positions of the microphones in Philadelphia and the setup of the loudspeaker array in Washington had taken months. Much of the theory of auditory perspective was in place, but the execution required plenty of improvisation and trial and error. Originally, there were meant to be nine speakers on the stage in a three-by-three array, creating a "sheet of sound." But Fletcher and his engineers realized that only three horizontal speakers would be necessary. In an interview, he recalled, "Well, we were just dumb enough not to realize that on stage people don't jump up and down… for something like Hamlet's ghost, it would be alright to have the speakers run up and down. That's about all there was to that" (Knudsen and King, 1964).

The loudspeakers themselves were a special invention. Based on a study during the rehearsal season by the engineers Wente and Thuras (1934), the loudspeakers were designed to have one enormous drum for transmitting low-frequency sounds with two high-frequency horns sitting atop it. This was inspired by Wente and Thuras' finding that low-frequency sounds were less spatially directed than high-frequency sounds, and thus a natural compromise in the reproduction system could be reached by allowing the two registers to be transmitted differently.

The transmission system was a technical marvel as well. Although the music was ethereal to the audience, the signal bearing the recording of the Philadelphia Orchestra traveled like water through a pipe down the East Coast. Engineering a transmission system that could handle the frequency and amplitude range of the orchestra, without introducing substantial distortion and maintaining a flat frequency response function, was no simple feat. Several challenges stood in the way. First, the ordinary circuits for telephone transmission typically limited signals to 200-3,000 Hz and typically limited the volume range to no more than 30 dB. This was handled by modulating the frequencies of the orchestral recording up, from 40-15,000 Hz to 25,000-40,000 Hz, and transmitting the high-frequency currents through 3 channels in an all-underground cable with repeaters every 25 miles (Affel et al., 1934). The signal was demodulated back to its original frequency range in Washington. The frequency shift was used to prevent cross talk with other channels on the cable, which were usually transmitted at lower frequencies. Repeaters, equipped with equalizers to prevent unintentional attenuation of certain frequencies, kept the signal from losing power as it traveled more than 100 miles. Because the transmission involved higher frequencies than typical phone calls, more repeater stations than usual were in play that night: stations at the towns of Holly Oak, Delaware, and Elkton, Abingdon, Baltimore, and Laurel, Maryland, bridged the gap between Philadelphia and Washington. For this purpose, two temporary huts to house the repeaters and their power supplies had to be constructed at Abingdon and Laurel.

Amid this demonstration of technological prowess, something fundamental about psychophysics was also shown. Whatever the audience's psychological experience of the concert—wonder, shock, distaste, or pleasure—they were responding to a stimulus that was as real and plastic to the engineers and Stokowski as clay to a sculptor. The medium of music was no mere incident to its enjoyment but an inseparable and defining part.

The Enduring Legacy of the Collaboration

The collaboration between Bell Telephone Laboratories and Leopold Stokowski lasted until 1940, spanning nearly a decade and bringing many demonstrations of stereophonic and enhanced sound to the public, including the one *The New York Times* deemed the loudest show of all time. Stokowski began splitting off when he was approached by Walt Disney to conduct the epic score of the movie *Fantasia*. Originally, Disney intended to contract Bell Telephone Laboratories to engineer stereophonic recording for the film to give the illusion of instruments following characters across the screen, but the laboratory leadership declined to accept a commercial contract. The work instead went to a team at RCA, who leveraged much of the groundwork laid by Fletcher and his associates to build the "Fantasound" system. If you watch *Fantasia*, the silhouetted conductor who shakes hands with Mickey Mouse is none other than Stokowski (listen to the remastered soundtrack, conducted in its entirety by Stokowski, goo.gl/nV44pu; Stokowski talks to Mickey Mouse, goo.gl/bSaofa).

While Stokowski was expanding his cultural influence, Fletcher continued his influential work in psychoacoustics and eventually became a professor at Brigham Young University. His lifelong career in research has been renowned for establishing the cornerstone methods of communication science (Allen, 1996), and his contributions to the music industry were recognized with a posthumous Technical Grammy awarded in 2016 (goo.gl/8B35MG).

That Harvey Fletcher and Stokowski became partners in a joint expedition for nearly 10 years is almost surprising considering their enormously different temperaments: the notoriously impassioned conductor with unkempt hair and the straight-laced acoustician with an eye for the smallest of details. Stokowski dreamed of changing music with technology and forever reshaping the landscape of musical experience by sculpting raw signal into something beyond nature (Milner, 2010). Fletcher wanted to capture the pure essence of sounds, to collapse the distance between friends on the telephone, and to make foreign scenes and voices sound real and honest. Between them, though, was a common appreciation for the inexorable link between the physical qualities of sound and its perceptual experience. It was what led them to the experiments and technology that innovated sound recording for the modern world.

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BioSketch

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