

Though sound and music are essentially incorporeal aspects of human experience, they are dependent on the latent potentials of matter: bamboo tubes, stretched animal skin, throat-flesh. Even more fundamentally, sound rests upon vibration, the analogue fluctuations of that vaporous fluid we call air. But in the late 19th and early 20th centuries, that ocean of vibration became *electrified*. Just as traditional instruments can be seen as alchemical transformations of earth and air, woods and metals, so can the revolutionary sonic media that followed in the wake of the telegraph – telephone, phonograph and radio, not to mention theremins, Moogs and Roland 303s – be regarded as creative transmutations of the new 'elements' that would come to undergird the 20th century's cultural consciousness: electricity and electromagnetism.

"I am electrical by nature," wrote Ludwig Van Beethoven. "Music is the electric soil in which the spirit lives, thinks and invents." The old man's curious quip introduces us to what I like to call 'the electromagnetic imaginary': the mythic, animistic and just plain weird cultural dimensions of electricity and electromagnetism, those cosmic forces which carry an imaginative load as powerful for us as air, earth, water and fire were for the ancients. The word 'electricity' first entered the English tongue in a 1650 translation of a treatise on the healing properties of magnets by Jan Baptist Van Helmont, a Flemish physician and Rosicrucian who worked, significantly, on the borderline between natural magic and modern chemistry. Indeed, many of the earliest books on electricity described the force in distinctly alchemical terms, dubbing it the 'ethereal fire', the 'quintessential fire', or the 'desideratum', the long-sought universal panacea. Emerging from the gap between biology and physics, matter and the unseen ether, electricity is a liminal force that inevitably carries a powerful imaginative load.

In the 18th and 19th centuries, electricity also catalyzed the kind of heady enthusiasm that data devices do today. One of these electrogeeks, a failed American painter named Samuel Morse, was blessed with a formidable insight in the 1830s: if electric current could be squeezed through a wire, then "intelligence might... be instantaneously transmitted by electricity to any distance". After convincing Congress to plough \$30,000 into his project, Morse strung up a wire between Baltimore and Washington DC. The first official message to careen along the line, in

1844, was a strangely oracular pronouncement: "What hath God wrought!" This message reads as much like an anxious question as a cry of glee, and today we know the answer: what God wrought, or rather, what men wrought in their God-aping mode, was the information age.

Morse's system was not just electrical (and hence, effectively instantaneous); it was digital. The electric current that ran along telegraph wires was an analogue medium, flowing in the undulating waves that everywhere weave the world. But by regularly breaking and reestablishing this flow with a simple switch, and by establishing a code to interpret the resulting patterns of pulses, Morse chopped the analogue dance into discrete digital signs. But these signs were also electro-metallic *beats*, a rat-a-tat that foreshadowed the frenetic rhythms of the coming machine age. With Morse code in hand, railroads improved their ability to move goods over America's vast distances, newspapermen sped up the perceived pace of historical events, businessmen upped their managerial control (and their stress), and stock markets started pulsing in sync. In Nathaniel Hawthorne's *The House Of The Seven Gables*, the character Clifford asks a question at once ironic and prophetic of all the electromania to come: "Is it a fact – or have I dreamt it – that, by means of electricity, the world of matter has become a great nerve, vibrating thousands of miles in a breathless point of time?"

Writing about the telegraph in *Understanding Media*, Marshall McLuhan also argued that "whereas all previous technology (save speech itself) had, in effect, extended some part of our bodies, electricity may be said to have outered the central nervous system itself". For McLuhan, Morse's electric ganglion was only the first in a series of media that served to dissolve the logical and individualistic mindframe hammered out by alphanumeric characters, the printing press and Renaissance perspective drawing. The telegraph sparked the "electric retribalization of the West", a long slide into an immersive electronic sea of mythic participation and collective resonance. But McLuhan also saw this "outering" as the technological roots of the age of anxiety. "To put one's nerves outside," he wrote, "is to initiate a situation – if not a concept – of dread."

Because the self is partly a product of its communications, new media technologies remould the boundaries of being. As they do so, the

shadows, doppelgängers and dark intuitions that haunt human identity begin to leak outside the self as well – and some of them take up residence in the emerging virtual spaces suggested by the new technologies. Spiritualism, for example, was bound up from the start with the telegraph: the knocks and rappings that passed back and forth between the Fox sisters and the dead pedlar in their Hydesdale cottage in 1848 – the spooky communiques which first sparked the popular religion of mediumship – were spectral echoes of the dots and dashes then hurtling through wires across the land. During the 1950s, the movement's most popular newspaper was called *The Spiritual Telegraph*, and Spiritualists like Allan Kardec and scientists like Michael Faraday both looked to electricity to explain the raps, creaks and table-hops that occurred during seances. By the 1860s and 70s, mediums had become the professional pop stars of the Victorian era; the attendees were treated to occult sideshows, as tables rapped and danced across the room, gooey ectoplasm materialised out of thin air, and musical instruments played creepy jigs in the dark – apparently all by themselves.

Sound clearly plays a privileged role in both manifesting and mystifying electricity. According to one contemporary account, the 'Finale' of a Boston lecture given by representatives of the Edison Company in 1887 was nothing less than a seance. "Bells rung, drums beat, noises natural and unnatural were heard, a cabinet revolved and flashed fire, and a row of departed skulls came into view." And when Alexander Graham Bell and Thomas Watson gave demonstration lectures for the telephone, the two men also conjured up tricks that delivered all the thrills and chills of a magic show.

The telephone always possessed a kind of shadow side. Though Bell came up with the notion of translating the vibrating pressures of the human voice into an electrical signal that could pass along a wire, Watson actually built most of the man's early devices. Like a lot of the electrical hackers of the time, Watson combined loads of practical know-how with weak and frequently wacky theories about the mysterious fluid itself – electricity is an experience before it is a fact, a dream before it is a science. In Watson's case, electrical theories were mixed up with spiritualist notions. Watson treated Spiritualism as a non-mystical science, and he initially concluded that, just as "a telegraph instrument

transforms pulsations of electricity into the taps of the Morse code", so too did mediums transform energetic radiation into raps and knockings. He also believed spirits from the other side were helping the telephone along. And why not? We associate sentient life with what communicates, and here was an inert thing full of voices. As the emperor of Brazil exclaimed when he first heard the gadget: "My God, it talks!"

A similar shock, impossible for us to reconstruct, awaited folks first confronted with the phonograph. The telephone had already transformed sound waves into the fluctuations of an electric current, but in 1877 Thomas Edison discovered that changing an electric current in a stylus changed the amount of friction the stylus exerted on a rotating cylinder – which could therefore become a medium of sonic inscription. Though Edison himself was a most practical man, he was also something of a techno-spiritualist, and later attempted to build a radio device capable of capturing the voices of the dead. Such desires would persist, sublimated and not, throughout the 20th century. The Swedish researcher Konstantin Raudive claimed that magnetic tape recordings of silence often turn out, on repeated listening, to contain distinct voices, and contemporary devotees of 'Electronic Voice Phenomenon', a parapsychological hobby loosely inspired by Raudive's researches, have tuned into similar murmurs on non-broadcast radio frequencies, some of which are interpreted as messages from beyond the veil.

These dreams and sonic phantasms are not just kookery; they arise in the virtual spaces carved out by electrical media. By siphoning a bit of the 'soul' into an externalised device, such technologies triggered the ancient dread of the doppelgänger, that psychic simulacrum of the self that moves through the world of its own eerie accord. Freud dubbed the dread produced by the doppelgänger "the uncanny", which he connected to the queer feelings one gets from dolls and automata. It seems important to note that when Edison was imagining possible applications for his new device, one of his first notions, alongside producing platters of music, was to make dolls "speak, sing, cry and make various sounds".

Electricity had other tricks up its sleeve. In the 1830s, the great British experimental scientist Michael Faraday discovered that changing the electrical current in a wire coil somehow induced an energetic fluctuation in a nearby coil. This decidedly bizarre action-at-a-distance,

which came to be called electromagnetic induction, is the driving force behind electrical power plants to this day. For his part, Faraday explained the mysterious force connecting the two coils as a "wave of electricity". Pointing to the strange patterns that iron filings create around the end of a magnet, Faraday also suggested that electromagnetic "fields" consisted of "lines of force", vibrating patterns that spread throughout space. Though Faraday initially considered these undulating images of fields and lines of force as nothing more than useful fictions, he gradually accepted them as a basic description of reality.

In the 1860s, James Clerk Maxwell translated Faraday's experimental findings into the language of mathematics, synthesizing optical, magnetic and electrical phenomena into four magnificent equations that governed the whole of electromagnetic reality. In doing so, Maxwell predicted the existence of the electromagnetic spectrum whose waves we now exploit for everything from broadcasting pop music to reheating food to analysing the chemical composition of Alpha Centauri. Einstein later called Faraday and Maxwell's work the "greatest alteration in the axiomatic basis of physics – in our conception of the structure of reality". Their electromagnetic universe set the stage for the final deconstruction of atomic materialism: the dissolution of the ether, the emergence of Einsteinian space-time, and ultimately the arrival of quantum mechanics and its colossal oddities. The corporeal cosmos melted into an immense sea of vibrations and insubstantial forces.

Metaphorically speaking, Faraday and Maxwell's model was also intensely musical, though its music was very different from the tonal structures of Western music – structures which, perhaps not coincidentally, began to dissolve just as the new model of the universe entered popular consciousness. Towards the end of the century, wireless hackers like Marconi and Tesla made direct technological contact with the invisible radio waves theoretically limned by Maxwell. In 1899, after five years of fiddling around with induction coils, batteries and primitive aerials (some of which he hung from balloons), Guglielmo Marconi equipped two ships with radio gear that issued speedily telegraphed reports on the yacht race for the Americas Cup. This little sports thrill captured the world's imagination, and the 20th century can be said to have started on a wireless note. Wireless telegraphy also served as a

kind of sonic prophecy: those monotone Morse beep-beep-beeps that once signified news sound like post-Techno dance music.

Marconi's wireless flowered into radio, which in its first few decades reproduced a pattern of intense technical development and prophecies about world peace and democratic communication that sound eerily familiar in the wake of the Internet boom and bust. Moreover, early radio attracted legions of hackers, teenage and otherwise, who endowed their homebrewed crystal sets with an undeniable charge of experiment and anarchic play. For the first few decades of radio's life, hobbyist hams across the globe chatted up a storm while making important discoveries about the spectrum, especially on the shortwave side of things. By the 1920s, federal and commercial interests began stringing barbed wire across the many-to-many spectrum, professionalising and segmenting the formerly free-range medium.

Even as the airwaves were filling up with ads for laundry soap, radio freaks continued to hear some seriously otherworldly stuff in their primitive headphones. Thomas Watson got an early taste of these unearthly transmissions late at night in Bell's lab, when he would listen to the snaps, bird chirps and ghostly grinding noises that popped up on a telephone circuit: "My theory at this time was that the currents causing these sounds came from explosions on the sun or that they were signals from another planet. They were mystic enough to suggest the latter explanation but I never detected any regularity in them that might indicate they were intelligent signals." As Avital Ronell points out, "Science acquires its staying power from a sustained struggle to keep down the demons of the supernatural with whose visions, however, it competes." Watson may have been the first person to *listen to noise*. Though the sounds he heard may well have had terrestrial origins (the 'sferics' that radio hounds continue to hunt today), Watson made the crucial recognition that human ears could now directly register cosmic vibrations.

Watson was by no means the only electrohead to believe he was picking up play-by-play reports from other planets. During the summer of 1899, when inventor Nikola Tesla manufactured lightning and dreamed of broadcasting wireless power across the globe, he also started picking up regular signals on his 200 foot radio tower in Colorado, and tentatively concluded that he was "the first to hear the greeting of one

planet to another". For decades, many early radio operators continued to pick up powerful, persistent and seemingly unexplainable signals, some of which were reported to be rather Pynchonesque repetitions of the Morse code for 'V'. Marconi himself claimed to have received such signals on the low end of the longwave spectrum, and in 1921 flatly declared that he believed they originated from other civilizations in space. On 24 August 1924, when Mars passed unusually close to the earth, civilian and military transmitters voluntarily shut down in order to leave the airwaves open for the Martians; radio hackers were treated to a symphony of freak signals.

These popular passions may seem corny in retrospect, but that is because the sublime and visionary edge of technology is always changing, opening up new virtualities that then become integrated into business as usual. For aeons, the hardwired side of human perceptions has been limited to our own unique sensory apparatus, an apparatus that partly determines the apparent nature of the world. New technologies of perception unfold new worlds of sublimity and threat, worlds which challenge us to reconfigure the limits of ourselves and to shape the meaning of the new spaces we find ourselves in. When ocular instruments extended human sight into Galileo's heavens and Robert Hooke's microscopic cellular regimes, they installed new explanatory spaces for the universe, spaces which reorganised the meaning of the cosmos and the actors in it.

But what kind of 'space' does our expanded encounter with electricity and the electromagnetic spectrum lead us into? Though the spectrum includes the wavelengths of visible light, and X-rays, ultrasound and radio astronomy can all be used to illuminate new dimensions of the universe, the essence of electromagnetism is invisible. In one of his more suggestive intuitions, Marshall McLuhan argued that electronic technologies were installing an "acoustic space" in the place of an earlier "visual space" – the linear, logical and sequential conception of the world that had dominated Western consciousness for many centuries. McLuhan believed that electronic media eroded this crisp and objective grid of facts, dissolving it into a psychic, social and perceptual environment that resembles the kind of space we hear: multi-dimensional, resonant, invisibly tactile, "a total and simultaneous field of relations". Though

McLuhan used "acoustic space" as an analogy for a psycho-social process that did not necessarily tickle the bones of the inner ear, his oceanic vision of acoustics does foreground the central role that music – and its electromagnification – would play in mapping and constructing pleasure and perception in the first fully technological century.

This secret sympathy between music and the electromagnetic imaginary was first intuited in the 17th century by the Jesuit polymath Athanasius Kircher, who identified certain vibrating musical tones as 'magnetic'. Kircher also invented the glass harmonica, an instrument that exploited the resonant tones produced by rubbing glass tumblers filled with water. Kircher's researches were carried on by the animal magnetist Franz Anton Mesmer, known today either as the king of charlatans or the man whose healing journeys into the netherworlds of the mind inadvertently spawned psychoanalysis. Mesmer believed that animal magnetism was "communicated, propagated and intensified by sound", and, as the liner notes to Ash International's 1995 compilation CD *Mesmer Variations* point out, he used to improvise on a version of Kircher's glass harmonica in order to set the mood in his healing salons. One visiting Viennese doctor described the "shiver through my nerves caused by the instrument", and suggested that "many of the phenomena of magnetism must have been brought out by the extremely penetrating tones of this music".

For us, Mesmer might serve as a utopian figure – half comic, half cosmic, experimental and underground – for the continued promise of electroacoustic phenomena in a world ravaged by technologies with far more violent and banal issue. Along with cinema, 20th century music has become one of the principal aesthetic zones where humans have used innovative gadgetry to make sense – and nonsense – of their own increasingly technologized souls. Musicians and composers both highbrow and pop have twiddled and tweaked electronic and electrical instruments, as well as electromagnetic recording and broadcasting technologies, in order to tune into new sonic, compositional and expressive possibilities. In so doing, they have also gone a long way toward reimagining the scrambled boundaries of subjectivity as it makes its way through the invisible landscapes – both dreadful and sublime – that make up the acoustic space of electronic media.

The uncanny undercurrent of electromagnetism also helps explain why electronic tones and timbres have, throughout the 20th century, frequently been associated with outer space, mysticism and cosmic consciousness. These connections run throughout both popular and experimental genres, encompassing Hollywood soundtracks, acid rock, the avant garde, lounge, Ambient, dub, Techno, jazz, funk and Trance. From Stockhausen and Subotnick to George Clinton and Juan Atkins, from Sun Ra and Klaus Schulze to Les Baxter or Goa Trance, electrical tones have operated as both cosmic signifiers and vibratory portals into altered states and spaces.

These associations speak to the deep legacy of the electromagnetic imaginary, a legacy that, as we've seen, goes back to Mesmer, alchemy and German nature philosophy. But it's important to suggest that these associations are not merely cultural constructions. The expressive power of electronic sounds is intimately linked with timbre, and one of the most fundamentally electronic timbres we know – the eerie metallic moan of the theremin – is not simply a quirk of technology or an aesthetic decision on the part of its inventor, Léon Thérémin. Theoretically, the theremin's tone is a pure sinewave. Though in practice a variety of non-harmonic effects can intrude delightfully, the fact remains that the theremin's haunting sound is not a product of synthesis, but of the fundamental conditions of electromagnetic reality. It is more like an Aeolian harp than a Casio beatbox, but the winds it rides are electromagnetic ones, stretching from here to the edges of the universe.