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When mobile communication technologies were new

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In the 19th century, mechanical hearing aids opened up new possibilities for controlling sound waves and managing conversations. Components and ideals from these acoustical instruments became part of the foundation for electroacoustics, the conversion of sounds into ''signals''. Mechanical hearing aids also set lasting standards for portability and unobtrusiveness in the design of personal communication technology.

Little telephones

At the turn of the twentieth century, the Wilson Ear Drum Company of Louisville, Kentucky began advertising "wireless phones" to the deaf readers of *McClure's*, *Cosmopolitan* and *Popular Mechanics*. The firm promoted its rubber inserts as "little telephones" and "listening machines", capable of amplifying sound. The optics and acoustics of these devices were equally marvelous, as one ad affirmed: "They are so soft in the ear one can't tell they are wearing them. And no one else can tell, either, because they are out of sight when worn."[1] Wilson Co. capitalized on the mystique of electroacoustics while distancing its Ear Drums from the visibility – and seeming discomfort – of wires and metal.

In 1912, the Bureau of Investigation of the American Medical Association published a pamphlet on "Deafness Cures" as part of its *Nostrum Evil and Quackery* series.[2] "The viciousness of the victimization carried on by the deafness-cure quacks" distinguished them even from their associates in the areas of obesity, alcoholism and men's health.[3] The Bureau concluded that the new electrical hearing aids, made from telephone components, were superior to the "therapeutic" alternatives such as rattlesnake oil, ear balsa, radioactive Hearium, special tobaccos, osteopathic finger surgery, restrictive diet plans, "electromagnetic head-caps", nasal douches and gargling solutions. As for Wilson's prosthetic "phones", they were "just as worthless as most devices of this sort and just as potent for harm".[4]

Mechanical hearing devices are easily banished *en masse* to the realm of quackery and comics, or to the era of the "pre-electric". Yet the early hearing aid industry exchanged components, vocabulary and metaphors with other acoustic – and eventually electroacoustic – fields. Trumpets and conversation tubes, like string or wire transmitters, went by the name of "telephone" early in the 19th century.[5] Nor were trumpets, tubes and ear drums cleanly supplanted by electrical inventions. Through the process of repurposing, some of the design principles from these mobile communication technologies have persisted to the present day.

In *The Soundscape of Modernity*, Emily Thompson establishes that "a fundamental compulsion to control the behavior of sound drove technological developments in architectural acoustics, and this imperative stimulated auditors to listen more critically".[6] According to her timeline, the growth of commercial theater in Europe in the late-18th century motivated research into sound amplification, coupled with echo restriction, for large spaces. Later, in urban homes and workplaces in the United States, machine noises and efficiency measures fanned public interest in sound control. Throughout the 19th century, architects and scientists experimented with building materials and room shapes, but their efforts were only occasionally successful and rarely, if ever, repeatable. "The concert halls and opera houses built in America at mid-century pointed toward a new cultural ideal," Thompson explains, "but did not yet attain it".[7] She dates modern acoustics to 1900, when Wallace Sabine published his formula for measuring reverberation.[8] "Clear, direct, and nonreverberant" sound became increasingly common in the built environment.[9] With sounds analogized to electrical signals, this ideal migrated into electroacoustics—and disseminated ever more widely via microphones, radios, and sound films.

Interest in "controlling the behavior of sound" marked the small-scale design of hearing instruments as much as the architecture of lecture halls. Indeed, the history of conversation aids provides an even more direct passage

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[1] Kenneth Berger, *The Hearing Aid: Its Operation and Development* (Detroit: National Hearing Aid Society, 1970): 17.

[2] American Medical Association Bureau of Investigation, *Deafness Cures* (Chicago: American Medical Association, 1912). A copy of this pamphlet is held in the "Hearing" files, "Pathological/Medical View" folder, Division of Medical Sciences, Smithsonian NMAH.

[3] For details, see Francis Randolph Packard, *The History of Medicine in the United States Vol. II* (New York: Hafner Publishing Co, 1963): 1161.

[4] American Medical Association, *Deafness*, 135.

Available online 4 November 2009

[5] Brian Winston, *Media Technology and Society: A History: From the Telegraph to the Internet* (London: Routledge, 1998): 30–34.

[6] Emily Thompson, *The Soundscape of Modernity: Architectural Acoustics and the Culture of Listening in America, 1900–1933* (Cambridge, MA: The MIT Press, 2002): 2.

[7] Emily Thompson, *The Soundscape of Modernity: Architectural Acoustics and the Culture of Listening in America, 1900–1933* (Cambridge, MA: The MIT Press, 2002): 48.

[8] As she puts it, Sabine's architectural research was the "first significant and successful effort to control the behavior of sound in rooms." Emily Thompson, *The Soundscape of Modernity: Architectural Acoustics and the Culture of Listening in America, 1900–1933* (Cambridge, MA: The MIT Press, 2002): 235.

[9] Emily Thompson, *The Soundscape of Modernity: Architectural Acoustics and the Culture of Listening in America, 1900–1933* (Cambridge, MA: The MIT Press, 2002): 3. Thompson concludes *The Soundscape of Modernity* with a discussion of the postmodern turn away from "one best sound," and the concurrent rise in simulated sounds and spatial effects. Despite all of the changes in aural culture across the century, she notes that sound *control* became paradigmatic.

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from acoustics to electroacoustics. Efforts to channel speech through portable devices gained momentum between the 16th and 19th centuries. As was the case with theatres and auditoria, amplification had to be balanced against distortion. The design of trumpets, tubes and tympana was often haphazard and imperfect, yet these devices imagined – "pointed toward" – the future of mobile communication. Instrument-makers improvised with the phenomena of reflection, absorption, resonance and directionality. They tested the capacity of different materials to guide or carry sound waves, as well as the portability and comfort of particular instrument designs. Everyday communication aids, unlike concert halls, were not always built for fidelity. Some aimed to "filter" speech from environmental sounds; others, to selectively amplify *parts* of speech, such as high tones. Ear trumpets and speaking tubes aided communication in ways both obvious and subtle; for instance, they potentially increased a listener's control over privacy, background noise and even the initiation of speech. Nonetheless, this control was eventually coupled with concealment, due to the increasing stigmatization of hearing loss and miscommunication.

The long history of loud-speaking

In their survey of antique hearing devices, Mary Lou Koelkebeck, Colleen Detjen and Donald Calvert explain that fortuitous amplification long preceded custom-manufacture: standing beside a rock or a wall provided environmental magnification; fans, umbrellas, brimmed hats and, as rumor had it, Native American headdresses served as more portable "extemporized aids".[10] Shells and animal horns doubled as prostheses.

Interest in hearing aids rose in the 16th century, concurrent with deaf education.[11] In *Magia Naturalis* (1558), Giovanni Battista della Porta mentioned "hollow catches" worn by the Roman emperor Hadrian, as well as recent instruments that mimicked the ears of animals with keen hearing. Francis Bacon's *Sylva Sylvarum*, published shortly after his death in 1626, told of Spanish cone- and trumpet-shaped "ear-spectacles" for the "thick of hearing".

Since ancient times, sailors, hunters and military commanders had communicated at a distance with speaking trumpets. Claim to the invention of the more powerful *loud-speaking trumpet*, however, was a source of rivalry between Samuel Morland and Athanasius Kircher. Morland's *Tuba Stentoro-Phonica*, published in 1671, described his sequence of trials with horns of varying lengths, shapes and materials. The loudest of these, a copper trumpet 21 ft in length, with a bell 2 ft across, carried speech as far as a mile and a half. As a voice traveled the length of the trumpet, Morland theorized, it "reundulated" and reverberated, thus magnifying the sound (Fig. 1). Francis Digby, Captain of Deal Castle, contributed a letter to Morland's pamphlet testifying "that by laying one of these Instruments to the Ear, the Words

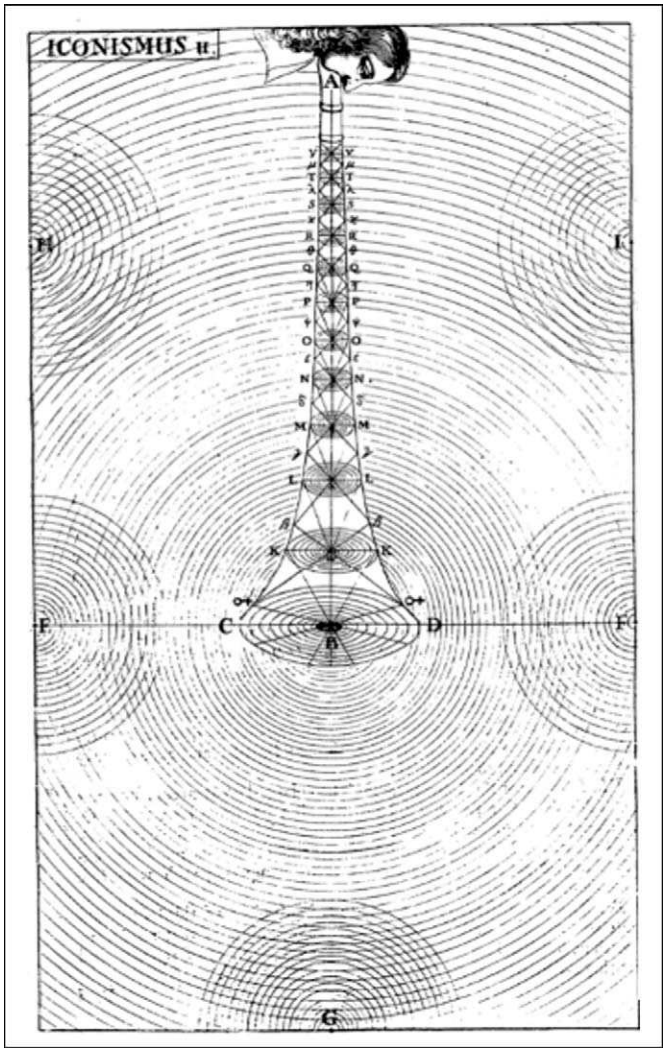

Fig. 1. Illustration from Samuel Morland's brochure, *Tuba Stentoro-Phonica*.

are heard more distinctly".[12] Speculation ensued about the horn's aptness for improving deafness; interested parties could purchase the device from the king's trumpeter.

Athanasius Kircher claimed priority to the loud-speaking trumpet based on his 1650 acoustics treatise, *Musurgia universalis*, which described an enormous, coiled horn installed through the exterior wall of a building for the dual purposes of broadcasting and overhearing.[13] He published an expanded discussion of hearing instruments in *Phonurgia Nova* (1673). To increase the reflection and reinforcement of sound waves, Kircher favored "cochleate" designs (Fig. 2), something Frederick V. Hunt attributes to the depictions of curved ear structures resulting from 17th-century dissections.[14] Twisting or resonant devices seemed to promise constructive wave interference and hence

[10] Mary Lou Koelkebeck, Colleen Detjen and Donald R. Calvert, *Historic Devices for Hearing: The CID-Goldstein Collection* (St. Louis, MO: The Central Institute for the Deaf, 1984): 5.

[11] Mary Lou Koelkebeck, Colleen Detjen and Donald R. Calvert, *Historic Devices for Hearing: The CID-Goldstein Collection* (St. Louis, MO: The Central Institute for the Deaf, 1984): 12.

[12] Samuel Morland, *Tuba Stentoro-Phonica* (London: W. Godbid, 1672): 4.

[13] Siegfried Zielinski depicts this horn as a "Panacousticon." In 1787, Jeremy Bentham would include a system of tin speaking-tubes, for overhearing and for issuing commands, as part of his Panopticon. Siegfried Zielinski, *Deep Time of the Media* (Cambridge, MA: MIT Press): 125.

[14] Hunt critiques Kircher's theory of passive amplification in *Origins in Acoustics* (New Haven: Yale UP, 1978): 126, 128–129. For the co-evolving history of ear anatomy and prosthetic devices, see Georg V. Békésy and Walter A. Rosenblith, "The Early History of Hearing—Observations and Theories," *The Journal of the Acoustical Society of America* 20, 6 (1948): 727–748.

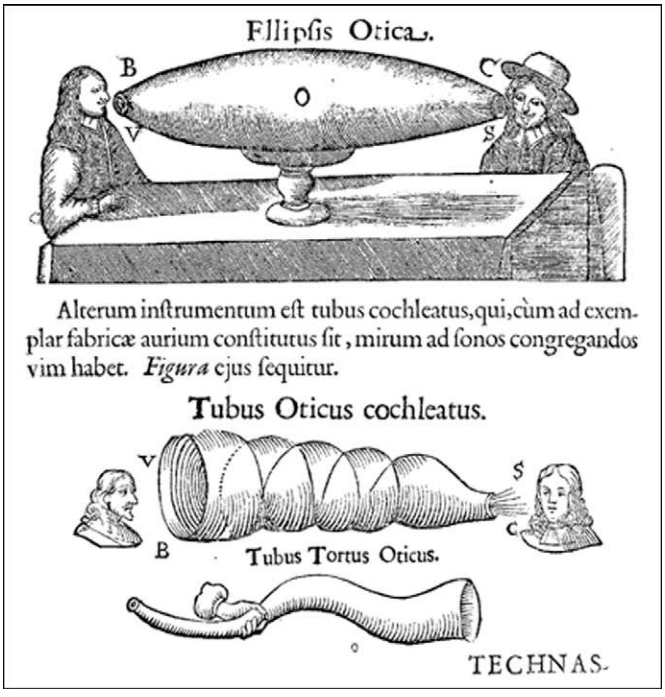

Fig. 2. Illustration from Athanasius Kircher's *Phonurgia Nova*.

amplification of certain speech components. However, the result of reflected sound waves joining with the changing syllables of ongoing speech was often annoying reverberation.

Trumpets for the ears

The mechanical hearing aids that proliferated in the 19th century were objects that incorporated and extended ideas about "normal" outer and middle ears. By then, hearing had been subdivided into "parts"; within the ear itself, it was clear that sound vibrations passed from medium to medium (air, eardrum, bone, fluid), being modified at each step. With this understanding, hearing was literally *instrumental*—it had become an active process.[15]

Based on the model of an enlarged auricle and auditory canal, ear trumpets "amplified" by collecting or concentrating sound waves that would otherwise disperse. In the late-18th century, Arnold Finchett's Tin Ware Manufactory sold hearing trumpets alongside mugs, spoons and saucepans. The first dedicated hearing aid firm, Frederick Rein of London, began to manufacture devices for the well-to-do in 1800. They were followed by competitors (in England, France, Germany and the United States) in the second half of the century. These companies, and their advertising campaigns, induced a substantial number of people to try out mediated voice communication. Hearing aids were cast from every conceivable material: ivorine, vulcanite, gutta percha, tortoiseshell, leather, gold.[16] Still, "tin ears" and other lightweight metals seemed best to reinforce the frequencies of speech.

Increasing the width of a trumpet's mouth and the length of its neck provided the only reliable means of amplification. Thomas Edison picked up this line of experiment, attaching a 7 ft long funnel to a speaking trumpet and broadcasting speech a distance of 2 miles. He paired this "megaphone" with its reverse, a "telescopophon" or "long-range ear" for detecting faraway sounds. In an 1878 circular sent to friends and colleagues, Edison – himself hard of hearing – discussed his plan to adapt these instruments into a prosthesis: "I have now two assistants engaged at my laboratory in experimenting upon an apparatus for the benefit of the deaf. The results so far have been quite satisfactory and I hope soon to have a practical apparatus for introduction to the public. The only drawback as yet is the large size of the apparatus."[17] This war of amplification and portability drove hearing aid manufacturers to try out diverse angles and curves, coupled chambers and schemes for adjustable volume control.

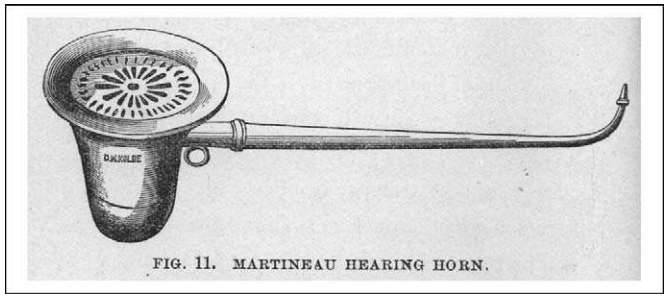

Fig. 3. Martineau hearing horn. Image reprinted from James A. Campbell, *Helps to Hear* (Chicago: Duncan Brothers, 1882): 36.

English author Harriet Martineau was so closely associated with her ear trumpets that a popular version was named after her (Fig. 3). Nathaniel Hawthorne described her trumpet as a new organ:

> All the while she talks she moves the bowl of her ear-trumpet from one auditor to another, so that it becomes quite an organ of intelligence and sympathy between her and yourself. The ear-trumpet seems a sensible part of her, like the antennae of some insects. If you have any little remark to make, you drop it in; and she helps you to make remarks by this delicate little appeal of the trumpet, as she slightly directs it towards you, and if you have nothing to say, the appeal is not strong enough to embarrass you.[18]

Conversation aids thus changed the status of the listener, enabling her to silently direct a conversation.

Ear trumpets were recurrent symbols of (often-magical) overhearing in fiction, from Florence McLandburgh's 1873 story "The Automaton Ear" to Leonora Carrington's *The Hearing Trumpet*, published a century later. Assorted trumpets were indeed used by soldiers and ship captains for the detection and location of acoustic signals—an important precursor to radar. Martineau found that deafness actually precluded the pleasures of overhearing, though the trumpet provided her with other advantages. During a tour of the United States in 1834, she recorded that it made her the beneficiary of many *intended* secrets:

[15] The workings of the inner ear had just begun to be detailed in the 19th century, at the same time that engineers were increasing the scope of transduction.

[16] Elisabeth Bennion, *Antique Hearing Devices* (London: Vernier Press, 1994).

[17] Thomas Edison to Alexander Melville Bell, 6 July 1878, "The Megaphone," Bell Family Papers, Box 16 (7th folder in box), Alexander Graham Bell Association for the Deaf and Hard of Hearing Archival Collection, The History Factory.

[18] Nathaniel Hawthorne, *Our Old Home, and English Note-books, Volume I* (Boston: Houghton Mifflin, 1912): 518.

> This [deafness] does not endanger the accuracy of my information, I believe, as far as it goes; because I carry a trumpet of remarkable fidelity; an instrument, moreover, which seems to exert some winning power, by which I gain more in tête-à-têtes than is given to people who hear general conversation. Probably its charm consists in the new feeling which it imparts of ease and privacy in conversing with a deaf person. However this may be, I can hardly imagine fuller revelations to be made in household intercourse than my trumpet brought to me.[19]

Some, however, depicted Martineau's trumpet as a distraction or even a deterrant to conversation. One among her audience in Massachusetts commented that the device drew *too much attention*, making a spectacle out of the medium of speech. "Our ignorance and our imaginations of what we had never seen magnified it into an instrument of dreadful resonance, drawing every eye upon the speaker. . .gray-headed statesmen lost their presence of mind as they took it from her hand."[20]

Many ear trumpet models were anything but discreet. A Danish customer of the Oticon Company insisted that their obtrusiveness lay as much in their use as their appearance, "I remember when my grandfather came in from the countryside to visit us in Copenhagen, and my mother and I would ride with him on the town tram. He used to ask all sorts of questions and pull his hearing trumpet out from his pocket. Mother would shout so loud that everyone in the tram could hear the conversation. And I just sat there wishing I could disappear."[21] Oticon acknowledged, nevertheless, that trumpets had persisted in Europe until 1940, with "perhaps the greatest advantage" being their very recognizability: "people automatically spoke up when presented with a hearing trumpet, so the hearing-impaired person automatically heard much better".[22]

Voicepipes and conversation tubes

Other mechanical aids responded to the varied causes of deafness and the manifold ways to redirect sound waves. The conversation (or speaking- or hearing-) tube, comprised of a hose with a funnel at one or both ends, reduced the problem of background noise and allowed talk to be carried on with more privacy, at a comfortable distance.[23] Johann Heinrich August von Duncker is generally credited with patenting the first hearing-tube for deaf people in 1819.[24] His Optische Industrie-Anstalt in Rathenow had sold eyeglasses since 1801; to magnify the voice, he placed a large metal cone at the end of a portable leather tube. In those same years, "voicepipes" were being installed on ships and longer speaking-tubes were becoming relatively common fixtures in British office buildings.[25]

In his 1832 publication *On the Economy of Machinery and Manufactures*, Charles Babbage argued that architectural speaking tubes were gainful for at least one mode of communication—they made giving orders swifter and easier:

> The simple contrivance of tin tubes for speaking through, communicating between different apartments, by which the directions of the superintendent are instantly conveyed to the remotest parts of an establishment, produces a considerable economy of time. It is employed in the shops and manufactories in London, and might with advantage be used in domestic establishments, particularly in large houses, in conveying orders from the nursery to the kitchen, or from the house to the stable. . .The distance to which such a mode of communication can be extended, does not appear to have been ascertained, and would be an interesting subject for enquiry. Admitting it to be possible between London and Liverpool, about seventeen minutes would elapse before the words spoken at one end would reach the other extremity of the pipe.[26]

Speaking tubes of all kinds were called "telephones", and their electrical descendent would take the economy of human communication to even greater lengths—by compressing speech itself as well as time, and by multiplexing to send several messages down a channel at once.

Even when speaking-tubes were designed for dispensing instruction to deaf people, they were inevitably rerouted toward conversation. In 1860, at least one New York church installed a group device based on the principle of concentrating desired sounds and eliminating noise: a giant cone near the pulpit "drained" into a series of pipes that ran to the pews held by hard of hearing churchgoers. A *New York Times* commentator mischievously imagined that such sound-pipes might be laid throughout the city to do away with the need for churches altogether. Moreover, why should not such a communication system be used for demands to issue in the opposite direction, namely *from* the populace?[27]

Vibratory communication

Another category of hearing aid was designed to be pressed against the skull or held between the teeth, exploiting the fact that bones conduct sound waves. Less common than the trumpet or the tube, "hearing fans" and "dentaphones" created a new channel for communication in cases of middle-ear deafness, directing sound to an intact auditory nerve via the skull. In the 17th and 18th centuries, a number of physicians, educators and deaf individuals separately noted that an object held between the teeth – a rod, a pipe, a spear – transmitted sound from a vibrating source

[19] Harriet Martineau, *Society in America Volume I* (London: Saunders and Otley, 1837), xiii–xiv.

[20] Maria Weston Chapman, ed., *Harriet Martineau's Autobiography and Memorials of Harriet Martineau*, *Volume II* (Boston: James R. Osgood & Co., 1877): 267.

[21] *Founded on Care—Oticon through 100 years* (Hellerup, Denmark: Oticon Foundation, 2004): 65.

[22] *Founded on Care—Oticon through 100 years* (Hellerup, Denmark: Oticon Foundation, 2004): 63. Trumpets were also 20 times less expensive than electrical devices, and never loaded with batteries or other replaceable parts.

[23] Researchers at the Central Institute for the Deaf have also found that "the tube acts as a resonating device which transmits some frequencies better than others. In general, the larger the diameter of the tube, the lower the frequency region that would be reinforced." Koelkebeck et al., *Historic Devices*, 10.

[24] Bennion, *Antique Hearing*.

[25] For a discussion of architectural acoustic tubes from the Enlightenment to the 19th century, see Leigh Eric Schmidt, *Hearing Things: Religion, Illusion, and the American Enlightenment* (Cambridge, MA: Harvard UP, 2000): 117–121.

[26] Charles Babbage, *On the Economy of Machinery and Manufactures* (London: Charles Knight, 1832). Digital version available via Project Gutenberg, http://www.gutenberg.org/dirs/etext03/cnmmm10.txt.

[27] "City Intelligence," *New York Times*, 16 March 1860, p. 8.

such as a musical instrument.[28] Others found that the sounds of faraway events could be carried in this way from earth to mouth to inner ear.

Contemporary scholars theorized sound as a media phenomenon, a wave that surprisingly could travel through water, string, wire and bone as well as through the medium of air. In his 1665 *Micrographia*, Robert Hooke suggested that the "infirmities" or limitations of the *normal* ear might be remedied through "artificial organs" that acted on this transmission principle:

> It has not yet been thoroughly examin'd, how far *Otocousticons* may be improv'd, nor what other wayes there may be of *quickning* our hearing, or *conveying* sound through *other bodies* then [sic] the *Air*: for that is not the only *medium*, I can assure the Reader, that I have, by the help of a *distended wire*, propagated the sound to a very considerable distance in an *instant*.

In this case, Hooke did not mistake the constraints of hearing for actual deafness; more accurately, amplification and instantaneous wire transmission made "defects" of air and distance.

Charles Wheatstone explicitly developed Hooke's proposition in the 1820s. His Enchanted Lyre, called by some a telephone, sent the vibrations of a piano along a series of metal rods to a lyre on the floor above, which then resonated, sounding simultaneously. Wheatstone maintained that these musical experiments were "objects of far less importance than the conveyance of the articulations of speech"; in the future, it might "be as easy to transmit sounds through conductors from Aberdeen to London, as it is now to establish a communication from one chamber to another".[29]

The electrical speaking telephone would eventually require a conceptual shift from mechanical wave transmission between media to *transduction*, or energy conversion (in this case, converting a mechanical wave to an electromagnetic one). Yet many early investigators of electrical transmission – including Wheatstone himself, and Heinrich Hertz – analogized from acoustics to electricity when theorizing wave behavior or planning the transmission media to guide those waves.[30]

In terms of bone conduction, Chicago publisher Richard Rhodes patented one of the more famous devices in 1879—the Audiphone (Fig. 4). After 20 years of deafness and too many failed encounters with the ear trumpet, Rhodes observed that he could hear his watch ticking when he held it in his mouth. He constructed a flexible vulcanite fan that picked up airborne sound waves and transmitted them "through the medium of the teeth" when its leaf was bitten. Rhodes announced the Audiphone as a revolution in the

Fig. 4. Audiphone fan re-enactment, 1954. American Hearing Aid Association, "Hearing Aid Industry Progress" campaign. Photograph courtesy of the Division of Medicine and Science, Smithsonian Institution's National Museum of American History.

biology of communication: "An inventor has now come forward, however, who has struck out on a new path; who has discarded the ear as the means of hearing, and putting on one side all those ear trumpets, large and small...has utilized the mouth – or, to speak more directly, the teeth – as the means of making the deaf hear."[31]

Invisible disability, transparent media

Acoustic instruments and hearing aid firms proliferated throughout the nineteenth century—matched by a rising emphasis on concealment. By *drawing attention to communication*, hearing aids provoked antagonisms between its visual and oral elements: some technologies were distracting or confusing, certain fashions obstructed function. Clearly, mechanical hearing aids also functioned as stigma symbols, marking the otherwise invisible disability of hearing loss.[32] To resolve this paradox of mediation, nineteenth-century manufacturers began to endorse discreet or invisible hearing aids. The subset of "disguised" hearing devices promised to conceal disability as well as its rehabilitation. These objects signify one of the first applications of *transparency* – the design principle of "naturalness",

[28] For a more comprehensive history of bone-conduction, see Kenneth Berger, "Early Bone Conduction Hearing Aid Devices," *Arch Otolaryngology* 102 (May 1976): 315–318.

[29] Charles Wheatstone, "On the transmission of musical sounds through solid linear conductors, and on their subsequent reciprocation," in *The Scientific Papers of Sir Charles Wheatstone* (London: Taylor and Francis, 1879): 62.

[30] According to one engineer, Wheatstone "transfer(red) his ideas from acoustics to optics, and from optics to electricity." Rollo Appleyard, *Pioneers of Electrical Communication* (London: Macmillan and Company, 1930), Ch. 4. For another set of analogies from acoustics and optics to electricity, see Heinrich Hertz, *Electric Waves: Being Researches on the Propagation of Electric Action with Finite Velocity through Space*, trans. D.E. Jones (London: Macmillan and Company, 1893).

[31] "The Audiphone: A New Invention that enables the deaf to hear through the medium of the teeth, and the deaf and dumb to hear and learn to speak" (Chicago: Rhodes & McClure, 1880): 8. Pamphlet from the Warshaw Collection, Box 5, File 15, Smithsonian NMAH Archives Center.

[32] In 1880, the International Congress of Milan endorsed oralism as the most effective pedagogical strategy for deaf schools. This censure of sign language was in fact a vote against deafness in all its forms. As a result, the stigmatization of both deaf and hard of hearing people increased, as did the twin pressures to correct and conceal hearing loss. (It should be noted that in the 19th century "hardness of hearing" was often a euphemistic synonym for deafness, although deaf people were increasingly distinguished from those who were "semi-deaf" in clinical settings.)

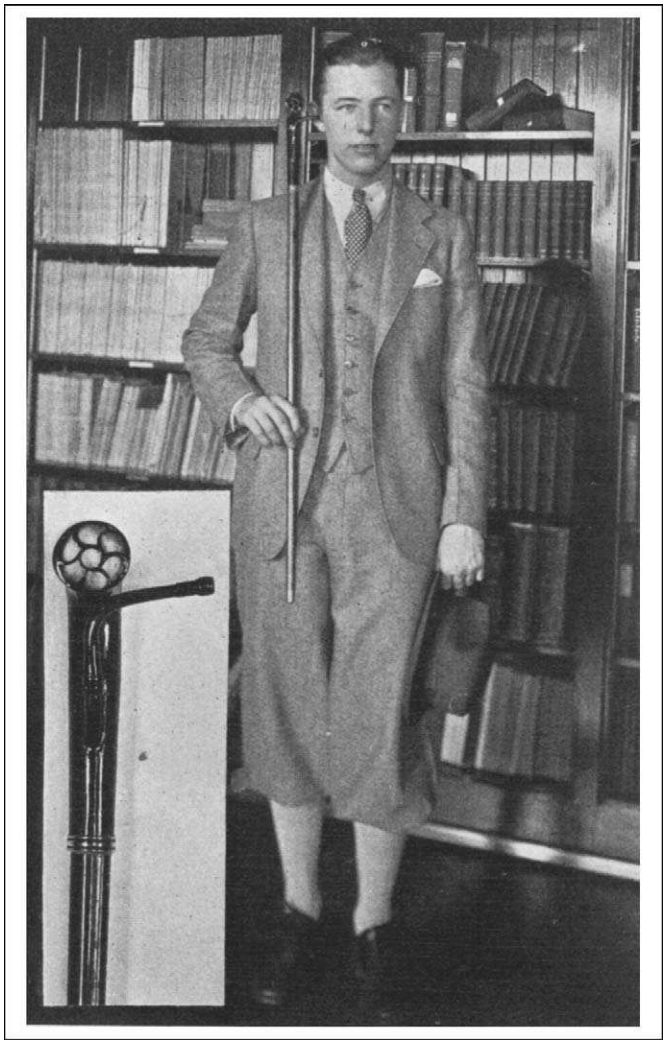

Fig. 5. ''Acoustic cane or walking-stick''. Photograph from Max Goldstein, *Problems of the Deaf* (St. Louis: The Laryngoscope Press, 1933): 339.

"intuitiveness" and "unobtrusiveness" – to communication technology.

The mechanization of personal communication was often mitigated by fashion. Some deaf aids were engraved or otherwise embellished; many more were designed to resemble the customary furniture, clothing or accessories of their users.[33] From the first F.C. Rein catalogue, one could purchase small "ear phones" or floral "cornets" on headbands, to eliminate the inconvenience of holding a trumpet to the ear—or to hide a prosthesis in the hair. Concealed aids *reveal* details of social setting, especially in terms of class and gender. Acoustic muffs, bouquet holders, opera glasses and vases sustained wealthy women in their formal social affairs—particularly supporting their roles as audience members. Office chairs inlaid with speaking tubes allowed managers to *grant an audience* within the workplace, while false beards, canteens and hearing canes granted men a more generic mobility (Fig. 5). In an early instance of "convergence", many of these disguised mechanical aids actually combined multiple functions. Students at the first deaf school in Japan raised funds, for example, by assembling instruments on the model of the Audiphone that looked and worked like lacquered fans.[34]

Reporting on a hearing-umbrella in 1884, a journalist for the *New York Times* noted that conventional trumpets were furthermore "a grievous embarrassment *to the man with whom the deaf person desires to enter into conversation*".[35] Cathy Sarli and her colleagues at the Central Institute for the Deaf argue that hearing instrument catalogues framed concealment in terms of distraction as well as shame. Thomas Hawksley admonished his customers in 1895 that they should not *in any way* interrupt the flow of a conversation: "A deaf person is always more or less a tax upon the kindness and forbearance of friends. It becomes a duty, therefore, to use any aid which will improve the hearing and enjoyment of the utterances of others without anyone murmuring about its size and appearance."[36] Fashion and acoustics competed with one another in the design of these technologies; Sarli et al. conclude, "the majority of the population wanted and would pay for increasingly inconspicuous devices even if they were of little benefit to their hearing."[37]

Concealment eventually took the form of miniaturization, with the least favorable acoustic results. Makers of "inserts" and "invisibles" alleged that simply propping the ear canal open would benefit hearing loss. "Obturators" and artificial ear drums (such as Wilson's) served as surrogates for punctured tympana, to somewhat better effect.[38] By marketing "invisibles," advertisers ensured that hearing aids would remain stigma symbols. Indeed, the tradition of hearing aid diminution and disguise continued into the electronic era with miniature components meeting demands for wearability *and* unobtrusiveness.

Histories of ''new media''

In their conclusion to *Mobile Communication and Society: A Global Perspective*, Manuel Castells, Mireia Fernández-Ardèvol, Jack Linchuan Qiu and Araba Sey assert that "because the first users are the shapers of the technology itself, the youth culture and the professional culture have framed the forms and content of wireless communication".[39] It is possible to imagine the "cutting edge of

[33] According to one catalogue from 1883, "the sensitiveness of the sufferers should not be wounded by the necessity of having to use instruments either unsightly in form or objectionable in color or material. . .the sound receivers or collectors are made to resemble in form some ordinary article of everyday life, where there is little to offend the taste beyond the slender elastic tube which connects the sound collector with the deaf person's ear." Koelkebeck et al., *Historic Devices*, 104.

[34] "A Rival of the Audiphone," *New York Times*, 12 July 1881, p. 3.

[35] "A New Umbrella," *The New York Times*, 17 September 1884, p. 4. Italics mine.

[36] Cathy Sarli, Rosalie M. Uchanski, Arnold Heidbreder, Kimberly Readmond, and Brent Spehar, "19th-Century Camouflaged Mechanical Hearing Devices," *Otology and Neurotology* 24, 4 (2003): 692. For an outstanding website with a timeline of hearing aid development and numerous photographs of disguised devices, see Cathy Sarli et al., "Deafness in Disguise: Concealed Hearing Devices of the 19th and 20th Centuries," Bernard Becker Medical Library, Washington University St. Louis, http://beckerexhibits.wustl.edu/did/timeline/index.htm.

[37] Cathy Sarli, Rosalie M. Uchanski, Arnold Heidbreder, Kimberly Readmond, and Brent Spehar, "19th-Century Camouflaged Mechanical Hearing Devices," *Otology and Neurotology* 24, 4 (2003): 692–693.

[38] The New York League for the Hard of Hearing recommended artificial drums for their "cheapness," but advised that they could be dangerous unless inserted by an otologist. Peck et al., *Ears*, 63. James Yearsley, who began experimenting with wool pellets and other inserts in the 1840s, insisted that they made the ears of some patients "too sharp"—they detected every whisper and were bothered by street noise. James Yearsley, *Deafness Practically Illustrated* (London: John Churchill, 1857): 201.

[39] Manuel Castells, Mireia Fernández-Ardèvol, Jack Linchuan Qiu and Araba Sey, *Mobile Communication and Society: A Global Perspective* (Cambridge, MA: The MIT Press, 2007): 245–246.

cultural and technological innovation" more generously.[40] Moreover, the present uses of "new media" are shaped by old histories. Electroacoustics inherited concerns with noise reduction, focused transmission, listener control, selective amplification and the ability to move speech through different media in part from users of the first (commercial) mobile communication technologies—mechanical hearing aids. This is the history of speech becoming "signal": a *thing* that could be isolated, amplified and otherwise processed or "improved".

Hearing aid manufacturers' experiments with resonance, bone conduction and sound concentration often failed technically. Their concepts and apparatus transferred, nonetheless, to other scientific research. Joseph Henry, for instance, measured sound reflection in a hearing trumpet as part of his 1856 study of building acoustics; he eventually recommended a "fan-shaped" lecture hall, with the speaker "placed as it were in the mouth of an immense trumpet".[41] The following year, Édouard-Léon Scott reported on his phonautograph, a boar's bristle attached to a goldbeater's membrane that was stretched across the neck of an ear trumpet (*cornet acoustique*).[42] This apparatus "conducted and condensed" airborne sound vibrations, inscribing them on a piece of sooted glass; it famously influenced the development of telephony and phonography.

Throughout the 1880s, numerous patents affixed "ear trumpets" to speaking telephone and phonograph machines as transmitters or recorders.[43] In the employment of these technologies, the stigma of visibility sometimes transferred, too. An 1884 *New York Times* article on "Women as Telephonists" contended that the spectacle of girls holding "an instrument like an ear trumpet to their heads would appear ridiculous enough were it not well known how indispensable the telephone has been to civilization".[44] The attractions of mediated communication – amplification, efficiency, increased control – were thus tempered by new distractions. Novel approaches to speech and hearing might, in turn, be normalized by invisible or unobtrusive designs. Mounting concerns with hearing loss and with conspicuous mediation were part of the same milieu—one that defined communication as a seamless act and demanded control over communication difference.

[40] Manuel Castells, Mireia Fernández-Ardèvol, Jack Linchuan Qiu and Araba Sey, *Mobile Communication and Society: A Global Perspective* (Cambridge, MA: The MIT Press, 2007): 247.

[41] Joseph Henry, "On Acoustics Applied to Public Buildings," *Proceedings of the American Association for the Advancement of Science* 10 (1856): 134.

[42] Édouard-Léon Scott, "Principes de Phonautographie," trans. Patrick Feaster, First Sounds Working Paper No. 1, http://www.firstsounds.org/working-papers/.

[43] Phonograph amplification later spurred a great deal of research on the topic of compact "horns," which were related to speaking trumpets. Percy Wilson and Geoffrey L. Wilson survey this history in "Horn Theory and the Phonograph," *Journal of the Audio Engineering Society* 23 (April 1975): 194–199.

[44] "Women as Telephonists," *The New York Times*, 25 May 1884. For a related argument, see Sidney H. Aronson, "Bell's Electrical Toy: What's the Use? The Sociology of Early Telephone Usage," in The Social Impact of the Telephone, ed. Ithiel de Sola Pool (Cambridge, MA: The MIT Press, 1977): 22. The affiliation between hearing aids and telephones was ongoing; by 1900, hearing aids assembled from telephone components numbered among the first (electrical) "mobile phones."