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Sparks to Signals: Literature, Science, and Wireless Technology, 1800-1930

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Sparks to Signals: Literature, Science, and Wireless Technology, 1800–1930

by

Erik Christopher Born

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Professor Niklaus Largier, chair

Professor Anton Kaes

Professor Mary Ann Doane

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Abstract

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"Going wireless" involves not only the elimination of wires but also the production of electromagnetic waves, a realization that had far-reaching implications for the cultural logics of German modernity. As a media archaeology of wirelessness, this dissertation situates the "discovery" of electromagnetic radiation and the "invention" of wireless transmission in a richer field of scientific, experimental, and aesthetic relations during the early and pre-history of national broadcasting. Before wireless transmission came to be synonymous with the mass distribution medium of radio or even the long-distance communication medium of wireless telegraphy, it was at the center of speculation about a variety of possible wireless futures. Understanding the rhetoric of the new media of radio and wireless telegraphy in the first chapter opens onto questions of continuity and change in the longue durée of the second chapter. The insights gained from this comparison of pre-modern cultural techniques and modern electronic technologies are crucial for understanding the "discovery" of electromagnetic radiation and the "invention" of wireless telegraphy examined in the third and fourth chapters with a focus on the immediate pre-history of national broadcasting in the late nineteenth and early twentieth century. The significance of this pre-historical period and the contingency of national broadcasting in the mid-twentieth century arguably only became apparent with the revival of wireless transmission at the turn of the twenty-first century, as the fifth chapter makes evident. As a contribution to the early and pre-history of national broadcasting, this dissertation suggests a new way of thinking about the order of wirelessness, from "wireless" as synonymous with the communication medium of telegraphy or the distribution medium of radio, to "wireless" as electromagnetic radiation and a medium of experimentation.

To Judy

Contents

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Note

Unless otherwise noted, all translations are my own.

INTRODUCTION

The Wired World, ca. 1900

> Wenn ihr Bäume pflanzt, so sei's in Reihen,
> Denn sie lässt Geordnetes gedeihen.
>
> In planting, put your trees in rows;
> That's how order flourishes and grows.
> —Johann Wolfgang von Goethe

Kabelsalat. The untranslatable German word describes an impossibly tangled mess of cables that have been tied, twisted, and intertwined into something like a modern-day Gordian knot. While cables are fundamental for our modern information society, they are usually invisible, disappearing inside cable ducts, behind the walls, or at the bottom of the ocean. Only when cables run counter to the functional order of technology do they become visible in a symbolic form of disorder. When written with a dash, "Kabel-Salat" makes visible an otherwise overlooked rupture between the symbolic order (Salat) and the functional order (Kabel), and, like a dash, the cable is something that separates and connects at the same time.[1] As a breakdown between the functional and the symbolic in the order of technology, Kabelsalat is a figure of extreme disorder, of technology developing out of control.

The word, translated literally as "cable salad," captures a moment when the possibility of untangling these cables becomes just as unthinkable as unmixing a salad. Once tied, a knot cannot be undone without using the free ends of the material it secures because the individual strands of a linear material cannot move through each other. Kabelsalat, as a network of knots, is something that cannot be disentangled without knowing the ends of wired technology, perhaps even the ends of the human, and yet, there is also something fundamentally human about Kabelsalat. Tying and untying knots—and, by extension, installing and disentangling cables—is an elementary cultural technique involving the art of intertwining strands and threads so that they unite into a compact, flexible, and sustainable form. Knots are a fundamental concept of network studies, where they are known as "nodes" (Lat. *nodus*, "knot"), designating either a piece of equipment attached to a network or a point at which lines or pathways in a network topology branch or intersect.[2] Poetry, too, can be understood as an art of tying and untying knots, of weaving together various strands into the fabric of textuality, thereby creating dramatic entanglements.[3] To what extent, then, can this concept of Kabelsalat be

1. See Peter Bexte, "Kabel im Denkraum," in *Updates: Visuelle Medienkompetenz*, ed. Arthur Engelbert and Manja Herlt (Würzburg: Königshausen & Neumann, 2002), 18.

2. See Sebastian Giessmann, *Netze und Netzwerke: Archäologie einer Kulturtechnik, 1740–1840* (Bielefeld: Transcript, 2006), 13.

3. See Juliane Vogel, "Verstrickungskünste – Lösungskünste: Zur Geschichte des dramatischen Knotens," *Poetica* 40, no. 3/4 (2008): 269–88.

transferred to the study of literature, media, and culture? Does the order of "wirelessness," to borrow media philosopher Adrian Mackenzie's term for the contemporary sensation of ubiquitous connectivity, represent anything more than a promise to clean up the wired mess of Kabelsalat?[4] Is there a point at which the prospect of disentangling modernity from a history of the cable itself becomes unimaginable?

While wires held out the promise of instantaneous communication, they also constituted a threat to urban environments, since a downed wire, vulnerable to the elements, could easily electrocute unlucky passersby. Around 1900, the common scene of wired infrastructure tended to be centered on the utility pole, the physical support for a dense communications network leading off into many different directions.[5] Without the utility pole, the cables would quickly form a Kabelsalat. A mid-nineteenth-century innovation, the utility pole was intended to consolidate telegraph wires and allow for easier service access. The orderliness of telegraph lines, the rectilinear grid of a network attesting to foresight and planning, also became symbolic of Western progress.[6] Kabelsalat indicates the fragility of this order. While the utility pole allowed wires to be run through cities with less danger to public safety, they eventually came to be used for precisely the opposite purposes, as the telephone pole, in the United States, became a site of public lynchings.[7] By the 1890s, there was a growing resistance to the aesthetics and politics of wired infrastructure, as a result of which, utility poles were increasingly removed from high-traffic areas, and pushed out into the outskirts. The utility pole makes visible the strain on wired infrastructure: were the pole to collapse, the orderly network of wires leading off into all directions would spill over into disorder.

One striking image of Kabelsalat features prominently in the Introduction to Friedrich Kittler's *Gramophone, Film, Typewriter* (1985), one of few scholarly works that begins and ends with the same word—in this case, *Verkabelung* (cabling, networking, connecting, hooking up).[8] Putting aside the infamous Preface with the claim "Media determine our situation,"[9] the first word of the Introduction establishes Verkabelung as a red thread that will run throughout the entire book, tying together Kittler's concerns for the constitution of the human through medial operations and the predicted convergence of formerly autonomous media in the form of a unified system of transmission:

> *Optical fiber networks* [*Verkabelung*]. People will be hooked to an information channel that can be used for any medium—for the first time in history, or for its end.

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4. Adrian Mackenzie, *Wirelessness: Radical Empiricism in Network Cultures* (Cambridge, MA: MIT Press, 2010).

5. For further analysis of images of wirelessness around 1900, see Erik Born, "Going Wireless in the Belle Époque: A Photo Essay," Palais des Beaux Arts Wien, last modified January 3, 2016. http://medium.com/palais-des-beaux-arts-wien/going-wireless-in-the-belle-époque-4284a928dfd8/

6. See Carolyn Marvin, *When Old Technologies Were New: Thinking About Electric Communication in the Late Nineteenth Century* (New York: Oxford University Press, 1990), 37.

7. See Eula Bliss, "Time and Distance Overcome," *The Iowa Review* 38, no. 1 (Spring 2008): 83–89.

8. Friedrich A. Kittler, *Grammophon, Film, Typewriter* (Berlin: Brinkmann & Bose, 1986), 7, 379; translated by Geoffrey Winthrop-Young and Michael Wutz as *Gramophone, Film, Typewriter* (Stanford: Stanford University Press, 1999), 1, 263.

9. Kittler, *Gramophone, Film, Typewriter*, xxxix.

> Once movies and music, phone calls and texts reach households via optical fiber cables [*Glasfaserkabel*], the formerly distinct media of television, radio, telephone, and mail converge, standardized by transmission frequencies and bit format. The optoelectronic channel in particular will be immune to disturbances that might randomize the pretty bit patterns behind the images and sounds. Immune, that is, to the bomb. As is well known, nuclear blasts send an electromagnetic pulse (EMP) through the usual copper cables, which would infect all connected computers.[10]

In other words, the historical shift from copper wires to fiber optic cables signals the end of media history as we know it. As systems of delivery and distribution, film, radio, telephone, and the post office traditionally depended on distinct information channels. However, they have now been standardized, in the form of digital information, and can be transmitted over the same channel. Furthermore, this channel offers a sinister military advantage: while copper cables are vulnerable to electromagnetic disturbances, fiber optic cables are insulated from the risk of electromagnetic warfare. At the end of the book, the circuit closes: "Trenches, flashes of lightning, stars—storage, transmission, *the laying of cables* [*Verkabelung*]."[11]

The translation of the difficult term Verkabelung, in English editions of Kittler's seminal work, as "optical fiber networks" for the first word of the book and as "the laying of cables" for the last, is probably the reason the main topic of the book is often overlooked.[12] Historically, even though the explicit target of Kittler's remarks is the Pentagon, there are unexplored parallels with the politics of Verkabelung in the Bundesrepublik. Shortly before the introduction of cable television in 1984, there were protests against *Zwangsverkabelung* or *Zwangsverdrahtung*, the compulsory connection to the *Deutsche Bundespost*'s cable network. However, taking Verkabelung too literally can reinforce the stereotypical reading of the book as a "narrative of [digital] media convergence," which easily becomes a straw man in many subsequent studies.[13] It may also be responsible for the strange impression that Kittler focused solely on media of inscription at the detriment of media of transmission,[14] when his interest lay squarely in the holy trinity of information theory—storage, transmission, and processing. What is lost in translation is the word's resonance with the image of the telephone cables discussed above. Kittler's description of the invisible, underground fiber optic cables in the text contrasts neatly with the seemingly antiquated woodcut showing visible, aboveground

10. Ibid., 1.

11. Ibid., 379.

12. Verkabelung is translated as "optical fiber networks" in both Geoffrey Winthrop-Young and Michael Wutz's book-length translation of 1999 and Dorothea von Mücke and Philippe L. Similon's translation of the Introduction as Friedrich A. Kittler, "Gramophone, Film, Typewriter" *October* 41 (1987): 101–18. The decision to translate *Verkabelung* as "optical fiber networks," capturing something of the root *Kabel* and reinforcing Kittler's emphasis on hardware, is due probably to the mention of that technology in the second sentence of the first paragraph. However, the problem is similar to translating *Aufschreibesysteme* as "discourse networks," thereby losing the sense of both inscription and systems.

13. Matthew G. Kirschenbaum, *Mechanisms: New Media and the Forensic Imagination* (Cambridge, MA: MIT Press, 2008), 6.

14. See, for example, Douglas Kahn, *Earth Sound, Earth Signal: Energies and Earth Magnitude in the Arts* (Berkeley: University of California Press, 2013), 21.

cables, captioned "Telefonverkabelung."[15] At the end of the book, Kittler's discussion of Verkabelung is followed by another image, included only in the German edition, of a circuit diagram showing a digital signal processor.[16] From the analog to the digital, the circuit of Verkabelung gets completed at multiple rhetorical levels simultaneously: even if the cable escapes the cyclical, self-reflexive figure of ouroboros, the mythological serpent or dragon eating its own tail, since a cable will always exhibit two distinct ends, the rhetorical figure of epanadiplosis, or starting and ending a sentence with the same word, proves irresistible for Kittler. Transferred, however, from the sentence level to the level of the medium itself, the linguistic repetition of Verkabelung emphasizes the structural conditions of the printed book, and the pictorial repetition of Verkabelung underscores the perceived ends of that medium. Ultimately, Kittler's concept of Verkabelung as media convergence promises to clean up the Kabelsalat in poststructural discourse analysis.

Images of the wired city were popular at the turn of the twentieth century, when the telegraph, telephone, and electrical networks were rapidly expanding. On a trip to Berlin in 1887, Jules Laforgue noticed the "sky like a spider's web, crisscrossed with telephone wires,"[17] and described the newly wired city with a picturesque image: "On certain evenings in April, seen from far away, the statue of Frederick looks good with his little cocked hat against the background of a sunset and the triumphal arch, and, a little above his head, a span of forty telephone wires."[18] Seen from close-up, the common street scene involved a group of city-dwellers going about their business, mostly oblivious to the modern technology suspended precariously above their heads. In 1900, Alfred Kerr reflected that "the Parisians, when faced with the prospect of electric trams and overhead power lines, threatened revolution. They had no wish to see their beautiful streets disfigured by wires and poles. There is little prospect of the Berliners going to the barricades!"[19] Despite being equipped with this vast infrastructure, as Kurt Tucholsky observed in 1926, "the only thing we are missing is traffic [*Verkehr*]," a crucial term covering commerce, intercourse, communication, and transportation.[20] The Kabelsalat manifest in the wired world at the turn of the century was not necessarily equivalent to an increase in communication.

Understood as an attempt to manage Kabelsalat, the history of wirelessness is entangled with the history of wires. To deal with the growing Kabelsalat at the end of nineteenth century, different attempts to eliminate wires proceeded in tandem. The congestion of wires at the turn of the century attests not only to the limitations of wired

15. Kittler, *Gramophone, Film, Typewriter*, 6.

16. Kittler, *Grammophon, Film, Typewriter*, 379.

17. Jules Laforgue, *Berlin, la cour et la ville* (Paris: Éditions de la Sirène, 1922), 86. "[U]n ciel en toil d'araignée de fils téléphoniques."

18. Ibid., 84. "A certains soirs d'avril, vue du loin, la statue de Frédéric fait bien avec son petit tricorne penché, sur fond de couchant et d'arc de triomphe, avec un peu au-dessus de la tête une portée de quarante fils téléphoniques."

19. Alfred Kerr, "New and Beautiful!—Bülowstrasse?" [1900], in *Metropolis Berlin 1880–1940*, ed. Iain Boyd Whyte and David Frisby (Berkeley: University of California Press, 2012), 114.

20. Kurt Tucholsky, "Berliner Verkehr" [1926], *Die Weltbühne* 40 (October 5, 1926): 545. "Das einzige, das uns noch fehlt, ist der Verkehr."

technology, but also to nascent service practices. To keep up with the demand for service, telephone wires were usually laid one-at-a-time with each new subscription, all being attached to utility poles. As a means for preventing Kabelsalat, the utility pole performs the same function as the cable ties and harnesses in today's network architecture, namely, laying cables next to each other in an orderly fashion and fixing them to one another, so that they can be separated from each other in the future. The aim of infrastructure is the creation and maintenance of order. To this end, urban planners gradually consolidated wires and increased the height of utility poles. Out of sight, out of mind—wires tended to remain far overhead or buried underground, occupying a tenuous position in the margins of everyday life. Even though electromagnetic radiation, which would eventually become the dominant physical medium of modern wireless communications, was discovered in the late 1880s, it would take another decade for wireless telegraphy to become practical, and another two to three decades until wireless transmission would expand from dots and dashes to include the possibility of transmitting the sounds of radio and the moving images of television.

To many observers at the turn of the twentieth century, the advent of wireless technology seemed to solve many of the problems inherent in the growing Kabelsalat. As one American engineer put it, "Telegraphing without wires—how attractive it sounds. No more unsightly pole lines disfiguring the streets and highways, ornamented with the dangling skeletons of by-gone kites. No more perpetual excavation of the streets, to find room beneath their surfaces for additional circuits that cannot possibly be crowded on to the staggering lines that darken the sky with their sooty cobwebs."[21] The motivations for going wireless, as this quotation suggests, were not only aesthetic but also social, political, and economic. In the early twentieth century, the wireless revolution promised not only to do away with the familiar urban infrastructure of physical wires, but also to enable the creation of a new electromagnetic world without borders. Since wireless signals are universally available, at least in theory, to anyone with a receiver, the spread of wireless technology was taken to be a sign of impending universal social equality.[22] In this respect, wireless technology was thought to promote free circulation, a dominant precondition for progress since the Enlightenment. The flip side of the coin was the threat of contagion and infection, evident at the level of hardware in Kittler's apocalyptic description, quoted above, of electromagnetic warfare. In both cases, the invisibility of wireless transmissions, in contrast to the visible and at times even spectacular dimension of wires, have often obscured their place in the public sphere.[23]

Even though "going wireless," to borrow the term prominent in Silicon Valley for the transitional period of the 2000s that applies equally well to the transitional period around

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21. Arthur V. Abbott, "Electrical Radiation," *Electrical World and Electrical Engineer* 23 (June 10, 1899): 802.

22. See Frank Hartmann, *Globale Medienkultur: Technik, Geschichte, Theorien* (Vienna: WUV, 2006); for a typical period source, see Ivan Narodny, "Marconi's Plans for the World," *Technical World Magazine* 18 (October 1912): 145–50.

23. See Peter Schaefer, "Dematerialized Infrastructures: On the Ethereal Origins of Local Area Networks," in "Network Archaeology," ed. Nicole Starosielski, Braxton Soderman, Cris Cheek, special issue, *Amodern* 2 (2013). http://amodern.net/article/dematerialized-infrastructures-and-the-ethereal-origins-of-local-area-networks/

1900, was supposed to solve many of the social, political, and economic problems inherent in wired systems, many of these problems resurfaced in different forms after the transition. Although wireless services offered obvious economic advantages over wired telegraphy in terms of the cost of producing, laying, and maintaining cables, collecting payments for wireless services proved a more difficult task than it had been for wired services, where information producers and receivers are directly connected.[24] Universally accessible, at least in theory, wireless services required the development of subscription services and advertising to turn a profit. Wireless infrastructures may have also presented an initial improvement on the vulnerability of wired infrastructures, evident when undersea telegraph cables were cut at the onset of the Spanish-American War and again during World War I. However, wireless transmissions are themselves vulnerable to interception, which required the creation of various encryption techniques.[25] In a similar vein, wireless technology may have seemed to represent a more efficient medium for European nations to monitor their colonies, though remote stations were more difficult to maintain in times of crisis.[26] Only a combination of these factors can account for the rapid growth of wireless technology at the end of the century, which, however, did not, and never will, put an end to the Kabelsalat.

In my analysis, then, both the theoretical relations between wired and wireless technology, and the historical development of wireless technology itself, largely defy the traditional "problem–solution" logic of media history. To what extent, in other words, was wireless technology actually a solution to the problem of wires? Or was it not a solution to another constellation of problems entirely? The four main explanations for the growth of wireless technology appeal to economic (Castells), military (Kittler), imperial (Innis), and scientific (Hagen) forces.[27] For the purposes of my research, however, wireless technology cannot be understood as the response to any single problem, but only to an array of problems and constellations. The path to the development of wireless technology was hardly straightforward or inevitable. Only slowly did wireless come to be understood on its own terms, and only gradually did applications for wireless technologies change from establishing point-to-point connections into broadcasting omnidirectional transmissions. In many respects, the early understanding of wireless transmission tended to follow established thinking about wired transmission, making it seem at once a continuation and a negation of a familiar medium.

While *electromagnetic radiation* is the formal scientific term for what Heinrich Hertz demonstrated with his experimental apparatus in the late 1880s, and electromagnetic

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24. See Randall Patnode, "Path Not Taken: Wired Wireless and Broadcasting in the 1920s," *Journal of Broadcasting & Electronic Media* 49, no. 4 (2005): 383–401.

25. See Friedrich A. Kittler, "Rock Music: A Misuse of Military Equipment," in *The Truth of the Technological World: Essays on the Genealogy of Presence*, trans. Erik Butler (Stanford: Stanford University Press, 2013), 152–64.

26. See Reinhard Klein-Arendt, *Kamina ruft Nauen! Die Funkstellen in den deutschen Kolonien 1904–1918* (Cologne: Wilhelm Herbst, 1996).

27. Manuel Castells, *The Rise of the Network Society* (Malden, MA: Blackwell, 1996); Kittler, "Rock Music"; Harold Adams Innis, *Empire and Communications* (Oxford: Oxford University Press, 1950); Wolfgang Hagen, *Das Radio: Zur Geschichte und Theorie des Hörfunks – Deutschland/USA* (Munich: Fink, 2005).

radiation is what would become the dominant physical medium of any kind of wireless transmission by the late 1890s, many other terms were used during the early days of wireless telegraphy, and some even persisted into the early days of radio.[28] "New technologies are always born nameless," as Rick Altman puts it. Only gradually does a name for a new technology gain widespread acceptance. "Assimilated to multiple possible models, new technologies always begin life with multiple monikers rather than a single stable name."[29] The controversy over terminology for wireless telegraphy was summed up nicely in the exasperated title of a 1901 article: "Spark, Space, Wireless, Etheric, Hertzian Wave or Cableless Telegraphy—Which?"[30] In the article, A. Frederick Collins, a prominent wireless engineer and prolific author of several popular accounts of wireless technology, laments that "the moot question relating to the applicability of the word 'wireless' to electrical communication without intervening connecting wires has been again brought up."[31] As Collins points out, complaints about the inappropriateness of the adjective "wireless" for describing a system containing visible wires on both the transmitter and the receiver, date back at least to the earliest scientific lectures on wireless topics in the 1890s. In a discussion at the Royal Society of Arts following William H. Preece's lecture on "Electric Signalling Without Wires" (1894), the British Attorney General, Richard Webster, "decided that the objection was hypercritical, because it is ordinarily understood that *telegraphy by wire* means over a wire, and *without wires* that there are no wires connecting the sending with the receiving instrument."[32] In other words, the popular imagination of wireless telegraphy meant telegraphy without any *connecting wires*, i.e., wires connecting the transmitter and receiver, even though wires may be involved in the construction of the transmitter and receiver themselves. In fact, every wireless device is full of wires, and the antenna itself is nothing more than a wire without a terminal.

By the late 1890s, the main term competing with *wireless* telegraphy was *spark* telegraphy, a term with "a crisp, fresh, crackling sound" to Collins's ear, the very sound the spark-gap transmitter made in early wireless telegraphy. In Germany, the designation of wireless as sparks (*Funken*) would become the most common term for wireless telegraphy (*Funkentelegraphie*), and would even continue to be preserved in the most common term for the radio (*Rundfunk*, literally, a "circular spark," figuratively, an "omnidirectional broadcast").[33] In 1898, for example, the German wireless pioneer Adolf Slaby argued that wireless telegraphy is a misnomer: "Since these wires are the essence

28. See Winfried B. Lerg, *Die Entstehung des Rundfunks in Deutschland: Herkunft und Entwicklung eines publizistischen Mittels* (Frankfurt am Main: J. Knecht, 1965), 19–23; Adrian Haus, "Radiogerede – Worte rund um 'Funk,'" in *Radio Radio: Studien zum Verhältnis von Literatur und Rundfunk*, ed. Heiner Boehncke and Michael Crone (Frankfurt am Main: Lang, 2005), 9–38; Kai Steffan Knörr, "Funken," in *Historisches Worterbuch des Mediengebrauchs*, ed. Matthias Bickenbach, Heiko Christians, and Nikolaus Wegmann (Cologne: Böhlau, 2014), 268–87.

29. Rick Altman, *Silent Film Sound* (New York: Columbia University Press, 2004), 19.

30. A. Frederick Collins, "Spark, Space, Wireless, Etheric, Hertzian Wave or Cableless Telegraphy—Which?," *Western Electrician* 29 (August 24, 1901): 119.

31. Ibid.

32. Ibid., emphasis added.

33. Lerg, *Die Entstehung des Rundfunks in Deutschland*, 19; Haus, "Radiogerede," 14–17; Knörr, "Funken."

of Marconi's discovery, the term 'telegraphy without wires' is really erroneous; more correctly should it be called 'telegraphy by sparks', in opposition to the term used hitherto, 'telegraphy by circuit.'"[34] Almost 25 years later, there would still be complaints in Germany that wireless technology would only deserve its name once wireless devices came to use less wires.[35] If the meaning of wireless was always underdetermined, a combination of older and newer meanings contributed to the overdetermined meaning of sparks, especially the conception of Funken in the early days of German radio and wireless telegraphy.[36] However, I would argue that the continued focus on Funken in German-language scholarship today remains problematic, since the designation *spark* telegraphy, as Collins already recognized, excludes at least three other wireless systems that did not use a spark: James Lindsay's, Willoughby Smith's, and Samuel Morse's *conductivity* method; William Preece's *magneto-induction* system; and Collins's own *electrostatic* system. Hence, Collins argues that the general adoption of the term spark telegraphy would be even more absurd for these systems than would the term wireless telegraphy.

There were also problems, as Collins recognized, with other potential substitutes for *wireless*. Another qualifying adjective was *space* telegraphy, designating the propagation of waves through the earth or the air. Yet, the wired telegraph also operates through space, which makes the term less descriptive. Given that "one feature in common with all the various systems of wireless telegraphy is their adaptability for marine transmission of intelligence," a suitable term might be *cableless* telegraphy, which works for ship-to-shore communications but runs into problems for dry land. In 1901, in response to the *Electrical Review*'s call for a shortened name for wireless telegraphy, one reader suggested the term *atmography*, a portmanteau of "atmosphere" and "telegraphy," though, as might be expected, the proposal fell on deaf ears.[37] Eventually, the term *radiotelegraphy* was adopted as a universal standard at the 1906 Berlin Radiotelegraph Convention, and by 1910, communicating with radio waves was almost universally referred to as "radio," the term *wireless telegraphy* being largely replaced by *radiotelegraphy*. However, it would take many years before synonyms for wirelessness disappeared from general usage. Recently, the word *wireless* has made a comeback in the terminology for wireless local-area data networks, commonly known as WLAN or Wi-Fi. In 1901, Collins had already wondered whether the question of terminology might eventually become academic: "In the distant future when all wire systems, both telegraph and telephone, have been superseded by the so-called wireless, there will be no confusing qualifying adjectives, for there will be no dual systems requiring qualification, and wireless telegraphy and telephony will be spoken of as simply telegraphy and telephony."[38] In other words, the qualifying adjective "wireless" will no longer be necessary when wireless will have became our default technology through a process of

34. Adolf Slaby, "The New Telegraphy: Recent Experiments in Telegraphy with Sparks," *The Century* 55 (1898): 867–74.

35. Artur Fürst, *Im Bannkreis von Nauen: Die Eroberung der Erde durch die Drahtlose Telegraphie* (Stuttgart: Deutsche Verlags-Anstalt, 1922), 86.

36. See Knörr, "Funken."

37. G. C. Dietz, "What Shall We Call It?," *Electrical Review* 39, no. 22 (November 30, 1901): 670.

38. Ibid.

media convergence. Although this is not quite the case with Wi-Fi, the trademark originally coined in analogy to Hi-Fi, wireless does now seem to be the default mode of short-range transmission.[39]

After World War I, the state of wireless technology had advanced to the point where it could be implemented in the form of a mass medium of national broadcasting. However, the implementation of wireless transmission in the form of one-to-many broadcasting (radio), rather than a point-to-point connection (telegraphy) was hardly inevitable. As Bertolt Brecht famously reflected in 1932, "It was not the public that waited for radio but radio that waited for a public."[40] Brecht's instructions for turning the wireless radio into a wireless telephone are based on the fact that there is no technological difference between these two modes of wireless transmission. About the difference, one American radio amateur wrote in 1925, "There ain't none such, that's all [….] *There is no difference between radio and wireless except the spelling*." What equated the two, for this amateur broadcaster, was their common operational process, namely, "the process of communication by either voice or telegraphic code by using the ether and ground in place of direct wires."[41] According to this procedural definition, the term radio, like wireless, should be used in the adjectival rather than the nominal form: "Thus, don't say you 'have a radio' in your house. What you mean is that you have a radio receiver or a wireless receiver in your home. If you think that there's any difference between a radio receiver and a wireless receiver then how do you explain hearing code signals on your so-called 'radio'?"[42] These early arguments in favor of using the term radio in the adjectival rather than the nominal form resonate surprisingly well with recent arguments in media studies in favor of using the term wireless only as a qualifying adjective.[43] Building on these insights, the aim of my research on a period known as the "pre-history" of national broadcasting is to weigh up the continuities and discontinuities first in terms of the transition from wired to wireless transmission, next, in that from wireless telegraphy to national broadcasting.

At the heart of the history and theory of wirelessness is a dialectic between these point-to-point and omnidirectional modes of transmission. What is commonly understood under the model of broadcasting are mass media like radio and television that exhibit a centralistic tendency because the structure of their connections is one-to-many, rather than one-to-one or many-to-many.[44] Hence, the main characteristics of this model are monologic rather than dialogic speech; an orientation to the market and to the masses

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39. While "high fidelity" designates the degree of exactness to which something is copied or reproduced, "wireless fidelity" is an empty signifier.

40. Bertolt Brecht, "Der Rundfunk als Kommunikationsapparat" [1932], in *Kursbuch Medienkultur: Die maßgeblichen Theorien von Brecht bis Baudrillard*, ed. Claus Pias (Stuttgart: Deutsche Verlags-Anstalt, 1999), 259–63. "Nicht die Öffentlichkeit hatte auf den Rundfunk gewartet, sondern der Rundfunk wartet auf die Öffentlichkeit."

41. Edward C. Hubert, "Radio vs. Wireless," *Radio News* 6 (January 1925): 1165, italics in the original.

42. Ibid.

43. Timothy C. Campbell, *Wireless Writing in the Age of Marconi* (Minneapolis: University of Minnesota Press, 2006).

44. See Hartmut Winkler, "Tauschen, Austauschen, Kommunizeren: Netzbildung in Ökonomie und Medien," in *Netzwerke: Eine Kulturtechnik der Moderne*, ed. Jürgen Barkhoff, Hartmut Böhme, and Jeanne Riou (Cologne: Böhlau, 2004), 309–18.

instead of to a small elite; and centralized control over content, programming, and systems of address. A paradigmatic example can be found in totalitarian regimes: the audience is spoken to by a single voice, addressed as a national unit, and mobilized as an undifferentiated mass. In the course of the twentieth century, the broadcasting model was used in a series of national, colonial, and imperial projects with the aim of disciplining subjects and consolidating state power.[45] Although broadcasting was the dominant model of wireless transmission throughout the twentieth century, it is almost already extinct in the twenty-first. In the course of the so-called "digital transition" starting in 2006, the most powerful worldwide communications towers that enabled nationwide radio and television broadcasts have been switched off or switched over to other wireless services that are more in demand, above all, cellular service. In addition, the term *narrowcasting* is used more and more, for example for podcasting, webcasting, and streaming video, directed at particular target audiences rather than at a national audience composed of the "average man."

In media studies, some have argued that the classical paradigm of broadcasting was a historical exception, only prominent in the mid-twentieth century, and only in industrialized countries.[46] Even though there is still no consensus about broadcasting's universality, there is one point that many agree on: one of the most significant moments in the history of wirelessness was the transition from point-to-point communication to one-to-many distribution in the sense of broadcasting.[47] For many years, media historians focused exclusively on this implementation of wireless technology in the form of national broadcasting at the expense of other uses of wireless. For every study of wireless telegraphy, there are hundreds of studies of the radio. Recently, however, media historians are attempting to salvage the term *telecommunications* for a restricted but significant case—long-distance communications networks that transmit messages from point to point.[48] While national broadcasting was once thought to represent the wave of the future, telecommunications, especially in the form of mobile cellular service, are now on the rise in much of the world. The aim of my research is not to abandon scholarship on broadcasting entirely but to sharpen its contours in comparison not only to wireless transmission as a form of telecommunication, but also to further applications of electromagnetic radiation within the radio frequency spectrum for a range of other wireless services including radar, radio astronomy, radiodetermination, and wireless energy transmission.

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45. See Debra Rae Cohen, Michael Coyle, and Jane A. Lewty, eds., *Broadcasting Modernism* (Gainesville: University Press of Florida, 2013).

46. For a summary of the arguments and indications of directions for future research, see Lucas Bessire and Daniel Fisher, "The Anthropology of Radio Fields," *Annual Review of Anthropology* 42 (2013): 363–78; Gabriele Balbi and Richard R. John, "Point-to-Point: Telecommunications Networks from the Optical Telegraph to the Mobile Telephone," in *Communication and Technology*, ed. Lorenzo Cantoni and James A. Danowski (Berlin: Walter de Gruyter, 2015), 35–55.

47. For the American context, see Susan Douglas, *Inventing American Broadcasting, 1899–1922* (Baltimore: Johns Hopkins University Press, 1987).

48. Balbi and John, "Point-to-Point."

Broadcasting literally means "transferring," "sending," "distributing."[49] The term comes from an agricultural technique with which seeds are cast out onto a field. This technique runs counter to one of the most basic laws of agriculture, formulated presciently in Goethe's well-known couplet, quoted as the epigraph to this Introduction. While planting seeds in rows creates order, casting seeds on the widest possible field involves stochasticity: some seeds may grow, others will not, and it is difficult to determine where they have landed after being thrown. The contingency of broadcasting raises questions about the constitution of audiences. While it is often thought to create a symbolic order in the form of a unified, national audience, I argue that broadcasting is actually predicated on disorder. Goethe's American counterpart would be the legendary gardener John Chapman, who planted so many apple trees along the northeast coast that he earned the nickname "Johnny Appleseed." As Johnny travelled across the states to "broadcast" his apple seeds, he also spread the "good news" of Emmanuel Swedenborg's New Church, a reminder that the mission of broadcasting has often overlapped with the Christian mission. The difference between omnidirectional broadcasting and point-to-point transmission in the history of wirelessness is similar to what media historian John Durham Peters describes in terms of the tension between "dialogue" and "dissemination" in the history of communication.[50]

In the 1920s, there was a German word for the perceived chaos of the airwaves, analogous to Kabelsalat, that has since fallen into disuse, namely, *Wellensalat*.[51] Translated somewhat freely as the "chaos of the airwaves," the word indicates a fundamental tension in the history of wirelessness, which comes about with the "discovery" of electromagnetic radiation in the late nineteenth century and the "invention" of radio and wireless telegraphy in the early twentieth century. Even after Heinrich Hertz verified the existence of electromagnetic radiation with his epochal experiments of the late 1880s, the European scientific community was not initially interested in applying them to the wireless transmission of information. In laboratory experiments and scientific lectures, the study of electromagnetic phenomena was primarily a means of vindicating a series of equations about the relation of electric and magnetic phenomena. To be used for long-distance communication, wireless research had to move out of the laboratory, due to the size restrictions of wavelengths and that of the corresponding apparatus. Only with Guglielmo Marconi's successful demonstrations of the potential for using electromagnetic radiation did the history of wireless telegraphy proper begin, and only with Adolf Slaby's observation and replication of these experiments did it come to Germany. The challenges then involved in making wireless telegraphy practical included creating a continuous signal and propagating it effectively, as well as picking out a desired signal from among many and amplifying or relaying it at a distance.[52] To my mind, this multiplicity only makes the media history and theory of wireless technology

49. John Durham Peters, *Speaking into the Air: A History of the Idea of Communication* (Chicago: University of Chicago Press, 2001), 209.

50. Peters, *Speaking into the Air*.

51. Franz Dornseiff, "Nachtrag zu 15.14. Berliner Scherzbezeichnungen für Rundfunkgerät," in *Der deutsche Wortschatz nach Sachgruppen* (Berlin: Walter de Gruyter, 1934).

52. Sungook Hong, *Wireless: From Marconi's Black-Box to the Audion* (Cambridge, MA: MIT Press, 2001), 2.

even richer, since one of the main tasks of this research is to further define the set of problems that motivated experiments in electromagnetism and their application to wireless transmissions in the first place.

The main argument at the heart of this work is that going wireless involves not only the absence of wires, but also the presence of electromagnetic radiation. Hence, my guiding questions are aimed at the eventual implementation of electromagnetic radiation for the purposes of signaling without connecting wires, which created a twentieth-century order of wirelessness out of the eighteenth- and nineteenth century (dis)order of the wire: Why, if electromagnetic radiation is present everywhere on earth and has always existed, was it only first disclosed and exploited for the purposes of wireless transmission in the course of roughly the long nineteenth century?[53] What, in other words, were the historical questions to which wireless technology was the answer? How, in this period of "media-in-transition," should we understand the relation of wireless services, networks, and devices to the extant wired communications infrastructure?[54] What refinements were necessary for the earliest wireless devices, which emitted sparks indiscriminately in all directions, to transmit a concentrated signal over long distances? Above all, what happens to the symbolic and imaginary domain of letters and literature in this process, as the apparently non-symbolic order of modern wireless technology, predicated on the physics of electromagnetism and the science of information theory, takes over the function of formerly symbolic cultural techniques of signaling at a distance?

While studies of wireless technology in modernity tend to focus on its perceived novelty,[55] I argue that many aspects of the discourses of wireless telegraphy and radio as new, quintessentially modern media can actually be better understood as traditional themes, formulas, or what Errki Huhtamo calls "media topoi."[56] In the first chapter, "Wireless Topoi: Common Places of National Broadcasting," I examine several topoi that were typical of media debates in the 1910s–20s including the consciousness of an epochal change in space-time relations, and the promise of more peaceful social relations by expanding communicative possibilities. Many of these wireless topoi crystallized in the ideal of national broadcasting in the Weimar Republic, encapsulated in the catchphrase "Radio for all!" (Rundfunk für alle!). Since electromagnetic radiation, the dominant material support for wireless transmission, is a naturally occurring resource, available everywhere on earth, and since wireless broadcasts relying on electromagnetic

53. On the periodization of the long nineteenth century in the German context, spanning the years from the French Revolution to World War I, see David Blackbourn, *The Long Nineteenth Century: A History of Germany, 1780–1918* (New York: Oxford University Press, 1997).

54. On the historiography of "media-in-transition," see David Thorburn and Henry Jenkins, *Rethinking Media Change: The Aesthetics of Transition* (Cambridge, MA: MIT Press, 2003).

55. See, for example, Dieter Daniels, *Kunst als Sendung: Von der Telegrafie zum Internet* (Munich: Beck, 2002); Clas Dammann, *Stimme aus dem Äther, Fenster zur Welt: Die Anfänge von Radio und Fernsehen in Deutschland* (Cologne: Böhlau, 2005); Clara Völker, *Mobile Medien: Zur Genealogie des Mobilfunks und zur Ideengeschichte von Virtualität* (Bielefeld: Transcript, 2010).

56. Erkki Huhtamo, "Dismantling the Fairy Engine: Media Archaeology as Topos Study," in *Media Archaeology: Approaches, Applications, and Implications*, ed. Erkki Huhtamo and Jussi Parikka (Berkeley: University of California Press, 2011), 27–47; Erkki Huhtamo, "Pockets of Plenty: An Archaeology of Mobile Media," in *The Mobile Audience: Media Art and Mobile Technologies*, ed. Martin Rieser (Amsterdam: Rodopi, 2011), 23–38.

radiation can travel in every direction at once, the ideal of national broadcasting as "radio for all" may seem natural. Against this naturalized rhetoric of novelty, universality, and inclusivity, I argue with Huhtamo's approach to media topoi, which "emphasizes the clichéd, the commonplace, and 'the tired,'"[57] that the creation of national broadcasting can be understood not only as a process of inclusion but also as one of exclusion—namely, the same process of exclusion characteristic of all mass media since the eighteenth and nineteenth century. Ideally, studying these conventional aspects of media topoi should not only counterbalance the rhetoric of novelty surrounding new media; accounting for present changes to our media environment also reveals new paths for historical study.

In this respect, I highlight media topoi particular to the discourse of wirelessness in the transitional period from (point-to-point) wireless telegraphy to (one-to-many) radio broadcasting, such as "perpetual contact," "pocket wireless" and "chaos on the airwaves." These wireless topoi reveal not only the clichés of national broadcasting, but also several "roads not taken" in the history of the medium. Even within the program of "Rundfunk für alle," the radio could have developed into a public medium, much like the cinema, through the postal ministry's plans for establishing *Funkhalle*, or communal spaces for listening to the radio. What probably should have happened, however, reading an undercurrent of critiques of the mass medium throughout the twenties, was the development of wireless transmission into a private, domestic medium, more like the telephone, capable of two-way communication. At the heart of this chapter, then, is a question about the cultural mission of national radio broadcasting in the Weimar Republic: What figures were excluded, in the creation of this totality, from the symbolic order of broadcasting? Where, in this period, did technophobes, electrosensitives, jammers, unlicensed broadcasters, and cultural critics fit into the order of the spectrum? To what extent did these "abject figures" of broadcasting, to borrow Julia Kristeva's term, contain the potential to disturb conventional identity, cultural concepts, and the symbolic order of wirelessness?

While the first chapter addresses a synchronic cross-section of the historical moment when wireless telegraphy gave way to the radio, the next three chapters proceed in a diachronic, roughly chronological order, covering the "pre-history" of wireless telegraphy, the "discovery" of electromagnetic radiation, and the "invention" of wireless telegraphy, before returning with a fresh perspective to the historical moment when the radio seems to be inevitable beginning with the construction of monumental antenna towers. In the second chapter, "Signaling Without Wires: Origin Stories and Primal Scenes of Wireless Communication," I examine several competing narratives about the development of wireless technology, which tended to trace techniques for signaling at a distance without wires to three main historical moments. While an optical technique of signaling with fires across beacon chains can be traced back to Greek and Roman antiquity, acoustic techniques of drum signals date back even further to Africa and China. If the former represented an ideal of order, in subsequent German origin stories, the latter

57. Erkki Huhtamo and Jussi Parikka, "Introduction: An Archaeology of Media Archaeology," in *Media Archaeology: Approaches, Applications, and Implications*, ed. Erkki Huhtamo and Jussi Parikka (Berkeley: University of California Press, 2011), 14.

was a common symbol of disorder. Although these optical and acoustic techniques probably remained known throughout the Middle Ages, they were only "rediscovered" and systematically described in the transition from the Late Middle Ages to the early modern period. During this period, techniques of signaling at a distance assumed a new significance with the discovery of magnetism, thought to enable a form of sympathetic communication among interlocutors who had touched the same material with a compass needle. In developing these systems, codes often referred to the medieval order of communication with spirits, though it remains uncertain whether the reference was actually a symbolic code or more of an elaborate means of encryption. Around 1800, optical telegraphy and research in electricity developed roughly simultaneously in Europe, and each challenged the established order of the postal service with the development of a new kind of sign. As a direct precursor to wireless telegraphy, the invention of (wired) electrical telegraphy by the mid-nineteenth century may seem inevitable, since, in the common history of telecommunications, each generation of technology is supposed to optimize the speed of transmission, the distances covered, the times required, and the code used to transmit messages. However, I argue that the equation of electricity and telegraphy in the form of electrical telegraphy was hardly inevitable. Many pre-modern techniques of signaling without wires continued to be used even after the invention of electrical telegraphy, as remains the case today.

However, if modern wireless technology is predicated primarily on the physics of electromagnetic radiation, then, as Alfred Döblin puts it in one description of a primal scene of communication, is there anything more for literature to say about it other than "it functions, and that's all"? In sorting through the origin stories and primal scenes of wireless communication, I compare the self-evident symbolic dimension in pre-modern literary representations of wireless techniques, and modernist attempts to come to terms with the apparent non-symbolic dimension of wireless technology. What ultimately distinguishes these pre-modern cultural techniques from modern media technologies is precisely the difference between everyday symbolic language and the technical code of modern mathematics operating physical processes that are faster than human perception. Nevertheless, I argue that, contrary to the received wisdom about literature playing a subordinate role to technology, there was a more symbiotic relation between the two, at least up to the mid-nineteenth century. In this respect, literary practices of transmission, such as Heinrich von Kleist's "Entwurf einer Bombenpost" (Project for a Projectile Postal System) are revealed to be operations just as technical as sending a wireless telegram, operating a remote control, or speaking into a microphone for a radio play. Due to its imaginary and symbolic dimensions, literature is able to register changes in what media historian Siegfried Zielinski calls the "deep time of the media."[58] What could have happened, as these literary projects indicate, is the development of another system of wireless transmission, rather than the modulation and demodulation of electromagnetic radiation within the radio frequency spectrum, such as (light-based) optical telegraphy, (earth-based) conductive telegraphy, or (water-based) inductive telegraphy.

58. Siegfried Zielinski, *Deep Time of the Media: Toward an Archaeology of Hearing and Seeing by Technical Means*, trans. Gloria Custance (Cambridge, MA: MIT Press, 2006).

Even though electromagnetic radiation has always existed, everywhere on earth, its existence was only scientifically verified around 1890 and it was only applied to wireless transmission around 1900, thereby effectively completing everything needed for wireless telegraphy. Bracketing the question of the "discovery" of electromagnetic radiation for the fourth chapter, I examine the "invention" of wireless telegraphy in the third chapter, "Going Wireless: The Poetics and Politics of Invention." Although the application of electromagnetic radiation to radio, television, and wireless telegraphy may seem inevitable, the equation of radio waves and information transmission, was anything but a foregone conclusion. In this chapter, I work through several formulations of the historical question to which wirelessness was the answer. If England had created the "Victorian Internet," as Tom Standage famously called it, Germany was working on something like "Wilhelmine Wireless."[59] If one follows the development of wireless telegraphy up to the First World War, what seems like it should have happened, even within the model of using electromagnetic radiation for the purposes of communication, was the development of a medium for long-distance communication, with national networks growing and competing on an international scale, rather than the development of wireless into a medium-distance medium, encompassing entire cities, regions, or nations within a "coverage area."

In this chapter, then, I examine the development of wireless technology in the years 1897–1921, a period documented in Rudolf Brunngraber's *Der tönende Erdkreis: Roman der Funktechnik* (The resounding world: A novel about wireless technology; composed 1940–46; published 1951). Composed in Austria after the Anschluss and during the height of Nationalist Socialist radio politics, Brunngraber's now forgotten novel bypasses the development of national radio broadcasting entirely and reads more like a nostalgic love letter to the early days of wireless technology, from the earliest reports of successful wireless telegraph transmissions in 1897 to the first international radio broadcasts in 1921. Despite this problematic context of production and reception, I argue that *Der tönende Erdkreis* not only provides a highly representative narrative, even if at times fairly plodding, of the development of wireless technology in the early twentieth century, but also sheds light on the historical shift from the poetics of expressionism to those of realism in the interwar period. At the heart of the novel is a patent struggle between the British Marconi Company and the German Telefunken Company, which allows for comparison with literary expressionist texts that work at the constellation of science, patents, and fiction. While Christian Morgenstern's poetry questions the authoritative status of the sciences in Wilhelmine Germany and Paul Scheerbart's work on a perpetual motion machine points out the fallacies of patent law, Salomo Friedländer's (pseud. Mynona) idea of telehaptics takes the common rhetoric of ubiquitous connectivity through wireless transmission *ad absurdum*. Ultimately, I argue that these poetics are not merely a reaction to, or symptom of, contemporary technological developments, but also an attempt to point out internal contradictions in the unattainable desire for telepresence that will become a common topic in early cybernetics and information theory.

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59. Tom Standage, *The Victorian Internet: The Remarkable Story of the Telegraph and the Nineteenth Century's On-Line Pioneers* (New York: Walker, 1998).

While the aim of my first three chapters is to explain the historical and cultural logics giving rise to a functional and symbolic order of wireless communication, the aim of my fourth chapter, "The Wireless Spectrum: The Discovery of Electromagnetic Radiation and Intermedial Television," is to explain the constitution of wireless technology as what Hans-Jörg Rheinberger calls an "epistemic thing" (epistemisches Ding).[60] How, in short, did wireless technology come to constitute a unified object of scientific research emerging out of disparate fields at a particular cultural moment? At the turn of the twentieth century, the traditional concept of the luminiferous ether as a universal substance connecting all matter, a concept that had thrived for several millennia, suddenly gave way to that of the electromagnetic spectrum as a useful physical construct for sorting the order of all electromagnetic phenomena, including not only the newly discovered radio waves, but also X-rays, Gamma Rays, UV-Rays, etc. While the historical shift from the pre-modern concept of the ether to the modern concept of the spectrum may seem inevitable, the movement was not simply the triumph of science over superstition. As transmission media, the ether and the spectrum fulfilled similar functions. Whereas things "communicated" in and through the ether, however, electromagnetic radiation eventually became a medium of communication in its own right.

At the end of the nineteenth century, the perception of electricity and magnetism fueled a crisis of perception, evident in Heinrich Hertz's proof of the existence of electromagnetic radiation in his famous experiments of 1886–89. Electromagnetic radiation, which would become the basis for any and every wireless transmission as we know it, is at once invisible yet material, an ontological status that created problems in terms of the production of evidence. The main difficulty, as Hertz explained, is "that it is not easy to speak of these matters in a way at once intelligible and accurate. It is in empty space, in the free ether, that the processes which we have to describe take place. They cannot be felt with the hand, heard by the ear, or seen by the eye. They appeal to our intuition and conception, scarcely to our senses."[61] In other words, electromagnetic radiation must be converted, translated, or "articulated" in order to gain any knowledge of it at all. Figurations of wireless are means of giving form to the formless, of creating a symbolic order of wirelessness in the forms of sparks, waves, rays, and energy. What could have happened, before the application of electromagnetic radiation to wireless information transmission, was the development of wireless energy transmission, a topic that has re-emerged recently as the holy grail of wireless transmission. In the pre-historical period of wirelessness, there was a well-developed discourse of wireless television as a form of energy conversion, the concept of television not referring to "seeing at a distance" but primarily to converting sounds into images and vice versa.

As a coda to the pre-history of wirelessness, the fifth and final chapter, "In Praise of the Antenna: A Celebration of Wireless Infrastructure," provides a media archaeology of this fundamental component of wireless systems: the antenna. What, in the end, is every wireless device if not a glorified antenna? Once a crucial aspect of wireless engineering

60. Hans-Jörg Rheinberger and Gerhard Herrgott, *Experimentalsysteme und epistemische Dinge: Eine Geschichte der Proteinsynthese im Reagenzglas* (Göttingen: Wallstein, 2001).

61. Heinrich Hertz, "On the Relations Between Light and Electricity" [1889] in *Miscellaneous Papers*, ed. Philipp Lenard, trans. D. E. Jones and G. A. Schott (New York: Macmillan, 1896), 314.

(*Funktechnik*), antenna technology (*Antennentechnik*) remains a neglected aspect of the history of wirelessness. The twentieth century witnessed the creation of enormous, permanent, monumental radio towers as symbols of national broadcasting, a development that started with the creation of the first large wireless telegraph stations in the first two decades of the twentieth century and radio towers in the third. These structures were central to urban and national identity, as evident in the celebration of infrastructure surrounding the Berliner Funkturm (Berlin Radio Tower) and the wireless telegraph station at Nauen. What could have happened, however, in the history of the antenna was the creation of antennas for smaller, mobile stations, or the use of the earth as an underground antenna or *Erdantenne*. In retrospect, however, radio and television towers seem like a historical anomaly, since most of them are today derelict or have been switched over to cellular service in the course of what is known as the "digital transition." Today, the antenna continues to vanish from the public sphere, raising questions for the twenty-first century about what Brian Larkin calls the "politics and poetics of infrastructure."[62]

The aim of my historical work on literature, science, and wireless technology is to historicize what media philosopher Adrian Mackenzie describes as the contemporary sensation of "wirelessness," an ephemeral sense of being connected that occurs only at the edges of perception.[63] As a contribution to the early and pre-history of national radio broadcasting, the structure of my work follows recent historiographical arguments for a revised periodization based on the implementation of wireless transmission in two radically different periods: in the mass medium of radio (1920s–1980s), and its prior development in a variety of experimental, scientific contexts (1800–1920s).[64] If, during its "entertainment" period, wireless transmission was primarily implemented as a mass medium for broadcasting, and radio waves involved the structured, macrotemporal "flow" of programming, during its "media-archaeological" period (1800–1920s), wireless transmission was an epistemological entity, generating knowledge about the nature of electromagnetic radiation, with the frequencies of electromagnetic radiation oscillating in the "time-critical" range of physics. In other words, if we view the 1920s as the end, rather than the beginning, of wireless technology as a producer of media knowledge, then we might consider early wireless technology not merely to have been a precursor to radio, but as an intersection of "roads not taken," a nexus of interests held together less by a concern for transmitting language or music, than for producing electromagnetic waves and high-frequency signals. Lastly, changing the history of radio around also means changing our perspective on the digital-analog divide (1980s–present), since early

62. Brian Larkin, "The Politics and Poetics of Infrastructure," *Annual Review of Anthropology* 42 (2013): 327–43.

63. Mackenzie, *Wirelessness*, 5.

64. Wolfgang Ernst, "Distory: One Hundred Years of Electron Tubes, Media-Archaeologically Interpreted, Vis-à-Vis One Hundred Years of Radio," in *Digital Memory and the Archive*, ed. Jussi Parikka, trans. Dawn Michelle d'Atri (Minneapolis: University of Minnesota Press, 2013), 158–71; Daniel Gethmann, *Die Übertragung der Stimme: Vor- und Frühgeschichte des Sprechens im Radio* (Zurich: Diaphanes, 2006); Susan Lorene Brinson, "From Marconi to *Cop Rock*: An Introduction to Broadcasting History," in *Transmitting the Past: Historical and Cultural Perspectives on Broadcasting*, ed. J. Emmett Winn and Susan Lorene Brinson (Tuscaloosa: University of Alabama Press, 2005), 1–15.

wireless transmissions were closer to a digital code than to an analog medium. Although this work will not provide an exhaustive or comprehensive narrative of developments in the early and pre-history of radio, it will highlight moments of "media-in-transition," when different options appeared to be open for future developments.

Media tend to create their own periodizations, which do not necessarily coincide with those of literary and cultural history. Hence, the order of the following chapters is not strictly chronological. The thematic, or more precisely "recursive" historiography,[65] serves as an indication of my attempt to situate wireless transmission in a richer field of scientific, experimental, and aesthetic relations. Understanding the rhetoric of the new medium of radio in the first chapter, "Wireless Topoi," opens onto questions of continuity and change in the longue durée addressed in the second chapter, "Signaling Without Wires." The insights gained from this comparison of pre-modern cultural techniques and modern electronic technologies are crucial for understanding the "invention" of wireless telegraphy examined in the third chapter, "Going Wireless," and the "discovery" of electromagnetic radiation in the fourth, "The Wireless Spectrum," both of which focus on the immediate pre-history of national broadcasting in the late nineteenth and early twentieth century. The significance of this pre-historical period and the historical contingency of national broadcasting arguably only became apparent with the revival of wireless transmission at the turn of the twenty-first century, as the fifth chapter, "In Praise of the Antenna," makes evident. In short, the order of this work is intended to suggest a new way of thinking about wirelessness, from "wireless" as synonymous with the communication medium of telegraphy or the distribution medium of radio, to "wireless" as electromagnetic radiation and a medium of experimentation. The aim of this work is to discover what could have or should have happened in the historical development of wirelessness, rather than to rehearse what seems as though it had to have happened.[66]

65. Ana Ofak and Philipp von Hilgers, eds., *Rekursionen: Von Faltungen des Wissens* (Munich: Fink, 2010).

66. For a similar approach, see Anton Kaes, Nicholas Baer, and Michael Cowan, eds., *The Promise of Cinema: German Film Theory, 1907–1933* (Berkeley: University of California Press, 2016).

CHAPTER ONE

Wireless Topoi:
Common Places of National Broadcasting

When asked, in 1926, to address a future generation of wireless users, in the spirit of the Goetheism "Do something nice for us young people, too" (Tu uns Jungens auch was zu liebe), Hans Bredow, whom the prefatory remarks to his address called the "creator of German radio" (Schöpfer des Deutschen Rundfunks), came up with the following words of wisdom:

> What we have begun, you will need to bring to completion. Only with you will the secrets of electric waves become a natural, universal cultural heritage, and smiling you will look back on all the errors and mistakes in the evolution of wireless.
>
> Then the time will have come in which there is no longer any separation between people. The concept of space, of distance, of being alone will have been overturned, and there will no longer be any borders, if you are mature enough, for friendship and brotherhood.
>
> This is the new epoch of world and cultural history that begins with the radio.[1]

Though full of such platitudes, Bredow's address, together with the short editorial notice preceding it, sheds light on the social and institutional framework of national radio broadcasting in the Weimar Republic.[2] Throughout the 1920s, the radio was primarily under the jurisdiction of the *Reichspost*, an institution in which Bredow was a civil servant and, as of the year of this address to future generations, the newly appointed *Reichs-Rundfunk-Kommissar*. While most officials in the postal ministry dismissed the new medium as a mere means of minimizing the financial deficit the ministry had racked up due to its telegraphic services, Bredow viewed the radio as a mass medium with a

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1. Hans Bredow, "Eure Aufgaben im Rundfunk," *Funkhenizelmann* 1 (1926): n.p., repr. with commentary in *Medientheorie 1888–1933: Texte und Kommentare*, ed. Albert Kümmel and Petra Löffler (Frankfurt am Main: Suhrkamp, 2002), 230. "Was wir begonnen, sollt ihr zur Vollendung führen. Mit euch erst werden die Geheimnisse der elektrischen Wellen zum allgemeinen selbstverständlichen Bildungsgut, und lächelnd werdet ihr auf die Irrungen und Wirrungen der Entwicklungsgeschichte des Funks zurückblicken. Dann wird die Zeit gekommen sein, in der es keine Trennung mehr zwischen Menschen gibt. Der Begriff des Raums, der Entfernung, der Einsamkeit wird gefallen sein, für Freundschaft und Verbrüderung wird es, wenn ihr innerlich reif dazu seid, keine Grenzen mehr geben. Das ist die neue Epoche der Welt- und Kulturgeschichte die mit dem Rundfunk beginnt."

2. My analysis of Bredow's address builds on Kümmel and Löffler's insightful commentary in the sourcebook *Medientheorie 1888–1933*. For overviews of the history of national broadcasting in the Weimar Republic, see Karl Christian Führer, "A Medium of Modernity? Broadcasting in Weimar Germany, 1923–1932," *The Journal of Modern History* 69, no. 4 (1997): 722–53; Lerg, *Die Entstehung des Rundfunks in Deutschland*; Hans Jürgen Koch and Hermann Glaser, *Ganz Ohr: Eine Kulturgeschichte des Radios in Deutschland* (Cologne: Böhlau, 2005).

more democratic potential than film, the newspaper, or the printing press. The radio, under Bredow's direction, should serve the interests of the entire nation, instead of those of private investors, as he conceived of the situation of privatized broadcasting in the United States. Through the creation of a program centered on education and culture, national radio broadcasting should integrate all levels of society, especially the lower classes, into a reinvigorated German *Kulturnation*.[3] These ambitious radio politics, to be implemented in the form of communal assembly-hall radio listening spaces known as *Funkhalle* or *Funksäle*, an astonishing "road not taken" in the history of the medium, were encapsulated in Bredow's slogan "Radio for all!" (Rundfunk für alle!)[4]

Mentioned in the same breath as Goethe in the editorial comments prefacing his address, Bredow is presented here as the direct successor to the foundational figure of German arts and letters. By extension, the new medium of radio, still seeking legitimacy in a period of intense media competition, also gets inserted into the traditional national mythology. "Alongside sound and vision the wireless transmission of light and power will have to appear," writes Bredow. "Only this will bring God's gift of Hertzian waves to completion and lead the radio to the highest height."[5] With these remarks, Bredow's address of the future wireless age captures not only his politics of nation-building through the creation of communities of radio listeners, but also his metaphysics of wireless transmission, derived from German Romanticism, in which electricity and magnetism feature as elemental, polarizing forces. In the Neo-Romantic idiom, the elemental force of nature, or *Kraft*, was commonly understood to be the master elemental figure organizing all polar forces, thereby serving as a manifestation of the *Weltseele*, or world-soul. Drawing on Hermann von Helmholtz's seminal lecture "Die Erhaltung von Kraft" (The Conservation of Energy, 1847), Bredow's address to a future wireless age concludes with the following statement about the unifying, world-mastering force of electricity: "Then the continuous universal element, which accompanies all material and atmospheric existence, the world-soul, as Goethe calls electricity, will become the ruler of the world."[6] Written in the future perfect, the conclusion of Bredow's address alludes to a utopia of wireless energy transmission, arguably the holy grail of wirelessness, even today. Since electromagnetic radiation is a naturally occurring resource available everywhere on earth and since wireless broadcasts relying on electromagnetic radiation are made to propagate in all directions at once, the formation of national broadcasting as a realization of "radio for all" may seem natural.

In this chapter, I argue that the official program of national broadcasting in the Weimar Republic did not mark the natural beginning of a wireless epoch, as Bredow claimed, but rather the end of one. What came to an end was the media archaeological

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3. On Bredow's program, see Führer, "A Medium of Modernity?," 728–30.

4. On the problematic origins of the slogan and the motivations behind providing "Funk für alle," see Lerg, *Die Entstehung des Rundfunks in Deutschland*, 114–22.

5. Bredow, "Eure Aufgaben im Rundfunk," 231. "Neben Gesicht und Gehör muß dann die drahtlose Übertragung von Licht und Kraft treten. Sie erst wird das Gottesgeschenk der Hertzschen Welle zur Vollkommenheit bringen und den Rundfunk zur höchsten Höhe führen."

6. Ibid. "Dann wird das durchgehende allgegenwärtige Element, das alles materielle und atmosphärische Dasein begleitet, die Weltseele, wie Goethe die Elektrizität nennt, zum Weltbeherrscher werden."

period of wireless transmission in which electromagnetic radiation functioned in a variety of scientific, aesthetic, and experimental contexts. The implementation of wireless technology in the form of a mass medium of national broadcasting flying the banner of "radio for all" was neither inevitable nor serendipitous. Even if the socialists and conservatives never realized the dream of "radio for all" during the Weimar Republic, the National Socialist radio politics that followed it arguably realized a perverted form of the slogan in the form of the *Volksempfänger*. For this reason, even though the myth of Bredow as the "creator" of German radio has long since been debunked, the status of Weimar radio as a "medium of modernity" remains problematic.[7] Admittedly, the wireless age that came to an end with the invention of the radio was not necessarily a golden age. It was characterized by a rhetoric of exclusion on the basis of gender, class, and ethnicity, inherited largely from the nineteenth-century discourse of (wireless) telegraphy, wherein modern mass media were not necessarily "for all." Nevertheless, examining the pre-history of national broadcasting can help further challenge the common teleological narrative of the ease of the National Socialist appropriation and expansion of the Weimar Republic's existing wireless infrastructure.

At the heart of the official discourse of national radio broadcasting in the Weimar Republic, there was a fundamental tension in fulfilling the promise of "radio for all:" on the one hand, radio was to provide something for everyone in terms of the content of programs; on the other hand, everyone was to be connected to the radio due to the universal availability of electromagnetic radiation. In both cases, I argue, something had to be excluded. Since their beginnings in the eighteenth century, mass media have been determined by the fact that they were "for all" in two main senses, roughly mapping onto the distinction between *inclusiveness* and *inclusivity*: mass media are not only accessible and available to all in the sense of Jürgen Habermas's classic *Strukturwandel der Öffentlichkeit* (The Structural Transformation of the Public Sphere, 1990); they are also characterized by forms of universal address, which involves the paradox, as radio historian Irmela Schneider argues, that "media address everyone and at the same time each individual, *omnes et singulatim*."[8] Mass media may make the entire world able to communicate, but they leave communication itself fragile, since the constitutive feature of communication media withers in the form of distribution media—namely, the difference between information and a message. Ultimately, I argue that the all-inclusive gesture of addressing a program to a national audience in the equation "radio for all" was accompanied by an operation of exclusion: radio *for* all excluded the possibility of radio *by* all.[9]

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7. On Bredow's role in the creation of German radio, see Lerg, *Die Entstehung des Rundfunks in Deutschland*; on broadcasting and modernity, see Cohen, Coyle, and Lewty, *Broadcasting Modernism*; cf. Führer, "A Medium of Modernity?"

8. Irmela Schneider, "Rundfunk 'für alle:' Verbreitungsmedien und Paradoxien der All-Inklusion," in *Medien – Diversität – Ungleichheit: Zur medialen Konstruktion sozialer Differenz*, ed. Ulla Wischermann and Tanja Thomas (Wiesbaden: Verlag für Sozialwissenschaften, 2008), 23, italics in the original. "Medien adressieren *alle* und zugleich *jeden Einzelnen*, *omnes et singulatim*."

9. My argument only concerns national broadcasting in the Weimar Republic. In theory, the phrase "radio for all" could also indicate an explanation of the principles of radio *to* all, so that it could become

Even though amateur radio and national broadcasting share the same historical roots, there was never an amateur radio movement in the Weimar Republic to the extent that there was in the United States, Great Britain, France, the Netherlands, Italy, and many other countries.[10] In this respect, the fact that Bredow's address of a future wireless age was published in the *Funkheinzelmann*, a periodical for amateurs, hobbyists, and enthusiasts, is especially ironic. While the German wireless industry had reached at least the same prominence as in other countries, the amateur radio movement struggled to get off the ground. Throughout the twenties, the main objective of the amateur radio movement in Germany was working toward the reformation of a seemingly draconian law, the German Empire's telegraph law of April 6, 1892 (Gesetz über das Telegraphenwesen des Deutschen Reiches), which stated: "The German Empire is entitled to the exclusive right to erect and to operate telegraph stations for the transmission of messages. Telephone stations are also included under telegraph stations."[11] Even though the telegraph law originally applied only to wired transmissions, the formulation of the law was so vague that it would later automatically encompass wireless stations, including not only wireless transmitters but even receivers. Eventually, the right to operate wireless stations was transferred to the postal ministry, administered by Bredow, and those who wished to operate a radio were required to obtain a permit. Hence, Brecht's famous remarks that "the radio would be the finest possible communication apparatus in public life […] if it knew how to receive as well as to transmit, how to let the listener speak as well as hear, how to bring him into a relationship instead of isolating him."[12] This conditional statement would continue to be a rallying call for the leftist politics of wireless transmission throughout the history of national broadcasting in Germany, repeated so many times that it would eventually be abandoned as a commonplace.[13]

In this chapter, I argue that such commonplaces, many of which were inherited from earlier discourses of telegraphy and telephony, were consequential in the symbolic order of national broadcasting in that they indicate both the conventionality of the rhetoric of radio as a new medium as well as several "roads not taken" in the course of its eventual development into an everyday technology. The media topos of a "wireless age" promised a new era of all-inclusiveness, universal accessibility, and seamless connectivity, though

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radio *by* all. There is a potential discursive connection here with the amateur radio movement in the United States, e.g., Hugo Gernsback, *Radio for All* (Philadelphia: J. B. Lippincott, 1922).

10. Ulrich Kern, "Radio für alle: Funk und Rundfunk in den 20er Jahren," in *Radio für Alle*, ed. Horst Steffens and Ulrich Kern (Mannheim: Landesmuseum für Technik und Arbeit, 1994), 2–10.

11. Qtd. in Kern, "Radio für alle," 6. "Das Recht, Telegraphenanlagen für die Vermittlung von Nachrichten zu errichten und zu betreiben, steht ausschließlich dem Reich zu. Unter Telegraphenanlagen sind die Fernsprechanlagen mit begriffen."

12. Bertolt Brecht, "The Radio as an Apparatus of Communication" [1932], in *Brecht on Theatre: The Development of an Aesthetic*, trans. John Willet (New York: Hill & Wang, 1964). "Der Rundfunk wäre der denkbar großartigste Kommunikationsapparat des öffentlichen Lebens […] wenn er es verstünde, nicht nur auszusenden, sondern auch zu empfangen, also den Zuhörer nicht nur hören, sondern auch sprechen zu machen und ihn nicht zu isolieren, sondern ihn in Beziehung zu setzen."

13. Hans Magnus Enzensberger, "Constituents of a Theory of the Media," *New Left Review* 64 (1970): 13–36; cf. Hans Magnus Enzensberger, "Das digitale Evangelium," *Der Spiegel* 2 (January 10, 2000): 92–101.

not necessarily in the form of national broadcasting. Before the invention of radio, there were various understandings of the meaning of wireless transmission. One common way of "(mis)understanding wireless" framed it in terms of a negation of the familiar medium of telegraphy, thereby making wireless out to be nothing more than wired transmission without the wires. As in the case of telegraphy, the topos of wireless telemedia overcoming space and time played a crucial role in negotiating the categories of proximity and distance. The promise of "perpetual contact," the possibility of always being reachable, anytime, anywhere, though often linked to fantasies of global connectivity, was also accompanied by concerns about the ineluctability of technology in modernity. While wired technology addressed itself only to the two people who found themselves at the end of a wire, wireless technology addressed itself, at least in theory, to anyone, anywhere. The unknown composition of this audience, the fact that it was never certain who was on the receiving end of a wireless dispatch, and the impossibility of knowing whether or not anyone was even there at all—these were what fueled the topos of "chaos on the airwaves." The cosmopolitanism and international sensation of radio, primarily attributed to the ability to be able to tune in broadcasts from distant places,[14] was only one side of a coin, the flip side of which was a concern for absent-minded listeners either immersed in their headphones or addicted to turning the dial.

Wireless topoi reveal not only the clichés of national broadcasting, but also several "roads not taken" in the history of the medium. The sources examined in this chapter are primarily popular literary, satirical, and functional texts from the period in which the historical change from wireless telegraphy to national broadcasting was still very much up in the air. Even within the Weimar program of "radio for all," the radio could have developed into a public medium, much like the cinema, through the postal ministry's plans for establishing communal spaces for listening to the radio. What probably should have happened, however, reading an undercurrent of critiques of the mass medium throughout the twenties, was the development of wireless communication into a private, domestic medium, more like the telephone, capable of two-way communication. Instead of viewing this period as a precursor to National Socialist radio politics, it can be understood as the endpoint of many earlier developments, and the early twentieth-century discourse of the radio can be understood as a point of convergence for the nineteenth-century discourses of telegraphy and telephony. At the heart of this chapter, then, is a question about the cultural mission of national radio broadcasting: What figures were excluded, in the creation of this totality, from the symbolic order of broadcasting? Where, in this period, did technophobes, electrosensitives, jammers, unlicensed broadcasters, and cultural critics fit into the order of the spectrum? To what extent did these "abject figures" of broadcasting, to borrow Julia Kristeva's term, contain the potential to disturb conventional identity, cultural concepts, and the symbolic order of wirelessness? Although wireless technology can often maintain the illusion of direct, intimate connection, a feeling of contact, community, and inclusion, every wireless conversation

14. See Aaron Jaffe, "Inventing The Radio Cosmopolitan: Vernacular Modernism at a Standstill," in *Broadcasting Modernism*, ed. Debra Rae Cohen, Michael Coyle, and Jane Lewty (Gainesville: University Press of Florida, 2009), 11–30.

is always mediated, and, in this very act of mediation, I argue, maintaining the illusion of immediacy requires something to be excluded.

Modernity, Novelty, Media Topoi

While many scholars studying the early history and the so-called "pre-history" of national broadcasting do so for either its perceived novelty or its purported antiquity,[15] I argue that it can actually be better understood through the articulation of traditional themes, formulas, or what Errki Huhtamo calls "media topoi." Instead of emphasizing the novelty of media, Huhtamo's approach "emphasizes the clichéd, the commonplace, and 'the tired.' Media culture relies on the already known: the past lives on in the present, allowing us to detect novelties."[16] The negative connotations of the clichéd, the commonplace, and the tired are what originally led the pioneering figure of topos study, Ernst Robert Curtius, to adopt the more solemn-sounding term *topos*. In discussing the etymology of the word, Curtius mentions the Greek *koinoi topoi*, the Latin *loci communes*, and, in his native language, the antiquated early modern German *Gemeinörter*—all roughly translating to a "common place." Once the modern German *Gemeinplatz* was formed after the English "commonplace," however, the concept came to be associated with platitudes, which is why Curtius retains the Greek *topos*.[17] While the topoi of interest to Curtius were primarily literary topoi in the Latin tradition of rhetoric, Huhtamo extends the concept to account for more kinds of cultural artifacts and for various vernacular cultures. Studying media topoi, in Huhtamo's approach, entails "identifying topoi, analyzing their trajectories and transformations, and explaining the cultural logics that condition their 'wanderings' across time and space."[18] Media topoi, I would add, are preserved even after media archaeological ruptures, such as that of the switch from wireless telegraphy to radio in the 1920s, thereby indicating points of continuity in periods of apparent discontinuity. Ideally, studying the conventional aspects of media topoi should not only counterbalance the rhetoric of novelty surrounding new media; accounting for present changes to our media environment should also reveal new paths for historical study. In this respect, the study of wireless topoi can help question the seeming inevitability of the development of (one-to-many) national radio broadcasting out of (one-to-one) wireless telegraphy.[19]

Far from being original, Bredow's short address of a future wireless age condensed several common topoi that were typical of media debates in the late nineteenth and early twentieth century, including the consciousness of an epochal change, an awareness of changes in traditional space-time relations, and the hope of integrating all medial

15. See, for example, Daniels, *Kunst als Sendung*; Dammann, *Stimme aus dem Äther, Fenster zur Welt*; Völker, *Mobile Medien*.

16. Huhtamo and Parikka, "Introduction: An Archaeology of Media Archaeology," 14.

17. Ernst Robert Curtius, *European Literature and the Latin Middle Ages* [1953], trans. Willard R. Trask (Princeton: Princeton University Press, 1990), 70.

18. Huhtamo, "Dismantling the Fairy Engine," 28.

19. On the recent scholarly re-evaluation of this historical shift, see my Introduction and Balbi and John, "Point-to-Point."

possibilities in the form of a singular medium.[20] Even within the corpus of Bredow's own writings, there are many repetitions of the same stock phrases, showing how commonplace the rhetoric of the radio's novelty already was at the time. In December 1924, for example, Bredow had already referred to the media topos of the wireless age inaugurating a new era in the mastery of space and time, albeit with a slight variation of scenery: "Humanity's ancient fight against the barriers of space and time has entered into a new stage [….] and with the help of radio it has become possible to distribute messages in a fraction of a second over the entire earth. This development has led to the fact that we can today look at the world as a communal speech chamber [*Sprechsaal*], regardless of whether we are neighbors or antipodes."[21] While Bredow's reference to the radio as a communal "speech chamber" resonates directly with his plans to create assembly-hall listening spaces, known as *Funkhalle* or *Funksäle*, the conception of communications media as an assembly hall or public forum is a venerable media topos, arguably dating back to the ancient Greek space of the agora. Recently, the topos has been revived in the utopian conception of the Internet as a "virtual community:" while the Rousseauian ideal of direct democracy is limited to the number of people who can physically convene in one location, the extension of the public sphere in the digital age, creating virtual communities through virtual presence, seemed to Howard Rheingold, to bring about an "electronic agora."[22]

The perceived ability of communications media to overcome space and time and to create virtual communities also featured in one of the foundational works in the German science of *Verkehrswissenschaft*, or the study of transportation. In *Der Telegraph als Verkehrsmittel* (The telegraph as a means of transport, 1857), Karl Knies adapted the topos of the agora, of "people and nations […] united in an enormous speech hall [*Sprechhalle*]," to describe the virtual space of telegraphy: "Despite the immeasurable distances between them, individuals can hear each other immediately, they are within earshot of each other, the transportation of messages is transformed into an oral exchange, a mutual dialogue."[23] In Knies's extended metaphor, the virtual space of telegraphy is connected to the iconography of justice, unlike in Bredow's image, since the two interlocutors in the virtual space between the ends of a wire "stand next to each other in

20. My analysis here follows the commentary in Albert Kümmel and Petra Löffler, eds., *Medientheorie 1888–1933: Texte und Kommentare* (Frankfurt am Main: Suhrkamp, 2002).

21. Hans Bredow, "Weihnachtsansprache an das amerikanische Volk," [1924], qtd. in Daniel Gethmann and Florian Sprenger, *Die Enden des Kabels: Kleine Mediengeschichte der Übertragung* (Berlin: Kadmos, 2014), 89. "Der uralte Menschheitskampf gegen die Schranken von Raum und Zeit ist in ein neues Stadium getreten […] ist es doch mit Hilfe des Radios möglich geworden, Nachrichten im Bruchteil einer Sekunde über die ganze Erde zu verbreiten. Diese Entwicklung hat dazu geführt, dass wir heute die Welt als gemeinsamen Sprechsaal ansehen können, ganz gleich, ob wir Nachbarn sind oder Antipoden."

22. Howard Rheingold, *The Virtual Community: Homesteading on the Electronic Frontier* (Cambridge, MA: MIT Press, 2000), 50, 376.

23. Karl Knies, *Der Telegraph als Verkehrsmittel mit Erörterungen über den Nachrichtenverkehr überhaupt* (Tübingen: H. Laupp, 1857), 242. "Die Menschen und Völker zeigen sich uns wie in einer riesigen Sprechhalle vereinigt. Trotz der ungemessenen Abstände sind sich die Einzelnen unmittelbar vernehmbar, sie sind sich in die gegenseitige Hörweite gebracht, der Nachrichtenverkehr ist in eine mündliche Unterhaltung, in ein Wechselgespräch verwandelt."

this enormous speech hall [*Sprachsaal*] with their eyes bound. Nobody can see what happens at some distant place; he must first inquire or give instructions in advance to somebody specially communicating with him."[24] As Knies's formulation of the topos makes evident, there is a fundamental ambiguity in the virtual space of telecommunications in terms of the number of participants present at the assembly. A servant, in Knies's account, enters the scene to deliver the message, performing the role that will eventually be taken over by physical media of transmission like the cable in wired telegraphy or electromagnetic radiation in wireless.[25]

In the wake of World War I, the once celebratory hymns of brotherhood and the promise of bringing about more peaceful social relations by expanding communicative possibilities gave way to more apocalyptic and dystopian visions, which had been largely informed by the wartime experience of technology as a form of alienation, standardization, and disindividuation. In 1931, Karl Jaspers captured "Die geistige Situation der Zeit" (The spiritual situation of the times): "The technological conquest of space and time through the daily press, travel, the massiveness of copying and reproduction through cinema and radio has made it possible for everyone to contact each other. Nothing is distant, secret, wonderful."[26] For Jaspers, the collapse of distance created a new "kind of type-ism that sucks everything up, on a new level comparable to the most primitive times. The individual is dissolved into functions."[27] Ultimately, the collapsing codes of spatial and temporal distance into a new form of proximity and simultaneity spoke to a fear of perpetual contact, of the ineluctable nature of wireless transmission, of the sensation that anyone is always reachable, anytime, anywhere.

At the heart of this dialectic of alienation and empowerment through technology, manifest in universal wireless transmission, was the equation of being modern with the willing adoption of new media.[28] As Bredow reminded the future wireless age, the eager consumption of new gadgets and other mass-produced devices would become crucial for the formation of a wireless infrastructure: "You have to reach the point when people can get in touch with each other from any point of the globe, when, even if a thousand miles lie between them, they can ask each other questions and answer them, as if they were standing next to each other, when they can see how their brothers in other worlds laugh

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24. Ibid. "Freilich stehen sie wie mit verbundenen Augen in diesem riesigen Sprachsaal neben einander. Keiner kann sehen, was an irgend einer entfernten Stelle vorgeht; er muß erst anfragen oder im Voraus an eine mit ihm speciell verkehrende Person Auftrag ertheilt haben."

25. On the shift from human servants to technological servers, see Markus Krajewski, *Der Diener: Mediengeschichte einer Figur zwischen König und Klient* (Frankfurt am Main: Fischer, 2010).

26. Karl Jaspers, "Die geistige Situation der Zeit," [1931], qtd. in Wolfgang Kaschuba, *Die Überwindung der Distanz: Zeit und Raum in der europäischen Moderne* (Frankfurt am Main: Fischer, 2004), 203–4. "Die technische Überwindung von Zeit und Raum durch die tägliche Mitteilung der Zeitungen, das Reisen, die Massenhaftigkeit des Abbildens und Reproduzierens durch Kino und Radio hat eine Berührung aller mit allem ermöglicht. Nichts ist fern, geheim, wunderbar."

27. Ibid. "Im Verhalten des Alltags drängt sich das Regelhafte vor. Der Anspruch, etwas zu tun, wie es alle machen, nicht aufzufallen, bringt einen alles aufsaugenden Typismus zur Herrschaft, auf neuer Ebene vergleichbar dem der primitivsten Zeiten. Das Individuum ist aufgelöst in Funktionen."

28. See Leander Scholz et al., "Rhetorik des Neuen: Mediendiskurse zwischen Buchdruck, Zeitung, Film, Radio, Hypertext und Internet," in *Die Kommunikation der Medien*, ed. Jürgen Fohrmann and Erhard Schüttpelz (Berlin: Walter de Gruyter, 2004), 251.

or cry. Just like pocket watches, the transmitter and the receiver have to become people's constant companions."[29] Although Bredow's description of "pocket wireless" may seem like a prescient statement about the ubiquitous connectivity and perpetual contact characteristic of a future generation of smartphone owners, I argue that it is better understood as a commonplace of media debates in the early twentieth century.[30] In my cynical reading, the title of Bredow's address, "Eure Aufgaben im Rundfunk" (Your tasks in the radio), can ultimately be reduced to a consumer appeal. The task of the current generation was not to develop content for state-sponsored radio programs, which the postal ministry would take care of for them, or even to experiment in designing their own radio sets, since amateur broadcasting would threaten the national order, but simply to buy more radio sets and whatever other gadgets might follow them. Even recently, the rhetoric of a wireless communications revolution has continued to focus mostly on device ownership, which not only signals status, money, and power, but also creates a sense of belonging and promises social change.[31]

The Wireless Age

On the eve of World War I, the journalist Robert Thompson Sloss laid out a typical romantic vision of a coming wireless age, capturing the ideal of internationalism at the turn of the century.[32] Sloss's prediction about the wireless age was published in a collection of twenty essays, edited by Arthur Brehmer and illustrated by Ernst Lübbert, on *Die Welt in hundert Jahren* (The world in a hundred years, 1909/10).[33] Composed by luminaries and Nobel Prize recipients, the essays cover a wide range of topics, including art, literature, theatre, music, sports, medicine, pedagogy, women's rights, social conventions, and international relations.[34] Interweaving science and fiction, some of their predictions seem especially uncanny, especially Hudson Maxim's description of solar energy in the first chapter "The 1000-year Empire of Machines" (Das tausendjährige Reich der Maschinen) and Sloss's predicted applications of wireless technology in the second chapter "The Wireless Century" (Das drahtlose Jahrhundert). Sloss's wireless age includes not only virtual shopping and wireless power, for which reason the text is frequently quoted, but also more mundane situations, such as contacting a distant family

29. Bredow, "Eure Aufgaben im Rundfunk," 231. "Ihr müßt erreichen, daß sich die Menschen von jedem Punkt der Erde aus untereinander in Verbindung setzen können, daß sie, wenn tausend Meilen zwischen ihnen liegen, sich fragen und antworten können, als ob sie nebeneinander ständen, und daß sie sehen können, wie ihre Brüder in anderen Welten lachen oder traurig sind. Wie die Taschenuhren müssen Sender und Empfänger zum ständigen Begleiter des Menschen werden."

30. For the term *pocket wireless*, a period term designating a speculative device commonly featuring in early twentieth-century trade publications, and an argument, like mine, that it was not a direct precursor to the smartphone, see Grant Wythoff, "Pocket Wireless and the Shape of Media to Come, 1899–1922," *Grey Room* 51 (April 2013): 40–63.

31. See Joyce Virginia Gab Kneeland, "Rhetoric and the Wireless Revolution" (PhD diss., Northwestern University, 2008), 198–200.

32. See, for example, Narodny, "Marconi's Plans for the World."

33. Arthur Brehmer, ed., *Die Welt in hundert Jahren* (Berlin: Buntdruck, 1910).

34. See Kathrin Forster, "'Die Welt in 100 Jahren' – wissenschaftliche Prognosen in der Literatur um 1900" (Mag. phil. thesis, University of Vienna, 2010). Despite his inclusion in this collection of famous experts, little is known about the American journalist Robert Thompson Sloss (1872–1920).

member or receiving an opera broadcast. The style of Sloss's essay alternates between concrete descriptions of wireless devices, journalistic reports of recent developments in wireless engineering (e.g., Adolf Slaby in Germany, Lee De Forest in America, and Guglielmo Marconi in England, who is presented here as "Wilhelm Marconi"), and short fictional narratives. One of these describes a wireless-powered spaceship making a voyage to the North Pole,[35] and another follows a couple engaged to be married as they shop for a wedding dress in virtual space.[36] Significantly, none of these projected applications for wireless technology comes close to the program of national radio broadcasting as the distribution of education and culture to domestic audiences; even the opera broadcast is imagined to be received by two explorers at the South Pole.[37]

In a complex mixture of indicative and subjunctive moods, Sloss negotiates the liminal status of the wireless century:

> I could go on in this style, God knows how long, and tell wonders on top of wonders, without straining the powers of my imagination [*Phantasie*] in the least, since all the things in the course of the "story" [*Erzählung*, also "narrative"] up to this point, which have sounded so wonderful, are actually problems that have been already solved today, or that are by no means part of the realm of pious wishes or overwrought hopes and expectations. No, they are facts that are only waiting to be introduced into our practical life, just as the telegraph and telephone and phonograph have been.[38]

Starting in the subjunctive, this passage first equates the content of the narrative with the realm of possibility, though what may seem to be fantasy is then grounded in the reality of science and engineering. The problem, however, is that the "facts" of this reality are not givens, but "are only waiting to be introduced into our practical life." To overcome this problem, Sloss shifts the terms of realism from the common distinction between the imaginary and the real, i.e., the actually existing and the merely imagined, to a different distinction between the practical and the impractical. His primary question about the wireless age is not that of *when* it will come, but *where* it is already located now, and his provisional answer is that it can already be found precisely at the cusp of the commonplace. While, in recent years, Sloss's prediction about the wireless age has often been quoted for its perceived anticipation of ubiquitous connectivity,[39] I argue that the

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35. Robert Sloss, "Das drahtlose Jahrhundert," in *Die Welt in 100 Jahren*, ed. Arthur Brehmer (Berlin: Buntdruck, 1910), 27–32.

36. Ibid., 46–47.

37. Ibid., 31–32.

38. Ibid., 32. "Ich könnte in diesem Stille fortfahren, Gott weiß wie lange, und Wunder über Wunder erzählen, ohne meine Phantasie auch nur im geringsten anzustrengen, denn alles, was in dem bisherigen Gang der 'Erzählung' so wunderbar sich angehört hat, sind Probleme, die heut schon gelöst sind und die keineswegs mehr in das Gebiet der frommen Wünschen oder der überspannten Hoffnungen und Erwartungen gehören. Nein, es sind Tatsachen, die nur darauf warten, in unser praktisches Leben eingeführt zu werden, gerade so, wie Telegraph und Telephon und Phonograph sich darin eingeführt haben."

39. See, for example, Uwe Fraunholz, Thomas Hänseroth, and Anke Woschech, "Hochmoderne Visionen und Utopien: Zur Transzendenz technisierter Fortschrittserwartungen," in *Technology Fiction:*

prediction can actually be better understood in terms of media topoi. Ultimately, the intricate mixture of fact and fiction in Sloss's prediction speaks to a utopian vision of a wireless world in which the universal availability of wireless signals would enable universal social equality.

The wireless century promised to overturn the familiar urban infrastructure of physical wires, and enable the creation of a wireless world without borders, a new totalizing space that would be universal and all-inclusive. In an allegorical engraving accompanying Sloss's essay, Ernst Lübbert illustrates this fantasy of global connectivity with a dramatic vision of the earth seen from outer space. In the background and at the sides of the image, the ornamentation draws on the fin-de-siècle idiom of electricity and magnetism—streams, fluids, fields, and currents.[40] At the center of the image, four scarcely clad female figures with their faces contorted in a scream—an allusion to the dangerously alluring Sirens of Greek mythology—join hands to form a human chain around the earth. At the bottom of the image, a three-headed figure, one hand raised as if calling to someone in the distance, emits lightning bolts out of its three mouths in three different directions. The depiction of the three-headed figure combines elements of the mythology of Jupiter, the sky god associated with atmospheric phenomena, and Janus, the guardian of gates, doorways, and passages. While most depictions of Janus contain only two faces, looking to the future and to the past, this representation of Janus has three faces, with an implied fourth, an allusion, in my analysis, to the omnidirectional nature of wireless transmission. Like the text it illustrates, this image transforms the temporality of the wireless age into a spatial construct. As an allegory for the wireless century, the presentation of these mythological figures in the fin-de-siècle idiom of electricity and magnetism makes a similar point to Bredow's statement about the universality of wireless transmission, though it also emphasizes the danger of an alluring new medium that seems to transcend both space and time.

Based primarily on the principle of extension, the conception of the wireless age was, in several key respects, a continuation of the wired age. In the mid-nineteenth century, the topos of global connectivity was common to the discourse of telegraphy, even before the first attempt to lay a transatlantic cable. In an iconic editorial cartoon, the British mining magnate, Cecil John Rhodes, is depicted as the "Colossus of Rhodes," stretching a telegraph wire across the continent of Africa. One foot in Cape Town and the other in Cairo, the colonialist with his hands on the wire becomes a derisible wonder of the modern world. In a somewhat less iconic image, the wire is held by Puck, a character immortalized in *A Midsummer Night's Dream*; in fact, the caption for this image contains a line Puck speaks in Shakespeare's play "I'll put a girdle round about the earth / In forty minutes." Standing on top of the world, the mischievous figure holds the ends of a cable wrapped around the globe in each of his hands. If he were to pull one end, as Florian Sprenger observes, the other would move: the cable functions here a transmitter and a receiver at the same time and, as such, does not merely connect two distinct places to

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Technische Visionen und Utopien in der Hochmoderne, ed. Uwe Fraunholz and Anke Woschech (Bielefeld: Transcript, 2014), 11.

40. On this idiom of painting, see Christoph Asendorf, *Ströme und Strahlen: Das langsame Verschwinden der Materie um 1900* (Berlin: Anabas, 1989), 132–38.

each other, but rather forms a connection that ends exactly where it began.[41] In contrast to the mythology of Puck in this image and that of the Seven Wonders of the Ancient World in the other, the mythology of the Sirens in Lübbert's allegory of wireless makes the new medium into something dangerously alluring. Who would dare resist the siren song of the wireless, the image seems to be asking, already a decade before the introduction of national broadcasting.

Following World War I, however, the media topos of the wireless age as a foil for the wired age would only encounter "cynical reason."[42] In a cartoon captioned "Im drahtlosen Zeitalter!" (In the wireless age, 1924), the once romantic vision of a wireless age is driven *ad absurdum*.[43] Drawn by Ferdinand Barlog, one of the most popular illustrators of the interwar period, and printed at the end of Charlie K. Roellinghoff's comedic text "Radio im Humor: Ein Paar Drahtlosigkeiten" (Radio in humor: A few wirelessnesses, 1924), the cartoon exploits the principle of substitution in the concept of "going wireless"—the idea that wireless technology does everything wired technology did, only without the wire—in the service of a visual pun.[44] The wires that are vanishing, in this vision of the wireless age, are not the cables of telegraphy, telephony, and electricity, but more mundane material found in everyday situations—a dogcatcher's leash, a mousetrap, the bars on a birdcage, the strings on a harp and a cello, and a barbed-wire fence. Even in the wireless age, the cartoon suggests, things stay basically the same. The dog-catcher is still able to impound the dog, the mouse will still fall prey to the trap, the bird will still not fly away, the musicians' performance will still go on, the barbed-wire fence will still ensnare the thief. The last image in the series, captioned "completely wireless" (ganz drahtlos), depicts a down-and-out vagrant with empty pockets, an allusion not only to the three-year period of hyperinflation in the Weimar Republic that was slowly coming to an end, but more specifically to the prohibitive costs of early radio sets.[45] Ultimately, the cartoon complicates the official rhetoric of "radio for all," and reveals a crack in the discourse of wireless inclusivity, universal brotherhood, and overcoming space and time.

Understanding Wireless

What this cartoon of the wireless age makes visible is the common conception of wireless as a negation of something familiar. In this respect, the cartoon is hardly absurd, merely articulating in pictorial terms the common terminology for wireless technology. In many languages, the term wire*less* names only the lack of an attribute in a familiar

41. Florian Sprenger, *Medien des Immediaten: Elektrizität, Telegraphie, McLuhan* (Berlin: Kadmos, 2012), 318.

42. Peter Sloterdijk, *Critique of Cynical Reason* (Minneapolis: University of Minnesota Press, 1987).

43. Charlie K. Roellinghoff, "Radio im Humor: Ein paar Drahtlosigkeiten," *Uhu* 3 (December 1924): 87.

44. Born Karl Roellinghoff, Charlie K. Roellinghoff (1897–1935) was a journalist, musician, and author of cabaret pieces and screenplays. Several of these were about the radio including *Aether-Brettl* (1934) and Walther Ruttmann's lost film *Des Haares und der Liebe Wellen* (1929).

45. Many radio sets were bought on credit or during the Christmas shopping, and they were often shared among an entire family. On consumer practices and the prohibitive costs of radio sets in the Weimar Republic, see Führer, "A Medium of Modernity?," 735–36.

medium: the English *wireless telegraphy*, the German *drahtlose Telegraphie*, the French *télégraphie sans fil*, and the Italian *telegrafia senza fili* are all definitional negations of the familiar medium of wired telegraphy.[46] Is the concept of wireless telegraphy anything more than a tautology of telegraphy without wires? In *Understanding Media*, the word *wireless* was a prime example, for Marshall McLuhan, of "Horseless Carriage Syndrome," a phrase referring to early conceptions of the automobile as a horse-drawn carriage without the horse. In transportation as in communication, the new medium of wireless telegraphy was initially conceived as fulfilling the same function as the old one, thereby revealing a society's tendency to think of technology only through a well-established framework. However, even if the concept of wireless telegraphy is a tautology, it can still serve as an indicator of what McLuhan calls "bias," thereby shedding light on the interaction of old media and new media. "The bias and blindness induced in any society by its pre-existent technology" was evident for McLuhan in the following misunderstanding: "The word 'wireless,' still used for radio in Britain, manifests the negative 'horseless-carriage' attitude toward a new form. Early wireless was regarded as a form of telegraph, and was not seen even in relation to the telephone"—not, that is, as a medium for transmitting voices and sounds as would eventually become the case with the radio.[47] In my analysis, McLuhan was not "disparag[ing]" the term wireless, as Timothy Campbell suggests, but emphasizing the function of media bias.[48] McLuhan's claim was that while everyone was busy taking the wireless for an enhanced form of telegraphy, i.e., the transmission of discrete digital information, they could not see it in relation to the telephone, i.e., the transmission of continuous analog voice data. In my understanding, neither conception is entirely apt, as the discourse of radio was more of a fusion of telegraphy and telephony.

(Mis)understanding wireless technology in this fashion—(mis)taking wireless telegraphy for a form of wired telegraphy without the wires, so my argument, is itself a common media topos in the history of telegraphy. The following anecdote, often falsely attributed to Albert Einstein, encapsulates this kind of horseless-carriage thinking: "The wireless telegraph is not difficult to understand. The ordinary telegraph is like a very long cat. You pull the tail in New York, and it meows in Los Angeles. The wireless is the same, only without the cat."[49] The wireless telegraph is the same, in other words, as the wired telegraph, only without the connecting wire. Despite its seeming novelty, there appears to be only one difference between the new medium and the old one—namely, the absence of a connecting wire—though it is this minor difference, from McLuhan's perspective, that will actually turn out to make all the difference. "Smiling you will look back on all the errors and mistakes in the evolution of wireless," writes Bredow in his above-quoted address, indicating how this topos of wireless difference so often takes the form of a joke. Switch out the characters, the disembodied animal, or the names of the

46. On terminology, see Haus, "Radiogerede."

47. Marshall McLuhan, *Understanding Media: The Extensions of Man* [1964] (Cambridge, MA: MIT Press, 1994), 304.

48. Campbell, *Wireless Writing in the Age of Marconi*, ix.

49. Steve Mirsky, "Antigravity," *Scientific American* (September 2002), qtd. in Thomas H Lee, "Overview of Wireless Principles," in *The Design of CMOS Radio-Frequency Integrated Circuits*, 2nd ed. (Cambridge: Cambridge University Press, 2004), 40.

cities it connects, and the joke can be found in many different permutations in many different historical moments in many different cultures.[50] Significantly, however, the topos of wireless as a form of disembodied animal is neither ancient nor universal, but only arises in tandem with the popularization of telegraphy in the mid-nineteenth century.

Even though the functional order of wireless transmission may seem neutral, there was always someone on the receiving end of the joke about misunderstanding wired and wireless transmission. In one of its earliest formulations, "A Novel Illustration of the Telegraph" (1866), the joke takes the form of a dialogue between two French peasants, who are certainly no Einsteins, discussing the use of telegraphy in the Austro-Prussian war:

> A most ludicrous conversation took place a few weeks ago in a small village near Paris. Two peasants were discussing about the war between Austria and Prussia, when one of them remarked that he could not understand how messages could be sent by the electric telegraph. His companion after having tried to make him comprehend the manner in which the telegraph works, at last, struck with a bright idea, exclaimed:
>
> "Imagine that the telegraph is an immense long dog—so long that its head is at Vienna and its tail is at Paris. Well, tread on its tail, which is at Paris, and it will bark at Vienna. Do you understand now, stupid, what the telegraph is like?"
>
> "O, yes," replied the other. "I have an idea now what a telegraph must be."[51]

In this version, the joke highlights the perceived inability of the lower classes to understand the immateriality of electricity and the apparent simultaneity of electrical transmission. Unable to grasp the science behind telegraphy, their only recourse is to a tangible metaphor: the telegraph is like a dog—when you pull its tail, it barks.

In this form, the joke would be retold in different settings and with a shifting cast of characters, who were usually targeted for their inability to grasp the science of electricity. In 1873, for example, the simile of an "immense dog" stretching from London to Tehran was purportedly used to explain the workings of the telegraph to the "Shah of Persia," since he, like the French peasants, could allegedly not wrap his mind around the immateriality of electrical transmission.[52] By 1917, a new elaboration was added to the evolving joke of the wireless as a disembodied animal, now accounting for recent developments in wireless telegraphy. In a German version from 1923, translating an American version from Hugo Gernsback's *Electrical Experimenter*, the setup is as follows:

> "Say, Uncle Teddy, how does telegraphy work?"

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50. Garson O'Toole, "The Telegraph Is Like a Very, Very Long Cat (or Dog)," *Quote Investigator: Exploring the Origins of Quotations*, February 24, 2012, http://quoteinvestigator.com/2012/02/24/telegraph-cat/.

51. "A Novel Illustration Of The Telegraph," *Providence Evening Press* (August 31, 1866), qtd. in "The Telegraph Is Like a Very, Very Long Cat (or Dog)."

52. Augustus J. C. Hare, *Story of My Life* (1901), qtd. in "The Telegraph Is Like a Very, Very Long Cat (or Dog)."

"It's the simplest thing in the world, my boy! Just watch! Imagine a terrifyingly long dog whose head is in Boston and whose tail is in New York. If you step on its tail here, then it'll howl in Boston."

"Alright, Uncle, but how about wireless?"

"Precisely the same, my boy! Just imagine that the pooch isn't there."[53]

In this case, the joke ridicules the Weimar Republic's cultural other, America, through Uncle Teddy (Roosevelt)'s inability to grasp the science underlying wireless transmission, which is explained in the pages of the book the joke illustrates. My argument is that the joke is not an "illustration of the telegraph," as the title of the first iteration has it, but an illustration of the contradictions inherent in the rhetoric of telegraphy as a connective medium. If, as Florian Sprenger argues, the telegraph cable materializes the fundamental difference between the transmitter and the receiver at the heart of all communication, then the topos of misunderstanding wireless further illuminates the nuanced cultural logics informing identity and difference.[54]

As Carolyn Marvin demonstrates, nineteenth-century media topoi were often tied to the rhetoric of exclusion on the basis of class, race, and gender,[55] an argument that I extend to describe the early twentieth-century discourses of radio and wireless telegraphy. In trade publications on telegraphy and engineering, there were many anecdotes about country bumpkins who climbed telegraph poles to eavesdrop on messages as they went by, as is perhaps the case in the images of the telephone poles discussed in my Introduction. The lower classes were often ridiculed for their perceived inability to understand modern technology, as in the joke about the wireless dog, and in the following joke in Roellinghoff's "Radio im Humor:" "Today, of course, the antenna is already so popular that the servants [*Dienstbolzen*] in the entire area hang their clothes on it."[56] Illustrating the verbal joke are a cartoon reprinted from the American *Strand Magazine* depicting the wireless antenna as "the musical clothesline," and a drawing showing a worker using a broom-like contraption "for the spring cleaning" of his antenna, thereby failing to understand the nature of maintaining and servicing electrical technology. "By the way," begins another joke in "Radio in Humor" about the jokester's cleaning lady [*Portierfrau*], "there are naturally still people today who understand the radio about as much as a Hindukuli [i.e., a porter] understands the history of German literature."[57] After informing her, in Hochdeutsch, that he has recently acquired an "antenna," she responds

53. Artur Fürst, *Der Verkehr im Draht und im Äther* [1923], ed. Kurt Mauel, vol. 1 of *Das Weltreich der Technik: Entwicklung und Gegenwart* [1923–27] (Düsseldorf: VDI-Verlag, 1985), 306. "'Sag' mal, Onkel Teddy, wie geht das eigentlich zu mit dem Telegraphieren?' 'Die einfachste Sache von der Welt, Jung'! Paß mal Achtung! Denk dir ein schrecklich langes Hundevieh, das den Kopf in Boston und den Schwanz in New York hat. Wenn du ihm hier auf den Schwanz trittst, dann heult es in Boston.' 'Fein, Onkel, aber drahtlos, wie ist denn das?' 'Akkurat genau so, Jung! Du denkst dir bloß den Köter weg.'"

54. Sprenger, *Medien des Immediaten*.

55. Marvin, *When Old Technologies Were New*.

56. Roellinghoff, "Radio im Humor," 80. "Heute natürlich ist die Antenne schon so populär, daß die Dienstbolzen der ganzen Umgegend ihre Wäsche darüber hängen."

57. Ibid., 84. "Übrigens gibt es natürlich auch heute noch Leute, die von Radio so viel Ahnung haben wie ein Hindukuli von der deutschen Literaturgeschichte. Ich nenne nur meine Portierfrau."

in a thick Berliner dialect: "I prefer *dogs*! […] I can't stand cats. And make sure that this beast doesn't spoil the new staircase!"[58] In this case, the butt of the joke is the economic other, spilling over into the ethnic other in the reference to Indian literature.

Throughout the nineteenth century, there were numerous anecdotes about the "educational" use of electrical wires on indigenous peoples. During the 1860s, for example, the famous German electrical scientist and entrepreneur Werner von Siemens "found it necessary to intimidate the natives" while building the Djulfa-Tabriz portion of the Indo-European telegraph from London to Calcutta. Taking advantage of rainy-season conditions, "he brought about a gathering of the natives and persuaded one of their notables to ascend a ladder and touch the wire, saying the wire would defend itself. On doing so, the man received such a shock that he fell down the ladder, and the wire was considered after that by the natives as being bewitched."[59] Turning the situation around, newly arrived immigrants were the butt of similar jokes about electrical transmission for their inability to grasp what the natives already knew: a cartoon reprinted, in Roellinghoff's comedic text, from the Madrid-based magazine *Buen Humor* depicts two birds saying "Where will we go when everything goes wireless!";[60] a similar cartoon in *Harper's Weekly* shows a "newly arrived and bewildered Britisher" pointing toward some overhead wires and exclaiming "My goo'ness grashuh! Jes' look at all the sparrows!"[61] Although these jokes may seem only to reinforce stereotypes, such misunderstandings may actually indicate a means for grasping the materiality of electrical technology, as Lisa Gitelman argues.[62]

Women were often ridiculed for similar errors with regard to new technology, or for their perceived misgivings about technological progress. Even though electrical technology took hold quickly in workplaces, it did so more slowly in the home, and fin-de-siècle comparisons of electrical progress in domestic and in occupational settings remarked on the reluctance with which homeowners gave permission "to tear up the house to have the wires strung."[63] One of the questions raised by the introduction of the radio into the home was who would have control over the device, a precursor to stereotypes about the "battle of the sexes" playing out in terms of the television remote control. One cartoon in "Radio im Humor," reprinted from *The Sketch*, shows "the wireless widow" who is forced to knit while her husband operates the radio set: she reclining in a rocking chair, he leaning forward over the radio set—it is clear who is identified as the more modern of the pair. Another cartoon, reprinted from the *Berliner*

58. Ibid. "'Na, Frau Kuhl,' erzähle ich ihr neulich, 'ich habe mir jetzt auch eine Antenne zugelegt!' 'Ick zieh' Hunde vor!' sagt sie kategorisch. 'Ich kann nu mal Katzen nich vaknusen. Und denn sehnse Ihnen vor, detma det Biest nich de neuen Treppenläufa vaschandelt!'"

59. "A Bewitched Telegraph Wire," *Scientific American* (May 1, 1880), qtd. in Marvin, *When Old Technologies Were New*, 35.

60. Roellinghoff, "Radio im Humor," 80. "Wo sollen wir bloß bleiben – wenn doch alles drahtlos wird!"

61. Harper's Weekly 32 (1888): 160, qtd. in Gib Prettyman, "Harper's Weekly and the Spectacle of Industrialization," *American Periodicals* 11 (2001): 42.

62. Lisa Gitelman, "Holding Electronic Networks by the Wrong End," in "Network Archaeology," ed. Nicole Starosielski, Braxton Soderman, Cris Cheek, special issue, *Amodern* 2 (2013), http://amodern.net/article/holding-electronic-networks-by-the-wrong-end/.

63. Marvin, *When Old Technologies Were New*, 77.

Illustrierte, shows an "absent-minded doctor" listening to the heartbeat of a female patient whose top is falling down: "That's funny," he says "so much interference [*Nebengeräusche*]? The concert from London is probably getting in the way!"[64] Another of Roellinghoff's misogynistic jokes features a dialogue between a married man and a radio service technician:

> "How is your apparatus functioning?" […]
> "Unfortunately, I only hear troublesome interference!"
> "Well, then, permit me to take your apparatus along with me!"
> "No! […] Take my wife!"[65]

What these jokes reveal is how, in the early days of German national broadcasting, radio programs increasingly came to be targeted to at women at home, making the effeminization of the radio listener into a constant concern.[66] The threat of interference impinged upon the ideal of attentive listening.

While the immateriality of electricity and the disembodiment of the voice over the radio played a crucial role in these processes of ethnic, gender, and class-based othering, they also linked up with a philosophical problem. One variant of the joke about the wireless as a disembodied animal served as a testament to the "learned ignorance" of a great mind of science, as in both the version attributed to Einstein and in the following version attributed to Thomas Edison: "When I was a little boy, persistently trying to find out how the telegraph worked and why, the best explanation I got was from an old Scotch line repairer who said that if you had a dog like a dachshund long enough to reach from Edinburgh to London, if you pulled his tail in Edinburgh he would bark in London. I could understand that. But it was hard to get at what it was that went through the dog over the wire."[67] In this instance, the topos of understanding wireless as a disembodied animal ultimately speaks to a fundamental debate in the history and philosophy of science, namely, the problem of action at a distance (*actio in distans*): Is it possible for a cause to effect an action at a distance, or must all causes and effects be connected in space and time? In the Aristotelian tradition, most scientists and philosophers would side with the French peasants, the Shah of Persia, and Uncle Teddy. As a tenet of the medieval Aristotle reception has it, "All action occurs by contact, with the result that nothing acts at a distance, unless by some kind of medium."[68] Since this tradition of thinking about

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64. Roellinghoff, "Radio im Humor," 81. "Nanu, soviel Nebengerausche? Da kommt wohl das Konzert aus London dazwischen!"

65. Ibid., 84, 86. "'Wie funktioniert Ihr Apparat?' […] 'Leider höre ich lästige Nebengeräusche!' 'So? Dann erlauben Sie, daß ich Ihren Apparat mal mitnehme!' 'Nein!' sagte mein armer Freund. 'Nehmen Sie meine Frau mit!'"

66. See Kate Lacey, "Towards a Periodization of Listening: Radio and Modern Life," *International Journal of Cultural Studies* 3, no. 2 (2000): 279–88.

67. *The Diary and Sundry Observations of Thomas Alva Edison*, 216; qtd. in Sprenger, *Medien des Immediaten*, 318.

68. Qtd. and trans. in John Durham Peters, *The Marvelous Clouds: Toward a Philosophy of Elemental Media* (Chicago: University of Chicago Press, 2015), 47. "Omnis actio fit per contactum, quo fit ut nihil agit in distans nisi per aliquid medium."

causality rules out the possibility of an immediate effect at a distance, various media have been introduced to explain the apparent effects of action at a distance caused by electricity and magnetism, such as ethers, spirits, corpuscles, or effluvia. And, of course, the wireless cat-dog. These media ensure continuity and connection even where there seems to be none. Within this philosophical tradition, the media topos of misunderstanding wireless, and, by extension, misunderstanding the physics of electromagnetic radiation, gets inflected, as the many permutations of the wireless animal show, with the historically contingent logic of different cultures. At the end of the Weimar Republic, for example, it is what would ultimately become assimilated to the *Volkskörper*. The philosophical and scientific problem of *actio in distans*, wedded to the (false) belief that information can be transmitted instantaneously, is also what gives rise to the wireless topoi of perpetual contact and ubiquitous connectivity, the feeling of always being reachable, anytime, anywhere, due to one's possession of a speculative gadget that came to be known as "pocket wireless."

Pocket Wireless

> The philosophical question is no longer who I am really am but where I presently am.
> —Paul Virilio, *Polar Inertia*

Always connected—anytime, anywhere. In 1897, the year Guglielmo Marconi would be awarded his first patent for wireless telegraphy,[69] the task of establishing a wireless connection between a transmitter and a receiver separated at a distance of only several kilometers was still problematic. Yet, there were already countless predictions about the possibility of making contact with anyone, at any desired time, in any imaginable place around the world.[70]

The *locus classicus* for these wireless fantasies, crystalizing around the desire for a "pocket wireless" device, is a comment made by a professor of physics and electrical engineering in an evening lecture at the Imperial Institute in London on Monday, February 15, 1897, which started relatively late around 8:30pm.[71] During the course of what must have been a highly entertaining evening, the lecturer referred to "historical letters, documents, and specimens," he displayed "hydraulic models, lantern slides, and portraits of eminent cable men," and following the lecture, "the staff of the Eastern Telegraph Company entertained the audience in sending and receiving messages over the artificial [Trans-]Pacific cable."[72] In retrospect, however, the most memorable part of that evening remains the lecturer's oft-quoted prediction about a possible future of wireless technology:

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69. Guglielmo Marconi, Improvements in Transmitting Electrical Impulses and Signals, and in Apparatus Therefor, British Patent No. 12039, filed June 2, 1896, and issued July 2, 1897.

70. See Marvin, *When Old Technologies Were New*, 154–57; Imar O. De Vries, "Mobile Telephony: Realising the Dream of Ideal Communication?," in *Mobile World: Past, Present, Future*, ed. Lynne Hamill and Amparo Lasen (Amsterdam: Amsterdam University Press, 2012), 9–28.

71. William Edward Ayrton, "Sixty Years of Submarine Telegraphy," *The Electrician* 38, no. 17 [979] (February 19, 1897): 548.

72. Ibid.

> I have told you about the past, I have told you about the present. What about the future? Well, there is no doubt the day will come, maybe when you and I are forgotten, when copper wires, gutta-percha coverings and iron sheathings will be relegated to the museum of antiquities. Then when a person wants to telegraph to a friend, he knows not where, he will call in an electromagnetic voice, which will be heard loud by him who has the electromagnetic ear, but will be silent to everyone else, he will call, "Where are you?" and the reply will come loud to the man with the electromagnetic ear, "I am at the bottom of the coal mine, or crossing the Andes, or in the middle of the Pacific." Or perhaps no voice will come at all, and he may then expect the friend is dead.[73]

What usually gets omitted from quotations of the prediction are two additional lines about its implications, which follow the impactful statement about the death of the friend: "Think what that will mean. Think of the calling which goes on from room to room, then think of that calling when it extends from pole to pole—a calling quite audible to him who wants to hear, absolutely silent to him who does not."[74] As this additional explanation makes evident, the prediction is not only about the future, but also about the past—namely, the promise of extending the range of communications from a domestic scene ("from room to room") to an international one ("from pole to pole"), and the attendant threat of losing the content of the exchange within a cacophony of competing voices. Ultimately, I argue that pocket wireless was primarily an updated take on older telegraphic and telephonic topoi.

William Edward Ayrton's prediction, first published as part of a transcription of the lecture in the technical journal *The Electrician* and then popularized in the form of a lecture summary in the more widely circulated *Nature*, would become one of the most widely quoted statements about wireless technology in the early twentieth century. In the decade following the lecture, it would feature as either an epigraph or a framing statement in many technical handbooks and early histories of wireless technology in a variety of languages. Translated into German, Ayrton's prediction would appear in a wide range of contexts, from the physicist Adolf Slaby's lectures about wireless technology for Kaiser Wilhelm II, King of Prussia and the last German Emperor, to the Dadaist Raoul Hausmann's work on a wireless device for converting between light and sound.[75] By 1909, when Guglielmo Marconi and Karl Ferdinand Braun were jointly awarded the Nobel Prize in Physics "in recognition of their contributions to the development of wireless telegraphy," the prediction would be presented before an international audience. "Whatever may be its present shortcomings and defects," Marconi stated confidently at the end of his acceptance speech, "there can be no doubt that

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73. Ibid.

74. Ibid.

75. Adolf Slaby, *Die Funkentelegraphie: Gemeinverständliche Vorträge* [1897] (Berlin: Leonhard Simion, 1901), 119; Otto Jentsch, *Telegraphie und Telephonie ohne Draht* (Berlin: Julius Springer, 1904), "Vorwort," n.p.; Ernst Walter Ruhmer, *Drahtlose Telephonie* (Berlin: Ernst Ruhmer, 1907), 142; Raoul Hausmann, *Scharfrichter der bürgerlichen Seele: Raoul Hausmann in Berlin 1900–1933*, ed. Eva Züchner (Berlin: Hatje, 1998), 176.

wireless telegraphy—even over great distances—has come to stay, and will not only stay, but continue to advance."[76] Having heard Ayrton's prediction several years earlier when the professor was in attendance at one of his own lectures, Marconi tacked on his own prediction for a wireless future even more perfect: "If it should become possible to transmit waves right around the world, it may be found that the electrical energy travelling round all parts of the globe may be made to concentrate at the antipodes of the sending station."[77] Out of the dream of contacting a friend halfway around the world, already taken to have been realized in the form of wireless telegraphy, grows the even greater dream of wireless energy transmission, still evident in Bredow's address of the future wireless age.

In recent years, Ayrton's prediction has been quoted frequently in studies of mobile telephony and wireless data networks due to its resonance with contemporary concerns about perpetual contact and ubiquitous connectivity.[78] In these quotations, the prediction is usually linked to an essentialist history of communication, as in the following prefatory remarks to Ayrton's comments: "Arguably, wireless communication between humans is as old as the human civilization itself, for as soon as the first humans started communicating with each other using their vocal cords, we had achieved wireless communication."[79] In glossing over the differences among different applications for wireless technology in telecommunication, such as that between the point-to-point media of telegraphy and telephony and the one-to-many media of radio and television, wireless transmission is reduced to a form of universal communication, which also ignores the various applications of wireless technology beyond communication, such as radar or radio astronomy. What makes Ayrton's prediction so quotable is not only its lack of technical details, shifting the present limitations of technology into a future perfect, but also the apparent timelessness of the scene of communication: two friends, separated at a distance, must overcome some obstacle to make contact, and they can only do so with the aid of technology. In other words, the invention of wireless technology is taken to be a response to a universal desire for communication and Ayrton's prediction is taken to constitute a primal scene of communication—the problem that will be the subject of my next chapter. While many citations of Ayrton's prediction rely on either its perceived novelty or its purported antiquity, I argue that the comment can actually be better understood as a media topos.

Ayrton was hardly alone in imagining the invention of wireless telegraphy and telephony at the end of the nineteenth century as the realization of a dream of centuries. In *When Old Technologies Were New*, Carolyn Marvin views Ayrton's prediction, along with other contemporaneous wireless fantasies, as a form of "enhanced conversation," "a fascination with perfect spiritual intimacy, inherited from a dream of centuries, which

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76. Guglielmo Marconi, "Wireless Telegraphic Communication: Nobel Lecture, December 11, 1909," 221, http://www.nobelprize.org/nobel_prizes/physics/laureates/1909/marconi-lecture.pdf.

77. Ibid.

78. See, for example, Arthur C. Clarke, *1984, Spring: A Choice of Futures* (New York: Ballantine Books, 1984), 12.

79. Praphul Chandra, *Bulletproof Wireless Security* (2005), xii, qtd. in Wythoff, "Pocket Wireless," 63n38.

seemed to be on the verge of materializing in the late nineteenth century."[80] Many of these predictions were bound up with projected inventions, underscoring not only the importance of optimizing wireless devices throughout the history of wirelessness, but also the significance of negotiating the projected functionality of media through the materiality of machines.[81] One apocryphal invention, usually attributed to Thomas Edison, consisted of two synchronized compass needles, capable of communicating messages at a distance through a combination of "electric sympathy" and "concentrated thought" transference.[82] Another invention, exhibited at the Electrical Exposition in Paris in 1881, "gives us the hope of being able, sooner or later, to see by telegraph, and behold our distant friend through the wire darkly, in spite of the earth's curvature and the impenetrability of matter."[83] There were even speculations about developing the telephone into a videophone, as in the following prediction by a vice president of AT&T: "Some day we may see as well as hear our distant friends when we communicate with them by the telephone."[84] In each case, wireless telemedia appear to fulfill the fantasy of making instantaneous contact with a distant friend, and each generation of wireless technology, from telegraphy through telephony to television, increasingly appears to approach the ideal of unmediated communication—telepathy, teleportation, and telepresence.

Even though Marvin alludes to the past and future of wireless fantasies, her analysis is focused exclusively on their present implications for a particular historical moment at the end of the nineteenth century. For Marvin, these enhanced conversations contrasted with a form of "enhanced spectacles," "the elaborately staged and brazenly public spectacles of light that were the crown of late nineteenth-century electrical grandeur."[85] My present interest, on the other hand, is not in this synchronic relation of electromagnetic transmission and electric light spectacles, but in the diachronic relations among techniques of signaling without wires. Furthermore, Marvin's excellent observation that many of the authors of late nineteenth-century wireless fantasies were "experts and other interested commentators" accounts only for the predictions published in the pages of trade journals, and not for reactions to these predictions. In literature and popular culture, I would add, the media topos of contacting a friend at a distance could be reworked from an imaginative perspective, shedding light on non-obvious problems inherent in wireless fantasies.[86] Though I am sympathetic with Marvin's work on wireless fantasies, I remain skeptical of the claim that wireless telemedia can be understood as a form of "enhanced conversation," i.e., a heightened *degree* of face-to-face conversation, rather than as something entirely different in *kind*.

Despite some continuity, the topos of making contact at a distance actually has changed dramatically over time, as have the conditions of possibility for conversing with

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80. Marvin, *When Old Technologies Were New*, 154.

81. Wythoff, "Pocket Wireless."

82. "Edison's Telepathic Machine," 129, qtd. in Marvin, *When Old Technologies Were New*.

83. "The Electrical Exhibition at Paris," qtd. in Marvin, *When Old Technologies Were New*.

84. Remarks by E. J. Hall, Jr., Electrical Review, 9, qtd. in Marvin, *When Old Technologies Were New*.

85. Marvin, *When Old Technologies Were New*, 154.

86. Compare my analysis of Mynona's "Idee vom Ferntaster" in the section of the third chapter under the heading "Tele-Everything."

an absent friend. Reflecting, in 1913, on the relation of rapid advancements in wireless telegraphy to the more slowly developing field of wireless telephony, the author of one elementary handbook of wireless technology commented: "In one sense, the extension of the present range from a few hundred kilometers to the antipodes, or half way around the world (20,000 kilometers, or 12,000 miles) would be less wonderful than the already accomplished feat of reproducing recognizable speech at the range now attained; because the extension of the range of speech to the antipodes is a matter of *degree*; whereas the achievement of wireless telephony to a range of even 100 kilometers (60 miles), is a wonderful acquisition in *kind*."[87] The difference between telegraphy and telephony alluded to here is a technical difference in terms of transmission methods: telegraphy means the transmission of discrete, digital information, whereas telephony involves continuous, analog data. This was the main reason for the delay in the development of wireless telephony and the radio out of wireless telegraphy.

In addition to the differences between tele*graphy*, tele*phony*, and tele*vision*, there is also a key technical difference between their *wired* and *wireless* transmission, evident in the following wireless fantasy, which often gets lumped together with Ayrton's prediction. In 1892, William Crookes offered a slightly different vision of wireless communication in a popular article on "Some Possibilities of Electricity." Though the scene of communication is similar to Ayrton's, it is arguably a more direct precursor to national broadcasting: "Any two friends living within the radius of sensibility of their receiving instruments, having first decided on their special wavelength and attuned their respective instruments to mutual receptivity, could thus communicate as long and as often as they pleased by timing the impulses to produce long and short intervals on the ordinary Morse code."[88]Admittedly, the content of the exchange in Crooke's prediction is not yet a voice over the telephone or the radio, but rather the familiar dots and dashes of telegraphy. Significantly, however, what Crookes calls the "radius of sensitivity" reflects a nascent awareness of the propagation of electromagnetic waves, which will become crucial for omnidirectional broadcasting. While a wire describes a one-dimensional line, connecting two different places, wireless can describe the radius of a two-dimensional circle, or even a three-dimensional sphere, circumscribing an area of receptivity, or a "coverage zone." As a result, the space connecting the two friends is no longer equivalent to the extension of wire; it becomes a circular figure whose diameter is determined only by the sensitivity of their receivers, and, as Crookes neglects to mention, the power of their transmitters. Whereas wires connect points in space, creating a virtual space between them, wireless can cover spatial areas, overlaying a virtual space on top of them. In other words, if wired communication connects point A to point B, wireless communication can connect point A to several hundreds or thousands of other points within a given "coverage zone."

While the structure of a wired network generally corresponds to the configuration of connecting cables in physical space, the structure of a wireless network is given only by

87. Arthur E. Kennelly, *Wireless Telegraphy and Wireless Telephony: An Elementary Treatise* (New York: Moffat, Yard, 1913), 262.

88. William Crookes, "Some Possibilities of Electricity," *Fortnightly Review* 51 (February 1892): 175; on this article's influence throughout Europe, see Hong, *Wireless*, 10–12.

the positions of transmitters and receivers, which is what made pocket wireless such a sensational topos. Although data circulating within a wired network can be made to flow along different paths, thereby creating various "network topologies," a virtual address in a wired network remains equivalent to a physical location—the ends of the cable. As Florian Sprenger argues, the materiality of the cable, necessarily consisting of two ends, implies this system of address.[89] Wireless transmission, I argue, is an entirely different matter. While wired transmissions are addressed to the ends of a cable, the materiality of wireless transmissions does not necessarily imply an address. In a wireless network, a physical location is not necessarily equivalent to a virtual address, since wireless transmitters and receivers can be mobile. As a result, wireless protocols rely on the presence or absence of electromagnetic waves to generate knowledge about unknown targets and to predict their physical locations. Ultimately, then, I argue that wireless telegraphy and telephony were not an enhancement of wired telegraphy and telegraphy but something fundamentally different in kind. If the main question asked in wired transmission is "Who's there," a question about the identity of the person at the other end of a wire, the most important question in wireless transmission is a question of location: "Where are you now?" In the age of radio, when wireless transmission will come to be used as a system of distribution rather than of communication, these questions of identification and localization will take on a radically different meaning due to the fact that the composition of the audience at any given moment is truly unknown. On the one hand, the radio, as a system of addressing an unknown audience, ideally immersed in the contents of radio programs, was often imagined to be a form of speaking with the dead, as in the cartoon discussed above featuring the "wireless widow." On the other hand, the audience of these broadcasts often figured as travelers able to explore the imaginary landscape of broadcasting. Between these two poles there was the wireless order of *Wellensalat*, or chaos on the airwaves, a conflict between the symbolic order of the management of the radio frequency spectrum and the functional order of wireless transmission.

Chaos on the Airwaves

"Radio," observed Siegfried Kracauer in his seminal essay on "Langeweile" (Boredom, 1924), "vaporizes beings, even before they have intercepted a single spark. Since many people feel compelled to broadcast, one finds oneself in a state of permanent receptivity [*Empfängnis*, also "pregnancy"], constantly pregnant with London, the Eiffel Tower, and Berlin."[90] In my reading, the "Boredom" essay is not about attention and distraction, but rather *Geistesabwesenheit*, meaning both "absent-mindedness" and "spiritual emptiness." The operative categories here are not yet surface and depth, as in Kracauer's famous essay on the Berlin movie palaces, but rather emptiness and fullness.[91]

89. Sprenger, *Medien des Immediaten*.

90. Siegfried Kracauer, "Boredom" [1924], in *The Mass Ornament: Weimer Essays*, trans. Thomas Y. Levin (Cambridge, MA: Harvard University Press, 1995), 332–33. "Auch das Radio zerstäubt die Wesen, noch ehe sie einen Funken gefangen haben. Da viele senden zu müssen glauben, befindet man sich in einem Zustand dauernder Empfängnis, trächtig stets mit London, dem Eiffel-Turm und Berlin."

91. *Zerstäubt* (vaporizes, atomizes) is the term Kracauer uses, and not *zerstreut* (distracts, scatters).

In contrast to the official discourse of radio as productive *Bildung*, the radio here puts listeners into a "state of permanent receptivity or pregnancy." As Wolf Kittler observes, the verbs *empfangen* (to receive, to conceive) and *verbreiten* (to broadcast, to spread seed) were often double entendres in the early days of radio.[92] In particular, as Kate Lacey has shown, the effeminization of the radio listener was a constant concern in the early days of broadcasting, especially since programs increasingly came to be targeted to at women at home. In this respect, Kracauer's image of radio listeners pregnant with international broadcasts registers the feared penetration of modern technology into traditional domestic spaces, much like earlier concerns about the novel as a new medium. This anxiety would resurface throughout the twenties, whether in attempts to black-box the radio apparatus as a form of furniture, or in the strange proposal for the petty bourgeoisie to build a *Rundfunk-Zimmer*, an entire room dedicated to the radio on the model of the traditional library.

Kracauer's description of radio listening practices in the "Boredom" essay features two images of the audience emptied out and put into a state of receptivity due to the mediation of technology. His first image features listeners wearing headphones, which was the dominant mode of listening to the radio in the early twenties. Even though state officials pushed for the use of public assembly-hall radio, most people in the Weimar Republic listened to the radio at home. Furthermore, even though headphones and loudspeakers are basically the same in technical terms,[93] the only widely available means of listening to the radio until the late twenties was not loudspeakers but headphones.[94] Alone together, an entire family would gather around their shared radio set and each plug their own headphones into the apparatus.[95] For Kracauer, the use of headphones isolates listeners from each other, not only making them less communicative but also reinforcing their Geistesabwesenheit:

> Who would want to resist the invitation of those dainty headphones? They gleam in living rooms and entwine themselves around heads all by themselves; and instead of fostering cultivated conversation (which certainly can be a bore), one becomes a playground for worldwide noises that, regardless of their own potentially objective boredom, do not even grant one's modest right to personal boredom. Silent and lifeless, people sit side by side as if their souls were wandering about far away. But these souls are not wandering according to their own preference; they are badgered by the news hounds, and soon no one can tell anymore who is the hunter and who is the hunted.[96]

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92. Wolf Kittler, "Kurt Schwitters," in *Praktizierte Intermedialität: Deutsch-Französische Porträts von Schiller bis Goscinny/Uderzo*, ed. Fernand Hörner, Harald Neumeyer, and Bernd Stiegler (Bielefeld: Transcript, 2010), 124.

93. Both operate according to the exact same technological principle of electroacoustic transduction. Taking an electric signal as their input and sound as their output, the one is only a more private version of the other, differing only in their size and the volume of air they move in order to produce vibrations.

94. Koch and Glaser, *Ganz Ohr*, 14.

95. Führer, "A Medium of Modernity?"

96. Kracauer, "Boredom," 333. "Wer wollte dem Werben der zierlichen Kopfhörer widerstehen? Sie glänzen in den Salons, sie ranken sich selbsttätig um die Häupter – und statt eine gebildete Unterhaltung zu

Kracauer's second image of listening practices features the loudspeaker, a technology that forces one's participation in a community of listeners:

> Even in the café, where one wants to roll up into a ball like a porcupine and become aware of one's insignificance, an imposing loudspeaker effaces every trace of private existence. The announcements it blares forth dominate the space of the concert intermissions, and the waiters (who are listening to it themselves) indignantly refuse the unreasonable requests to get rid of this gramophonic mimicry.[97]

Although Kracauer's complaints may seem to ally him with contemporary noise abatement campaigns,[98] I argue that they are better understood as part of a larger unease about the possibility of being always reachable, of being forced to participate in the wireless revolution. Kracauer's hyperbolic statement that "many people feel compelled to broadcast" is hardly a characterization of the nascent medium of national radio broadcasting in Germany, since he refers as well to the international broadcasts received from London and Paris. The imaginary here is more the suppressed field of amateur broadcasting, an imaginary inherited from the topos of pocket wireless. With the advent of radio, the topos of pocket wireless was re-encoded in the technology of headphones, loudspeakers, and the radio dial.

A revealing intertext for Kracauer's "Boredom" essay is "Von den Wundern und Plundern der Technik" (On the wonders and blunders of technology, 1922), a short essay composed by Alexander Moszkowski, a cultural critic arguably more famous than Kracauer in his day.[99] In the essay, Moszkowski reflected that every destination point will soon have restaurants, music, and telephones connected to the stock markets and news services in one's home country, which will make it impossible to have an experience of being alone. "Switch it on, however you want, escaping from it, rolling toward it, we'll find you, we'll get you!" writes Moszkowski, adopting the perspective of technology. "We don't even need metal ropes anymore to throw a lasso around you; our new wires are woven out of atoms of the ether, for us every mathematical line is a wire. That's why we call the procedure 'wireless', and we are about to create a 'wireless station

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pflegen, die ja gewiß langweilen mag, wird man zum Tummelfeld von Weltgeräuschen, die ihrer etwaigen objektiven Langeweile ungeachtet, nicht einmal das bescheidene Recht auf die persönliche Langeweile zugestehen. Stumm und leblos sitzt man beisammen, als wanderten die Seelen weit umher; aber die Seelen wandern nicht nach ihrem Gefallen, sie werden von der Nachrichtenmeute gehetzt, und bald weiß niemand mehr, ob er der Jäger ist oder das Wild."

97. Ibid. "Gar im Café, hier, wo man wie ein Igel zusammenschnurren und seiner Nichtigkeit inne werden möchte, tilgt ein bedeutender Lautsprecher jede Spur der privaten Existenz. Seine Mitteilungen durchwalten in den Konzertpausen den Raum, und die lauschenden Kellner wehren entrüstet das Ansinnen ab, diese Mimikry eines Grammophons beiseite zu schaffen."

98. For this reading of Kracauer's "Boredom" essay, see Theodore F. Rippey, "Kracauer and Sound: Reading with an Anxious Ear," in *Culture in the Anteroom: The Legacies of Siegfried Kracauer*, ed. Gerd Gemünden and Johannes von Moltke (Ann Arbor: University of Michigan Press, 2012), 185–87.

99. Alexander Moszkowski, "Von den Wundern und Plundern der Technik," in *Die Welt von der Kehrseite: Eine Philosophie der reinen Galle* (Berlin: F. Fontane, 1922), 97–129.

in the coat pocket.'"[100] While the wire presents a tangible image of entanglement in technology, the invisible medium of electromagnetic radiation operating at the scale of an atom, together with the miniature pocket wireless devices carried by users, make it more difficult to avoid wireless transmissions. At first, Moszkowski imagines resisting technology in the traditional manner: "Technology, you sorceress, I want to respond, you won't catch me yet. Everybody may call wirelessly, but I won't listen wirelessly, since I've decided never to purchase this pocket ghost."[101] However, in the course of this reflection, he soon realizes that he will probably give in to the temptation of adopting the newest fad: "Ah, I already see how I'm enmeshed in the vicious cycle, one person can't fight everyone, and so I, too, will fall into the wireless trap; into the workable foldable antenna together with overworked nerves. And my first wireless phone call will be: *bene vixit, qui bene latuit*," he lives happily who lives in hiding, the words of Ovid and the stoics Epicurus, Plutarch and Horace.[102] What Moszkowski critiqued in the form of pocket wireless, Kracauer would come to critique in the form of headphones and loudspeakers.

In cartoons, sketches, and photographs, headphones became not only an iconic symbol of the new medium of radio but also a means of visualizing and imagining the other members in a community of unknown radio listeners.[103] One of the most iconic of these representations of headphones, Kurt Günther's painting *Radionist* (1927) conveys what art historian Günther Metken refers to as "attentive passivity." In the painting, the radio is depicted as a natural part of the private, bourgeois sphere: the radio listener sits alone, next to a wine bottle and a single, thin-stemmed wine glass; his headphones and eyeglasses represent his aural disconnection and his distanced gaze. "Fed up with the world," Franz Roh commented on the painting in 1928, the radio listener "has walled himself in between his wheezing radio, his too-tight headphones, his opera libretto and his cigar, in a vindictive bachelor idyll of our epoch, a musical fortification glittering with hostility."[104] Another of the most iconic images, Kurt Weinhold's *Mann mit Radio* (*Homo sapiens*) (Man with radio (homo sapiens), 1929) is an even more radical depiction of the perceived isolation created by the new medium. Naked apart from his headphones, the radio listener seems vulnerable, though in the protection of his home, he remains

100. Ibid., 113. "Stell' es an, wie du willst, entfliehe, rolle dahin, wir finden dich, wir kriegen dich! Metallfäden brauchen wir gar nicht mehr, um dich im Lasso zu fangen; unsere neuen Drähte sind aus Ätheratomen gewebt, jede mathematische Linie ist für uns ein Draht. Deshalb nennen wir das Verfahren 'drahtlos', und wir sind eben dabei, die 'drahtlose Station in der Rocktasche' herzustellen."

101. Ibid., 114. "Hexe Technik, möchte ich entgegnen, mich fängst du damit doch nicht. Jene mögen drahtlos anrufen, aber ich werde nicht drahtlos hören; da ich entschlossen bin, mir dieses Taschengespenst niemals anzuschaffen."

102. Ibid. "Ach, ich merke schon, wie mich der circulus vitiosus aufs neue umgarnt, einer kann nicht gegen alle, und so werde ich auch in das drahtlose Geschlinge fallen; in die zusammenzuklappenden Antennen mit zusammengeklappten Nerven. Und mein erstes drahtloses Telephonat wird lauten: bene vixit, qui bene latuit."

103. Christine Ehardt, "Phones, Horns, and 'Audio Hoods' as Media of Attraction," in *Sounds of Modern History: Auditory Cultures in 19th- and 20th-Century Europe*, ed. Daniel Morat (New York: Berghahn, 2014), 115.

104. Qtd. and trans. in Sergiusz Michalski, *New Objectivity: Painting, Graphic Art and Photography in Weimar Germany 1919–1933* (Cologne: Taschen, 1994), 175.

detached from the outside world. In front of the radio listener, there is a discarded newspaper (*Lokal-Anzeiger*) and a bottle of beer. The radio, often praised as a means of imaginary travel and global community, is depicted again as the contrary—a consumer item that functions only as a narcotic and soporific, ultimately representing a withdrawal from the public sphere.[105]

In contrast to these iconic images and to Kracauer's description of the "dainty headphones" that "entwine themselves around heads all by themselves," most other commentators described their experience of using headphones in the presence of others, as in the image of the family sitting around a table all plugged in to a communal radio set. Furthermore, most descriptions of the experience of wearing headphones focused not on the comfort of relaxing and listening to the radio, but on the discomfort caused by these unwieldy headsets. When asked, for example, about his experience of listening to the radio for the first time, the German radio pioneer Hans Flesch admitted "I cannot remember when I heard the radio for the first time. I only know when I had a pair of headphones on for the first time: […] I sat for half an hour in front of the bulky machine housing and felt, due to the weight of the headphones […] and to the senseless, unarticulated noise in my head, considerably intimidated and cramped."[106] It was to this painful and noisy experience that some people would later attribute this future Frankfurt radio station director's preference for broadcasting *Neue Musik*.[107] The noise of the radio and the discomfort of wearing headphones also feature in the Viennese radio amateur Karl Flanner's recollections of listening to his uncle's radio for the first time: "He had squeezed the clasp with the earpiece, which looked like the earmuffs you wear in winter, over our heads. From these earpieces resounded a nasty crackle, sputter, and whistling, which my uncle's finger suddenly brought into order, and then the noise suddenly fell silent, and the sound of music rang out and words became comprehensible."[108] In both of these accounts, the headband designed to mount headphones to the user's head, originally intended to allow hands-free operation, has become a source of irritation.

Despite the common image of headphones isolating listeners and loudspeakers bringing them together, the difference between headphones and loudspeakers may be purely linguistic, as the Austrian cultural critic Alfred Polgar observed in his essay "Aus

105. Ursula Peters, "Kurt Weinhold: Mann mit Radio (Homo sapiens)," *Monats-Anzeiger* 275 (February 2004): 2–4.

106. Hans Flesch, *Der Deutsche Rundfunk* (1928): 2547, qtd. in Solveig Ottmann, *Im Anfang war das Experiment: Das Weimarer Radio bei Hans Flesch und Ernst Schoen* (Berlin: Kadmos, 2013). "Wann ich zum erstenmal Rundfunk hörte, kann ich mit Bestimmtheit nicht angeben. Ich weiß nur noch, wann ich zum erstenmale Kopfhörer aufhatte: […] Ich saß eine halbe Stunde lang an einem unförmigen Gehäuse und fühlte mich durch die Schwere der Kopfhörer […] durch ein noch sinnloseres unartikuliertes Geräusch in meinem Kopf erheblich eingeschüchtert und beengt."

107. Ibid. "Es gibt Leute, die behaupten, daß in diesem Erlebnis der Ursprung für die Vorliebe des Frankfurter Senders für neue Musik zu suchen sei."

108. Karl Flanner, *Hallo! Hallo! Hier Radio Wien!* (Wiener Neustadt: Verein Museum und Archiv im Viertel unter dem Wienerwald, 2007), 3–4. "Zuvor hatte er uns die Spangen mit den Hörmuscheln über den Kopf geklemmt, die den Ohrenschützern im Winter ähnlich waren. Aus diesen Muscheln ertönte nun ein hässliches Krächzen, Kreischen und Pfeifen, in welches des Onkels Finger schließlich Ordnung brachten, worauf das Geräusch plötzlich verstummte, aus den Muscheln Musik erklang und auch Worte verständlich wurden."

Aufzeichnungen eines Radiohörers" (From the notebooks of a radio listener, 1930): "Headphones—actually, they should not be called *phones* but *speakers*," because even when they are left on the tabletop, they "emit a sound, admittedly a very thin, faint sound, as though they were dreaming of music or speech."[109] Headphones, in other words, will continue to broadcast, just like loudspeakers, regardless of whether anyone is listening or not. Seeing as the addressee of radio broadcasts was still not fully determined—early radio programs being addressed to all and each, *omnes et singulatim*—when "the silence suddenly breaks out in sounds, and out of the silence a human being falls into the middle of a mixed choir that persistently demands, 'I should and must court you'," it makes Polgar wonder, "Huh, who is he saying that to?"[110] To deal with these problems of address, different strategies of speaking on the radio developed, such as the use of two moderators holding a dialogue for the audience to eavesdrop on, instead of one moderator directly attempting to hold a dialogue with the absent audience, or the use of meta-discourse markers, intended to reflect the mediated status of the radio.[111] From the perspective of the receiver rather than that of the transmitter, Polgar describes a unique listening practice, designed to introduce chance into the otherwise ceaseless flow of programmed content: "From time to time, I hold [the headphones] to my ear, without knowing what they're loaded with at the moment, and let myself be surprised. (What's the name, when it comes to the ear, for what we call a 'glance' for the eye? A 'hear'?) From time to time, then, I cast an ephemeral hear into the ether."[112] Whereas the act of looking encompasses both attentive and distracted vision, the act of listening necessarily means devoting one's attention to a sound. Polgar's idea of "giving a quick listen" to the radio sounds so strange, because the act of listening is a time-based activity, and the act of listening to the radio is orchestrated to keep listeners glued to one specific station for an extended period of time.

Headphones command the attention of listeners, just as loudspeakers command the attention of passersby—a form of "interpellation" through an imperative, disembodied voice. As Polgar recognized, however, the radio listener actually has more agency, despite being interpellated, than both the everyday viewer and the everyday listener, due precisely to the intervention of technology: "He does not have to listen for one second longer than he wants. At any time, he can take back the sense of hearing that he has

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109. Alfred Polgar, "Aus Aufzeichnungen eines Radiohörers," *Der Tag* (May 11, 1930): 3, repr. in *Kleine Schriften*, ed. Marcel Reich-Ranicki and Ulrich Weinzierl (Reinbek bei Hamburg: Rowohlt, 1982), 28. "Der Kopfhörer – eigentlich sollte es nicht: Hörer heißen, sondern: Töner – ruht, wenn er nicht benützt wird, auf der Tischplatte. Auch so, aus der Entfernung, gibt er Geräusch von sich, allerdings ganz dünnes, leises, als träumte ihm nur von Musik oder Rede."

110. Ibid. "[D]as Schweigen plötzlich in Töne ausbricht, und der Mensch aus der Stille mitten in gemischten Chor fällt, der beharrlich fordert: 'ich soll und muß ein' Buhlen haben.' Ach, wem sagt er das?!" The line, "Ich soll und muß ein' Buhlen haben" is from the German folksong, "Sollen und Müssen," collected in Achim von Arnim and Clemens Brentano's *Des Knaben Wunderhorn* (1805–8).

111. See Gethmann, *Die Übertragung der Stimme*; Peters, *Speaking into the Air*.

112. Polgar, "Aus Aufzeichnungen eines Radiohörers," 28–29. "Ich halte ihn von Zeit zu Zeit, ohne Kenntnis seiner augenblicklichen Geladenheiten, ans Ohr, lasse mich überraschen. (Wie heißt für das Ohr, was für das Auge ein Blick heißt? Ein Hör?) Von Zeit zu Zeit also werfe ich einen flüchtigen Hör in den Äther."

borrowed, removing himself in the middle of a sentence, word, or syllable."[113] For the same reason, the advertising specialist Fritz Pauli argued that radio advertisements were inferior to film advertisements, because "one can take off one's headphones during radio advertisements or simply turn off the receiver; but it is not easy to close one's eyes in the film theatre."[114] Along similar lines, Arnold Zweig had already described "the feeling of boredom" as the true censor for the radio in 1926, suggesting a possible way-station between Kracauer's and Polgar's contrasting views of headphones: "Nobody will listen to what they do not want to hear, if they have the ability to free themselves from unwanted boredom with the simple turn of a dial or the flip of a switch."[115] While Kracauer considers the radio listener to be unable to switch off, Zweig and Polgar consider the possibilities of at least changing the channel.

If the topos of the absent-minded listener was materialized in the forms of headphones and loudspeakers, symbols of an entire generation susceptible to National Socialist radio politics, the radio dial came to represent another form of the concern for the absent-minded audience. The satirical poem "Von Welle zu Welle" (From wave to wave, 1931), published in the *Fliegenden Blättern*, simulated the phenomenon of radio listeners "surfing" through radio stations in an almost Dadaistic manner:

> Crrsh! Crrsh! Phwee! Phweee!
> We interrupt the broadcast and continue the concert with gramophone records
> At 7:10 pm, Mussolini will speak
> Potatoes 4.50 Marks
> Achtung! Murder!
> Boom boom!
> Chance of strong ground fog
> Snow White lay in a glass coffin
> Sehr geehrte Damen und Herren, wir sind nicht imstande
> Et nous verrons, messieurs, comment ça passé
> The goalkeeper bravely covers the ball
> And Capablanca pulls C8/D10
> The farmer awaits warm rain
> O Queen, life is beautiful
> I don't have a second one to send
> …Dolly the good is in Hollywood…
> I'm carrying Elizabeth in my hands…

113. Ibid., 29. "Er muß nicht eine Sekunde länger zuhören, als er will. Jederzeit kann er das Gehör, das er geliehen hat, zurücknehmen, mitten aus dem Satz, dem Wort, der Silbe sich entfernen."

114. Fritz Pauli, "Das Problem des Werbefilms," qtd. in Michael Cowan, "Taking It to the Street: Screening the Advertising Film in the Weimar Republic," *Screen* 54, no. 4 (December 1, 2013): 463–79.

115. Arnold Zweig, "Ästhetik des Rundfunks," *Funk* 51 (1927): 423–24, repr. in *Radio-Kultur in der Weimarer Republik: Eine Dokumentation*, ed. Irmela Schneider (Tübingen: Gunter Narr, 1984), 77–78. "In Wirklichkeit gibt es einen ungemein sicher arbeitenden Zensor in jedem Menschen, nämlich das Gefühl der Langeweile. Kein Mensch hört, was er nicht hören will, wenn er die Fähigkeit hat, durch das Herumdrehen eines Knopfes oder das Herunterdrücken eines Schalters sich von der Langeweile zu befreien, die ihm unerwünscht bereitet wird."

Phwee! Phwee! Crrsh! Tut![116]

In a variety of languages and registers, the poem attempts to capture the experience of surfing the airwaves. However, the poem glosses over the static noise that would have been audible between each line, only presenting it at the beginning and the end of the poem.

By the late 1920s, the ability of radio listeners to change the channel was celebrated, on the one hand, in the lyrics for a popular revue called "Ich schalte um…" (I change the channel, 1930),[117] while the same practice of channel surfing was pathologized, on the other hand, through the trope of an "addiction to channel surfing" (*Drehkrankheit*), the idea of radio listeners obsessively surfing the airwaves without ever stopping on any particular station. According to Johannes Maria Verweyen, "Radioitis occurs when the apparatus is not used as a tool of the mind, but as a means 'merely to pass the time' [….] In our days, the person who literally falls asleep wearing headphones makes it easy to diagnose a case of radioitis."[118] While the radio dial is usually understood as mediating between whomever is operating the radio and the stations being tuned in, media scholar Andreas Fickers argues that the radio dial mediates, in a different sense, between the functional order of allocating broadcast frequencies to various radio stations and the listener's imagined landscape of broadcasting.[119] Generalizing this argument, I claim that the entire radio receiver, consisting of a radio dial, headphones, loudspeakers, and other components for demodulating electromagnetic radiation, mediates between the functional order of signals and noises, and the symbolic order of the airwaves.

Whether praised or blamed, the agency of the channel surfer is due less to the psychological economy of attention and distraction, and more to the technical difference of modern media technology. While absent-minded radio listeners are able, as Polgar puts it, to "lend an ear" to the airwaves simply by putting on and taking off their headphones, wireless telegraph operators are never able to take off their headphones without losing the

116. Qtd. in Andreas Fickers, "Sichtbar hörbar! Rundfunkapparat und Stadt – Knoten im vernetzten Kommunikationsraum," in *Zentralität und Raumgefüge der Grossstädte im 20. Jahrhundert*, ed. Clemens Zimmermann (Stuttgart: Franz Steiner, 2006), 89. "Krtsch! Krtsch! Fuiiiiih! Fuiiiiih! / Wir unterbrechen und setzen das Konzert mit Platten fort / Punk 19:10 wird Mussolini sprechen / Kartoffeln 4.50 Mark / Achtung! Mord! / Bumbum! / Vermutlich starker Bodennebel / Schneewittchen lag in einem Sarg aus Glas / Ladies and Gentlemen, we are not able / Et nous verrons, messieurs, comment ça passé / Der Torwart schmeißt sich kühn dem Ball entgegen / Und Capablanca zieht C8/D10 / Der Landwirt wartet auf den warmen Regen / O Königin, das Leben ist doch schön! / Ich habe keinen zweiten zu versenden / …Der Dolly gut, die ist in Hollywood… / Ich trage Elisabeth auf Händen… / Fuiiih! Fuiiiih! Krtsch! ! Tut!"

117. Günther Bibo and Theo Mackeben, "Aus der Funk-Revue 'Ich schalte um…,'" *Scherl's Magazin* 8 (August 1930): 856–57.

118. Johannes Maria Verweyen, "Radioitis! Gedanken zum Radiohören," *Werag* 1 (1930): 2–5, 8, repr. with commentary in *Medientheorie 1888–1933: Texte und Kommentare*, ed. Albert Kümmel and Petra Löffler (Frankfurt am Main: Suhrkamp, 2002), 454. "Sie ist als Radioitis dort feststellbar, wo der Apparat nicht als Werkzeug des Geistes, sondern als Mittel zum 'bloßen Zeitvertreib' Verwendung findet [….] Der buchstäblich mit den Kopfhörern einschlafende Mensch unserer Tage bietet einen leichten Fall zur Diagnose der Radioitis dar."

119. Fickers, "Sichtbar hörbar!," translated and revised as Andreas Fickers, "Visibly Audible: The Radio Dial as Mediating Interface," in *The Oxford Handbook of Sound Studies*, ed. Trevor Pinch and Karin Bijsterveld (New York: Oxford University Press, 2012), 411–39.

signal entirely. Since the analog signals of voice-over radio are modulated and demodulated via a vacuum tube in a continuous process, the radio apparatus functions as the center of processing, removing the radio listener entirely from the process of encoding and decoding encrypted signals. A wireless telegraph operator, on the other hand, needs to encode and decode the digital signals of Morse Code, transmitted via changes to the medium of electromagnetic waves themselves. In other words, the ear of wireless telegraph operators functioned as a filter; with the advent of radio, technological devices took over this function previously performed by the human body. It was the vacuum tube, in particular, that eliminated the need to isolate a signal out of the noise, and turned the listener into a "message sink" (Nachrichtensenke), as Bernhard Siegert puts it.[120] Automatic tuning devices using vacuum tubes would develop throughout the twenties and thirties, eliminating the need to know how to operate one's radio at all. As the 1931 slogan for the NORA radio put it: "Don't search, just dial!" (Nicht suchen, nur wählen!). Incidentally, this was the kind of radio Polgar owned: "I have a little radio," his essay begins, "its name is Nora, but we call it Kitty."[121] Ultimately, what Polgar, Zweig, Kracauer, and other critics were registering was a radical shift from the cultural techniques of reading, writing and counting, which had still been necessary for the transmission and reception of wireless telegraphy, to the technological devices capable of processing signals according to their own intelligence and operating according to their own temporality. This epistemic shift from pre-modern cultural techniques to modern electronic technologies will be the subject of my next chapter.

At the end of his essay on the radio listener, Polgar describes how, before going on vacation one time, he forgot to turn off his radio set, and left the headphones sitting on the tabletop. He imagines the radio broadcasting non-stop while he is away: "The recipient of dialogues and polemics, humor and stock prices, pretty much anything that moves the human heart, always or only now, was my tabletop."[122] The classical figure of the author, composing silently in his studio, has been replaced by the low hum of *Bildung* over the radio, and the message of the medium now only gets transmitted from the cold steel of the radio receiver into the lifeless wood of the tabletop. Upon returning home from his vacation, Polgar is amazed that there is no trace of the broadcasts, reflecting what I view as an epistemic rupture from absentmindedness (*Geistesabwesenheit*) to something like the absence of the mind (*Abwesenheit des Geists*). The essay ends: "No trace remained, not even such a tiny one as would be left by one's breath. When I think, 'What if I had left the water running for two weeks!' It's good that the spirit [*Geist*] does not have a substance."[123]

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120. Bernhard Siegert, *Passage des Digitalen: Zeichenpraktiken der neuzeitlichen Wissenschaften 1500–1900* (Berlin: Brinkmann & Bose, 2003), 397.

121. Polgar, "Aus Aufzeichnungen eines Radiohörers," 28. "Ich habe einen kleinen Radioapparat. Er heißt Nora, aber wir rufen ihn Mieze."

122. Ibid., 30. "Zwiesprache und Polemik, Humor und Börsenkurse, von so ziemlich allem, was Menschenherz bewegt, immer oder nur jetzt, empfing meine Tischplatte."

123. Ibid., 30–31. "Nicht einmal so winzige Spur wie die vom Hauch eines Atems war zurückgeblieben. Wenn ich denke, ich hätte während der vierzehn Tage den Wasserleitungshahn offen gelassen! Es ist doch gut, daß der Geist keine Substanz hat."

Conclusion: Rundfunk für alle!

A coda to the Weimar program of "radio for all" came on August 22, 1930, when the honor of delivering the opening address at the seventh annual radio exhibition in Berlin went to none other than the newly famous ambassador of German science, Albert Einstein.[124] The speech marked the seven-year anniversary of German radio, a span of time during which the number of radio sets registered to the postal ministry had grown rapidly from around 500,000, in 1924, to over 3,500,000, by the year of Einstein's address.[125] This meant that roughly 10 million out of 65 million Germans had the opportunity to hear Einstein's speech, which was delivered beneath the *Berliner Funkturm* at the site of the radio exhibition fairgrounds in Charlottenburg, and simultaneously broadcast on the *Reichs-Rundfunk-Gesellschaft*'s radio station. This simulcast created an unusual rhetorical situation that Einstein acknowledged in his even more remarkable salutation: instead of the expected formulaic greeting, "Esteemed ladies and gentlemen" (Sehr geehrte Damen und Herren), the speech opens with the more reflective, "Distinguished guests present and absent" (Verehrte An- und Abwesende). In contrast to the conventional gendered division of the audience, Einstein's salutation divided the audience into those present and those absent, thereby reflecting on the technological conditions of possibility underlying the new medium, as he was encouraging listeners to do as well. In the speech, Einstein reminded the audience(s) not to forget the origins of their new favorite medium: "Whenever you listen to the radio, remember how this wonderful communication tool came into our possession. The original source of all technical achievements lies as much in the divine curiosity and the ludic drive of researchers [*Forscher*] tinkering and ruminating, as in the constructive fantasy of the technical inventor [*Erfinder*]."[126] In attributing more credit for the invention of the radio to incremental engineering improvements than to a singular moment of technological invention, and more credit to either of those than to announcers, actors, musicians, and broadcasters, Einstein's speech must have appealed to the present audience—primarily, a group of hobbyists and enthusiasts attending the radio exhibition. In a more demotic turn, Einstein then admonished those uninterested in wireless technology, presumably in the absent audience: "Those who thoughtlessly accept the wonders of science and technology should be ashamed, for they do not understand science and technology any more than a cow understands the botany of the plants it eats complacently."[127] With this prescient image of mindless consumption, Einstein's speech shifts the terms of radio from the *metaphysics* of presence and absence to the *physics* of electromagnetic radiation.

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124. Albert Einstein, "Rede zur Eröffnung der Siebten Großen Deutschen Funkausstellung in Berlin, 1930," *Rundfunk-Jahrbuch* (Berlin: Reichs-Rundfunk-Gesellschaft, 1931), 240.

125. For these numbers, see Führer, "A Medium of Modernity?," 731.

126. Einstein, "Rede," 240. "Wenn Ihr den Rundfunk höret, so denkt auch daran, wie die Menschen in den Besitz dieses wunderbaren Werkzeuges der Mitteilung gekommen sind. Der Urquell aller technischen Errungenschaften ist die göttliche Neugier und der Spieltrieb des bastelnden und grübelnden Forschers und nicht minder die konstruktive Phantasie des technischen Erfinders."

127. Ibid. "Schämen sollten sich die Menschen, welche die Wunder der Wissenschaft und der Technik gedankenlos hinnehmen und nicht mehr davon geistig erfasst haben, als die Kuh von der Botanik der Pflanzen, die sie mit Wohlbehagen frisst."

In my analysis, Einstein's speech can be understood as a direct response to Bredow's address of the future wireless age, discussed at the start of this chapter. In fact, Bredow was seated in the front row when Einstein delivered his speech. For Einstein, the significance of the radio was not to be found in the voices of moderators, in the sounds of records, or in the hybrid noises of radio plays, all of which together make up the content of radio programming; and the state secretary with a front row seat was definitely not its creator. Rather, the wonders of radio, for Einstein, were taken to be the result of the techniques and technologies that were developed in order to modulate electromagnetic waves to be the carriers of information in the first place. Whereas Bredow writes,

> Think of the blind, think of the sick and weak, think of the lonely people in the solitude of the steppes and minefields, think of the boatman crossing the desert of the ocean for weeks and months, they all have the potential to live together and to experience together in the community of people who are like-minded and speak the same language,[128]

Einstein writes,

> Think of [Hans Christian Oersted] who was the first to notice the magnetic effect of electrical current, and [Philipp] Reis, who was the first to use this effect to create sound in an electromagnetic way, of [Alexander Graham] Bell, who, using sensitive contacts with his microphone, was the first to convert sonic vibrations into variable electric currents. Think, too, of [James Clerk] Maxwell who demonstrated the existence of electric waves in a mathematical way, of [Heinrich] Hertz, who, using a spark, was the first to create them and verify them. In particular, remember [Robert von] Lieben, who conceived of an incomparable organ for detecting electric vibrations in vacuum tubes [*Ventrilröhre*], which also turned out to be the ideal simple instrument for creating electric vibrations. Remember, in gratitude, the nameless technicians who simplified the instruments of radio communication and adapted them to mass production to the extent that they have become available to everyone [….] Think, too, that it is the technicians [*Techniker*, also, "engineers," "repairmen"] who are the first to make true democracy possible.[129]

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128. Bredow, "Eure Aufgaben im Rundfunk," 230. "Denkt an die Blinden, denkt an Kranke und Schwache, denkt an die Einsamen in den Einöden der Steppen und Minenfelder, denkt an den Schiffer, der wochen und monatelang die Wasserwüste der Ozeane kreuzt, sie haben heute alle die Möglichkeit, mitzuleben und mitzuerleben in der Gemeinschaft der Gleichsprachigen und Gleichgesinnten."

129. Einstein, "Rede." "Denkt an Oersted, der zuerst die magnetische Wirkung elektrischer Ströme bemerkte, an Reis, der diese Wirkung zuerst benutzte, um auf elektromagnetischem Wege Schall zu erzeugen, an Bell, der unter Benutzung empfindlicher Kontakte mit seinem Mikrophon zuerst Schallschwingungen in variable elektrische Ströme verwandelte. Denkt auch an Maxwell, der die Existenz elektrischer Wellen auf mathematischem Wege aufzeigte, an Hertz, der sie zuerst mit Hilfe des Funkens erzeugte und nachwies. Gedenket besonders auch Liebens, der in der elektrischen Ventilröhre ein unvergleichliches Spürorgan für elektrische Schwingungen erdachte, das sich zugleich als ideal einfaches Instrument zur Erzeugung elektrischer Schwingungen herausstellte. Gedenket dankbar des Heeres namenloser Techniker, welche die Instrumente des Radio-Verkehres so vereinfachten und der

Bredow, adopting the style of a jeremiad, envisioned the democratic potential of the new medium to be the formation of a monolingual public sphere. Einstein, turning around the jeremiad into a eulogy, attributed the democratic effects of the radio to scientific internationalism. If the least common denominator uniting individuals in Bredow's community of radio listeners is language and culture, the one uniting individuals in Einstein's community of science is technological progress. In both cases, the democratic space of radio is imagined to be free of conflict and dissent.[130]

However, wireless communication is not only a matter of inclusion—of making connections, creating communities, and providing a semblance of immediate contact at any location around the world. As Michel Serres argues, every act of communication is also an act of exclusion: "*To hold a dialogue is to suppose a third man and to seek to exclude him*; a successful communication is the exclusion of the third man. The most profound dialectical problem is not the problem of the Other, who is only a variety—or a variation—of the Same, it is the problem of the third man. We might call this third man the *demon*, the prosopopoeia of noise."[131] The demon, the third person, the figure of noise—whomever or whatever must be excluded from the act of communication in order for it to succeed, is what Serres will famously come to call the "parasite." Playing on the French *bruit parasite*, designating the static, interference, or scrambling of signals in every electronic system, Serres extends the logic of eavesdropping and interception to any conceivable system composed of stations and pathways: "Saying that this system includes the telephone, the telegraph, television, the highway system, maritime pathways and shipping lanes, the orbits of satellites, the circulation of messages and of raw materials, of language and foodstuffs, money and philosophical theory, is a way of speaking clearly and calmly. And looking to see who or what intercepts these different flows is also a way of speaking clearly and calmly. It is a complicated way of speaking, but it is really an easy way."[132] In my analysis, the complications arise not only in extending the logic of communication to the logic of any relation, but also in extending the logic of relation from two to three to four, *ad infinitum*: "As soon as we are two, we are already three or four," Serres writes. "In order to succeed, the dialogue needs an *excluded* third; our logic requires the same thing. Maybe they also require an *included* fourth."[133] While Serres' theory of the parasitic third is becoming increasingly well

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Massenfabrikation anpaßten, daß sie jedermann zugänglich geworden sind [….] Denket auch daran, daß die Techniker es sind, die erst wahre Demokratie möglich machen."

130. Einstein's list is, above all, a list of "firsts," the classic mode of narration for the history of technology. See Patrice Flichy, *Dynamics of Modern Communication: The Shaping and Impact of New Communication Technologies*, trans. Liz Libbrecht (London: Sage, 1995); for a more comprehensive collection of inventors than those named in Einstein's speech, see Siegfried von Weiher, *Männer der Funktechnik: Eine Sammlung von 70 Lebenswerken deutscher Pioniere der Funktechnik (drahtlose Telegrafie, Radar, Rundfunk und Fernsehen)* (Berlin: VDE-Verlag, 1983), the title of which is highly revealing.

131. Michel Serres, *Hermes: Literature, Science, Philosophy*, ed. Josué V. Harari and David F. Bell (Baltimore: Johns Hopkins University Press, 1982), 67, italics in the original.

132. Michel Serres, *The Parasite*, trans. Lawrence R. Schehr (Baltimore: Johns Hopkins University Press, 1982), 11.

133. Ibid., 57, emphasis added.

known in media studies, his comment on the parasitic fourth does not factor into any media theory I know of. Yet it is at precisely this precarious position between the *excluded* third and the *included* fourth, I would argue, that wireless technology is implemented for the purposes of broadcasting.

Each wireless topos discussed in this chapter involves not only a third, a noisy demon that must be excluded, but also in some cases an included fourth. In the topos of the wireless age, the rhetoric of wireless replacing wires in a single revolutionary moment excludes the possibility that the two will continue to co-exist side-by-side. Understanding wireless as a replacement for wires, often framed in terms of misunderstanding the novelty of the technology itself, exposes not only the widespread rhetoric of exclusion on the basis of race, class, and gender, but also the ways in which many were excluded from participation in technology, and by extension, in the project of modernity. The flip side of perpetual contact and enhanced conversation is the threat of proximity engendered by wireless telemedia, expressed in the Weimar Republic in the form of concerns about reverse colonization and the order of national culture dissolving in the chaos of the airwaves. In the case of national broadcasting, the parasite of radio *for* all is the possibility of radio *by all*. All wireless communications, at least in the mode of omnidirectional broadcasting, are available to anyone with the appropriate receiver. In order for multiple people to be able to communicate at the same time, however, the order governing wireless transmissions must exclude not only those who do not want to listen (i.e., the excluded third), but also those who want to listen *in* (i.e., the included fourth). With the development of national broadcasting, the wireless parasites are amateur broadcasters who might create interference and overlapping transmissions. In the transition from amateur wireless telegraphy to national radio broadcasting following World War I, the German word that developed for these parasites was *Funkerspuk*, the ghosts of paramilitary radio amateurs threatening the order of the radio frequency spectrum with chaos.[134] These wireless parasites were what had to be excluded for the formation of a symbolic order of national broadcasting.

In the end, the study of media topoi need not be restricted to the category of space. To become a viable research methodology, Huhtamo's approach to media topoi, as spaces or places, needs to be complemented by an approach to media kairos, a conception of media time or temporality. As Bruno Latour argues, "Place is not a feature easier to understand than time. When a place counts as a topos it also counts as a kairos. Deeper than time and space there is another question about who or what counts."[135] In contrast to the concept of time as *chronos*, or duration, Latour develops the concept of time as *kairos*, an opportunity for action: "Which actants can interrupt, modify, interfere, interest which others, thus producing as many topoi-kairoi?"[136] In similar terms, Peter Sloterdijk, following Martin Heidegger, speaks of "Kairologie", the study of what comes at the right time; and, in describing the "deep time of the media," Siegfried Zielinski views kairos in

134. On the *Funkerspuk*, also referred to as the *Funkspuk*, see Lerg, *Die Entstehung des Rundfunks in Deutschland*.

135. Bruno Latour, "Trains of Thought: Piaget, Formalism and the Fifth Dimension," *Common Knowledge* 6, no. 3 (Winter 1997): 170–91.

136. Ibid.

similar fashion as an opportunity for action.[137] To speak of media topoi thus means to keep the spatial and the temporal, the logics of inclusion and exclusion, of the constitutive folding of past, present, and future in mind, demonstrating that any history of the emergent order of wirelessness cannot be written as a linear narrative of progress and invention. In the next chapter, I continue this inquiry, asking the question of why, if electromagnetic radiation has always existed, it was only first detected and exploited for the purposes of wireless transmission in the course of the long nineteenth century. What techniques were previously available for signaling at a distance, and what was it that made this historical moment the right place and the right time for the birth of wireless?

137. Siegfried Zielinski, *Deep Time of the Media*; on kairology, see Peters, *The Marvelous Clouds*, 242.

CHAPTER TWO

Signaling Without Wires: Origin Stories and Primal Scenes of Wireless Communication

There is a memorable comparison in Alfred Döblin's *Berlin Alexanderplatz* (1929) between two historical modes of "wireless" transmission.[1] The first mode is not the new mass medium of radio, as one might expect today in light of the novel's adaptation into a radio play the following year and the author's own enthusiasm for the new medium.[2] Instead, it is the already aging, elite informational medium of wireless telegraphy, still in use across Germany at the time for sending telegrams, stock prices, and weather reports. The second mode is the ancient technique of signaling at a distance using chains of beacons, famously used on one occasion to transmit the news of the Fall of Troy, and, with that, the return of Agamemnon to his wife Clytemnestra, from the site of the battle on the northern Aegean coast to the remote location of Argos in Southern Greece. In the extended aside comparing these two modes of signaling at a distance without wires, the narrator ultimately comes to a provocative conclusion: "We can't compare ourselves with this way of doing things. Here again we're *inferior*."[3] To most readers, the modern technology of wireless telegraphy, transmitted in the form of electromagnetic waves traveling at the speed of light, must have seemed infinitely *superior* to anything that came before it, as is evident in the common media topoi of wireless transmissions overcoming space and time, enabling perpetual contact, and creating a form of enhanced conversation. To Döblin, however, there is "no comparison" between the two, in the sense that the modern technology is inferior to the pre-modern cultural technique, and yet the very act of drawing a comparison implies a significant question about the history of wirelessness. To what extent is the modern technology of wireless telegraphy at all comparable with pre-modern cultural techniques of communication at a distance? The question is anything other than trivial, for it addresses the fundamental problem of continuity versus discontinuity in the history of communication media.

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1. Alfred Döblin, *Berlin Alexanderplatz: Die Geschichte von Franz Biberkopf* [1929] (Baden-Baden: Suhrkamp, 1980), 140–41; translated by Eugene Jolas as *Berlin Alexanderplatz: The Story of Franz Biberkopf* (New York: Continuum, 2004), 75–76.

2. On the production and reception of the novel (1929), the radio play (September 1930), and the sound film (October 1931), see Peter Jelavich, *Berlin Alexanderplatz: Radio, Film, and the Death of Weimar Culture* (Berkeley: University of California Press, 2006); on Döblin's appearances on the radio and his enthusiastic work as an amateur radio tinkerer, see Matthias Prangel, "Die Rundfunktheoretischen Ansichten Alfred Döblins," in *Literatur und Rundfunk, 1923–1933*, ed. Gerhard Hay (Hildesheim: Gerstenberg, 1975), 221–29; on Döblin's literary and media aesthetics, in general, and his comparison between the two modes of wireless transmission, in particular, see Stefanie Harris, *Mediating Modernity: German Literature and the "New" Media, 1895–1930* (University Park, PA: Pennsylvania State University Press, 2009), 124–26.

3. Döblin, *Berlin Alexanderplatz*, 75–76, emphasis added. "Mit dieser Aufmachung können wir uns nicht vergleichen. Da stehen wir wieder zurück."

An absence of wires is not necessarily the same thing as the presence of wireless. To put it bluntly, the fact that no wires have been discovered in shipwrecks at the bottom of the Mediterranean does not mean that the ancient Greeks communicated wirelessly. While the beacon chains transmitting the burning message "wirelessly" from the site of the battle in the ancient Mediterranean to a remote location required the participation of an entire society, the wireless telegraph works according to its own cool logic—not only in the sense of Marshall McLuhan's distinction between "hot media" and "cold media," but also in that of Helmut Lethen's description of the "cool conduct" characteristic of the New Objectivity.[4] I argue that modern wireless telegraphy, as a cool medium in both of these senses, may seem to preclude analysis, though it actually only requires more hermeneutic work, at the same time as it provides interpreters a certain hermeneutic distance. Ultimately, Döblin's extended aside is symptomatic of the "problem of origins" starting around 1900 and coming to a head with the "crisis of historicism" in the 1920s.[5] In searching for an "origin" (*Ursprung*) or a "primal scene" (*Urszene*) of wireless communication, the narrator in *Berlin Alexanderplatz* can draw on an entire mythology surrounding the ancient Greek technique of fire signals—primarily, in the first play of Aeschylus's *Oresteia* trilogy, the origin of Western tragedy as such, concerning their use for relaying the news of the Fall of Troy. However, the only information the narrator can recall about the origins of wireless technology is where one of its inventors lived, when he died, and whether or not he had any facial hair. Is there anything more for literature to say about wireless technology, in the modern age of electric and electromagnetic transmission, other than, as Döblin puts it, "it functions, and that's all"?[6]

In this chapter, I consider the problematic pre-history of wireless communication in the *longue durée* through a comparative analysis of common origin stories (*Ursprung*) and primal scenes (*Urszene*) of wireless telegraphy. In Wilhelmine Germany, as soon as the first modern wireless technology appeared, there were immediate attempts to authorize the new medium through comparison with old media. In these narratives, techniques of signaling at a distance without wires were usually traced back to three main historical moments. In Greek antiquity, the optical technique of beacon chains described above developed at the same time acoustic techniques of drum signals were developing in Africa and China. If the former represented an ideal of order, in subsequent German origin stories, the latter was a symbol of disorder. Although many of these optical and acoustic techniques probably remained known throughout the Middle Ages, they were only "rediscovered" and systematically described in the transition from the Late Middle Ages to the early modern period. During this period, techniques of signaling at a distance assumed a new significance with the discovery of magnetism, thought to enable a form of sympathetic communication among interlocutors who had touched the same material with a compass needle. In developing these systems, codes often referred to the medieval

4. McLuhan, *Understanding Media*; Helmut Lethen, *Cool Conduct: The Culture of Distance in Weimar Germany*, trans. Don Reneau (Berkeley: University of California Press, 2001).

5. On the multiple meanings of "origin" and "primal scene," and the concepts of *Ursprung* and *Urszene*, see Yael Almog, Caroline Sauter, and Sigrid Weigel, "Ursprung/Urszene," *Trajekte* 30 (2015): 4–15.

6. Döblin, *Berlin Alexanderplatz*, 143. "[E]s funktioniert, und damit fertig."

order of communication with spirits, though it remains uncertain whether the reference was actually a symbolic code or more of an elaborate means of encryption. Around 1800, optical telegraphy developed as the first large-scale communications infrastructure in Europe even before electrical telegraphy, though each challenged the established order of the postal service with the development of a new kind of sign. Lastly, there was also an alternate genealogy of wireless technology that considered wireless telegraphy to be a much more recent invention, arising as a direct response to problems inherent in wired telegraphy.

The innovative approach of this analysis, covering a (relatively) long span of time, adopts the perspective of what Siegfried Zielinski, adapting a paleontological concept, calls the "deep time of the media."[7] The aim of comparing these different techniques of signaling without wires is not to encompass an entire process of historical development, wherein modern wireless technology inevitably evolves out of pre-modern and early modern techniques in a linear sequence of quantitative improvements—the speed of transmission becoming increasingly faster, the distances covered increasingly greater, the time required increasingly shorter, and the code involved increasingly more efficient. Rather, the perspective of the deep time of the media should allow qualitative turning points to emerge within this process of development.[8] These moments, Zielinski argues, are signs pointing to where "things and situations were still in a state of flux, where the options for development in various directions were still wide open, where the future was conceivable as holding multifarious possibilities of technical and cultural solutions for constructing media worlds."[9] In this respect, the deep time of the media is allied with the study of origin stories and primal scenes, which differ from the concept of "beginnings" in that they exceed a history of development, teleology, or models based on progress.[10]

As moments when something comes into focus, appears, or takes on a specific form, the origin stories of wireless telegraphy examined in this chapter illuminate distinctions currently debated in media theory between pre-modern cultural techniques and modern electronic technologies.[11] Alfred Döblin was hardly alone in ascribing the lack of a symbolic dimension to modern technology vis-à-vis pre-modern techniques: the claim is also at the heart of German media theory, as will be explained in the next section. During the periods of media-in-transition discussed in this chapter, the status of letters and literature was also in flux, and at the heart of this chapter is a question about the possibility of literature in the age of modern wireless technology: To what extent, to rephrase one of Wolf Kittler's thought-provoking claims as a question, "is literature in the age of universal communication, which starts with the spread of wireless and telegraphy during World War I, no longer legible as free play, but much more as a

7. Zielinski, *Deep Time of the Media*.

8. Ibid., 31.

9. Ibid., 10.

10. See Almog, Sauter, and Weigel, "Ursprung/Urszene."

11. See Bernhard Siegert, *Cultural Techniques: Grids, Filters, Doors, and Other Articulations of the Real*, trans. Geoffrey Winthrop-Young (New York: Fordham University Press, 2015); Wolfgang Ernst, "'Medien' im Mittelalter? – Kulturtechnische Retrospektive," in *Mediävistik im 21. Jahrhundert: Stand und Perspektiven der internationalen und interdisziplinären Mittelalterforschung*, ed. Hans-Werner Goetz and Jörg Janut (Munich: Fink, 2003), 347–57.

symptom that refers to a particular discourse beyond the speech of the individual subject?"[12] If, in the modern era, machines tend to aspire to the real but always seem to fall short of their virtual utopias, I argue that pre-modern techniques of signaling without wires indicate the lasting power of the symbolic and the imaginary, while also suggesting a means for providing a fresh reading of modern wireless literature.

Wireless Before Wireless

Before the wire, all communication was "wireless," and yet there was no such thing as "wireless communication." There was only "communication," itself not yet even named as such. The question of whether modern concepts of *media*, *communication*, and *information* can be applied to the study of pre-modern and early modern mediality remains controversial.[13] The concepts are a difficult fit for periods before the realization of communication as a discourse, before the materialization of devices capable of automatic storage, processing, and transmission, and before the formation of electromagnetic devices and the science of information theory as a means of understanding and optimizing these developments. Admittedly, the concepts of media, communication, and information have become much more expansive in recent years, encompassing not only "new media" like film, radio, and the computer but also "old media" like the book, the manuscript, and the human body. Still, a basic distinction is often made in historical studies of mediality between media *sensu stricto*, meaning modern electronic technologies of information processing, and media *sensu lato*, referring to more universal forms of symbolic communication.[14] In the broad sense, there obviously were media outside of modernity, many of which are still around today in the same or similar forms, though none of these pre-modern forms of mediality fulfill the conditions of modern electronic media, at least not in the *sensu strictissimo*, the quantitative sense of modern information theory—namely, the automatic storage, transmission, and processing of information.[15] In a still broad sense, there were also pre-modern terms for *media*, *information*, and *communication*, in both Latin and the vernacular, though the meanings of these words differed significantly from current usage.[16] Ultimately, none of these pre-modern concepts took into account the materiality of media, a neglect characteristic, in Friedrich Kittler's analysis, of the entire history of philosophy since Aristotle, whose "ontology deals only with things, their matter and form,

12. Wolf Kittler, "Grabenkrieg – Nervenkrieg – Medienkrieg: Franz Kafka und der 1. Weltkrieg," in *Armaturen der Sinne: Literarische und technische Medien 1870 bis 1920*, ed. Jochen Hörisch and Michael Wetzel (Munich: Fink, 1990), 301. "So ist Literatur im Zeitalter universaler Kommunikation, das mit der Ausbreitung von Funk und Telegraphie im ersten Weltkrieg angebrochen ist, nicht mehr zu lesen als ein freies Spiel, sondern vielmehr als Symptom, das auf einen ganz bestimmten Diskurs jenseits der Rede des einzelnen Subjekts verweist."

13. For a more detailed presentation of the following argument, see Erik Born, "Media Archaeology, Cultural Techniques, and the Middle Ages: An Approach to the Study of Media before the Media," *Seminar* 52, no. 2 (May 2016): 107–33.

14. See, for example, Horst Wenzel, "Medien- und Kommunikationstheorie: Ältere deutsche Literatur," in *Germanistik als Kulturwissenschaft: Eine Einführung in neue Theoriekonzepte*, ed. Claudia Benthien and Hans Rudolf Velten (Reinbeck bei Hamburg: Rowohlt, 2002), 129.

15. See Ernst, "'Medien' im Mittelalter?," 347.

16. See Stefan Hoffmann, *Geschichte des Medienbegriffs* (Hamburg: Meiner, 2002), 24–28.

but not with relations between things in time and space."[17] Nevertheless, I argue that, even if there were no concepts for media, information, and communication in the quantitative sense, and even if there were no direct precursors to modern electronic media, there was still a latent awareness of qualitative differences in the amount of work involved in transmitting a message within eyesight or earshot and doing so over significantly larger distances.

What allows for any comparison to be made, not only between pre-modern and modern modes of signaling at a distance without wires, but even between the radically different modern systems of telegraphy and telephony, is ultimately a modern interpretive construct—namely, telecommunications.[18] A French neologism, the word *télécommunication* was coined, in 1904, by the French postal administrator, Édouard Estaunié, as an umbrella term for the landline telephone and the electric telegraph, adding the Greek prefix *tele-* to the Romance language *communication*.[19] Surprisingly, the concept would not gain wide acceptance in France until the 1920s, and remained largely unknown in the rest of Europe until 1932, when it was included in the official title of a newly reorganized regulatory agency, the International Telecommunication Union (ITU). At the time it was coined, the once autonomous communication media it described—telegraphy and telephony—had already become linked in the form of international networks. Today, media historians use the term to describe a variety of communications networks, including the electric telegraph and the landline telephone, as well as their precursor, the optical telegraph, and their successors, radio, television, satellites, the mobile telephone, and the Internet. In the concept of telecommunications, a basic distinction is made in terms of "transmission systems" between "*line* transmission" and "*radio* transmission,"[20] precisely on the basis of the materiality of the transmission medium, wires versus wireless.

If scholarship in media studies at the end of the twentieth century tended to focus on radio transmission in the form of national broadcasting, which was still taken to represent a wave of the future, more recent scholarship is attempting to salvage the term telecommunication for the restricted but significant case, which is actually on the rise in Europe, North America, and much of the world, of long-distance communications networks that transmit messages from point to point.[21] In the most common definition of the concept, there are usually three main features: telecommunication eliminates geographic distances in favor of technological distance; it reduces the time needed to transport messages; and it does away with the need for messengers, and thus the master-servant relationship.[22] As I argued in the first chapter, these have been the common media topoi of wired and wireless transmission media since the mid-nineteenth century, when electricity had already become the dominant material support for transmission at a

17. Friedrich A. Kittler, "Towards an Ontology of Media," *Theory, Culture, and Society* 26, no. 2–3 (2009): 23–24.

18. For the following overview, see Balbi and John, "Point-to-Point."

19. Édouard Estaunié, *Traité pratique de télécommunication electrique*, qtd. in Anton A. Huurdeman, *The Worldwide History of Telecommunications* (New York: J. Wiley, 2003).

20. Ibid., 5.

21. See Balbi and John, "Point-to-Point."

22. Huurdeman, *The Worldwide History of Telecommunications*, 3.

distance. Ultimately, the main assumption underlying studies of telecommunications is that science and industrialization are necessary and sufficient conditions of possibility for the development of modern communication technology: "They made telecommunications possible, and on the other hand, cannot now exist without telecommunications," as media historian Anton Huurdeman puts it.[23] The aim of this chapter is to nuance and to contextualize this generalization.

In searching for the origins of wired and wireless technology at the turn of the twentieth century, early historians of science and technology struggled to strike a balance between the novelty of scientific developments and the need to legitimize their research. For example, William Ayrton's lecture, discussed in the previous chapter, is known today only for his concluding prediction about the future of wireless telephony, though the lecture itself was actually devoted to a slightly different topic: "Sixty Years of Submarine Telegraphy." This topic, transoceanic wired telegraphy, was far more in line with the mission of the Imperial Institute where the lecture was delivered, namely, promoting scientific research that would support the industrial and commercial development of the British Empire's colonial holdings. In my analysis, Ayrton's lecture can be understood not only in terms of its seeming prophetic qualities, but also as a testament to the difficulty of writing a history of technology that would keep pace with the speed of technological advancement. At the start of the lecture, Ayrton commented on the constraints of the format: "Sixty years in sixty minutes, the conventional hour for a lecture […] seems like express railway speed, and indicates the sort of electric speed at which I must go through the whole of the subject of my lecture this evening."[24] Then, after quickly reviewing early speculations about undersea cables from 1837, subsequent difficulties in the laying of the transatlantic telegraph cable in the 1860s, and plans for laying the transpacific cable (only to be executed five years after the lecture), Ayrton paused to reflect: "A map of the cables of the world shows that since that time many, many cables have been laid. These cables have no history. Happy is the cable that has no history!"[25] In this respect, Ayrton's prediction about the future of wireless technology at the end of the lecture, about a time "when copper wires, gutta-percha coverings and iron sheathings will be relegated to the museum of antiquities," functions as a comment about the perceived obsolescence not only of wired technology, but also of any possible history of that technology itself.

If the cable seemed to have "no history," thus escaping the jurisdiction of the traditional academic discipline, the task of writing the history of technology would fall not to historians but to physicists and engineers. In an editorial note at the start of the issue of *The Electrician* containing the transcript of Ayrton's lecture, the editors stated: "We have always been of [the] opinion that a writer could ask for no more inspiring theme than the inception and extension of submarine telegraphy; but until we heard Prof. Ayrton's lecture at the Imperial Institute on Monday evening it would have gone hard with us to name a possible historian."[26] Despite this claim, some popular histories of

23. Ibid., 7.
24. Ayrton, "Sixty Years of Submarine Telegraphy," 545.
25. Ibid., 548.
26. "Notes," *The Electrician* 38, no. 17 [979] (February 19, 1897): 527.

technology were composed during the period, and although they are often used as source material today, there has been little reflection on either the legitimizing strategies within these histories or the significance of writing these histories as a strategy for establishing the legitimacy of the technologies they described. One of the earliest histories of wireless technology, John Joseph Fahie's *A History of Wireless Telegraphy, 1838–1899* (1899), quotes Ayrton's prediction about two friends communicating in a future wireless age on the very first page as an example of the popular astonishment at the new medium of wireless telegraphy, of how "cautious men of science spoke, or should I not say dreamt thus," making it easy to "imagine the ideas that were passing in the minds of those of the general public who gave the subject a thought."[27] Similarly, Adolf Slaby's popular lecture series *Die Funkentelegraphie* (Wireless telegraphy, 1900), quotes Ayrton's prediction on the very last page, and comments that "the wonderful phenomena that nature has revealed to us in the mysterious play of electric sparks make many people into poets, indeed, even so serious a scholar as Professor Ayrton cannot resist dreaming up an image of the future in his waking moments." If nature had turned Ayrton into a poet, it turned Slaby into a comedian, who ends the book with the following quip: while the friend in the scene described by Ayrton may be dead, "Science lives eternally and in the blossom of youth, and, century after century, scoops valuable new treasures out of the bottomless fountain of nature."[28] Significantly, these kinds of quotations of Ayrton's prediction in early histories of wireless telegraphy were not located at any arbitrary place in the text, but specifically at the beginning of the introduction or at the end of the conclusion. Quoted as a framing statement, the function of Ayrton's prediction is twofold: on the one hand, it frames the history of technology currently being written as an attempt to counteract common astonishment at the novelty of the medium; on the other hand, it presents the invention of wireless technology around 1900 as a solution to the seemingly universal, pre-historic dream of communicating at a distance, captured in Ayrton's scene of primal communication.

Reviewing the history of wireless telegraphy in 1905, Eugen Nesper, trained not as a historian but as a high-frequency technician, was already weary of the common historiographical search for the origins of modern technology. Instead of attempting to trace the history of wireless telegraphy back to the dawn of time, Nesper's short overview of wireless technology's "historical development" (geschichtliche Entwicklung) is content with pointing out a flaw in the common approach: "Almost all the historical introductions to accounts of wireless telegraphy begin with the optical and acoustic transmission of signs used by ancient civilizations, even though these simple and, measured in terms of their own times, ingenious set-ups do not have anything more in common with electromagnetic wave telegraphy than that messages were transmitted from

27. John Joseph Fahie, *A History of Wireless Telegraphy, 1838–1899, Including Some Bare-Wire Proposals for Subaqueous Telegraphs* (New York: Dodd, 1899), viii.

28. Slaby, *Die Funkentelegraphie*, 119. "[A]ngesichts der wunderbaren Erscheinungen, welche uns die Natur in dem geheimnisvollen Spiel des elektrischen Funkens offenbart, wird man unwillkürlich zum Dichter, ja selbst ein so ernster Gelehrter wie Prof. Aytron kann es sich nicht versagen, ein Zukunftsbild wachend zu träumen. Ewig aber und jugendfrisch—so wollen wir hinzufügen—lebt die Wissenschaft und schöpft Jahrhundert um Jahrhundert neue werthvolle Schätze aus dem unversieglichen Born der Natur."

one place to another without any direct metallic wire."[29] This frank and accurate characterization of then-current scholarship, exemplified by the tradition of historiography stretching from Adolph Poppe's *Die Telegraphie von ihrem Ursprunge bis zur neuesten Zeit* (Telegraphy from its origins to the most recent times, 1848) through Richard Hennig's *Die älteste Entwicklung der Telegraphie und Telephonie* (1908), still rings true even for more recent historiography.[30] As Nesper points out, none of the ancient methods of signaling at a distance were actually a matter of tele*graphy*, in the sense of inscription, since they involved lighting fires, waving flags, and other similar visual techniques. "However, one would be mistaken," Nesper continues, "if one wanted to assume that wireless telegraphy is of a very recent origin, though it has to be admitted that the scientific treatment of the fundamental phenomena as well as their practical application for purposes of communication has only succeeded in the last decade."[31] On the one hand, Nesper dismisses pre-modern cultural techniques as the origins of wireless communication due to the technical differences between the complexity of electromagnetic radiation and the simplicity of light and sound; on the other hand, he is reluctant to abandon the search for origins entirely. The surprising Urszene of wireless telegraphy that Nesper eventually settles on is situated in the late eighteenth century—namely, the Italian anatomist Luigi Galvani's discovery that a frog's leg will twitch under the influence of an electric field. "In this case, the frog leg was the detector, and the copper hook that the leg with its bundle of nerve fibers was hanging on, the antenna."[32] Nesper's account of the origins of wireless telegraphy is so at odds with the common historiography of the time that it will have to wait until the end of this chapter for further analysis. More pressing for the present argument is his claim that pre-modern techniques of signaling without wires were non-technical, having nothing more in common with wireless telegraphy than the absence of a wire.

Early histories of wireless technology making reference to its "pre-history" can easily be dismissed as universalist or essentialist.[33] Still, I would argue that these early histories could be read, from a fresh perspective, as expressing an interest in elementary cultural

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29. Eugen Nesper, *Die drahtlose Telegraphie und ihr Einfluss auf den Wirtschaftsverkehr unter besonderer Berücksichtigung des Systems "Telefunken"* (Berlin: Julius Springer, 1905), 9. "Fast sämtliche historischen Einleitungen zu Darstellungen der drahtlosen Telegraphie beginnen mit den optischen und akustischen Zeichenübertragungen alter Kulturvölker, obwohl diese einfachen und, mit dem Maßstabe der damaligen Zeit gemessen, sinnreichen Einrichtungen mit elektromagnetischer Wellentelegraphie nichts weiter gemeinsam haben, als daß Nachrichten von einem Ort zum andern ohne direkte metallische Leitung übermittelt wurden."

30. See, for example, Russel W. Burns, *Communications: An International History of the Formative Years* (London: Institution of Electrical Engineers, 2004); Völker, *Mobile Medien*; an exception is Huurdeman, *The Worldwide History of Telecommunications*, which devotes only two pages to the "Evolution of Telecommunications Prior to 1750."

31. Nesper, *Die drahtlose Telegraphie*, 9. "Man würde indessen fehlgehen, wenn man annehmen wollte, daß die drahtlose Telegraphie erst allerjüngsten Ursprungs sei, obwohl zugegeben werden muß, daß die wissenschaftliche Klärung der Grundphänomene sowie deren praktische Nutzbarmachung zu Verkehrszwecken etwa erst im letzten Dezennium erfolgt ist."

32. Ibid. "Der Froschschenkel war in diesem Fall der Detektor, der kupferne Haken, an dem der Schenkel mit Nervenbündeln aufgehängt war, die Antenne."

33. For an anticipation of this objection, see Carus Sterne, "Alte Ahnungen der drahtlosen Telegraphie," *Prometheus* 12 [618], no. 46 (1901): 721–25.

techniques. "Self-evidently there must always have been technical media, because any sending of signals using acoustic or visual means is in itself technical," writes Friedrich Kittler in his programmatic outline for "The History of Communication Media" (1996), thereby reclaiming pre-modern modes of communication with the assertion that something apparently as non-technical as lighting a fire should actually be counted as *techne*. However, what ultimately distinguishes these pre-modern cultural techniques from modern media technologies, as Kittler goes on to explain, lies precisely in the difference between the everyday symbolic language used in these techniques and the technical code of modern mathematics used in modern media to operate physical processes that are faster than human perception. Admittedly, pre-modern acoustic and visual techniques of signaling at a distance were able to achieve speeds exceeding human dimensions by exploiting the speeds of light and sound: acoustic techniques, such as bush telegraphs, calling chains, church bells, or war trumpets exploited the speed of sound; and visual techniques, such as beacon chains, smoke signals, hydraulic telegraphs, ship flags, and semaphore lines took advantage of the speed of light. Significantly, however, the codes commonly used for signaling with smoke, fire, flags, or drums were not differentiated into semiotic systems, and they were only able to transfer a message after prior agreement had been made about the code that needed to be used. In other words, pre-modern acoustic and visual techniques of communication were generally hamstrung by the facts that they could only transmit one single bit of information (e.g., Agamemnon is coming!), and that the meaning of the message always had to be agreed upon in advance (e.g., The presence of fire means Agamemnon is coming; the absence of fire means he is not).

Despite the ingenuity of many pre-modern cultural techniques of signaling at a distance, modern German belles-lettres seem to have shown relatively little interest in them, and only then in terms of their non-technical dimension. As Hermann Glaser puts it, techniques for signaling without wires seem to have inspired poets the most when they worked "un-technically," that is, when the natural "elements" carried and announced "messages."[34] This is not to say that the techniques themselves were not technical, only that they were not described as such in the German literature of the eighteenth and nineteenth centuries, where there are only a handful of references to techniques of signaling at a distance. In Friedrich Schiller's *Wilhelm Tell* (1804), for example, a play set during the Swiss struggle for independence from the Habsburg Empire in the early fourteenth century, the legendary marksman's arrows are complemented by a system of smoke and fire signals operated by the peasants, thereby linking the system of communications to an ideal of participatory democracy. In Joseph Freiherr von Eichendorff's poem "Der Freiheit Wiederkehr" (Freedom's return, ca. 1848), optical signals are again linked to the fires of revolution, namely, the Revolution of 1848. In an even broader sense, one key principle of optical signaling techniques, the dynamics of waiting for an unambiguous signal to appear in the distance, can be discerned in Adalbert Stifter's short stories "Der Condor" (The condor, 1840), as a telescope is used to observe the appearance of the light from a distant air balloon, and in "Der Hochwald" (The high

34. Hermann Glaser, "Zeichen Wahrnehmen: Literarische Konnotationen," in *So weit das Auge reicht: Die Geschichte der optischen Telegraphie*, ed. Klaus Beyrer (Karlsruhe: Braun, 1995), 224.

forest, 1842/44), as the scientific instrument is again used to discern the appearance of a distant fire.[35] In each of these examples, the elemental mythology of fire encapsulates the order of Enlightenment, wherein the politics of media amount to a celebration of rationality and individualism. The flip side of this coin are origin stories of wireless technology set in the locations of the European Enlightenment's others.[36]

With the advent of radio in the 1920s, the most common primal scene of wireless communication in Weimar sources, decades before Marshall McLuhan's famous characterization of radio as "the tribal drum,"[37] was that of aboriginal drumming practices. In "Arbeitsrhythmus als Morsezeichen" (Work rhythm as Morse code, 1927), for example, Hans Traub provides a comparative ethnography of drumming practices in Africa, Mexico, and New Zealand, alongside an analysis of the rhythms of the modern German workday. Situating modern communication codes within a longer history of optical and acoustic signs, Traub asserts that the phenomenon of "communication" (Nachrichten) arises from the primal "urge to communicate" (Mitteilungsdrang), which, in turn, forms the bonds of "community" (Gemeinschaft). Hence, Traub presents an etymology of the word "message" (Nachricht) as a "command" (Befehl) or "instruction" (Instruktion): "The message was a command to act" (Die Nachricht war der Befehl zu handeln).[38] For Traub, the idea of sending a message as issuing a command to act in society cuts across different periods in the history of technology. Ultimately, Traub emphasizes not only the communicative aspects of communal drumming, but also the impression that tribal drums, as a community-building practice, depended on a code that remained incomprehensible to outsiders.

Throughout Europe at the time, African tribal drums were often conceived of in analogy to telegraphy and thought to contain a digital code akin to Morse code. However, "the obvious analogy led people astray," as popular historian of science James Gleick argues. "They failed to decipher the code of the drums because, in effect, there was no code."[39] As analog devices, the talking drums did not rely on a mediating symbolic layer like the written alphabet, as is the case in Morse code, but rather transformed speech itself. The person to crack this code, in Gleick's narrative, was the English missionary, John F. Carrington, who explained the phenomenon, as early as 1914, after learning the practice himself, and went on to publish the seminal book *The Talking Drums of Africa* (1949).[40] However, I would add that the same explanation—that the talking drums employed only tone, thereby creating an entire language of pitch contours out of a single pair of phonemes—was also given, in 1914, when the *Hamburgische Kolonialinstitut*

35. For this reading of Stifter's "Hochwald," see Glaser, "Zeichen Wahrnehmen."

36. For an example set in medieval China, see Hermann Hesse, "King Yu: A Story from Old China" [1929], in *Pictor's Metamorphoses and Other Fantasies*, ed. Theodore Ziolkowski, trans. Rika Lesser (New York: Picador, 2003), 135–43.

37. McLuhan, *Understanding Media*, 297–307.

38. Hans Traub, "Arbeitsrhythmus als Morsezeichen," *Tägliche Rundschau* (May 21, 1927): Unterhaltungsbeilage, repr. with commentary in *Medientheorie 1888–1933: Texte und Kommentare*, ed. Albert Kümmel and Petra Löffler (Frankfurt am Main: Suhrkamp, 2002), 281.

39. James Gleick, "Drums That Talk (When a Code Is Not a Code)," in *The Information: A History, A Theory, A Flood* (New York: Vintage, 2012).

40. Ibid.

began studying the talking drum, and recorded 95 African drum signals on gramophone records.[41] To control the colonies, the code had to be mastered, and to do so, the most modern technology available was deployed. Ultimately, even if the symbolic dimension of techniques of signaling at a distance was the only thing of interest for centuries, the modern technology of the gramophone was able to inscribe its real dimension.

Symbolic Communication

> It is possible in a natural way, removed from superstition and without the intercession of any spirit, for a man to transmit his trend of thought to another man at no matter what distance and location, in a very short time. It is not possible to estimate exactly the time it takes, but all that takes place within twenty-four hours. I knew how to do it myself, and I have often done it. Abbot Trithemius also knew how and used to do it.
> —Heinrich Cornelius Agrippa

Even though symbolic practices of signaling without wires, in Western Europe, date back to Greek and Roman antiquity, and advanced non-symbolic practices of signaling without wires are evident in African talking drums, the *fantasy* of communicating at a distance can only be traced back to the transition from the Middle Ages to the Early Modern Period. In *Die älteste Entwickelung der Telegraphie und Telephonie* (The oldest developments in telegraphy and telephony, 1908), for example, Richard Hennig lamented that most books available on telegraphy and telephony at the time were only practical guides for learning about modern telegraphy and telephony.[42] To remedy this situation, Hennig took a more expansive view of the history of these media, devoting the first chapter of his history to the development of optical and acoustic telegraphy from Greek and Roman fire torches through to the afterlife of the heliograph, before returning in the second chapter to the topic of telegraphic fantasies of magnetic sympathy, starting in the Late Middle Ages.[43] With the invention of radio in the 1920s, the origin scenes of wireless communications would again attract his interest, as evident in an article that he published in *Funk*, the most popular radio periodical at the time. The title of the article, "Funkspuk im 16. Jahrhundert" (Wireless spook in the sixteenth century, 1924), referenced the then-current rhetoric of a *Funkerspuk*, the purportedly horrific episode (*Spuk*) when amateur radio operators (*Funker*) representing paramilitary organizations took control over radio stations following World War I and used them for their own purposes.[44] The content of Hennig's article, however, was devoted to a more literal "Spuk," namely, the actual spirits or ghosts cropping up in many late medieval and early modern texts on the topic of communication. As the earliest example of wireless

41. Traub, "Arbeitsrhythmus als Morsezeichen," 282.

42. Richard Hennig, *Die älteste Entwicklung der Telegraphie und Telephonie* (Leipzig: Barth, 1908), "Vorwort," n.p.

43. A similar move occurs in the structure of the remaining chapters: after the second chapter on telegraphic fantasies, the third and fourth are devoted to electrical telegraphy and the undersea cable, respectively; after the fifth chapter on telephonic fantasies, the sixth and final chapter is devoted to electrical telephony.

44. Richard Hennig, "Funkspuk im 16. Jahrhundert," *Funk* 12 (1924): 207–8.

communication, Hennig mentions a late medieval text that hints tantalizingly at a method it does not describe: "The earliest reference can be found in the *Steganographia*, the work of the learned Abbot of Sponheim, Trithem or Trithemius, which remained fragmentary and unfortunately breaks off at precisely the point the author says he now wants *to teach the art of sending messages to a friend in the distance without any messenger*."[45] Still, as Hennig points out, there may be some hints of the method in one of the author's letters: "I can also communicate my will without a messenger to the initiated, even if he were sitting in prison, well guarded, three miles deep below the earth. And I can do so, as often as I will, in a natural way, without superstitious methods and without the help of spirits. I confess, it is wonderful."[46]

This mysterious method of communicating without spirits and without a messenger is usually taken to have been a form of sympathetic telegraphy. This mode of "wireless" transmission was based on the assumption that it would be possible to transmit intelligence after synchronizing magnetic objects: once two needles touched the same magnet, or lodestone, any subsequent movement of one needle was supposed to induce a similar movement in the other, no matter how far the two happened to be located from each other.[47] The common scene of sympathetic telegraphy involved two friends making contact by overcoming a seemingly insurmountable obstacle—not only, as in modern predictions, due to the remoteness of places that would be difficult or impossible to reach with wires, but also to restricted access to certain places, such as prisons.[48] For Siegfried Zielinski, the sympathetic telegraph described by the Italian polymath Giambattista della Porta and many others reveals "two lineages in the history of telematics, which occasionally converge but, from the viewpoint of technique and knowledge, are entirely disparate: on the one side are strategic focusing and acceleration of communication to serve the interests of established institutions, such as the church, the state, the military establishment, or private corporations, and on the other are the development of tactics and a culture for friends to communicate with each other, where it suffices for them to agree formally upon a code."[49] While media scholars working with the model of information theory tend to view the need for a prearranged code as the main limitation of

45. Ibid., 207, italics in the original. "Der früheste Hinweis findet sich in einem fragmentarisch gebliebenen Werke des 1516 gestorbenen, gelehrten Abtes von Sponheim, Tritheim oder Trithemius 'Steganographia', das leider gerade an der Stelle unvollendet abbricht, wo der Verfasser sagt, er wollte jetzt *die Kunst lehren, Freund ohne alle Boten Nachrichten in die Ferne zugehen zu lassen*."

46. Qtd. in ibid. "Ich kann auch ohne Boten meinen Willen aus weiter Ferne dem Eingeweihten mitteilen, selbst wenn er im Kerker säße, gut bewacht, drei Meilen tief unter der Erde. Und das kann ich, so oft ich will, auf natürlichem Wege, ohne abergläubische Mittel und ohne Hilfe von Geistern. Ich bekenne, es ist wunderbar."

47. Fahie, *A History of Wireless Telegraphy*, 2.

48. For several media historians, the scene involved in William Ayrton's prediction, discussed in the previous chapter, is even explicitly reminiscent of this form of sympathetic telegraphy: for the "electromagnetic ear" to hear the "electromagnetic voice," there must be *Gleichgestimmtheit*, a word meaning both emotional "sympathy" and radio "tuning," as in the Romance language words for being "attuned to" or "on the same wavelength" as someone. See Völker, *Mobile Medien*, 234; Regine Buschauer, *Mobile Räume: Medien- und diskursgeschichtliche Studien zur Tele-Kommunikation* (Bielefeld: Transcript, 2010), 287.

49. Zielinski, *Deep Time of the Media*, 75–76, cf. 269.

pre-modern signaling techniques, Zielinski reclaims it as a strength, a tactic of disruption. Though Zielinski emphasizes the difference between the official politics of optimizing communication efficiency and the unofficial tactics of disrupting communications, at least in the case of Porta's engagement with the sympathetic telegraph, I will consider a related case where the two models seem to have converged—a case that is a direct precursor to Porta, namely, the mysterious case of the *Funkspuk* mentioned above.

On March 25, 1499, Johannes Trithemius (Johann Heidenberg), the Abbot of Sponheim, a Benedictine monastery in modern-day southern Germany, addressed the letter quoted above to his friend Arnoldus Bostius (Arnold de Bost), a monk at the Carmelite monastery in Ghent, located roughly 410 km away from Sponheim, in modern-day Belgium.[50] Having neglected to respond to the last letter from Bostius for over a year, Trithemius anticipated his friend's irritation: "You will ask, I know, what I have been doing during the interim: I will tell you what I have been writing."[51] Among the compositions Trithemius mentions are primarily pastoral and reform texts, a testament to his reputation as a "German Renaissance humanist, advisor to Emperors, one of the most erudite book collectors of Germany, author of more than fifty books himself, the founder of scientific bibliography."[52] What Trithemius's letter to Bostius remains known for, however, is his subsequent mention of a work in progress, the contents of which were of a much different character: "I have in my hands a great work, which, if ever it is made public (God forbid!), will astonish the whole world. The title of the first book is *Steganographia* [….] It teaches very great things, astounding and unbelievable to those who do not know them, and unheard of in this age of the world."[53] The term *steganography* is a portmanteau, first recorded in this very letter, composed of the Greek adjective *steganos* (covering) and the verb *graphein* (to write). As this etymology indicates, steganography refers to the art of hiding secret text within non-secret text, thereby concealing the fact that the apparently non-secret text actually contains secret information. In doing so, steganography addresses the central problem inherent in cryptography—namely, the fact that encrypted messages can usually be identified as such due to the presence of strange symbols, jumbled letters, or other giveaways.[54] While common techniques of steganography are now known to include using invisible ink, stuffing messages inside hollowed-out objects, or secretly marking text through the use of superscripts, subscripts, upstrokes, downstrokes, or puncture marks in the material writing support, the technique presented in Trithemius's *Steganographia* turned out to be even more elegant in its simplicity.

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50. I quote and translate Trithemius's letter to Bostius as it is reprinted, from Paris Bibliothèque Mazarine Ms. 1565 (1308) saec. XVI, in Paulus Volk, "Abt Johannes Trithemius," *Rheinische Viertelsjahrsblätter* 27, no. 1 (1962): 42–45.

51. Ibid., 43. "Queris, scio, quid interea egerim. Quid scripserim dicam."

52. Jim Reeds, "Solved: The Ciphers in Book III of Trithemius's *Steganographia*" (Fordham Park, NJ: AT&T Labs—Research, March 26, 1998), 1.

53. Volk, "Abt Johannes Trithemius," 43. "In manibus iam habeo grande opus, quod si unquam publicatum fuerit, quod absit, totus mundus mirabitur. Cuius primi libri titulus est steginographia [….] maxima docet et omnibus necientibus studenda et incredibilia que a seculo nunquam sunt audita."

54. See Joachim von zur Gathen, *CryptoSchool* (Berlin: Springer, 2015), 409–16.

In the letter, Trithemius proceeds to explain the composition of what would become his unfinished treatise entitled *Steganographia* (written 1500; printed 1608): "There will be four books, each of which will be divided into at least one hundred chapters. I started this work at the command of a certain great prince, whom I need not name."[55] As a cultural technique of concealing writing, steganography establishes a division between the private and the public, and is an especially useful tool for heads of state: the prince whom Trithemius does not name was Count Philip of the Palatinate; and Emperor Maximilian I would commission Trithemius to write a continuation of the *Steganographia*, the *Polygraphia* (1518). I would argue that these treatises, as manuals of techniques of secret communication, were primarily a response to the increasing demand for negotiating the boundary between the private and the public due to the nascent development of modern bureaucracy. Unfortunately, Trithemius's ambitious plan for the work, consisting of "four books, each of which will be divided into at least one hundred chapters," was never fully realized in this form. In its published form, printed over a century later, Trithemius's *Steganographia* only seems to have realized the following description of the first book, which was to contain

> more than a hundred ways of secretly writing [*occulte scribendi*, also "occultly"] whatever you please, without any suspicion, without transposing letters, without any fear. Nobody in the world will be able, by means of natural ability, to know or even to suspect, what might be contained in my letters, apart from someone who has learned my art from me or someone to whom I shall teach it. The words are plain and familiar, free of any suspicion, but nobody without the art will be able to perceive my intention for all eternity, however learned they may be. It is truly a stupendous thing.[56]

While this description resembles our current understanding of steganography, Trithemius's description of the following planned books is more difficult to reconcile with the treatise in the form it comes down to us today. The second book was supposed to contain an intricate mode of communicating across considerable distances with or without a messenger; the third, a method for imparting complete command of Latin within a span of two hours; and the fourth, even more astounding experiments, including an extended form of thought transference for communicating while occupied with other things. The mismatch between the project and its realization would come to occupy the commentary tradition on the *Steganographia* in subsequent centuries.

In a strange twist of fate, the intended recipient of the letter, Trithemius's friend Bostius, passed away on April 4, 1499, while the letter was still en route. Instead of reaching its intended recipient, the letter arrived instead in the hands of the unsympathetic

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55. Volk, "Abt Johannes Trithemius," 43. "Erunt autem quator libri, quorum quilibet ad minus centum capitulis distnguetur. Incepi hoc opus ad instanciam unius mangi principis, quem nominare non est opus."

56. Ibid. "Primus liber continet plus quam centum modos occulte scribendi, quidquid velis sine omni suspicione sine literarum transpositione sine omni timore ita, quod sit homo in mundo, qui naturali industria scire vel suspicari possit, quid in literis meis contineatur preter eum, qui artem meam novit ex me vel ex eo, quem ego docuero. Verba sunt plana et familiaria omni suspicione carencia, sed intentionem meam nemo sine arte mea percipere poterit in eterneum quantumcumque sit doctus, et est res vere stupenda."

prior of the Carmelite convent in Ghent, who circulated it freely as an example of black magic.[57] Shortly after the first edition of Trithemius's *Steganographia* was printed, only over a century later, it would be placed on the Index Librorum Prohibitorum in 1609. No longer reputed to be an erudite Humanist and imperial counselor, Trithemius was now known as "the occultist, student of the Cabala, the mentor of Agrippa of Nettesheim [an inspiration for the Faust legend], the author of an ambiguous mysterious demonological and cryptographic book, the *Steganographia*."[58] In the *Chronicon Sponheimense* (Sponheim chronicle, 1495–1509), Trithemius had already attempted to set the record straight: "some thought that Trithemius was a divine man, others proclaimed him as one exceedingly erudite, but others, being slower of intellect and of a will more disposed to rashness, asserted that he was a magician and performed these things with the help of spirits. But how these things which are recounted in the same letter are all accomplished by entirely natural means he discloses from the beginning of the book called *Steganographia*."[59] In my analysis, this series of events was itself a performative recapitulation of the very problem that Trithemius's steganography was attempting to overcome—namely, the dangers of circulation. Just as any letter is vulnerable to the prying eyes of a messenger, the unintended circulation of Trithemius's letter, after falling into the hands of the wrong recipient, threatened his reputation. Had Trithemius sent it using the "wireless" methods he described, there would never have been any fallout.

At first glance, Trithemius's insistence in the letter to Bostius on the natural, immanent nature of the art of steganography appears to contradict the supernatural, transcendent contents of the treatise itself—primarily, ritual instructions for sending secret messages by summoning the very "spirits" whom Trithemius had claimed not to require. The first chapter of Trithemius's *Steganographia* begins with the following warning about summoning these spirits:

> The operation of this first chapter is very difficult and full of danger on account of the haughtiness and rebellion of its spirits who do not obey anyone save him who is most skilled in this art. For not only do they disobey novices and those less proven in this art, but oftentimes they vex and assail with various illusions those who press them too far. They are malicious and untrustworthy above all the other aerial spirits and they obey no one completely unless compelled by the most powerful rites. They often unfaithfully reveal to others the secret which has been entrusted to them, for as soon as they have been dispatched with their letters, they fly off and burst in upon him to whom they were sent, entirely without order, like a mob fleeing a battle without any leader. Raving mad they speed about and by filling the air with their shouts they often reveal the sender's secrets to everyone around.[60]

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57. See Noel L. Brann, *The Abbot Trithemius (1462–1516): The Renaissance of Monastic Humanism* (Leiden: Brill, 1981), 18–19.

58. Reeds, "Solved," 2.

59. Qtd. and trans. in Brann, *The Abbot Trithemius*, 19.

60. Since there is still no critical edition of Trithemius's *Steganographia*, I quote translations from a new online translation and interactive edition in-progress, Alexander Boxer, "Steganography," *Trithemius Redivivus*, accessed April 1, 2016, http://trithemius.com/; the online edition is based on Johannes Trithemius, *Steganographia* (Frankfurt: Matthias Becker, 1606). "Huius primi capituli est multum difficilis

These spirits are the familiar spirits of late medieval cosmology, a complex hierarchy including angels and demons. If the benevolent spirits, in their traditional role as mediators between the human and the divine, would deliver unadulterated information directly from the mouth of God, malicious spirits would manipulate their messages.[61] To tell the difference between good spirits and bad spirits, there was an entire art of *discretio spirituum*, the discernment of spirits.

Following this warning, the chapter contains the following instructions for invoking one of the most dangerous spirits, named "Pamersyel:" first, prepare the medium of inscription through an invocation of the Trinity; next, write a message, which can be in any language, while summoning a spirit through a special incantation; if necessary, repeat the incantation until the spirit appears; after writing the message, send it, via a messenger also versed in this art, to the intended recipient. Upon receipt of the letter, the process repeats in roughly the reverse order: the recipient must summon the corresponding spirit through a special invocation; instantly, the recipient will understand the meaning of the letter.[62] At the end of these instructions, there are two crucial caveats: first, the recipient must examine the message in solitude, since the spirits could betray him and reveal the secret to others present; second, each message must include the proper sign for a spirit, so that the recipient knows the spirit he is dealing with. To this end, the first chapter even contains a Table of Direction that presents the cabalistic names of all the spirits, their magical ciphers, and the cardinal directions where the spirits are located. In the end, Trithemius concludes: "Consider diligently everything which we have said in this chapter and you will easily be able to understand what we shall say in the following chapters."[63]

Trithemius's instructions for summoning a spirit are actually a polyalphabetic substitution cipher, a more complex variation of the widely known "Caesar cipher." Fortunately, there is a global key for the multiple cipher alphabets, which are contained in the chapter titles—namely, taking every second letter of the text, ignoring the first and last words, which indicate the cipher currently being used. For example, the title of the first chapter is: "The Key and Operation of Which is held by the spirit-prince Pamersyel, anoyr madriel, through the assistance of ebra sothean abrulges itrasbiel. And nadres ormenu itules rablion hamorphiel. An overture to them is made first of all with an

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et periculis plena operatio, propter superbiam et rebellionem spirituum eius, qui non ebediunt alicui, nisi fuerit in hac arte expertissimus. Nouitiis enim et minus in arte probatis non solum non obediunt, sed etiam si nimis urgeantur, eos frequenter laedunt, et variis illusionibus offendunt. Maliciosi et infideles sunt super omnes alios aëreos spiritus, et nulli penitus nisi maximis sacramentis compulsi obediunt, et secretum quod eis committitur saepe infideliter aliis ostendunt. Nam mox ut emissi fuerint cum literis auolant, et ad eum cui mittuntur, sine ordine irrumpentes, sicut populus sine duce fugiens de praelio, furiosi properant et aërem suo clamore replentes saepe omnibus in Circuitu mittentis arcana manifestant.

61. See, for example, from a media studies perspective, Jimena Canales and Markus Krajewski, "Little Helpers: About Demons, Angels and Other Servants," *Interdisciplinary Science Reviews* 37, no. 4 (2012): 314–31.

62. Trithemius, *Steganographia*, 1–2.

63. Ibid., 2. "Considera diligenter omnia quae in isto capitulo diximus, et facilius poteris intelligere quae in sequentibus dicturi sumus."

exorcism."[64] Taking the second letter of each word reveals the instructions for decryption, in a mixture of German and Latin: "Take the first letters of every word" (Nym die ersten Bugstaben de omnio verbo). As an example of text to be deciphered, Trithemius inserts a letter announcing war plans, which is encoded into a comprehensible but relatively innocuous hymn in praise of God. Ultimately, this method of encryption and decryption is a non-trivial task involving reading, writing, and counting.

Even after a key to the text was published, explaining this process in detail,[65] a controversy remained for the next several centuries over Trithemius's idea for communicating to a friend at a distance without a messenger.[66] While the modern art of steganography, as a subset of cryptography, is primarily a matter of information processing, the art described by Trithemius was also concerned with transmission. In his description of the planned second book in the letter to Bostius, Trithemius had gone into detail about techniques of communicating secret messages over a distance, preserving their secrecy, and overcoming any conceivable obstacle:

> The second book contains many even more remarkable things—namely, I am able, by means of this art, to make known the contents of my mind to someone who knows my art, over any distance, over a hundred miles or more, securely, without words, without writing, without signs, using any messenger whomever. Even if my messenger were captured on the way and questioned under the severest torture, he would not be able to say anything about my message, having absolutely no knowledge of it. Whatever may happen, my messenger will remain forever hidden, and all the men in the world gathered together would not be able to track him by their natural powers. And, if I want, I am able to do the same without a messenger: I can indicate my will to one who knows my art if he is sitting in a prison, no matter how far away and how well he is guarded, even if he were sitting three miles under the earth. This I can do anywhere and everywhere, whenever and as often as I want, naturally, without any superstition or the help of any spirits.[67]

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64. Ibid., 1. "Cuius clavis et operatio tenetur a spiritu principali Pamersyel, anoyr madriel per ministerium ebra sothean abrulges itrasbiel. Et nadres ormenu itules rablion hamorphiel. Ad hos fit commißio omnium cum exorcismo."

65. Johannes Trithemius, *Clavis Steganographiae* (Frankfurt: Johannes Bernerus, 1608).

66. For an overview of the commentary tradition, see Friedrich Wagner, "Studien zu einer Lehre von der Geheimschrift (Chiffernkunde)," *Archivalische Zeitschrift* 11 (1886): 156–89.

67. Volk, "Abt Johannes Trithemius," 43–44. "Secundus liber multo mirabiliora continet videlicet possum hac arte mentis mee conceptum notum facere artem meam scienti ad quantumque distanciam ad centrum miliaria vel plura secure sine verbis, sine scriptis, sine signis per quemcumque nuncium, qui si comprehensus in via fuerit, si interrogatus eciam per tormenta durissima nichil potest fateri de nuncio meo, quia nichil sibi penitus de illo constat. Quidquid occurrerit, nuncium meum semper manebit occulum, ne omnes tocius mundi, si simul essent congregati, posent illud investigare virtute naturali. Item si volo eciam sine nuncio idem facere, item voluntatem meam indicare possum sedenti in carcere artem meam scienti eciam longe absenti quantumcumque custodiatur eciam, si tribus miliaribus sub terra sederit. Et hec omnia latissime universaliter quoniam et quantumque voluero, possum naturaliter sine aliqua supersitione vel adiutorio spirituum."

Through negation, this description reveals the common disadvantages of sending messages. To overcome these drawbacks, the art described by Trithemius was supposed to involve sending messages "without words, without writing, without signs" (sine verbis, sine scriptis, sine signis). Furthermore, the art was supposed to function equally well without a messenger (sine nuncio). Above all, the art was supposed to rely on natural techniques, and not any superstitious beliefs or supernatural beings (naturalitur sine aliqua superstitutione vel adiutorio spirituum).

In subsequent years, readers of the treatise would puzzle over Trithemius's possible method for communicating a message to a well-guarded friend imprisoned three miles underground. The debate among Daniel Schwenter (pseud. Hercules de Sunde), Athanasius Kircher, Gaspar Schott, Giambattista della Porta, and Cornelius Agrippa is summarized neatly in the fourth chapter of one *Steganographia* commentary composed by the eighteenth-century Trithemius apologist Wolfgang Heidel. At the start of the chapter on Trithemius's "mode of sending secret messages using fire to some distance without words, without writing, without signs" (modus nuntiandi secreta per ignem ad quamcunque distantiam sine verbis, sine scriptis, sine signis), Heidel confesses that the earlier chapters of his commentary, devoted to explaining all kinds of secret writing systems, from beacon fires to the use of magnets, did not contain much novel material.[68] For, Daniel Schwenter had covered similar inventions in his *Steganologia & Steganographia Nova* (1620), which is incidentally a treasure trove of cultural techniques, organized in order of increasing signal range from "nearby" through "a half mile" to "over 3, 4, 40, 100, 1,000 miles."[69] Even after reviewing the debate, Heidel is unable to come to any conclusion.[70] In my analysis, the puzzlement was primarily the result of a scribal or printing error: the word *possum* (I am able), in an autograph copy of Trithemius's letter, was eventually corrupted, in printed editions of the letter, to *per ignem* (using fire).[71] This error changed the meaning of Trithemius's original claim from "I am able, by means of this art, to make known the contents of my mind […] using any messenger whomever" to the much more enigmatic, and non-grammatical, claim "I am able, by means of this art, to make known the contents of my mind […] using fire […] using any messenger whomever." As the medium of transmission became the elemental force of fire, various explanations arose to explain what Trithemius might have had in mind, often citing parallels with the origin stories about the use of fire signals in antiquity.

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68. Wolfgang Ernst Heidel, *Steganographia Vindicata, Reserata et Illustrata* (Nuremberg: Johannes Frederick Rudiger, 1721), 347.

69. Daniel Schwenter, *Steganologia et steganographia nova* (Nuremberg, 1620). The chapter titles of Schwenter's treatise on steganogrpahy make evident his awareness of qualitative differences in signaling at various distances. The title of Book One is "Wie man in der nahe / das ist / inn einem Gemach oder andern ort (da einer den andern sehen kan) einem andern sein Gemüht / andern unvermerckt entdecken solle." The title of Book Two is "Wie man natürlicher weiß / einem auff eine halbe meil und etwas näher oder weiter / bey Tag und Nacht / man könne an ein ort sehen oder nicht / etwas verborgener weiß soll zuverstehen geben." The title of Book Three is "Wie man einem über 3. 4. 50. 100. 1000. Meil / weiter oder neher geschwind solle etwas zu wissen thun."

70. Heidel, *Steganographia Vindicata*, 347–56.

71. See Universitätsbibliothek Basel, Ms. G2 15:1:9–10r (http://dx.doi.org/10.7891/e-manuscripta-21799); and the later Ms. G2 15:2:14–17 (http://dx.doi.org/10.7891/e-manuscripta-21800).

In the end, there may be a much simpler explanation for Trithemius's confounding method of communicating *without* words, *without* writing, or *without* signs—namely, *with* numbers. In recent years, Thomas Ernst, a Professor of German, and Jim Reeds, a mathematician at AT&T, independently solved the ciphers contained in Book III of the *Steganographia*, which turned out to be numerical substitution ciphers.[72] As Reeds points out, the main question remaining is why Trithemius drew on the rhetoric of spirits in the presentation of his *Steganographia*. In Reeds's analysis, "Trithemius's use of angel language might thus be a rhetorical strategy to engage the reader's interest," in which case he succeeded, since the book was banned as an example of black magic.[73] In my analysis, Trithemius's recourse to angelic language also played into the medieval and early modern conception of communication at a distance. Even though the commentary tradition never came to any conclusion, there is one thing they agreed on: Trithemius's method rests on a misconception, for "it is necessary that there be contact between the doer and the receiver" (contactus intercedat inter agens ac passum). As Wayne Shumaker argues, "the contemporary physics was at pains to establish the existence of a 'medium' whenever an effect was produced at a distance, as ether and air permitted the heavenly bodies to pour 'influence' upon the earth."[74] I would add that the medieval and early modern scene of communication is unimaginable without an intermediary, be it a human messenger, a non-human spirit, or a material substance. Ultimately, I argue that Trithemius's steganography was a response to a diplomatic problem: unlike modern information carriers, medieval messengers had the capacity to interfere with the contents of the messages they conveyed.[75] Trithemius's proposal may seem to be about doing away with the medium in favor of an ideal mode of angelic communication, though it is actually only a technique for concealing the message from the medium, for protecting letters from the eyes and ears of other readers, writers, and listeners by turning them into numbers. If talking drums turned out to be a "code that is not a code," steganography is something that seems not to be a code but is a code. As such, Trithemius's *Steganographia* is situated at the cusp of pre-modern communication and modern technology. It is a technical code verging on mathematics, presented in the form of a symbolic code, the everyday language of spirit communication.

In the seventeenth and eighteenth centuries, the idea of long-distance communication would frequently recur in scientific, utopian literature.[76] In line with the sympathetic telegraph described above, perhaps itself only an offshoot of a misunderstanding of Trithemius's text, the main application envisaged for signaling without wires was that of telepathic or romantic communication.[77] There were also several other proposals for a system of signaling without wires over great distances, some of which were even based on the newly discovered phenomenon of electricity. However, none of these proposals

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72. See Gina Kolata, "A Mystery Unraveled, Twice," *The New York Times*, April 14, 1998, sec. Science, http://www.nytimes.com/1998/04/14/science/a-mystery-unraveled-twice.html.

73. Reeds, "Solved," 18.

74. Wayne Shumaker, "Johannes Trithemius and Cryptography," in *Renaissance Curiosa* (Binghamton, NY: Center for Medieval and Early Renaissance Studies, 1982), 108.

75. Ernst, "'Medien' im Mittelalter?"

76. See Flichy, *Dynamics of Modern Communication*, 7.

77. See ibid.

were ever realized on a large scale, primarily because, as media historian Patrice Flichy argues, "there was no appropriate social structure capable not only of imagining the advantages of long-distance communication, but also of backing the construction of a permanent network." Only in France around 1800, during the Revolution and the creation of the modern state, were the possibilities of various codes for signaling at a distance without wires consolidated into a single system deployed in a semi-permanent, national telecommunications infrastructure.[78]

Telegraphy and Literature

The first successful modern system of signaling without wires, and arguably the first modern telecommunications network, was not a "virtual" medium involving sympathy, electricity, or magnetism, but rather a "real" system involving the transmission of visual signs, though in a slightly more differentiated form than in pre-modern optical and acoustic techniques.[79] In the semaphore system developed by the Chappes brothers in France around 1800, visual signs were transmitted between relay stations within visible sight of each other, a line of sight extended through the use of telescopes and encrypted through the creation of elaborate codebooks. In fact, there was nothing novel about the semaphore: all of the technologies it relied on, except for the telescope, existed in antiquity. The invention of optical telegraphy was, in a sense, a culmination of pre-modern cultural techniques, and in another sense, the start of something entirely new. For Kittler, the optical telegraph constitutes the first true technical medium because it created "information rates which exceeded all performance limits of writing," a great step toward maximizing the efficiency of the information channel.[80] In contrast to many pre-modern systems, the Chappes' system did not use letters, but rather elements of a numeric code (like Trithemius's), which were assigned to certain letters, words, or sentences in corresponding dictionaries.[81] In doing so, the Chappes' telegraph was able to accommodate any possible linguistic message. In the course of a century, however, optical telegraphy would be almost completely replaced by other systems of telegraphy using electricity and magnetism. What rendered line-of-sight communication obsolete was "the discovery that electricity could be transmitted great distances, including around corners."[82] Nevertheless, optical telegraphy remains significant as one of the first modern methods of wireless transmission, and it is increasingly recognized as such in recent scholarship.

On a visit to a semaphore telegraph station on top of the tower of the Strasbourg Münster church, in 1803, the Swiss writer Friedrich von Matthisson described the work of the French telegraph operators, known as *stationnaires*, as well as the various levels of encryption involved in maintaining the security of the system. After obtaining permission

78. Ibid., 8.

79. Völker, *Mobile Medien*, 123.

80. Friedrich A. Kittler, "The History of Communication Media," *CTHEORY*, July 30, 1996, http://www.ctheory.net/articles.aspx?id=45.

81. See Friedrich von Matthisson, "Auf dem Turm des Straßburger Münsters," in *So weit das Auge reicht: Die Geschichte der optischen Telegraphie*, ed. Klaus Beyrer (Karlsruhe: Braun, 1995), 148.

82. Kittler, "The History of Communication Media."

to ascend the tower from the Telegraph Director "not entirely without difficulty" (nicht ganz ohne Schwierigkeit), Matthison was able to observe the "wonderful telegraph" (wunderbaren Fernschreiber) in full operation: "The mysterious code is only understood by the Telegraph Director," and not by the operators themselves.[83] Although the speed of optical telegraphy was one of its most striking aspects, Matthison was also aware of the delays involved in transmission due to these human operators: "In fact, a laconic message from here to the capital takes only fifteen minutes, but since dispatching also requires time, the answer to a question, which for example, is made at 10:00 from Strasbourg to Paris, only arrives at the roof of the Münster church at 13:00."[84] Given that each station was staffed by two stationnaires, the one looking through the telescope, the other operating the machine, the main delays in relaying messages were caused by the need to look up the corresponding code in various codebooks and to verify the visual signals sent by previous stations. Matthison notes that he "saw very clearly through the telescope the degree of precision and speed with which the next telegraph station, four hours away, repeated the local figures," and imagines that "without the delay of translating and expediting, a telegraphic message could cover a path that would take two hundred hours in half an hour."[85] In other words, when looking through the telescope, what Matthison sees is not a distant telegraph station but the technical difference between the efficiency of modern techniques of wireless transmission and the inefficiency of their pre-modern counterparts.

Before the modern terminology of *optical telegraphy* became standard, there were debates about whether to call an optical signaling system a *tele*graph (distance-writer) or a *tachy*graph (fast-writer). The term *semaphore*, an irregular formation of the Greek *sema* (sign) and *-phore* (bearer), was used to describe the wings of the telegraphs.[86] A semaphore station consisted of a small observation house, erected on a high tower or another place that would be visible from far away. On the top of the observation house, there was a vertical mast supporting a long horizontal beam that could be turned around the middle pivot; on the end of the beam, there were two more arms that could each be turned around their center; using levers, the beams and arms could be adjusted from the observation house. One position of the semaphore represented a letter, another an entire sentence, such as a formulaic greeting. In doing so, the semaphore created a new kind of sign—visible but ephemeral, and thus not corresponding to conceptions of the sign in oral traditions and in traditional writing. If conventional writing is tied to a tangible storage medium and a material support (e.g., stone, parchment, paper), the semaphore "writes" at

83. Matthisson, "Auf dem Turm des Straßburger Münsters," 88. "Nur von den Direktoren des Telegraphen zu Straßburg und Paris werden seine geheimnißvollen Chiffern verstanden."

84. Ibid. "Eigentlich braucht eine lakonische Nachricht von hier bis zur Hauptstadt nur fünfzehn Minuten; aber da die Abfertigung auch Zeit verlangt, so kann die Antwort auf eine Frage, welche zum Beyspiele, um zehn Uhr von Straßburg nach Paris gethan wird, erst um drey Uhr auf dem Dache der Münsterkirche eintreffen."

85. Ibid. "Sehr deutlich sahe ich durch das Teleskop, mit welcher Präcision und Schnelligkeit der vier Stunden weit entfernte nächste Telegraph die Figuren des hiesigen wiederholte. Ohne die Verzögerung des Übersetzens und Expedierens könnte also eine telegraphische Nachricht einen Weg von zweyhundert Stunden in einer halben Stunde zurücklegen."

86. See Volker Aschoff, *Geschichte der Nachrichtentechnik* (Berlin: Springer, 1989), 1:170.

a distance using unfixed, mobile, and non-localizable signs. This irritated Johann Samuel Halles, who in 1796 complained about how the telegraph knows "no way to hold its disembodied, unwritten, though still legible letters, […] which the eye of the reader spells out in the air."[87] Though still legible, the visual signs of semaphore telegraphy created a disorienting sort of semiotics.

In the 1830s, Heinrich Heine, now famous in cultural studies circles for his description of the disorienting experience of time and space brought about by the railroad, reflected on the disorienting experience of interpreting signs brought about by the newly built semaphore telegraph. In the fourth of his letters "Über die französische Bühne" (On the French Stage, 1831/32), composed "in a village near Paris" (auf einem Dorfe bei Paris), Heine reflected on the disorienting experience of having messages that were visible and yet indecipherable seem to fly through the air around him. The Fourth Letter begins with a religious prophecy related to the political situation in France under the new bourgeois moneyed aristocracy. For Heine, the divine will functions in analogy to the semaphore telegraph: "Do you see it already, the will of God? It moves through the air like a telegrapher's silent secret, which communicates its message high above our heads, communicates it to those in the know, while the uninitiated live below in the tumult of the market and do not at all notice that their most important interests, war and peace, are being negotiated invisibly above them, in the air."[88] In other words, as important as the contents of semaphore telegrams may be, seeing as they usually address topics of war and peace, the cryptic messages remain indecipherable to the masses whose fates are in fact at stake in these very messages. Only a different figure can correctly interpret the signs: "If one of us looks up on high, and if he is an interpreter who knows how to read the signs on the doors, and warns the people of an imminent disaster, then they call him a dreamer and laugh at him. Sometimes even worse happens to him, and the people being warned bear a grudge against him on account of the wicked information and stone him. Sometimes, too, the prophet is put in a fortress until his prophecies come true, and he may sit there for a long time."[89] Like an Old Testament prophet looking up to the sky, the observer of optical telegraphy in France should be able to interpret similar signs, namely, Heine's prophecy about the downfall of the aristocracy. However, the authority of the prophet as the one who interprets divine signs has given way to the new authority of the telegraphic sign. On this reading, what Heine was observing in optical telegraphy is not merely a new

87. Qtd. in Frank Hasse, *Die Revolution der Telekommunikation: Die Theorie der telekommunikativen Aprioris* (Baden-Baden: Nomos, 1996), 57.

88. Heinrich Heine, "Französische Zustände [1831/1832]," repr. in *So weit das Auge reicht: Die Geschichte der optischen Telegraphie*, ed. Klaus Beyrer (Karlsruhe: Braun, 1995), 157. "Siehst du ihn schon, den Willen Gottes? Er zieht durch die Luft, wie das stumme Geheimniß eines Telegraphen, der hoch über unsern Häuptern, seine Verkündigungen den Wissenden mittheilt, während die Uneingeweihten unten in lauten Marktgetümmel leben und Nichts davon merken, dass ihre wichtigsten Interessen, Krieg und Frieden, unsichtbar über sie hin, in den Lüften verhandelt werden."

89. Ibid. "Sieht Einer von uns in die Höhe, und ist er ein Zeichenkündiger, der die Zeichen auf den Thüren versteht, und warnt er die Leute vor nahenden Unheil, so nennen sie ihn einen Träumer und lachen ihn aus. Manchmal widerfährt ihm noch Schlimmeres, und die Gemahnten grollen ihm ob der bösen Kunde und steinigen ihn. Manchmal auch wird der Prophet auf die Festung gesetzt, bis die Prophezeyung eintreffe, und da kann er lange sitzen.

carrier of signs, but also a carrier of a new kind of sign.[90] What the wings of optical telegraphy transport are not signs of a legible world, nor those of a traditional script, but rather elements of a technical code. This code is the result of an intentional arrangement, which has broken any reference to nature, to the divine order, or to a transcendental signifier.[91] These signs become a hermetic sign, since the figures cannot be interpreted according to traditional hermeneutics—as a copy, symptom, or representation—but only through the arbitrary power of agreeing on the code.

In Germany, optical telegraphy would only be introduced four decades after the initial proposals, when the Prussian Semaphore System opened in 1832, and the Hamburg Ships Reporting Service in 1836. Media historian Völker Aschoff speculates that the reason for this delay was that there was not yet a German nation: since Germany consisted of over 300 more or less sovereign member states, there was no need for a centralized technical telecommunications system; for communication among the states, messengers remained more cost-effective.[92] Although this argument is speculation, the historical fact remains that the question of whether the German member states would adopt optical telegraphy, electrical telegraphy, or some other form entirely remained open until the mid-nineteenth century.

"C'est une idée germanique!" Napoleon reportedly scoffed when presented with the first working electrical telegraph on November 5, 1809.[93] A great believer in the French system of optical telegraphy, the Emperor must have doubted that any other system would be able to establish a direct, instantaneous connection between Strasbourg and Paris, as its inventor had claimed. Transmitted via optical telegraphy, a message would take around six minutes, at best, to make its way down the 480 km Strasbourg-Paris line, as it would need to be relayed between the 46 stations along the line positioned within visible distance of each other.[94] Relaying a message in this manner, as in the children's game of "telephone," entails inevitable data loss, not to mention the impossibility of working at night or under unfavorable weather conditions. Plus, Napoleon was the only one allowed to speak through the telegraph. No wonder, then, the Emperor dismissed the seemingly perfect communication enabled by the electrical telegraph as "une idée germanique," or so much "deutsche Träumerei," the transcendental nonsense of German Idealism. Despite the Emperor's misgivings, his personal physician, Baron Jean

90. My reading here draws heavily on Buschauer, *Mobile Räume*, 120.

91. Hasse, *Die Revolution der Telekommunikation*, 17.

92. Aschoff, *Geschichte der Nachrichtentechnik*, 1:211.

93. The most detailed version of the following anecdote can be found in Ernst Keil, ed., "Die Geschichte der deutschen Telegraphie," *Die Gartenlaube* 20 (1864): 318–20. Another version, reported by the inventor's son, can be found in Detmar Wilhelm Sömmering, "Auszüge aus dem Tagebuch von Samuel Thomas v. Sömmering," *Annalen der Physik* 183, no. 8 (1859): 647. Sömmering's son attributes the anecdote to an oral report from his father, who had apparently sent a complete apparatus with a description, in French, to Napoleon's personal physician, Baron Jean Dominique Larrey. According to Sömmering's son, Larrey ignored Napoleon's misgivings, and, being particularly inspired by Sömmering's idea of the galvanic wire as an analogy to the nervous system, copied and described the device in the second edition of his *Mémoires des Campagnes*. Unfortunately, I am unable to track down any direct reference to the anecdote in Larrey's *Mémoires*, despite multiple references to Sömmering.

94. On the construction of the Strasbourg-Paris line from 1794 to 1798 and the transmission speeds mentioned here, see Huurdeman, *The Worldwide History of Telecommunications*, 25–26.

Dominique Larrey, who had presented him with the device, copied the plans for the electrical—or, more precisely, electrochemical or electrolytic telegraph, which had incidentally been invented by another doctor, Samuel Thomas von Sömmering. Even though the world's first electrical telegraph line would only be introduced in 1839 in England,[95] and even though Sömmering's invention was still incapable of long-distance communication at the time, it was one of the first working telegraphs presented in Germany, where the need for a system of telegraphy was deeply felt, and this origin story about Napoleon's dismissal of the system proved significant to the imagination of telegraphy in Prussia.

In fact, Sömmering's telegraph was developed as a direct response to Napoleon's use of optical telegraphy earlier that year in Bavaria. On April 8, 1809, the optical telegraph had proved advantageous when Napoleon used it to announce Andreas Hofer's surprise revolt against the French and Bavarian occupation force, subsequently crushing the peasants in the Tyrolean Rebellion within a span of two weeks.[96] After that, telegraphy in Germany became a daily question, and Maximilian I, the king of Bavaria, demanded a comparable system from his scientific academy. On July 5, Sömmering dined with the Bavarian statesman Maximilian Josef Garnerin von Monteglas, who had requested him to have the academy work out proposals for introducing an optical telegraph. On August 28, Sömmering presented a working telegraph to the Munich Academy of Science. Drawing on his work as a doctor, Sömmering's telegraph was based on contemporary neurological knowledge—namely, the decomposition of water into hydrogen and oxygen, which made the telegraph cable "a rough physical analog of a nerve center, the individual fibers of which in the same way isolate both the received sensation impression in general and the smallest electrical spark in particular and transmit them to the brain."[97] Ultimately, Sömmering's telegraph was a delicate, wonderful apparatus, a masterpiece of German engineering with many wires coming out of a Volta flask as the power source. The only drawback was that it only had a range of only about 3 m, probably the main reason that Napoleon called it "une idée germanique." Despite this limitation, grandiose notices about the invention started circulating in the daily press, featuring in the *Nürnberger Korrespondent von und für Deutschland* of August 16, 1810, *Der Freimütige oder Berlinisches Unterhaltungsblatt* of August 28, 1810, and the *Königsberger Zeitung* of September 13, 1810.[98]

In direct response to these developments, a short text appeared on October 12, 1810, in the *Berliner Abendblätter*, a short-lived daily newspaper edited by Heinrich von Kleist, under the rubric "Nützliche Erfindungen: Entwurf einer Bombenpost" (Useful Inventions: Project for a Cannonball Postal System).[99] Of the newly invented system of

95. On the English telegraph, which created a direct connection between the railway stations of London-Paddington and West Drayton, see ibid., 59–60.

96. See Hennig, *Die älteste Entwicklung der Telegraphie und Telephonie*, 86–87.

97. Samuel Thomas von Sömmering, "Über einen elektrischen Telegraphen," (1809–10), 411, qtd. and trans. in Bernhard Siegert, *Relays: Literature as an Epoch of the Postal System*, trans. Kevin Repp (Stanford: Stanford University Press, 1999), 166.

98. See Aschoff, *Geschichte der Nachrichtentechnik*, 2:27.

99. Heinrich von Kleist, "Nützliche Erfindungen: Entwurf einer Bombenpost," *Berliner Abendblätter* 11 (October 12, 1810), translated by Philip B. Miller as Heinrich von Kleist, "Useful Inventions: Project for

electrical telegraphy, the author writes, in seeming anticipation of the media topos of the annihilation of space and time through telecommunications:

> They have recently invented, in order to expedite communications from the four corners of the globe, an electrical telegraph; a telegraph that by means of an electrophorus and a metal wire can transmit messages with the speed of thought, or, better said, in less time than chronometrical instruments could measure; so that if anyone, assuming the necessary apparatus were generally available, wished to inquire of an old friend, who lived in the Antipodes, "How are you?" this man, before you could turn a stone, and just as though he were standing in the very same room, could answer: "Very well, thank you."[100]

No sentence imaginable could be written less in the succinct style of a telegram than this one, which, as Peter Bexte observes, creates an effect of distancing the perspective on the recently invented telegraph.[101] Electricity, for Kleist, allows telegrams to travel faster and to reach their destination in a shorter amount of time, since a message transmitted via electrical telegraph "in a quite literal sense travels on wings of lightning" (auf recht eigentliche Weise, auf Flügeln des Blitzes reitet), a reference not only to the mythological figure of Hermes but also to the then-unmeasurable speed of electricity.

With electrical telegraphy, the human and therefore unreliable relay stations disappeared, and in their place a new economy of the sign emerged, as the numerous codes filling handbooks on optical telegraphy were reduced to the binary logic of the dot and dash in Morse code.[102] As a result, information would be decoupled—in the form of a massless flow of electromagnetic waves—from communication. With electricity, the national optical telegraph networks would also become international: distances were no longer calculated in terms of physical geography, as in pre-modern postal systems, but in terms of mathematical topography, because absolute speed is the only thing that counts with electricity. These features, outlined by Friedrich Kittler, are what allow media theorists Bernhard Siegert and Frank Haase to distinguish between a "postal a priori" and a "telecommunicative a priori."[103] Despite the advantages of electrical transmission, as Kleist and many others recognized, the electrical telegraph also has its limitations,

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a Cannonball Postal System," in *An Abyss Deep Enough* (New York: E. P. Dutton, 1982), 245–46. The acronym "rmz" allows attribution to Kleist, many of whose literary texts were first published in the *Berliner Abendblätter* including "Anekdote aus dem letzten preußischen Kriege," "Das Bettelweib von Locarno" and "Über das Marionettentheater." The text on the "Bombenpost" is dated October 10, two days prior to the publication. The first issue of the *Berliner Abendblätter* had only appeared on October 1.

100. Ibid., 245. "Man hat, in diesen Tagen, zur Beförderung des Verkehrs innerhalb der Grenzen der vier Weltteile, einen elektrischen Telegraphen erfunden; einen Telegraphen, der mit der Schnelligkeit des Gedankens, ich will sagen, in kürzerer Zeit, als irgend ein chronometrisches Instrument angeben kann, vermittelst des Elektrophors und des Metalldrahts, Nachrichten mitteilt; dergestalt, daß wenn jemand, falls nur sonst die Vorrichtung dazu getroffen wäre, einen guten Freund, den er unter den Antipoden hätte, fragen wollte: wie gehts dir? Derselbe, ehe man noch eine Hand umkehrt, ohngefähr so, als ob er in einem und demselben Zimmer stünde, antworten könnte: recht gut."

101. Bexte, "Kabel im Denkraum," 30.

102. Kittler, "The History of Communication Media."

103. Siegert, *Relays*; Hasse, *Die Revolution der Telekommunikation*.

namely, "being of small use to commercial interests, and good for dispatching only very short and laconic messages, not however for delivery of letters, reports, enclosures and parcel post."[104]

The projected cannonball postal system was to correct these defects. According to the plans for this unorthodox system, mail would be delivered, not in the traditional form of a package carried by a messenger on foot or horseback, nor in the novel form of information transmitted over an electrified wire, but in the form of a projectile shot out of a cannon. If the advancement of the media is usually a product of military interest, the project would accelerate the development by adapting for civilian life the military technology of "hollow shells, which have been stuffed full not of powder but letters and packages, and which could very easily be observed in flight, and wherever they might fall, short of some morass, be retrieved." Using "suitably situated artillery stations spaced within firing range of each other," the mail would be loaded into a cannon ("mortars or howitzers") and shot from one station to the next, at which point any local messages would be retrieved, and the entire process would repeat itself.[105] In my analysis, the proposal for a projectile postal system offered a compromise between the speed of transmission, exemplified by the electrical telegraph, and the materiality of communication, exemplified by the postal system. While the traditional system of postal delivery was often slow, at least in comparison to the speed of electricity, it allowed for the delivery of material objects. The recently invented system of electrical telegraphy was much faster, though it only allowed for the transmission of information in an immaterial form. The inevitable tradeoff between speed and materiality is what makes the proposal that promises to combine the two without sacrificing either so forceful.

While the speed and materiality of communication was the subject of the proposal for a projectile postal system, the contents of the messages being transmitted would come to the foreground four days later, with the publication of a (probably) fictional exchange between the editors of the *Berliner Abendblätter* and one of its readers. In a letter to the editors, a reader in Berlin objects that the speed of delivery should depend on whether one is receiving good news or bad news:

> This system, according to the exact words of your article, presupposes that the Berliner's friend in Stettin or Breslau, in response to his question "How are you?" would reply "Very well, thank you!" But if contrary to this assumption the answer were to be "So-so," or "Fair to middling," or "To tell you the truth, badly," or "Last

104. Kleist, "Project for a Cannonball Postal System," 245. "[S]o hat doch auch diese Fernschreibekunst noch die Unvollkommenheit, daß sie nur, dem Interesse des Kaufmanns wenig ersprießlich, zur Versendung ganz kurzer und lakonischer Nachrichten, nicht aber zur Uebermachung von Briefen, Berichten, Beilagen und Packeten taugt."

105. Ibid. "[E]in Institut, das sich auf zweckmäßig, innerhalb des Raums einer Schußweite, angelegten Artilleriestationen, aus Mörsern oder Haubitzen, hohle, statt des Pulvers, mit Briefen und Paketen angefüllte Kugeln, die man ohne alle Schwierigkeit, mit den Augen verfolgen, und wo sie hinfallen, falls es kein Morastgrund ist, wieder auffinden kann, zuwürfe; dergestalt, daß die Kugel, auf jeder Station zuvörderst eröffnet, die respektiven Briefe für jeden Ort herausgenommen, die neuen hineingelegt, das Ganze wieder verschlossen, in einen neuen Mörser geladen, und zur nächsten Station weiter spediert werden könnte."

> night while I was away my wife betrayed me," or "I am bankrupt, have lost everything, and have no recourse but to become a vagabond," then our ordinary postal system would be fast enough.[106]

Since the majority of mail contains so much bad news of this sort, the reader proposes the organization of an entirely different postal service,

> which, either by means of couriers on foot or for that matter ordinary oxcarts, would always arrive with answers like "I am well as can be expected" or "Not half bad" or "By gum, things are wonderful!" or "I've put my house in order" or "My books are finally balanced again" or "I married off both my daughters recently," or "Tomorrow with cannons booming we shall celebrate a national holiday."[107]

The editors answer that they appreciate such "persiflage and irony," and will consider transmitting the letter to the editor using the previously proposed projectile postal system.[108]

Despite these humorous descriptions, Kleist's project was hardly a joke or a satire, situated as it was in the context of competing plans to introduce telegraphy in Prussia.[109] Would it follow the proven French model of optical telegraphy, the unproven German model of electrical telegraphy, or some other system entirely? In fact, even before the proposal for a projectile postal system appeared, there had already been at least two proposals for the introduction of a similar service in Germany.[110] Furthermore, the idea of projectile warfare using electricity was common throughout the French Revolution, often featuring in caricatures of Jacobins blowing up the First and Second Estates by means of static electricity.[111] This literal form of "information warfare" remained around well into

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106. Heinrich von Kleist, "Letter from a Berliner to the Editors of the *Abendblätter*," in *An Abyss Deep Enough*, trans. Philip B. Miller (New York: E. P. Dutton, 1982), 247. "Erlauben Dieselben mir zu bemerken, daß diese Post, nach einer, in Ihrem eigenen Aufsatz enthaltenen Aeußerung, voraussetzt, der Stettiner oder Breslauer Freund habe auf die Frage des Berliners an ihn: wie geht's dir? Zu antworten: recht gut! Wenn derselbe jedoch, gegen die Annahme, zu antworten hätte: so, so! Oder: mittelmäßig! Oder die Wahrheit zu sagen, schlecht; oder gestern Nacht, da ich verreis't war, hat mich meine Frau hintergangen; oder: ich bin in Prozessen verwickelt, von denen ich kein Ende absehe; oder: ich habe Bankerot gemacht, Haus und Hof verlassen und bin im Begriff in die weite Welt zu gehen: so gingen, für einen solchen Mann, unsere ordinairen Posten geschwind genug."

107. Ibid. "[D]ie, gleichviel, ob sie mit Ochsen gezogen, oder von eines Fußboten Rücken getragen würde, auf die Frage: wie geht's dir? Von allen Orten mit der Antwort zurückkäme: je nun! Oder: nicht eben übel! Oder: so wahr ich lebe, gut! Oder: mein Haus habe ich wieder aufgebaut; oder: die Pfandbriefe stehen wieder al pari; oder: meine beiden Töchter habe ich kürzlich verheirathet; oder: morgen werden wir, unter dem Donner der Kanonen, ein Nationalfest feiern; — und was dergleichen Antworten mehr sind."

108. Heinrich von Kleist, "Antwort an den Einsender des obigen Briefes," *Berliner Abendblätter* 14 (October 16, 1810), repr. in *Sämtliche Werke und Briefe*, vol. 3, *Erzählungen, Anekdoten, Gedichte, Schriften*, edited by Klaus Müller-Salget (Frankfurt am Main: Deutscher Klassiker Verlag, 1990), 595.

109. See Siegert, *Relays*, 165–85.

110. Ibid., 167; Volker Aschoff, *Geschichte der Nachrichtentechnik* (Berlin: Springer, 1995), 2:27.

111. Hasse, *Die Revolution der Telekommunikation*, 18; Wolfgang Hagen, "'Stürmische Plötzlichkeiten:' Zur medialen Genealogie der Elektrizität," in *Blitzlicht*, ed. Katja Müller-Helle and Florian Sprenger (Zurich: Diaphanes, 2012), 160.

the twentieth century. During World War I, the art historian Aby Warburg suggested in a letter to the physicist and physiologist René du Bois-Reymond dated September 21, 1916, that electricity could be used as a weapon to fight enemies in war: "Why can't one actually shoot electrically, i.e., create an electric spark discharge at some particular point?—I'm thinking, e.g., of making the despicable English captive balloons explode in this way."[112] The origin story of telecommunications as warfare would remain potent in the German imagination well into the twentieth century.

The ultimate origin story about wireless telecommunications is perhaps an anthropological one. On April 25, 1923, at the end of his recovery from serious depression, due largely to "shell-shock" from World War I, Warburg held a lecture at the famous Bellevue Sanatorium in Kreuzlingen, Switzerland, then under the direction of the Swiss psychiatrist and pioneer in the field of existential psychology Ludwig Binswanger.[113] In the now-famous lecture, originally never intended for publication, Warburg traced "the evolution from primitive paganism, through the highly-developed pagan culture of classical antiquity, down to modern civilized man."[114] Having observed the North American Pueblo Indians on a trip in 1896, Warburg spent most of the lecture, composed over twenty-five years later, detailing their ritual form of rainmaking using the serpent as a symbol of lightning. At the end of the lecture, however, Warburg contrasted this description with a photograph that he had taken in San Francisco of "the type of man who overthrew the cult of the serpent and overcame the fear of lightning—the descendant of the indigenous race and of the gold-diggers who expelled the Indians: Uncle Sam in his tall hat walking proudly along the street past a pseudo-classical rotunda."[115] In his reading of the photograph, showing a bearded man in suit and tie walking along the street while clutching something in his left hand, Warburg emphasized one seemingly innocuous detail in the background that is not even visible in the photographic reproduction. "And away above his top hat runs the electric wire. In this copper-snake, invented by Edison, he has wrested the lightning from nature."[116] From this detail, Warburg derived massive implications: "The American of today no longer worships the rattle-snake. Extermination (and whisky) is his answer to it. Electricity enslaved, the lightning held captive in the wire, has produced a civilization which has no use for heathen poetry. But what does it put in its place? The forces of nature are no longer seen in anthropomorphic shapes; they are conceived as an endless succession of waves, obedient to the touch of a man's hand."[117] The man in the photograph was perhaps

112. Qtd. in Thomas Hensel, *Wie aus der Kunstwissenschaft eine Bildwissenschaft wurde: Aby Warburgs Graphien* (Berlin: Akademie Verlag, 2009), 66. "Warum kann man eigentlich nicht elektrisch schießen, d.h., an einem bestimmten Punkt eine elektrische Funkentladung hervorrufen? Ich denke daran, daß man so z. B. die verruchten englischen Fesselballoons zum Explodieren bringen könnte?"

113. Warburg's lecture, originally entitled "Reminiscences from a Journey to the Pueblo Indians," appeared first in English in 1939 as "A Lecture on Serpent Ritual," and only in German in 1988 as "Schlangenritual: Ein Reisebericht."

114. Aby Warburg, "A Lecture on Serpent Ritual," *Journal of the Warburg Institute* 2, no. 4 (April 1939): 277.

115. Ibid., 292.

116. Ibid.

117. Ibid.

operating some kind of pocket wireless device. For Warburg, the American imagined to be Uncle Sam in a top hat exemplified the type of person whose technological rationalism dispensed with the cult of the serpent and overcame an indigenous fear of lightning.

At the end of origin stories, signaled by the de-mythologization of nature, mastered in the form of the electric wire, there is always a trade-off. Warburg's impression was that "with these waves the civilization of the mechanical age is destroying what natural science, itself emerging out of myth, had won with such vast effort—the sanctuary of devotion, the remoteness needed for contemplation."[118] In a fashion typical of 1920s Weimar intellectuals, Warburg connected the advent of telecommunications to a collapse of distance.[119] His suspicion of the ability of Enlightenment "progress" to answer the fundamental questions of human existence led him to reverse the values in common origin stories of modern transport and telecommunication: "The modern Prometheus and the modern Icarus, Franklin and the Wright Brothers who invented the aeroplane, are those fateful destroyers of our sense of distance who threaten to lead the world back into chaos. Telegraph and telephone are destroying the cosmos. But myths and symbols, in attempting to establish spiritual bonds between man and the outside world, create space for devotion and scope for reason which are destroyed by the instantaneous electrical contact—unless a disciplined humanity re-introduce the impediment of conscience."[120] According to Ernst Gombrich, an art historian and Warburg biographer, this passage expresses Warburg's distaste for modern wireless technology: "He never accepted the wireless because of its threatening obliteration of distance."[121] Similarly, Wolfgang Hagen calls this Warburg's "anti-electrical outburst of rage" (anti-elektrischen Wutsausbruch).[122] However, in a detailed reading of the passage, Thomas Hensel challenges the assumption that Warburg was a technophobe, especially seeing as Warburg was, in a sense, the first person to digitize his own library.[123] With Hansel, I would argue that the concluding lines of Warburg's lecture show that symbolic practices, which secure the space of remoteness necessary for thought, are not merely a question of technology, but rather of one's distance from oneself.[124] The ultimate origin story about

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118. Ibid.

119. See Hans Ulrich Gumbrecht, *In 1926: Living at the Edge of Time* (Cambridge, MA: Harvard University Press, 1997), 364–71.

120. Warburg, "A Lecture on Serpent Ritual," 292.

121. E. H. Gombrich and Fritz Saxl, *Aby Warburg: An Intellectual Biography* (Chicago: University of Chicago Press, 1986), 224.

122. Wolfgang Hagen, "Funken und Scheinbilder: Skizzen zu einer Genealogie der Elektrizität," in *Mehr Licht*, ed. VVS Saarbrücken (Berlin: Merve, 1999), 112.

123. Hensel, *Aby Warburgs Graphien*, 155–64. Elsewhere, Hansel provides further evidence: Warburg's mother recounted to him physics lectures on electricity, lightning, and telegraphy; and Warburg visited the 1891 International Electrotechnical Exhibition in Frankfurt am Main (66). In a letter to his brother of July 27, 1924, Warburg placed his own construction of "eine Station zur Beobachtung der Werte seelischer menschlicher Schwingungen" on the order of "den Hertz'schen Versuchen, die energetischen Einheitlichkeit von Licht und Elektrizität nachzuweisen" (95–96); and Hertz's antenna, the "Hertz dipole," served as the model for the elliptical construction of the reading room of the *Kulturwissenschaftlichen Bibliothek Warburg* (98).

124. In a diary entry of September 23, 1929, Warburg also complains about the omnipresence and universal accessibility of the radio, and presents it as a question of one's distance to oneself: "Unheimlich war mir der Rundfunksprecher bei dem Friseur: wo soll das hinaus, wenn jeder Lümmel den Äther zu

wireless telecommunications is an anthropological story, shifting the emphasis on the distances overcome through telecommunications to the distance between the categories of *ars* and *techne*.

Ends of the Wire

Having reviewed the search for the symbolic origins of wirelessness, the one crucial origin story still left to be examined is that of a purely functional order. While many early histories of wireless telegraphy tended to trace the desire for communication back to the dawn of time, some claimed that the invention of wireless transmission was of a more recent vintage. Like Eugen Nesper, mentioned at the start of this chapter, Karl Ferdinand Braun, the German physicist, electrical technician, and inventor who would share the Nobel Prize in Physics with Guglielmo Marconi in 1909 for their contributions to the development of wireless technology, began his lecture series on *Drahtlose Telegraphie durch Wasser und Luft* (Wireless telegraphy through water and air, 1900) with the laconic statement that "attempts at *wireless* telegraphy are not much more recent than the invention of practically usable *wired* telegraphy [….] Only shortly after people accomplished transmission via the wire, they already started looking for ways to rid themselves of it."[125] Wireless telegraphy, in other words, is conceived as a solution to a problem within media history itself, namely, a problem of efficiency and optimization, of first reducing the number of connecting wires involved in wired telegraphy and then doing away with them entirely. In this respect, Braun's lectures present a unique genealogy of wirelessness before electromagnetic radiation came to be the dominant medium of signaling without wires in the years following Marconi's successful demonstrations of 1897. The meaning of "wireless telegraphy *through* water and air" in the title of Braun's lectures hinges on the two-fold meaning of *durch*, referring to attempts not only to signal *across* bodies of water or *through* the air (in the spatial sense of *durch*), but also to transform these elements themselves into the physical carrier medium of wireless signals (in the modal sense of *durch*, "by"). Admittedly, Braun's lectures were also an attempt to promote his own research in this area, and the teleology of his historical overview culminates in a presentation of his own system. Nevertheless, I argue that Braun's understanding of historical methods of signaling through water, air, and earth as a response to the problem of eliminating wires remains significant, since these methods represent both a "road not taken" in the history of wirelessness and an understudied area of scientific research beyond electromagnetic radiation.[126]

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seinem Pläsier melken kann, wo er will von [sic] Budapest, Stockholm oder Rom. Mutet mich [sic] wie nächtlicher Baumfrevel an." (qtd. in Hensel, *Aby Warburgs Graphien*, 64–65.)

125. Ferdinand Braun, *Drahtlose Telegraphie durch Wasser und Luft: Nach Vorträgen gehalten im Winter 1900* (Leipzig: Veit & Comp., 1901), 5, emphasis added. "Die Bestrebungen nach einer drahtlosen Telegraphie sind nicht viel jünger als die Erfindung der praktisch verwerthbaren Drahttelegraphie selber […] kaum, dass man eine Uebertragung mittels des Drahtes geschaffen hatte, suchte man sich desselben auch schon wieder zu entledigen."

126. For period overviews, see Fahie, *A History of Wireless Telegraphy*; Augusto Righi and Bernhard Dessau, *Die Telegraphie ohne Draht* (Braunschweig: Friedrich Vieweg & Sohn, 1903); for recent research, see I. V. Lindell, "Wireless Before Marconi," in *History of Wireless*, ed. Tapan K. Sarkar et al. (Hoboken, NJ: Wiley Interscience, 2006), 247–66; Völker, *Mobile Medien*, 145–48.

Wired telegraphs operate by sending electrical currents along wires: the telegraph key is merely a switch in an electric circuit that turns on an electric current; as the telegraph operator taps out a word, the switch completes a circuit which allows an electric current to flow around it. At least two wires are needed between the sender and the receiver, though for the very simplest of telegraphic circuits, only one physical wire is sufficient if the circuit is grounded. While the most iconic form of wired telegraphy would eventually become this single, physical wire stretched between two terminals—usually leading from the transmitter up a utility pole and through the air from one pole to the next all the way to the receiver—early experimental telegraphs often employed multiple connecting wires, and in some cases, even dedicated one wire to each letter of the alphabet. There were several obvious difficulties inherent in this approach to wired telegraphy: cables were expensive, often unreliable, subject to deterioration due to the weather, susceptible to being cut during war, and ultimately impractical for reaching moving targets in situations where transmission would be especially useful, such as contacting ships at sea and aircraft in flight. In light of these difficulties, attempts to remove at least one of the wired paths seem reasonable. Before attention to the propagation of electromagnetic radiation at the end of the nineteenth century, the main area of research on wireless telegraphy throughout the nineteenth century was focused on conduction and induction telegraphy, approaches based on distributing electric currents through water or the earth.[127]

While the semaphore system remained the only practical means of telegraphy until the mid-nineteenth century, other proposals were made for electrical and electrochemical telegraphy. Building on Galvani's discovery of the twitching of frog's legs, which showed that energy can be transmitted without metallic wires, a self-taught Italian scientist, Alessandro Volta, discovered in 1799 that "galvanic electricity" could be generated by placing two different metals into an acidic liquid. In doing so, he constructed an electrolytic cell, thereby creating the first continuous source of electricity, which came to be known as a "voltaic pile."[128] In the wake of these discoveries, the idea of using the stuff that frogs live in and are made of—water, or more generally, liquids—as a conductor for telegraphy became widespread in the European scientific community around 1800. Electricity is not only a physical but also a biological phenomenon, which is why so many doctors took part in the development of electrical telegraphy. The same idea of telegraphing using the formation of hydrogen bubbles through the application of electricity to water occurred to the Spanish doctor Salvá i Campillo in 1795[129] and to the German doctor Samuel Thomas von Sömmering, the inventor dismissed by Napoleon for his "idée germanique," in 1809. Sömmering's telegraph was one of the first functioning galvanic telegraphs presented in Germany.[130] The apparatus consisted of a transmitter, resembling a piano keyboard, a series of connecting wires dedicated to each letter of the alphabet, and a receiver, consisting of troughs filled with water, making it literally a form

127. See Lindell, "Wireless Before Marconi," 247.
128. See Huurdeman, *The Worldwide History of Telecommunications*, 30.
129. See Lindell, "Wireless Before Marconi," 247.
130. See ibid., 248.

of "wetware."[131] Touching a key would activate a cable, which would trigger electrolysis and thus produce water bubbles. Since it was impossible to store the letters signaled in this way, Sömmering would sit next to the apparatus and note down the speech bubbles in the "cloudy water of pure reason" (trüben Wasser der reinen Vernunft) as Siegert calls it.[132] In 1811, Sömmering expanded his experiments with galvanic telegraphy, with the assistance of Baron Schilling von Cannstadt, using wires that were insulated with sealing wax, and then passed through the Isar River and one of its branches as a conductor. However, since there are not any bodies of water with 24 different branches that would correspond to the letters of a shortened alphabet, the experiments were ultimately abandoned.[133]

In the 1820s, a series of discoveries shifted attention from electro*chemical* signaling to electro*mechanical* signaling, which resulted in practical *electrical* telegraphy by the 1850s.[134] On August 25, 1838, Carl August von Steinheil reviewed many of the earlier developments in a public lecture held at the Bavarian Academy of Science "Ueber Telegraphie, insbesondere durch galvanische Kräfte" (On telegraphy, particularly through galvanic forces). In the lecture, Steinheil made a distinction between "artificial carriers," such as electricity, and "natural carriers" (natürliche Träger), such as light, sound, heat, water, and dirt. While natural carriers contain the advantage that they "do not require any particular connection between the stations,"[135] artificial carriers run into a problem in terms of the "chain of connections between the stations,"[136] which would today be called an electrical circuit. André-Marie Ampère's telegraph initially required sixty wires, Sömmering's required thirty, Charles Wheatstone and William Fothergill Cooke reduced the number to five, and Carl Friedrich Gauss, Pavel Schilling, and Samuel Morse, down to one, "only one single chain that leads there and back. Many people believed that this was the limit of simplification," reflected Steinheil. "However, it is not the case. I have found that one can even manage without half of this chain, in certain circumstances, by replacing the other half with the ground."[137] According to Steinheil, many other scientists had dismissed the earth as a potential carrier of signals, since it is not as powerful of a conductor as metal (e.g., copper wires). The main caveat, as Steinheil conceded in the

131. See Friedrich A. Kittler, "Lakanal und Soemmering: Von der optischen zur elektrischen Telegraphie," in *Wunschmaschine Welterfindung: Eine Geschichte der Technikvisionen seit dem 18. Jahrhundert*, ed. Brigitte Felderer (Vienna: Springer, 1996), 286–95.

132. Qtd. in Bexte, "Kabel im Denkraum," 29.

133. See Völker, *Mobile Medien*, 146.

134. Huurdeman, *The Worldwide History of Telecommunications*, 31.

135. Karl August Steinheil, *Ueber Telegraphie insbesondere durch galvanische Kräfte: Eine öffentliche Vorlesung gehalten in der festlichen Sitzung der Königl. Bayerischen Akademie der Wissenschaften am 25. August 1838* (Munich: Carl Wolf, 1838), 10. "[S]ie zwischen den Stationen keiner besondern Verbindung bedürfen. Die Luft, das Wasser, das Erdreich, bilden die natürlichen Träger der erregten oder benützten Zustände, durch welche Mittheilungen geschehen. Dieser wesentliche Umstand unterscheidet sie vortheilhaft von andern Möglichkeiten, die wir jetzt näher erörtern wollen."

136. Ibid. "Verbindungskette zwischen den Stationspunkten."

137. Ibid., 16. "[N]ur einer einzigen Kette, die hin- und zurückführt. Man hätte glauben sollen, diess wäre die letzte Gränze der Vereinfachung; und dennoch ist es nicht der Fall. Ich habe gefunden, dass man noch die Hälfte dieser Kette entbehren kann, indem unter gewissen Bedingungen der Erdboden die andere Hälfte ersetzt."

conclusion to the lecture, was that earth transmission would only work for short distances.[138] "We have to leave to the future the question of whether telegraphing over great distances completely without a metallic connection will ever succeed," Steinheil concluded. "For shorter distances up to 50 feet, I have proven the possibility through experiments."[139]

Steinheil's remarks, supported by his experiment, led to speculation that it might be possible to eliminate the metallic wires involved in telegraphy entirely, and therefore transmit signals through the ground without any wires connecting the stations. The physical causes that allowed the return wire to be eliminated were misunderstood at the time, and the phenomenon became known as a "ground return." Although the electrical current seemed to flow through the ground from the transmitter to the receiver, thereby completing the circuit, it was not actually traveling a significant distance. Instead, the earth around the point where the circuit was grounded was acting as a sink, which effectively completed the circuit. Nevertheless, this mistaken belief that "ground return" currents were propagating over great distances through the earth, fueled by the media topos of telegraphy overcoming space and time, suggested the idea of signaling without any connecting wires to many researchers. Investigating the line of research proposed by Steinheil's work, many were disappointed to learn that they were unable to send electrical currents through the ground more than a few meters.

Ultimately, telegraphic communication using the earth and water was eventually found to be limited to impractically short distances. However, it continued to serve a practical function in some cases, as when a navel vessel's antenna was destroyed or troops attempted to communicate in the trenches during World War I. Even though it turned out that there was in fact no way to send standard electrical currents for long distances through the ground, in the mid-1890s, a group of experimenters, including Braun and others in Germany and several other key figures working independently around the world, would discover the next best thing—electromagnetic radiation in the radio frequency spectrum. Though initially thought to be impractical, electromagnetic radiation would be quickly developed into the dominant medium of wireless transmission, a development that will be examined in the next chapter.

Conclusion: Ursprung and Urszene

The aim of this chapter has been to register shifts in the pre-history of wirelessness from pre-modern forms of symbolic communication to modern forms of non-symbolic communication. Pre-modern communication is unthinkable without a medium, not in the modern sense of mass media, but in the sense of an intermediary or go-between, be it a human messenger, a spirit, demon, angel, or a physical substance like fire and corpuscles. In modern communication media, the very idea of a medium is what must be "dissimulated" for a medium to function. While pre-modern techniques of signaling at a distance were primarily linked to the elements, allowing for symbolic representations in

138. Ibid., 18.

139. Ibid., 17–18. "Wir müssen es der Zukunft überlassen, ob es je gelingen wird, auf grosse Distanzen hin ganz ohne metallische Verbindung zu telegraphieren. Für kleinere Entfernungen bis zu 50 Fuss habe ich die Möglichkeit durch Versuche nachgewiesen."

literature, modern media technology came to be based on electricity and magnetism, which allowed them to aspire to the real. To the extent that pre-modern communication involved inherited cultural techniques passed down through collective tradition, the invention of modern media is generally ascribed to science and technology. However, I argue that literature can still serve as a project, an imaginative space for expanding the possible relations between science and technology.

Is there, in the end, anything else for literature to say about wireless technology, other than, "it functions, and that's all"? The deep time of the media allows for a fresh and more nuanced reading of the extended aside in *Berlin Alexanderplatz* comparing the two historical modes of signaling at a distance without wires. The comparison comes in a chapter, at the end of Book Two, called "Dimensions of Franz Biberkopf: He is a Match for Old Heroes" (Ausmaße dieses Franz Biberkopf. Er kann es mit alten Helden aufnehmen). This chapter arguably represents a turning point in the novel in that it reveals both the crime for which the protagonist was imprisoned and his lack of remorse for it even after his release. The chapter title is not only an ironic comment on the protagonist's posturing as a muscleman, but also an indication of modernity's relation to traditional origin stories. Throughout the chapter, the narration pits the thoroughly unheroic Biberkopf, "formerly a cement-worker, then a furniture-mover, and so on, and now a newsvendor,"[140] against an exemplary tragic hero, Orestes, the son of Clytemnestra and Agamemnon, rulers of the Ancient Greek kingdom of Mycenae or Argos.[141] While the Furies, symbols of divine punishment, hounded Orestes after committing matricide in revenge for mariticide, "they don't hound Franz Biberkopf" after he murders his fiancée Ida.[142] In fact, the protagonist is able to drink one mug of beer after the next without any pangs of remorse, prompting the narrator to ask of Biberkopf and Orestes, "Who would not rather be in whose skin?"[143] With these kinds of interjections, the narration juxtaposes not only the fates of these two figures and the two different forms of signaling without wires, but also at least two different styles of narration—primarily, the style of the detached voice of modern science and the ecstatic voice of ancient mythology.

In doing so, the narration demonstrates the potential of literature to operate in different registers: the account of Ida's brutal and absurd death (Biberkopf beats her to death with a "little wooden cream-whipper" to the throat) is presented in terms of a clinical autopsy, with the narrator coldly remarking that "the following organs of the woman were slightly damaged"; and the reasons for her death are framed in terms of "the laws of statics, elasticity, shock, and resistance," and their corresponding mathematical equations: "The whole thing is wholly incomprehensible without a knowledge of those

140. Döblin, *Berlin Alexanderplatz*, 73. "Dieser Franz Biberkopf, früher Zementarbeiter, dann Möbeltransportör und so weiter, jetzt Zeitungshändler."

141. On the function of the Orestes story in the novel and Döblin's extensive knowledge of Aeschylus's Oresteia, see Joris Duytschaever, "Alfred Döblins Aischylos-Rezeption: Zur Funktion der Orest-Parodie in *Berlin Alexanderplatz*," *Revue de Littéraire Comparée* 53, no. 1 (1979): 27–46.

142. Döblin, *Berlin Alexanderplatz*, 73. "Franz Biberkopf hetzen sie nicht."

143. Ibid. "Wer möchte nicht lieber in wessen Haut stecken."

laws."[144] Adopting an ecstatic voice evocative of ancient mythology, on the other hand, the narrator describes the message relayed via beacons spanning the distance from Troy to Argos in heroic terms. After a memorable description of the Fall of Troy, the narrator exclaims: "How splendid, be it said in passing, this flaming message from Troy to Greece! How great it is, this march of fire across the sea, this is light, heart, soul, happiness, rejoicing!"[145] After the Fall of Troy, one watchman lights a torch, after seeing which another watchman lights another torch, after seeing which another lights another torch, after which…. The chain of communication stretches not only along the coastline, but all the way from the ancient scene of the battle to the modern scene of reading, as "this outcry continues, this madness, which you [i.e., the reader] see, flaming red: Agamemnon is coming!"[146] This symbolic, epoch-making message is described in a litany of elemental, anthropomorphic verbs, uniting the contents of the message, the technique for relaying it, and the experience of the event: "It burns, it blazes, it speaks, it feels, at every moment, in each place, and the joy is general: Agamemnon is coming!"[147] Ultimately, the narrator comes to the now seemingly inevitable, though still provocative, conclusion about the inferiority of modern technology: "We can't compare ourselves with this way of doing things. Here again we're inferior."

Quantitatively, modern wireless transmission, even in the aging form of wireless telegraphy, must have seemed infinitely superior to anything that came before it, at least in terms of the amount of information it transmitted, not to mention its speed, range, and reliability. Along these lines, the common rhetoric of technological advancement, discussed in the last chapter, framed the history of wireless technology in terms of incremental progress, each device representing an improvement on the last, increasingly connecting people in ever more intricate ways, and contributing to the eventual conquest of space and time. In period histories of telegraphy, for example, ancient beacon fires were usually taken to be the starting point for subsequent developments in later generations of mechanical, electrical, and radio telegraphy. The medium of transmission may differ, with (pre-modern) optical systems relying on visible smoke and fire, (early modern) electrical telegraphy on electricity conducted through a wire, and (modern) wireless telegraphy on invisible electromagnetic waves radiated through space. However, each is still a form of transmitting a message over a large geographic distance, and each involves the use of a technical code rather than the physical exchange of an object bearing the message. As electromagnetic phenomena, moreover, the radio wave used for wireless telegraphy and the light emitted from a flaming beacon will both travel at roughly the same speed, orders of magnitude faster than any foot-messenger, even Hermes. There is only a negligible difference here between optical, electrical, and wireless transmission. What makes modern technology "inferior" (*zurückstehen*, more

144. Ibid., 73–74. "[E] inen kleinen hölzernen Sahnenschläger"; "zunächst folgende Organe des Weibes leicht beschädigt wurden"; "Gesetzen von Starre und Elastizität, und Stoß und Widerstand. Es ist ohne Kenntnis dieser Gesetze überhaupt nicht verständlich."

145. Ibid., 75. "Wie herrlich, nebenbei bemerkt, diese glühende Meldung von Troja nach Griechenland. Ist das groß, dieser Zug des Feuers über das Meer, das ist Licht, Herz, Seele, Glück, Aufschrei!"

146. Ibid. "[I]mmer nur das Geschrei und die Raserei, die du siehst, glührot: Agamemnon kommt!"

147. Ibid., 76. "Sie brennt, sie lodert, in jedem Augenblick, an jedem Ort sagt sie, fühlt sie, und alles jauchzt darunter: Agamemnon kommt!"

literally, getting "left behind"), then, must not be a *quantitative* difference but a *qualitative* difference—namely, the difference between the subjective and collective dimension of pre-modern symbolic communication and the objectivity of modern scientific technology.

Qualitatively, the modern technology of wireless telegraphy can be understood as being inferior to the ancient technique of beacon fires in two main respects. First of all, the contents of wireless telegrams appear trivial compared to the contents of fire signals. The ancient Greek fire contained an epoch-making message and the relay system stretching from Troy to Argos was used only on this one special occasion when the public message "Troy has fallen" coincided with the private message "Agamemnon is coming." Wireless telegraphy, on the other hand, was, at the time of the novel's composition, used mostly for delivering private telegrams or seemingly trivial public news. In the Weimar Republic, wireless news services were handled primarily by the Drahtloser Dienst AG (DRADAG), an organization that supplied at least five daily news packages to nationwide radio stations. In fact, at one point in *Berlin Alexanderplatz*, Döblin even inserts a weather forecast copied verbatim from this service, suggesting that quotidian news about the city is more significant than any dramatic news about the protagonist of the novel.[148] In my reading, Biberkopf's job as a newspaper seller further underscores his absence from the headlines: while the entirety of ancient Greek society came together to form the wireless transmission system announcing Agamemnon's homecoming, there was no news of Biberkopf's murder of Ida in the papers, no message about his release from prison, no plans for any sort of possible homecoming. Reading the story of his failed reintegration into Weimar society as a synecdoche, pars pro toto, for the internal contradictions of modernity, the aside on the inferiority of wireless telegraphy can be understood as a comment on the internal contradictions of modern science and technology.

Second, despite understanding the intricate processes involved in wireless telegraphy, the narrator of *Berlin Alexanderplatz* finds it difficult to relate this modern technology, which consists of invisible vibrations and oscillations of electromagnetic waves, to any foundational narrative or any literary style. In contrast to the description of the ancient beacons, the description of modern wireless telegraphy deploys the cool voice of the New Objectivity, suggesting that the style of narration should reflect characteristics of the technology under discussion:

> To send a message, we make use of a few results from the experiments of Heinrich Hertz, who lived in Karlsruhe, died at an early age, and who, at least in the photo of the Munich Graphic Collection, wore a full beard. We telegraph by wireless. We produce high-frequency alternating currents through transmitters in big stations. We produce electric waves by oscillations of a vibrating circle. The vibrations spread out spherically, as it were. And then there is also an electron tube of glass and a microphone the disk of which vibrates in alternating degrees, thus reproducing tones,

148. Ibid., 257.

> precisely as when they entered the machine, and that is astonishing, clever, tricky. It's hard to get enthusiastic about all this; it functions, and that's all.[149]

In other words, what goes in to a wireless transmitter in one place is the same as what comes out of the receiver in another place. Although the reference made in the above passage to the reproduction of tones using a microphone may seem to evoke the media topos of the disembodied voice over the radio, it actually refers to a different use of a microphone for the purpose of modulating an electromagnetic wave to contain information. In my analysis, the system of wireless transmission described in the extended aside is that of Telefunken's famous *Tönenden Funken*, which uses a microphone switched into an electrical circuit, a technology that will be discussed in my next chapter.

What goes in at the start of a wireless transmission is the same as what comes out at the end—the statement at the heart of Döblin's digression on the two modes of "wireless" transmission might seem to apply equally well to the terminals involved in wireless telegraphy and to endpoints in a chain of beacons, since both involve technical operations of encryption and decryption. Furthermore, both beacon chains and wireless telegraphy transmit symbolic information using a form of digital code, though admittedly only the latter in a technical, mathematical code differentiated into an entire semiotic system. However, there remains a significant qualitative difference in terms of the physical medium of transmission connecting the transmitter and the receiver. Whereas sending a message using sound and light allows the message to remain in a symbolic form throughout the entire transmission that remains accessible to the human senses, sending a message using electromagnetic radiation requires multiple stages of conversion, whereby information is encoded and decoded in a machine-readable format. This has repercussions for the relation of literature to technology, as is evident in Döblin's choice to make the narrative style mirror the "wireless" systems being described, thereby demonstrating one of the potentials of literature as a producer of media knowledge. What literature can do, following Döblin's logic, is register a fundamental difference in the deep time of wireless media. If elementary fire signals once seemed to lead a symbolic life intertwined with the fates of the heroes ("it burns, it blazes, it speaks, it feels"), the wireless telegraph leads only a functional existence, a life of its own ("it functions, and that's all"). Even though we may insist that "*we* make use of a few results from the experiments of Heinrich Hertz," that "*we* telegraph by wireless," that "*we* produce high-frequency alternating currents through transmitters in big stations," and that "*we* produce electric waves," modern wireless technology remains indifferent to us.

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149. Ibid., 76, translation modified. "Wir bedienen uns für Meldungen einiger Resultate aus den Versuchen von Heinrich Hertz, der in Karlsruhe lebte, früh starb und, wenigstens auf der Photographie der Graphischen Sammlung München, einen Vollbart trug. Wir telegraphieren drahtlos. Wir erzeugen durch Maschinensender in großen Stationen hochfrequente Wechselströme. Wir bringen durch Oszillationen eines Schwingungskreises elektrische Wellen hervor. Die Schwingungen breiten sich kugelschalenartig aus. Und dann ist noch eine Elektronenröhre da aus Glas und ein Mikrophon, dessen Scheibe bald mehr, bald weniger schwingt, und so kommt der Ton hervor, genau wie er vorher in die Maschine hineingegangen war, und das ist erstaunlich, raffiniert, schikanös. Begeistern daran kann man sich schwer; es funktioniert, und damit fertig."

CHAPTER THREE

Going Wireless: The Poetics and Politics of Invention

As if in direct response to Alfred Döblin's claim that there is nothing more for literature to say about wireless technology than "it functions, and that's all," the Austrian novelist Rudolf Brunngraber composed *Der tönende Erdkreis: Roman der Funktechnik* (The resounding world: A novel of wireless technology; composed 1940–46; published 1951).[1] For over 500 pages, the characters in this hybrid work of non-fiction and roman à clef explain the functional principles of wireless technology in a series of extended monologues, delivered either to apprentice technicians or to strangely enraptured paramours. Composed after the Anschluss and during the height of Nationalist Socialist radio politics, Brunngraber's now forgotten novel bypasses the development of national radio broadcasting entirely and reads more like a nostalgic love letter to the early days of wireless technology, from the earliest reports of successful wireless telegraph transmissions in 1897 to the first international radio broadcasts in 1921.[2] Although several radio novels (*Radioromane*) had been published in the twenties and thirties, most of them were written in then-contemporary idioms of science fiction and fantasy, and perhaps only one dealt with realistic technical developments.[3] One of Brunngraber's several "novels of facts" (*Tatsachenromane*) or "biographies of a thing" (*Dingbiographien*), *Der tönende Erdkreis* interweaves documentary details about the

1. Rudolf Brunngraber, *Der tönende Erdkreis: Roman der Funktechnik* (Hamburg: Rowohlt, 1951); on its history of composition and publication, see Ursula Schneider, "Rudolf Brunngraber: Eine Monographie" (Phil. diss., University of Vienna, 1990), 417–27. Brunngraber worked on composing the novel for six years (1940–46), and then for another five to six years on getting it published. In 1947, the Paul Zsolnay Verlag announced that it would publish the 1000-page book under the title *Zwischen den Sternen*. However, the Soviet occupying forces objected to the exclusion of Russians from the story, especially the wireless pioneer Alexander Stepanovich Popov, and the novel had to be pulled from press. Eventually, Brunngraber reduced the novel to 575 pages for the Rowohlt Verlag, where it was published in 1951. I cite this edition of the novel, though further comparison could be made with other editions.

2. For Brunngraber's interwar biography and relationship to literary realism, see Jon Hughes, "Facts and Fiction: Rudolf Brunngraber, Otto Neurath, and Viennese Neue Sachlichkeit," in *Interwar Vienna: Culture Between Tradition and Modernity*, ed. Deborah Holmes and Lisa Silverman (Rochester, NY: Camden House, 2009), 206–23.

3. Adolf Saager, *Menschlichkeit: Zukunfts-Roman vom Geiste des Völkerbundes* (Lugano: Salvatore, 1923); Otto Soyko, *Im Bann der Welle* (Stuttgart: Engelhorn, 1925); Carl Storch, *Auf Radiowellen nach China*, vol. 3 of *Puckchen und Muckchen* (Ehrenbreitstein: Klausen, 1928); Felix Neumann, *Der Sender und die Sängerin: Ein Film- und Rundfunkroman der Zukunft* (Berlin: Guido Hackebeil, 1928); Theodor Heinrich Mayer, *Tod über der Welt: Roman* (Leipzig: L. Stackmann, 1930); Hans Nitram, *Achtung! Ostmarkenrundfunk! Polnische Truppen haben heute nacht die ostpreußische Grenze überschritten.* (Oldenburg: Gerhard Stalling, 1932); Guido Hackebeil, *1928* (Berlin: Guido Hackebeil, 1934). The exception was perhaps Otfrid von Hanstein, *Der Telefunken-Teufel* (Dresden-Niedersedlitz: H. G. Münchmeyer, 1924), which I have been unable to acquire.

functional order of wireless transmission with a symbolic order of Heimat,[4] embodied by the professional journey of a (probably) fictive technician, Eugen von Lorz.[5] Starting his career as a trainee for Siemens' telegraph division in Africa and eventually becoming a student of Karl Ferdinand Braun, the protagonist of the novel ultimately ends up serving as one of Germany's representatives at the Paris Peace Conference following World War I. In the process, the young technician must overcome a number of familial problems, including his stepmother having his child, and professional obstacles, primarily, an ongoing conflict with Guglielmo Marconi over the patents for wireless technology. Despite this dramatic narrative, or perhaps because of it, the critical consensus about the novel is that it was ultimately a disappointment, at best of interest only for true *Funkfanatiker*, at worst a symptom of the fascist politics of technology.[6] Nevertheless, I argue that *Der tönende Erdkreis* not only provides a highly representative narrative, even if at times fairly plodding, of the development of wireless technology in the early twentieth century, especially concerning the patent wars within Germany and with Marconi in England and others in America, but also sheds light on the historical shift from the poetics of expressionism to those of realism in the interwar period.

In this chapter, I examine the development of wireless technology in the years 1897–1921, a period that *Der tönende Erdkreis* divides into three main parts, each of which focuses roughly on developments in science, engineering, and politics, respectively. The first part of the novel, "A New Global Veil is Lifted" (Ein neuer Weltschleier fällt), is set in 1897, the momentous year not only of the first wireless experiments but also of the discovery of the electron, the formation of Freud's theory of the unconscious, Saussure's work with the medium Hèlene Smith, William Crooke's last speech as the president of the Society for Physical Research, and Daniel Paul Schreber's memoirs.[7] In the first part of the novel, the restriction of the events to this significant year allows for a comparison of Marconi's first successful wireless trials in England and Braun's in Germany. The second part, "The Birth of a Global Company" (Die Geburt einer Weltfirma) set in the years 1898–1905, focuses on the meteoric rise of the *Gesellschaft für drahtlose Telegraphie m.b.H.*, a company more commonly known as *Telefunken*, though not named as such in the novel.[8] In fact, the title of Brunngraber's novel is itself an allusion to

4. In contrast to nineteenth-century poets cum philosophers, Brunngraber saw himself as a "Dichter-Soziologe," a poet cum sociologist. See Hughes, "Facts and Fiction," 207.

5. In my view, the protagonist of Brunngraber's novel seems to be based largely on the German physicist and electrical engineer, Jonathan Zenneck (1871–1959), who served at the time of the novel's composition as the director of the Deutsche Museum in Munich.

6. See Schneider, "Rudolf Brunngraber," 417–27.

7. On this constellation of events, see Wolfgang Hagen, *Radio Schreber* (Weimar: VDG Weimar, 2001); for a critical response to Hagen's New Historicist claim that "it is no coincidence" (es ist kein Zufall) that all of these events occurred in 1897, see Albert Kümmel-Schnur, "Patente als Agenten von Mediengeschichte," in *Bildtelegraphie: Eine Mediengeschichte in Patenten (1840–1930)*, ed. Albert Kümmel-Schnur and Christian Kassung (Bielefeld: Transcript, 2014), 22.

8. For the history of Telefunken, see Fritz Schröter, Ernst Zechel, and Otto Nairz, eds., *25 Jahre Telefunken: Festschrift der Telefunken-Gesellschaft, 1903–1928* (Berlin: Willi Simon, 1928); Gregory Malanowski, "The Telefunken Saga," in *The Race for Wireless: How Radio Was Invented (or Discovered)* (Bloomington, IN: AuthorHouse, 2011), 122–31; Erdmann Thiele, ed., *Telefunken nach 100 Jahren: Das Erbe einer deutschen Weltmarke*, 2nd ed. (Berlin: Nicolai, 2003).

Telefunken's wireless system of *Tönenden Funken*. The third part, "The Road to Global Chaos" (Weg in die Weltwirrnis) begins with Telefunken's construction of the first wireless station in Germany at Nauen, near Berlin, in summer 1906 and ends with some of the first international broadcasts from the United States in summer 1921. Although Brunngraber planned at one point to write a sequel "on the radio itself, i.e., the period from 1920 to the present," he attempted only this single novel "on high-frequency technology," and "each volume was to be a self-contained work."[9] The period documented in *Der tönende Erdkreis* is in accordance with the recent revisionist periodization of the "pre-history" of national broadcasting, during which wireless transmission rapidly developed from a short-range system of *communication* into a long-range one, before its subsequent implementation as a medium-range system of *distribution* in the form of national broadcasting. Throughout this period, the main concern was increasing the range of wireless transmissions; the concept of "coverage," or furnishing an entire area with wireless services, as would become prominent with cellular networks only after World War II, was of almost no concern, and wireless networks grew rapidly in linear and not radial directions.

At the outset of this period, there was still no such thing as "wireless transmission" *sensu stricto*. Even after Heinrich Hertz's experimental verification of the existence of electromagnetic radiation in his seminal laboratory experiments of the late 1880s, it would take another decade for the newly discovered phenomenon to be implemented for practical purposes of signaling at a distance without wires. During this period, the technology of wireless telegraphy and its most important individual components arose around the same time in several countries. In 1897, the news started making the rounds in the German daily newspapers that the Italian-born Marconi had invented a system, in England, that made it possible to transmit a message without wires. As a result, three main groups of researchers in the German Empire started working on the scientific and technical development of wireless technology, each with different approaches, objectives, and institutional contexts.[10] In 1903, a patent war broke out between two of these groups, the one gathered around Braun working for Siemens & Halske to develop technology for the German Army; and the other gathered around Adolf Slaby working for the Allgemeine Elektricitäts-Gesellschaft (AEG) to develop wireless technology for the German Navy. Through the intervention of Kaiser Wilhelm II, the two companies were merged into the joint venture that came to be known as Telefunken, thereby consolidating their patent holdings. In the first decade of the twentieth century, these patents would become crucial, since several competing systems of wireless telegraphy developed in the

9. In a January 1946 letter to his friend Hans Dostal, Brunngraber described these plans to write a second part to the novel that would cover the period of 1920 to the present: "Meine Vorstellungen sind dabei folgende: ich werde bis Sommerbeginn diesen Roman über die Hochfrequenztechnik in einer Stärke von etwa 1000 Druckseiten und mit einem Handlungsspielraum von 1897 bis 1920 abgeschlossen haben. (Ueber den Rundfunk selbst, also die Zeit von 1920 bis zur Gegenwart, muss ich dann noch einen zweiten Band abfassen; doch wird jeder für sich abgeschlossen sein)" (qtd. in Schneider, "Rudolf Brunngraber," 417).

10. See Margot Fuchs, "Anfänge der drahtlosen Telegraphie im Deutschen Reich, 1897–1918," in *Vom Flügeltelegraphen zum Internet: Geschichte der modernen Telekommunikation*, ed. Hans Jürgen Teuteberg and Cornelius Neutsch (Stuttgart: Franz Steiner, 1998), 113–31.

German Empire, as happened in other countries, relying on at least four different transmission technologies: spark-gap, electric arc, high-frequency alternators, and vacuum tubes.[11] In other words, even after the "invention" of wireless telegraphy, there was still no single entity of wireless transmission, but rather a multiplicity of competing systems. On the eve of World War I, several worldwide wireless networks, such as Telefunken's planned *Weltfunknetz*, were already under construction. Though the war delayed and altered their completion, it also expedited the development of wireless technology, due to its significance for military strategy. During the war, the first experimental radio broadcasts also occurred, some of which could be heard on the fronts. In addition, many German soldiers, including many prominent physicists, were stationed in wireless divisions where they learned the principles of wireless transmission.[12] After the war, the number of people interested in wireless transmission was greater than ever before, and the radio was ready, at least technologically, to be introduced as a mass medium. Ultimately, I argue that the invention of *Funktechnik*, the term for the emerging field devoted to the physics and engineering of wireless technology in Germany, can be understood as an outgrowth of a conflict between the functional order of electromagnetic radiation and the symbolic order of empire that came to a head in the years leading up to World War I. What I would call "Wilhelmine wireless" was, in many respects, a direct response to what Tom Standage calls the "Victorian Internet."[13]

Going wireless involves not only the elimination of wires, but also the production of electromagnetic waves, and it was these waves that became the subject and object of Funktechniken. Wireless transmission, from here on out, will primarily exclude the kind of symbolic communication discussed in the previous chapter. Yet literature continued to engage with the new medium. In the first part of this chapter, I examine how *Der tönende Erdkreis* negotiates the historical facts of the "invention" of wireless telegraphy and the emerging demands of literary realism.[14] In the second part of this chapter, I then consider an alternative perspective on the questions of the "discovery" of electromagnetic radiation and the "invention" of wireless telegraphy through a comparative reading of early expressionist poetry and short-form essays by Christian Morgenstern, Paul Scheerbart, and Mynona (Salomo Friedländer). Although inventions are central to media history, especially that informed by the history of technology, in that an invention, as an event, seems to provide a touch of the real, there has been surprisingly little reflection on the act of invention in literary and cultural studies.[15] Patents, in particular, are usually the dominant source for media history, and are frequently presented in one German school of

11. See Michael Friedewald, *Die "Tönenden Funken:" Geschichte eines frühen drahtlosen Kommunikationssystems 1905–1914* (Berlin: Verlag für Geschichte der Naturwissenschaften und Technik, 1999).

12. See Jimena Canales, "The Media of Relativity: Einstein and Telecommunications Technologies," *Technology and Culture* 56, no. 3 (2015): 610–45.

13. Tom Standage, *The Victorian Internet. The Remarkable Story of the Telegraph and the Nineteenth Century's On-Line Pioneers* (New York: Walker, 1998).

14. For the theoretical outlines of literature and/as invention, see Albrecht Koschorke, *Wahrheit und Erfindung: Grundzüge einer allgemeinen Erzähltheorie* (Frankfurt am Main: Fischer, 2012).

15. See Albert Kümmel-Schnur and Christian Kassung, eds., "Vorwort," in *Bildtelegraphie: Eine Mediengeschichte in Patenten (1840–1930)* (Bielefeld: Transcript, 2014).

media theory in a sort of anti-hermeneutic gesture, but the social, cultural, and medial aspects of patents remain understudied.[16] Understanding the reasons for the contested patents surrounding the invention of wireless telegraphy requires understanding the connection between electromagnetic radiation and wireless telegraphy, which, in turn, first requires a brief explanation of the physics of wireless transmission.

The Physics of Wireless

Assuming a certain degree of consensus on the part of his audience, Brunngraber's novel did not address the question of why Funktechnik should matter. In fact, the title *Roman der Funktechnik* was even shortened in a subsequent edition to *Roman des Funks*, dropping the *Technik* in an attempt to downplay the novel's overt emphasis on technology and play up its implicit connections with *Funk* as (amateur) radio.[17] In recent years, however, the Austrian philosopher of science Walter Seitter has developed a productive approach to the study of the physics of media that can help address this gap. As Seitter is quick to point out, there is a fundamental tension in the phrase "physics of media:" while the term *physics* commonly refers to natural things, such as light, heat, atoms, or electromagnetic radiation, the term *media* generally refers to artificial things, such as film, radio, or newspapers.[18] Despite this productive tension, even within the academic discipline of physics, some sub-disciplines do examine artificial phenomena, and many media are themselves based on natural elements. Wireless transmission, for example, involves a transfer of energy based on the naturally occurring phenomenon of electromagnetic radiation, which is modified through technical operations to contain information, thereby becoming something artificial. To work out the productive tension between physics and media, Seitter's research program revisits the classical Aristotelian distinction between *physics* and *metaphysics*. For Aristotle, the decisive epistemological criterion of physics is perceptibility, which is taken to coincide with materiality. Physics, in other words, is concerned only with the perceptible; metaphysics with everything else. This distinction will be crucial for understanding the (meta)physics of wireless media due to the imperceptible materiality of electromagnetic radiation. While Aristotle declares that the task of physics is to investigate and formally define sensible, perceptible things, and the task of metaphysics is to investigate non-perceptible, non-material things, Seitter's physics of media is addressed to the problem of the "inconspicuousness" of both physics and media, in the spirit of Michel Foucault's aspiration "to make appear what is immediately present and at the same time invisible."[19] If, in making things perceptible, media hide their own perceptibility—or, to use Jean Baudrillard's term, "dissimulate" themselves—then the physics of media would allow media to appear. Ultimately, then, these are the two main aspects of the physics of media: the "straightforward extension of physics to encompass all empirical kinds of media: natural, technical, even personal"; and

16. Ibid.

17. Rudolf Brunngraber, *Der tönende Erdkreis: Roman des Funks*, Neubearbeitung für die Lizenzausgabe (Vienna: Volksbuchverlag Büchergilde Gutenberg, 1959).

18. Walter Seitter, "The Meta-Physics of Media," in *Media Matter: The Materiality of Media, Matter as Medium*, ed. Bernd Herzogenrath (New York: Bloomsbury, 2015), 19–27.

19. Qtd. in Seitter, "The Meta-Physics of Media," 27.

"the 'ontological' aspect."[20] While applying the former to the case of wireless technology is relatively straightforward, and will be the subject of this chapter, the latter will require more explanation, and will be the subject of the next chapter.

The physical processes at work in early analog wireless transmission are actually relatively easy to understand, at least in comparison with later electrical and electronic systems.[21] The dominant physical medium of wireless transmission is electromagnetic radiation, a transfer of energy through space at the speed of light resulting from the interaction of electric currents and magnetic fields. Electromagnetic radiation can be made to traverse very large distances in very short amounts of time, thereby creating particular effects of apparent action at a distance with significantly little energy loss. The propagation of electromagnetic radiation depends on the inverse proportion between two mathematical values used to describe the temporal and spatial characteristics of waves: frequency and wavelength. Shortwave, high-frequency radiation, which was originally used for wireless telegraphy, contains more energy than does longwave, low-frequency radiation, which was subsequently used for early experiments in radio, television, and radar, before returning to shorwave radiation in the mid-1920s. Furthermore, each interacts with the earth, the atmosphere, or other obstacles in different ways. Even though electromagnetic radiation is a naturally occurring phenomenon, it has to be encoded and decoded if it is to contain information. To this end, the transmission of information proceeds according to a relatively symmetrical structure.[22] At the starting point and the ending point of every wireless transmission, there will be an antenna.[23] On the transmitting end, the antenna converts an electric current into electromagnetic radiation; on the receiving end, the reverse happens, as the antenna converts electromagnetic radiation into an electric current. To transmit a signal across this circuit, a transmitter supplies the antenna's terminals with an electric current oscillating at a particular frequency (e.g., a high-frequency alternating current for radio transmissions), and the antenna then converts the electric current into an electromagnetic wave that propagates through space. To receive a signal, the setup is similar, and the process basically repeats in the reverse order: an antenna intercepts some of the power of an electromagnetic wave traveling through space in order to produce a tiny voltage at its terminals, which then gets applied to a receiver, where it is amplified and passed on to headphones, loudspeakers, printer tape, or some other output within the range of human perception.

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20. Seitter, "The Meta-Physics of Media," 27.

21. See, for example, Walter Seitter, *Physik der Medien: Materialien, Apparate, Präsentierungen* (Weimar: VDG Weimar, 2002), 373; on electric and electronic systems, see Joachim-Felix Leonhard, "Die drahtlose Informationsübertragung," in *Medienwissenschaft: Ein Handbuch zur Entwicklung der Medien und Kommunikationsformen*, ed. Joachim-Felix Leonhard et al., vol. 2 (Berlin: Walter de Gruyter, 2001), 1306.

22. Not all applications of electromagnetic radiation are symmetrical. In radio astronomy, for example, a radio telescope functions as a passive receiver, whereas the universe effectively functions as an active transmitter. In radar, the targeted object functions as something like an active transmitter, whereby the radar becomes a passive receiver.

23. As will be explained in my chapter on the antenna, this central component of wireless transmission, despite the somewhat misleading name "wireless," is made of metal wires or conducting rods, the simplest form of antenna, known as a "dipole," consisting of two co-linear wires or rods.

While the most important historical applications of wireless transmission have been in telegraphy, telephony, radio, and television, they currently lie in radar, astronomy, global-positioning systems, cellular communications, and wireless data networks.[24] It is important to note that all of these possibilities are present in the physics of wireless transmission. From the perspective of the physics of media, however, there is a crucial difference between the radio and wireless telegraphy, which is tantamount to the technological difference between the spark-gap transmitter used in wireless telegraphy, and the vacuum tube used in early radio transmissions. Although each of these devices produces electromagnetic radiation, the electromagnetic waves emitted from a vacuum tube are of a different nature than those emitted from a spark-gap transmitter: a spark-gap transmitter emits attenuated, pulse-shaped waves that are only able to produce the discontinuous dots and dashes of Morse or some other digital code; a vacuum tube, on the other hand, emits even, continuous waves, which are able to transmit speech, music, sounds, or tones in an analog form.[25] Examining wireless transmission not as a mass medium and broadcasting format known as the radio, but from the perspective of the physics of a medium underlying other media reveals some surprising connections at odds with the usual narrative of radio history. Before electromagnetic radiation was applied to the commercial purposes of wireless telegraphy, the spark-gap transmitter was primarily a "media-epistemological entity," as Wolfgang Ernst calls it, a technology that generated knowledge about the nature of electromagnetic waves.[26] Similarly, the vacuum tube can also be understood as an entity that cuts across and unites seemingly unrelated media complexes, since it has been implemented in the form of the cathode ray tube not only in radio receivers, but also in televisions, computers, and oscilloscopes.[27]

Although the physical processes involved in wireless transmission are relatively straightforward, the real problems arise when the histories of physics and media are linked to questions of "invention" and "discovery." Who, in short, invented the radio, and who discovered the electromagnetic waves that serve as its physical basis? Since the earliest patent struggles, there have been many, at times nationalistic, claims to the priority of discovery and invention: Was it the physicist Heinrich Hertz in Germany, the Italian-born engineer Guglielmo Marconi in England, or his compatriot, another physicist, Oliver Lodge? Or might it have been the Austro-Hungarian visionary and eccentric Nikola Tesla working in America, or the physicists Alexander Stepanovich Popov in Russia, or Jagadish Chandra Bose in India? Each of these figures made fundamental contributions to the development of wireless technology and can therefore lay claim to the priority of invention. In fact, claims to the priority of invention over wireless technology were long reflected in national encyclopedias: the *Encyclopaedia Britannica* cited Lodge, the *Larousse universel* Branly, the *Nuova Enciclopedia Sonzogno* Marconi,

24. Seitter, *Physik der Medien*, 373; Balbi and John, "Point-to-Point."

25. On the significance of the vacuum tube in media history, see Ernst, "Distory"; Siegert, *Passage des Digitalen*, 390–401.

26. Ernst, "Distory," 162.

27. Ibid.

the *Sovietskaia Entsiklopedia* Popov, and the *Lexicon der Deutschen Buchgemeinschaft* Hertz.[28]

Even though Hertz is rightly famous for providing proof of the existence of electromagnetic radiation, his experiments are not the origin point of radio, television, or even wireless telegraphy. While many popular accounts and some scholars still attribute the invention of these media to Hertz,[29] the intention, construction, and implications of his experiments are difficult to square with the invention of wireless technology. As media theorists Wolfgang Hagen and Wolfgang Ernst emphasize, Hertz did not invent a mass medium, and he even explicitly denied the possibility of using his apparatus for the purposes of telecommunication.[30] Reflecting on Hertz's denial of the possibility of using electromagnetic waves for telecommunications, one of Hertz's contemporaries seems to have been on the same page as today's media theorists: "As epoch-making and foundational as Hertz's investigations are, his research method requires an apparatus of significant dimensions—mirror surfaces, prisms, and wire netting all as tall as a man, and thus also large test spaces—so that repeating the experiments involves a great deal of trouble because the waves he created still had considerable lengths."[31] The main problem in adapting Hertz's experiments for practical telecommunications lay in its scientific context: his apparatus was roughly the size of an entire room, namely, a university lecture room cum scientific laboratory, which further naturalized the apparently limited range of wireless transmission. Ultimately, then, Hertz's experiments should be understood not as the beginning of wireless telemedia, but rather as the culmination of developments in the physics of electricity and magnetism in the seventeenth, eighteenth, and nineteenth centuries.

In recent years, media historians have reconsidered and revised the standard history of the "invention" of wireless telegraphy and the "discovery" of electromagnetic radiation. While the invention of wireless technology usually breaks down in terms of a binary between science and engineering, or theory and practice, with Hertz usually taken to represent one pole and Marconi the other, Patrice Flichy argues that "neither of these two contradictory analyses is entirely correct, for there is no unilinear model of the articulation between science and technology. More significantly, the sequence of different stages in the history of the wireless was not a foregone conclusion."[32] What today appears natural is actually the result of more complicated negotiations, a series of moves between science and technology, the military and the communications industry, or

28. Flichy, *Dynamics of Modern Communication*, 99.

29. See, for example, Völker, *Mobile Medien*, 163.

30. Hagen, *Das Radio*, 7; Wolfgang Ernst, "Experimenting with Media Temporality: Pythagoras, Hertz, Turing," in *Digital Memory and the Archive*, ed. Jussi Parikka (Minneapolis: University of Minnesota Press, 2013), 186–89.

31. August Weilenmann, *Die elektrischen Wellen und ihre Anwendung zur drahtlosen Strahlentelegraphie nach Marconi* (Zurich: Fäsi & Beer, 1903), 7. "So epochemachend und grundlegend die Untersuchungen von Hertz sind, erfordert seine Methode Apparate von bedeutenden Dimensionen, mannshohe Spiegelflächen, Prismen, Drahtgitter etc., somit auch grosse Räumlichkeiten, so dass ihre Wiederholung mit grossen Umständlichkeiten verknüpft ist, weil die von ihm erzeugten Wellen noch beträchtliche Längen hatten."

32. Flichy, *Dynamics of Modern Communication*, 99.

commerce, information, and entertainment. Building on this recent revisionist historiography, I argue that wireless technology is best understood, not as the result of any singular invention or discovery, but much more as the product of a set of cultural techniques and technologies that arose to address problems of first signaling at a distance, on the one hand, then detecting and proving the existence of electromagnetic radiation, on the other, and finally making it contain information through processes including amplification, modulation, and demodulation.

In summary, the term Funktechnik in the title of Brunngraber's *Roman der Funktechnik* designates a field of research at the nexus of science, engineering, and industry that only came into existence in the first decade of the twentieth century, after the first wireless telegrams had been transmitted. Only gradually, in other words, did Funktechnik emerge as what Hans-Jörg Rheinberger calls an "epistemic thing" (epistemisches Ding), a unified object of scientific research.[33] Even though the existence of electromagnetic radiation was verified in the late 1880s, experiments were originally dedicated to low-frequency electromagnetic waves, and foundational research in high-frequency physics would only be developed in the 1910s. As historian of science Wolfgang Schreier puts it, "Funktechnik arises without its scientific foundation, high-frequency technology, being expanded."[34] In this respect, the ontological and epistemological implications of Hertz's experiments were arguably even greater than their already significant contribution to the development of wireless technology, a point that will be discussed in my next chapter.

Range Tests

The first chapter of *Der tönende Erdkreis* begins—in medias res—with a young man identified only by his last name, "Lorz," lying in a hospital in the town Aného, in the German colony of Togo, Africa. Having come down with some unknown illness, Lorz has a feverish *Heimat*-laden dream, saying: "Home again, after a month in the ape-land Togo, after a diarrhea month, an ape diarrhea, back home from Togo, home in Germany."[35] The narrative switches between Lorz's perspective and that of an engineer, identified as "Laubinger," who is attending to the sick young Lorz and who cannot understand the reasons for his fever dreams. "This Lorz, who was a scientific type, a physicist, and only occasionally a technician," reasons Laubinger, "this Lorz could not be taken for a poser, neither a romantic-hysterical one nor a sentimental one."[36] The reason for Lorz's fever dream and for his "flight" to Africa in the first place, as will only be revealed in the fifth chapter, is that his stepmother, Katharina von Lorz, is pregnant with

33. Rheinberger and Herrgott, *Experimentalsysteme und epistemische Dinge*.

34. Wolfgang Schreier, *Die Entstehung der Funktechnik* (Munich: Deutsches Museum, 1995), 26. "Die Funktechnik entsteht, ohne daß ihr wissenschaftliches Fundament, die Hochfrequenztechnik, ausgebaut wird."

35. Brunngraber, *Der tönende Erdkreis*, 9. "Wieder daheim, nach einem Monat im Affenlande Togo, nach einem Diarrhöe-Monat, einer Affen-Diarrhöe, wieder daheim aus Togo, daheim in Deutschland!"

36. Ibid. "Dieser Lorz, der ein wissenschaftlicher Typ, Physiker, und nur gelegentlich Techniker war, und der, soweit er ihn hatte kennenlernen können, bei aller Jugend eine auf das Gehaltvolle und Strenge gerichtete Persönlichkeit vorstellte, – dieser Lorz konnte weder als romantisch-hysterischer noch als sentimentaler Poseur genommen werden."

his child.[37] In the course of the conversation in the hospital, Lorz is presented as homeless, unwilling to return to Germany and averse to life in the German colony. Suddenly, a song in the Ewe dialect of the Niger-Congo language spoken in southern Togo, interrupts them: "Hometale? Hometale? Hometale? Alletah! Sron je ale? Deviale? Ele! Ele! Alletah!" According to the narrator, the lyrics are basically translated as "How's it going? It's going well." The scene evokes the European imagination of the "tribal drum" as a primal scene of wireless communication. Significantly, this particular song, as the narrator explains, was not composed by native speakers, but by the German colonists with their rudimentary knowledge of the language. "The canon [of the song] was sung by the mechanics who had been sent to Togo along with the engineer Laubinger and the trainee [*Volontär*] Eugen v. Lorz, so that they would lay a telegraph line from Aného to Topli."[38] Before learning of the personal reason for Lorz's flight from Germany, the reader finds out the professional reason the protagonist of the novel has come to Africa: Lorz is employed as a trainee in the Siemens Company. In my reading, then, the opening of the book offers a complex origin story of wireless telegraphy in which the African tribal drum and European wired telegraphy are both relegated to the sidelines. By the end of the first chapter, Lorz will embark on a new career in wireless telegraphy after hearing one of the Siemens employees read aloud a newspaper report about wireless range tests currently being conducted in Europe. The reported event, which was "attended, at the request of the Kaiser [Wilhelm II], by a lecturer at the Technische Hochschule Berlin-Charlottenburg Professor Dr. Pallaban" (an absurd-sounding pseudonym for Adolf Slaby), was indeed a memorable one.[39]

On May 13, 1897, an unlikely party of five found themselves huddled together on a windy beach in South Wales inside a large wooden crate, resembling a piece of cargo dumped overboard to save a sinking ship.[40] Unlike the other scientists combing the beach in search of marine specimens, their interest lay not in the flotsam and jetsam washed ashore in the Bristol Channel but in the possibility of creating a new kind of information channel. Below the cliff face at Lavernock Point, their attention was directed that Thursday morning to a radiotelegraph receiver, mounted on a plank in the sand. From the wireless apparatus, a long insulated copper wire ran along the beach and up the 20 m high cliff face, wound around a 30 m high mast mounted on the cliff, and attached to one pole of a 2 m high cylindrical hood made of zinc affixed to the top of the mast; another wire ran from the other pole of the zinc cylinder down to the cliff face and into the ocean. A corresponding wireless radiotelegraph transmitter, set up in a similar fashion, had been installed in a little wooden cabin on the island of Flat Holm, roughly 5 km away in the

37. Ibid., 80.

38. Ibid., 12. "Und den Kanon sangen die Monteure, die die Berliner Firma Siemens mit dem Ingenieur Laubinger und dem Volontär Eugen v. Lorz nach Togo geschickt hatte, damit sie eine Telegraphenlinie von Anecho nach Topli legten."

39. Ibid., 17–18. "[D]er Dozent der Technischen Hochschule Berlin-Charlottenburg, Geheimrat Professor Dr. Pallaban, der auf Wunsch Sr. Majestät des Kaisers den Vorführungen beigewohnt hat."

40. For an overview of the Bristol Channel tests, see R. W. Simons, "Guglielmo Marconi and Early Systems of Wireless Communication," *GEC Review* 11, no. 1 (1996): 46–47; for period sources, see Slaby, "The New Telegraphy"; William Henry Preece, "Signalling Through Space Without Wires," *Science* 6, no. 155 (December 17, 1897): 889–96."

middle of the Bristol Channel. After an agreed upon visual signal, the day's first attempts at non-visual communication began, and for half an hour from 12:00–12:30pm, the first repeated Morse signal appeared over and over again on the ticker tape—the letter "V," an opening call signal that coincidentally has the same rhythm as the opening bars of Beethoven's Fifth Symphony, "dot-dot-dot dash." One visiting observer present at the experiment, Dr. Pallaban aka Adolf Slaby, recounted his excitement at the moment when, "ears and eyes bent with the most anxious care upon the receiving apparatus," they received the first clear wireless signals: "Silently and invisibly the message had been borne across the space from the rocky coast, ferried across by that mysterious medium, the ether."[41] While the physical medium of wireless transmission is no longer taken to be the water, the earth, or the air, it is still conceived as a connecting medium filling space—the luminiferous ether. As was common at the time, the luminiferous ether, imagined to be a sort of "etheric ocean," was mapped onto the conceptual framework of the mundane ocean: the one was thought to transport immaterial information as easily as the other transported material ships and passengers.[42]

The Bristol Channel experiments of May 13, 1897 marked the first successful long-range transmission of wireless signals via electromagnetic waves. "This day," the German historian Alfred Ristow would write in 1927, "is generally regarded as the birthday of wireless telegraphy."[43] Even though the existence of electromagnetic radiation had already been verified a decade earlier in Hertz's laboratory experiments of 1886–89, there was still a great deal of skepticism about implementing the newly discovered natural phenomenon in wireless telegraphy, due primarily to questions over whether electromagnetic radiation would be able to propagate at a distance. When asked in December 1889 whether his newly discovered electromagnetic waves could be used for the purposes of transmitting *telephone* conversations, Hertz replied in the negative: "If you could thus build convex mirrors as large as a continent, you might very well be able to set up the proposed experiments, but in practice nothing can be done, you would not perceive the slightest effect with ordinary convex mirrors."[44] According to Hertz and the conventional wisdom of the time, the frequency of waves required for voice

41. Slaby, "The New Telegraphy"; cf. his accounts, written in German, in *Die Funkentelegraphie*; and *Entdeckungsfahrten in den elektrischen Ozean: Gemeinverständliche Vorträge*, 5th ed. (Berlin: Leonhard Simion, 1911); for a dramatic literary representation of the incident in which Adolf Slaby features as "The German Spy," see the popular novel, Erik Larson, *Thunderstruck* (New York: Crown Publishers, 2006), 100–11.

42. On the success of these oceanic metaphors for the ether, at once a reminder of the isolation of early wireless operators and an encapsulation of anxieties about electrical disembodiment, see Jeffrey Sconce, *Haunted Media: Electronic Presence from Telegraphy to Television* (Durham, NC: Duke University Press, 2000), 62.

43. Alfred Ristow, *Die internationale Entwicklung und Bedeutung der Funkentelegraphie* (1926), 9, qtd. and trans. in Michael Friedewald, "Telefunken vs. Marconi, or the Race for Wireless Telegraphy at Sea, 1896–1914," SSRN Scholarly Paper (Rochester, NY: Social Science Research Network, 2012), 14.

44. Letter from Heinrich Rudolf Huber to Heinrich Hertz (December 3, 1889), qtd. and trans. in Charles Süsskind, "Hertz and the Technological Significance of Electromagnetic Waves," *Isis* 56, no. 3 (1965): 344. "Könnten Sie also Hohlspiegel von der Grösse eines Continents bauen, so könnten Sie damit die beabsichtigten Versuche sehr gut anstellen, aber praktisch ist nichts zu machen, mit gewöhnlichen Hohlspiegeln würden Sie nicht die geringste Wirkung verspüren."

transmissions would be much too fast and their corresponding wavelengths thus far too small. Even though Hertz was only answering a technical question, the myth of the founding father denying the possibility of implementing electromagnetic radiation in wireless *telegraphy* circulated freely, thereby deterring immediate research in this direction.[45] Developing Hertz's research in another direction, a group of British Maxwellians achieved slightly better results, and were able to achieve a maximum range of 64 meters by the mid-1890s, though their primary aim was not to increase the distance of wireless transmissions.[46] The social space of the scientific laboratory served to naturalize these limited transmission distances even further. In his own laboratory demonstrations with a concave mirror, Hertz had been able to detect a spark, first at a microscopic distance and eventually at a distance of only a few meters across the room. As he recognized, electromagnetic radiation became weaker with increasing distance from the transmitter, and his detector was not sensitive enough to detect it any further. Although he suspected that the sparks could be detected at greater distances, Hertz showed no interest in taking the experiment out of the laboratory and conducting field tests, having already settled on a "sweet spot" for his experiments at around 6–10 meters.[47] Ultimately, even when the Maxwellian physicists imagined signaling at a distance using electromagnetic radiation, they primarily conceived of the Hertzian apparatus, consisting of a transmitter and a detector, through an *optical* analogy to light sources and receptors, rather than a *telegraphic* analogy, consisting of two Morse devices connected by a long wire.[48] The discovery of electromagnetic radiation, in other words, was linked to the history of optical media, such as film and television, before it would be brought into the realm of telecommunications.

The first experiments dedicated to transmitting at great distances were performed during a series of field experiments conducted in England in the mid-1890s. Taking his transmitter and receiver into the field, Marconi was hoping to determine exactly how far a wireless signal could travel, since the transmission distance was already exceeding the dimensions of his laboratory. In August 1895, the distance was not more than 45 meters, though several tweaks increased it to 800 m by the end of the month.[49] At this point, Marconi made his most significant breakthrough. Inspired by the principles of wired telegraphy discussed in the previous chapter, particularly, the "good earth" principle, Marconi connected the receiver and the transmitter to the earth, thereby effectively "grounding" the circuit.[50] With this modification, the transmission distances quickly exceeded 3.2 km. The higher the antenna, the further the signals would go. The group assembled for the Bristol Channel experiments in 1897 was to bear witness to these results. The members of the group included the 23-year-old Marconi, the 63-year-old Welsh electrician and Chief Engineer of the British Post Office William Preece, and the 48-year-old professor who also served as the German Emperor's Privy Councilor

45. See, for example, Ferdinand Braun, *Drahtlose Telegraphie durch Wasser und Luft*, 15.

46. See Hong, *Wireless*, 6.

47. Heinrich Hertz, "On Electric Radiation," [1888], in *Electric Waves*, ed. Lord Kelvin, trans. D. E. Jones (New York: Macmillan, 1893), 176.

48. See Hong, *Wireless*, 7.

49. See ibid., 20.

50. See ibid., 21–22.

(*Geheimrat*), Adolf Slaby. In a little wooden cabin on the island of Flat Holm, roughly 5 km away in the middle of the Bristol Channel, the person operating the corresponding radiotelegraph transmitter that sent the encoded messages to them was the 40-year-old Cardiff-based post office engineer George Stephen Kemp. After having no success on the first several days of trials, the group at Lavernock Point moved the wireless apparatus from the cliff down to the beach, on the fourth day of the trials, thereby effectively doubling the length of the antenna and allowing for clear transmission. For the remainder of the week following the successful test at Lavernock Point, further trials would be carried out in various weather conditions and with different equipment settings, gradually increasing the transmission distance, eventually up to 16 km.

Following the Bristol Channel experiments, the members of the group would go their separate ways, though they would remain united through this shared experience. The following month, on June 4, 1897, Preece presented a lecture on the results of the experiments at the Royal Institution in London, defending Marconi's claim to the priority of invention against Oliver Lodge, one of the British Maxwellian physicists focusing mostly on optical media.[51] Slaby would defend Marconi, too, in an article published a year later, in the April 1898 issue of the popular American *Century* magazine.[52] Taking advantage of the publicity the experiments were receiving, Marconi took his newly acquired patents and established the Wireless Telegraph & Signal Company Ltd. in London, a move that prevented any further co-operation with the Post Office engineers who had assisted in the experiment. However, George Kemp immediately resigned from his position at the post office and joined Marconi's new company as head of engineering development. As for Slaby, the Privy Councilor to Kaiser Wilhelm II, he would return to Berlin and replicate the experiments. It was in this somewhat roundabout way that the history of European radio began.[53] As Wolfgang Hagen emphasizes, "European radio did not grow out of the soil of Wilhelmine physics," where Hertz was conducting his laboratory experiments, "nor out of the English physics of the Victorian Empire," where the British Maxwellians were working on the creation of optical media, but only through a transnational transfer of knowledge, from Marconi's work in England to Slaby's replication of that work in Germany, as various components necessary for wireless telegraphy were developed contemporaneously throughout continental Europe.[54]

In his article of April 1898 in *The Century*, Slaby readily acknowledged his debt to Marconi, admitting that before witnessing the demonstration, he "had not been able to

51. Preece, "Signalling Through Space Without Wires."

52. Slaby, "The New Telegraphy."

53. According to Wolfgang Hagen, the reason for the detour from Hertz to Marconi to Slaby can be found in the symbolic context of Hertz's discovery: at first, Hertz discovered the effect of a frequency and only after that, the carrier medium of that frequency; as a result, he called what he discovered "elektrische Kraft." Though Hertz was able to show that it behaved like light, and that he had found exactly the kind of wave that, at an ever higher frequency, is a visible radiation called light, he was unable to name it (*Das Radio*, 47).

54. Ibid., 46. "Das europäische Radio hat nicht in Deutschland angefangen, sondern nimmt seinen Umweg von Karlsruhe über Genf, Paris, Liverpool, Krontstadt und Bologna nach London. Es entsteht nicht auf dem Boden der wilhelminischen Physik und nicht auf dem der englischen Physik des viktorianischen Empire."

telegraph more than one hundred meters through the air."[55] Before his visit to England, Slaby, like Marconi, had already recognized the potential of electromagnetic radiation to propagate at a distance. Not yet ready to take his equipment into the field, the professor at the Technische Hochschule in Charlottenburg attempted to use the institute's long corridors for wireless range tests. Having set up the experimental apparatus, which consisted of an oscillator, spark conductor, and accumulator battery, on a mobile table with wheels, Slaby's "assistants" (Mechaniker) would stand in the corridor on the other side of a closed door and gradually roll the device further and further away. Whenever Slaby called out "Now!", they were supposed to release a spark from the transmitter, which would trigger a perceptible effect in Slaby's detector, a form of galvanometer. At Slaby's great surprise, the scientific effect seemed to appear on command, even, as it would later turn out, when the mobile table had already long fallen over, together with the experimental apparatus, spilling sulfuric battery acid all over the floor. All that Slaby was detecting while his assistants were busy mopping up the spill instead of making sparks, were the vibrations created in the air by the sound of his own voice whenever he called out "Now!"[56] The anecdote serves as a reminder that the study of electromagnetic radiation was always bound up with questions of evidence—namely, whether observations of electromagnetic effects were observations of something natural or artificial.

Upon returning to Berlin after witnessing Marconi's success, Slaby recognized the need to find a more expansive space for his wireless range trials. "Researching radiotelegraphy in the confined spaces of a laboratory is very difficult," he wrote. "We need kilometer-long distances in free space, not interrupted by forests, mountains, or houses."[57] Like Marconi, Slaby would bring radio waves out into the field, and he, too, would struggle with the greater amount of contingencies inherent in field experiments. For his initial trials, Slaby had again chosen his laboratory at the technical university, though this time to function as the receiver station, while a water-tower attached to a factory about 2 km away would serve as the transmitter station. However, he was forced to disconnect the setup after getting a query from the telephone company about whether there was a storm in the area, since all the telephone lines were suddenly out of order.[58] Fortunately for Slaby, Kaiser Wilhelm II had become interested in this new form of telegraphy, and granted him the use of a more controlled site for field tests, the region surrounding the Havel River near Potsdam. For Slaby, the site was "an actual laboratory of nature under a laughing sky, in surroundings of paradise!"[59] It was also the grounds of the royal parks where the imperial family would spend their summer vacations, sailing and rowing in the many bodies of water in the region. Accompanying the royal family

55. Slaby, "The New Telegraphy," 871.

56. Otto Nairz, "Aus vergangenen Tagen," in *25 Jahre Telefunken: Festschrift der Telefunken-Gesellschaft, 1903–1928*, ed. Fritz Schröter, Ernst Zechel, and Otto Nairz (Berlin: Willi Simon, 1928), 251–52.

57. Slaby, *Entdeckungsfahrten in den elektrischen Ozean*, 157. "Die Erforschung der Funkentelegraphie ist in den begrenzten Räumen eines Laboratoriums schwer möglich. Man braucht dazu kilometerlange Entfernungen in freier Luft, nicht unterbrochen durch Wälder, Berge oder Häuser."

58. Slaby, "The New Telegraphy," 871.

59. Ibid., 872.

was a company of sailors, and it was these men whom Slaby employed as his new lab techs, thereby solving the problem of how to find a staff when in the field.[60]

When these initial trials proved successful, the Emperor put the army's balloon division at Slaby's disposal. In contrast to the iconic forms of radio and television towers that would be built throughout the twentieth century, the earliest wireless stations were usually temporary mobile installations, like the setup in the Bristol Channel experiments, as antennas were mounted on temporary masts, or flown from kites or balloons. Setting up the receiver in the military balloonists' practice ground in Schöneberg near Berlin, and the transmitter in the village of Rangsdorf down a military railroad, Slaby succeeded on October 7, in transmitting at a distance of 21 km. At each station, a thin copper wire was fastened to the basket of the balloon, swinging in the wind 250 m above the apparatus, and swords stuck into the ground were used to ground the wire. As soon as they had obtained these usable results, Slaby and Arco received the request from Kaiser Wilhelm II to circumvent Marconi's patents, which were still pending in Germany. In 1898–99, Slaby and Arco applied for five crucial patents, primarily in an attempt to differentiate their work from that of Marconi.[61] The system secured by these patents would be developed, together with the AEG, through the support of the Imperial Marine Office.

Meanwhile, Braun had also started experimenting with wireless telegraphy on the other side of Germany only a few months after Slaby. As an expert consultant for three citizens of Strasbourg, Braun was tasked with providing a scientific explanation of *Hydrotelegraphie*, which I discussed in the previous chapter. Braun was also occupied with electromagnetic waves and would eventually apply for a patent, in early 1898, for his "Telegraphiesystem ohne fortlaufende Leitung" (Telegraphy without Directly Connected Wire).[62] Since potential users of wireless telegraphy tended to measure its success almost exclusively by the obtained transmission range, Braun, like Marconi and Slaby, initially sought to fulfill this demand by using longer wavelengths and by increasing the transmitting power. Quickly, however, Braun solved the problem of limited transmission range in a different way by coupling the antenna inductively onto a second closed oscillatory circuit.[63] In summer 1899, Braun's assistants Matthias Cantor and Jonathan Zenneck successfully tested the new "tuned spark transmitter" circuitry for the first time. For the commercial exploitation of Braun's patents, the backers of his project—a banker from Giessen and a chocolate manufacturer from Cologne—established the *Gesellschaft für drahtlose Telegraphie Professor Braun*, and tried to get into contact with shipping and insurance companies. However, due to financial difficulties and Braun's desire to escape from commercial pressure and to concentrate on his own scientific research again, the Braun company merged with Siemens & Halske in 1901, the latter having the upper-hand technically and financially.

Part One of *Der tönende Erdkreis* concludes, still in 1897, with a conversation between Braun and his assistants, Eugen von Lorz and Christian Probst, pseudonyms for

60. See Fuchs, "Anfänge der drahtlosen Telegraphie im Deutschen Reich, 1897–1918," 117.

61. See ibid. There were three patents for the receiver, one for the transmitter, and one for the switch used in the transmitter and receiver.

62. See ibid.

63. See ibid.

Zenneck and Cantor, about an imminent patent war. After explaining his own system and even sketching it out on something like a cocktail napkin, Braun says to Lorz, "We are getting drawn into a battle over wireless telegraphy. Perhaps, in the process, we will succeed in bringing back home the Hertzian waves, which were a German seed, and making them into a German harvest. And if we should then have a patent trial with Privy Councilor Pallaban [i.e., Slaby], I will send you to Berlin."[64] Following the conversation, there is an image in the book of three circuit diagrams comparing the wireless systems used by Hertz, Marconi, and Braun: Hertz's experimental laboratory apparatus (i.e., a spark-gap and an induction coil); Marconi's addition to make the setup capable of transmitting over long distances (i.e., adding a longer antenna and grounding the circuit); and Braun's resonating circuit (i.e., separating the antenna from the circuit and adding a capacitor).[65] Significantly, while Hertz's setup is dated "1889," and Marconi's "1897," Braun's system is not dated: the narrative structure, with Part One focusing only on the year 1897, runs into the problem that Braun did not patent his system until the following year. In fact, Part Two begins with precisely this patent, as Brunngraber copies the headings from the patent awarded to Braun for a "Telegraphiesystem ohne fortlaufende Leitung" (Telegraphy without Directly Connected Wire) on July 13, 1898 (Patent Nr. 111,578).[66] In this respect, Brunngraber's novel demonstrates the power of literature to process events in a non-chronological fashion: his provocative and problematic claim is that even if Braun's patent is dated and numbered after the others, it comes before them in terms of its significance. Ultimately, Brunngraber's negotiation of this difficulty situates him in the middle of a developing spectrum of realism, at one end of which facts were guarantors of the truth, at the other end of which, facts were not necessarily taken to be equivalent to reality, and the "invention" of wireless technology had a different meaning entirely, which will be discussed in the second part of this chapter.

Worldwide Wireless Networks

Not everyone was pleased with the spread of wireless telegraphy or with Marconi's claims to the priority of invention. Those who had invested considerable sums of money in wired systems across Europe and the United States did not welcome the new competitor.[67] After Marconi's system had established itself on coastlines, there were complaints in France that Marconi stations rendered some of the country's coastal radio stations ineffective due to the Marconi Company's policy of non-communication with competing systems. In the United States, there were further reports that a Marconi-equipped ship had refused to answer radioed queries about the position of a derelict ship in the shipping lanes. In Austria and Germany, the Marconi reception was especially negative.

64. Brunngraber, *Der tönende Erdkreis*, 140. "Wir ziehen in eine Schlacht um die Drahtlose Telegraphie. Vielleicht gelingt es uns dabei, die Hertzschen Wellen, die eine deutsche Aussaat gewesen sind, zu einer deutschen Ernte wieder heimzuholen. Und wenn wir dann den ersten Patentprozeß mit Geheimrat Pallaban haben sollten, will ich Sie nach Berlin schicken."

65. Ibid., 141.

66. Ibid., 145; cf. Huurdeman, *The Worldwide History of Telecommunications*, 215.

67. See Francis Lyall, *International Communications: The International Telecommunication Union and the Universal Postal Union* (Burlington, VT: Ashgate, 2011).

By 1902, some cultural critics had become sick of all the news of the "wireless impresario" (der drahtlose Impresario), as the Austrian architecture professor, Victor Loos, a cousin of the famous architectural critic Adolf Loos, took to calling Marconi.[68] The real target of Loos's spleen, seeing as he was writing in Karl Krauss's *Die Fackel*, was primarily the language and editorial decisions of the Austrian newspaper *Die Neue Freie Presse*: "There we saw Marconi in the laboratory, Marconi engaged, Marconi as disloyal fiancé, Marconi dancing around the telegraphic apparatus, Marconi informing the open hands of the reporters…. and the experimented millions, the 'towering goal' that had been reached, the 'great Christmas present for all mankind,' which, greased with Schiller and Heine verses, the *Neue Freie Presse* and the similarly minded commercial press dished out to its subscribers, when the impresario had connected Europe with America. And all that just in the last weeks!"[69] What sickened Loos was the newspaper's exploitation of the wireless topos of universal brotherhood. According to Loos, the Austrian news only picked up on stories about the invention of wireless technology when they could smell money as soon as Slaby and Braun struck a deal with Siemens and the AEG. For Loos, the dangers of competition made it necessary for Marconi to succeed, and yet the Austrian news only reported on Marconi and not on any other systems. What Loos overlooked in his criticisms of the financial motives behind the "endless advertisements" (masslose[n] Reclame) for wireless telegraphy were the different institutional settings of wireless in England and Germany: while Marconi identified as an entrepreneur, Slaby and Braun started out as professors of physics, their livelihood secured by the Wilhelmine professorial system.

In addition to all of these complaints, what finally produced the first real steps toward the development of wireless telegraphy in an international direction—above all, in terms of the regulation of radio frequencies and oversight regarding wireless telegraphy at sea—was a German complaint about the mundane refusal of a Marconi station to accept a diplomatic message. In March 1902, a ship-to-shore transmission caused a scandal, when Henry of Prussia, who was the Crown Prince of Germany, *Großadmiral der Kaiserlichen Marine*, and brother of Kaiser Wilhelm II, attempted, on a return voyage across the Atlantic, to send a wireless telegram to American President Theodore Roosevelt. The message was declined, because the receiving station on the coast was operated by the Marconi Company.[70] For the Emperor, the event probably seemed symptomatic of the threat of so-called "Marconism," i.e., Marconi's non-intercommunication policy, for, in

68. Victor Loos, "Der drahtlose Impresario," *Die Fackel* 3, no. 99 (April 8, 1902): 11–14; Victor Loos, "Der technische Impresario," *Die Fackel* 3, no. 93 (February 4, 1902): 12–14.

69. Loos, "Der drahtlose Impresario," 12–13, ellipses in the original. "Da sahen wir den Marconi in der Experimentierstube, den verlobten Marconi, Marconi als treulosen Bräutigam, Marconi den Telegraphenapparat umtanzend, Marconi die offenen Hände der Reporter informierend…. Dazu die verexperimentierten Millionen, das erreichte 'himmelhohe Ziel', das 'hohe Weihnachtsgeschenk für die ganze Menschheit', das, gespickt mit Versen Schillers und Heines, der Abonnentenwelt der 'Neuen Freien Presse' und gesinnungsverwandter Commerzblätter zu theil wurde, als der Impresario Europa mit Amerika drahtlos verbunden hatte. Und gar in den letzten Wochen!"

70. See Lars U. Scholl, "Marconi versus Telefunken: Drahtlose Telegraphie und ihre Bedeutung für die Schiffahrt," in *Sozialgeschichte der Technik: Ulrich Troitzsch zum 60. Geburtstag*, ed. Günter Bayerl and Wolfhard Weber (Münster: Waxmann, 1998), 281.

August 1903, he convened the First International Conference on Wireless Telegraphy (Erste Internationale Konferenz zur drahtlosen Telegraphie), to be held in Berlin. Representatives from seven nations took part in the conference, writing the first protocols for international wireless traffic, though these remained unofficial and were never strictly enforced. Meanwhile, Henry's urgent message had already been transmitted via undersea cable. The incident sparked not only international radio regulation, but also competing attempts to create worldwide wireless networks, as various heads of state were convinced, like Henry, of the priority of their messages.

As a result of these developments, there was growing anxiety about Marconi having a worldwide monopoly over messages, which would be tantamount to Great Britain having a monopoly, an anxiety not only in the German Empire but also in other world powers. Using this argument, Kaiser Wilhelm II intervened in the company politics of the two competing groups of wireless researchers and expedited the founding of the *Gesellschaft für drahtlose Telegraphie m.b.H.* (*Telefunken*) in 1903. Telefunken was given 20 years to focus on technical problems and to invent various wireless components, while also specializing in establishing wireless stations and facilities. Developing organizational abilities at a rapid pace, Telefunken would already have representatives in 39 countries by the start of the First World War. Starting in 1911, the government and the marines in Wilhelmine Germany were concentrating on exploiting their overseas holdings for the creation of a new information network, intended not to replace but to supplement the existing undersea cable. As the historian of technology Michael Friedewald demonstrates, the position of the German colonies not only determined the structure of the network and its stages of construction, but also defined the central demands for the development of long-distance wireless technology.[71] Given the position of the colonies, the plans for a worldwide network would have needed to proceed in four main stages. First, a number of coastal stations would have to be constructed in the German colonies for the purposes of communicating with their own ships and for surveillance of foreign ships on the important seaway to India and East Africa. Next, the colonies in Africa and in the Pacific could be connected to each other using large wireless stations with a range of at least 4,000 km. Only then could the African colonies be linked back up with the German Empire, using a transcontinental wireless station with a range of 6,000 km. Lastly, the oceanic colonies were to be connected to the rest of the colonial network with a further relay station. At the start of World War I, the first three stages of the plan had already been finished for the most part, though the fourth had not even been started and would not see completion before the end of the war. To this historical research, I add that network maps played an integral role in Telefunken's projection of a worldwide wireless network. If the scarce scholarship on networking maps has tended to approach them as representations of infrastructural politics,[72] analyzing maps as cultural techniques requires approaching them, as Bernhard Siegert puts it, "not as representations of space

71. See Friedewald, "Telefunken vs. Marconi"; Friedewald, *Die* "*Tönenden Funken*"; Klein-Arendt, *Kamina ruft Nauen!*

72. Lisa Parks, "Earth Observation and Signal Territories: Studying US Broadcast Infrastructure through Historical Network Maps, Google Earth, and Fieldwork," *Canadian Journal of Communication* 38, no. 3 (2013).

but as spaces of representation."[73] These maps also make visible a changing understanding of wirelessness in the early twentieth century: from wireless telegraphy to radio broadcasting, from a point-to-point substitution for wires to a universal medium of public address.

The endpoint of a worldwide wired network, though difficult to realize, remains conceivable: a wire so long as to wrap entirely around the world. But what would the endgame of a worldwide wireless network look like? The most extreme expansion of wireless networks would seem to be a worldwide network, broadcasting a signal from a single station powerful enough to cover the entire planet. In fact, it is technologically impossible to create a true 360 degree broadcast. Instead, multiple relay stations still need to be used even in long-distance transmission, as was made evident in a 1913 article on the "Funkentelegraphische Weltprojekte" (Radiotelegraphic world projects) of Germany, Great Britain, France, Italy, Portugal, Russia, Norway, Japan, India, and the USA.[74] The article, printed along with a map of Telelefunken's global *Weltfunknetz*, describes the significance of wireless networks for colonial communications, and restates the prevailing military view of wireless insecurity: "In these kinds of connections, the existing or planned cable connections are not usually taken into consideration, since radiotelegraphic connections are less in the interest of communication [*Verkehr*] than primarily […] in military and political interests, and they possess the advantage over the undersea cable that they cannot be destroyed by enemies in the event of war."[75] For the author of this article, wireless traffic, as we know it, whether in the form of radio, television, or even wireless telegraphy, was unimaginable. Of course, wireless stations can be and were destroyed, often by a nation's own troops, as would happen with the stations in German colonies during World War I. Reflecting on film's potential as a storage medium to "preserve […] ancient traditions, which will be swept away by the advancing civilization," one commentator reflected that "the construction of Telefunken's station in Kamina has also been saved by us in moving pictures for future generations," even after "this masterful example of pioneering technology […] had to be detonated by our own troops so as not to fall into enemy hands."[76] Even though images of the station survive, the transmissions do not, since wireless is primarily a present-oriented transmission medium.

Despite the common fantasy of global connection through wireless connectivity, early network configurations hardly took into consideration the concept of "coverage." Before World War I, radio was mainly conceived as a long-distance, point-to-point medium. Early networking maps may make it appear as through increasing service is a simple matter of connecting the dots or of filling in the empty spaces on a map. However, a wireless station's coverage is not equivalent to the geographic area covered by its

73. Bernhard Siegert, "The Map *is* the Territory," *Radical Philosophy* 169 (2011): 13.

74. "Funkentelegraphische Weltprojekte," *Telefunken Zeitung* 12 (June 1913): 134–40.

75. Ibid., 134. "Bei solchen Verbindungen wird meistens keine Rücksicht auf vorhandene oder geplante Kabelverbindungen genommen, da die funkentelegraphischen Verbindungen weniger im Interesse des Verkehrs als hauptsächlich […] im militärischen und politischen Interesse liegen und vor den Seekabeln den Vorzug besitzen, daß sie in Kriegsfällen vom Feinde nicht zerstört werden können."

76. Hans Schomburgk, "Africa and Film," [1922], trans. with commentary in *The Promise of Cinema*, ed. Kaes, Baer, and Cowan, 55–56.

transmission range. In technical and legal terms, the concept of *coverage*, *broadcast range*, or *Reichweite* is defined as the area in which the strength of a wireless signal is sufficient for a given number of receivers to decode. In reality, a station's signal strength depends on interference from other stations, and the propagation behavior of radio waves depends on the weather and tropospheric conditions. A coverage map is a rough approximation of these features. What is important is that increasing coverage is a function not only of optimizing technology but also of negotiating the number of stations present—of eliminating competing stations or at least compromising with them.

Surprisingly, one of the main reasons that thinking about wireless transmission failed to disentangle itself from the notion of linear transmission range and develop a concept of omnidirectional coverage area was that wireless transmission was conceived as a radically *different* problem than that of wired transmission. Although the telegraph network and the telephone network were optimized in the nineteenth century, the optimization of wireless networks went largely unnoticed until the rapidly growing number of subscribers to national radio services made it necessary to ensure quality of service. The main reason for this delayed development was a surprising blind spot in the theory and practice of switching technology: wired and wireless networks were viewed as radically *different* problems. Thus, as late as 1927, the American radio engineer Lloyd Espenschied, who had also been involved in the development of wireless networks with Telefunken in Germany, could observe that "in the case of radio broadcasting, the absence of a common control of the two ends makes this overall 'systems' aspect less apparent than it is for wire systems."[77] In other words, wired systems are based on a common control system—namely the wire, which can be optimized through engineering and switching technology. By contrast, wireless systems use two seemingly different control systems—namely, the transmitter and the receiver.[78] The endpoint of a Weltfunknetz may seem to be *Der tönende Erdkreis*, as the title of Brunngraber's novel has it, suggesting that the earth itself becomes a giant wireless station, though this would obliterate the technical difference between transmitters and receivers in the service of a symbolic image of a universal (German) community.

The competition between the German Telefunken Company and the British Marconi Company, described above, is one of the main themes of Brunngraber's *Der tönende Erdkreis*, and it is also what gives it such a marked nationalistic tone. Near the start of the novel, Lorz negotiates the difficult status of invention in a conversation with Michaela Pallaban, Adolf Slaby's daughter and Lorz's most recent love interest. Even though Michaela admits that she "understand[s] absolutely nothing of technical things," she knows "that there is a dispute over the priority [*Prioritätsstreit*] of this Italian inventor Marconi's achievement, or at least, the view that he only improved on what had been prepared by others."[79] Wrinkling his brow, Lorz's response is that calling it a "priority

77. Lloyd Espenschied, "Radio Broadcast Coverage of City Areas," *Bell System Technical Journal* 6, no. 1 (January 1, 1927): 117.

78. Before the invention of the transistor in the 1940s, which replaced the standard technology of the vacuum tube, all wireless devices had to be set up as either a transmitter or a receiver.

79. Brunngraber, *Der tönende Erdkreis*, 40. "[I]ch verstehe rein nichts von technischen Dingen, deshalb müssen Sie ganz von vorne, beim Grundlegenden, anfangen. Übrigens, setzte sie noch hinzu, glaube ich zu Hause auch gehört zu haben, daß es einen Prioritätsstreit um die Leistung dieses italienischen

dispute" (*Prioritätsstreit*) may be an overstatement, but "Marconi's invention, or constructions, does conceal much foreign preliminary work."[80] During the course of the novel, Lorz becomes employed by the Transradio-Gesellschaft to review patents for pending disputes with other companies. Near the end of the novel, he compares Marconi's famous patent Nr. 7777 and Braun's patent Nr. 111578, and comes to the conclusion that neither of them can ultimately lay claim to the invention of wireless telegraphy: "Even if Marconi was the immortal center of attention, wireless came about before, with, and after him as a collective work."[81] While the narrative of *Der töndende Erdkreis* seeks to expose Marconi's claims to the priority of invention, on the one hand, it does not simply reassign the priority of invention to Braun, on the other, instead resolving the question of invention within a (Fascist) collective.

After a number of setbacks, Lorz ultimately appears at the end of the novel as a representative of Germany at the Versailles Peace Conference: "Here he encountered Marconi once again, who was representing Italy, though not in matters of wireless, but in those of politics. Neither had any success: Lorz was not able to save the cable for Germany, and Marconi was not able to get Italy's imperialistic demands accepted. But the actual work they had both served had by now progressed to such a point that it was no longer theirs and belonged to the world."[82] No longer occupied with questions of national invention, the novel ends—at least in the 1951 version—with this chapter on "The Path of Service" (Der Weg des Dienstes). In doing so, it highlights what media scholar Markus Krajewski has identified as the fundamental shift in the history of computing technology, from the use of human servants to that of machine-based servers.[83]

As the individual failures of Marconi and Lorz are offset by their absorption into two different collectives, *Der tönende Erdkreis* ends with an allusion to the first amateur radio transmissions across the Atlantic, instead of to the national broadcasts of the years to come: "During the days of the Peace Conference, America opened up private occupation with wireless. Two years later, in summer 1921, Pittsburgh broadcast the first radio concerts and radio amateurs created a connection using the apparatuses they had cobbled

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Erfinders Marconi gibt, oder zumindest die Ansicht, daß er nur ausgebaut habe, was von anderen vorbereitet worden ist."

80. Ibid. "Prioritätsstreit, überlegte er laut, dürfte nach dem, was ich von der Sache weiß, zuviel gesagt sein. Aber daß in der Erfindung, oder den Konstruktionen Marconis, viel fremde Vorarbeit steckt, das glaube ich selbst darlegen zu können.

81. Ibid., 429–430. "Die Arbeit von vielen Physikern hatte Marconi die Gedankenwelt und die Elemente für seine Erfindung geschaffen; seine Tat war es gewesen, die Gedanken zu Ende zu denken und die Elemente zusammenzufügen; doch konnte er dabei nicht bloß als Konstrukteur betrachtet werden, sondern die Genialität seiner Tat hatte physikalisches Neuland erschlossen; das Verdienst des entscheidenden ersten Schrittes war ihm unter keinen Umständen zu bestreiten; die in der Praxis aber ebsenso wichtigen weiteren Schritte hatten andere getan. Der Funk war, wenn auch mit Marconi als dem unsterblichen Brennpunkt, vor, mit und nach ihm als Kollektivarbeit entstanden."

82. Ibid., 574. "Hier begegnete er noch einmal Marconi, der für Italien anwesend war, wenngleich nicht in Fragen des Funks, sondern in solchen der Politik. Sie hatten beide keinen Erfolg; Lorz konnte Deutschland die Kabel nicht retten, und Marconi konnte Italiens imperialistische Ansprüche nicht durchsetzen. Das eigentliche Werk aber, dem sie beide gedient hatten, war nun zu einer Größe gediehen, in der es sich von ihnen gelöst hatte und der Welt gehörte."

83. Krajewski, *Der Diener*.

together themselves, between the United States and England, the connection across the ocean."[84] While these wireless transmissions may have established a link between the United States and England, they would never find their way to Germany, where the connection to the amateur radio movement, as discussed in my first chapter, had already been severed.

Patent Fiction

> Die Wissenschaft – die Wissenschaft
> die Wissenschaft – die Wissenschaft.
>
> The science—the science
> The science—the science.
> —Christian Morgenstern

At the start of Charlie K. Roellinghoff's "Radio im Humor" (Radio in humor, 1924), mined in my first chapter for its collection of wireless topoi, is the following joke about the invention of wireless technology, which was no longer such a heated topic in the early days of radio, since the earlier patent wars among various individuals and national corporations over control of wireless telegraphy were long over. Instead of the usual suspects (Hertz, Marconi, Slaby, Braun, etc.), the inventor of wireless technology, in Roellinghoff's joke, is someone else entirely:

> Don't really believe the good jokers who tell you stories of Marconi or other important radioligarchs! The entire wireless affair had already been invented [*erfunden*] quite a few years ago by my friend E. Th. A. Knaller. It happened like this:
>
> One nice morning in the year 18** Knaller comes crashing into my best chamber and is already screaming at the door:
>
> "Guess what I did!"
>
> "You cadged money from your Uncle!" I tremble with joy.
>
> "No!" Knaller responds sonorously and seriously. "I just invented [*erfunden*] how to *telegraph* without a wire, telephone pole, and all that rubbish!"
>
> Perplexed I stammer: "Knaller, if that's the truth, you'll be the greatest man of the century!"
>
> Then Knaller says: "Who's talking about truth? I said: I *invented* [*erfunden*] it!"[85]

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84. Brunngraber, *Der tönende Erdkreis*, 575. "Während der Tage der Friedenskonferenz gab Amerika die private Beschäftigung mit dem Funk frei. Zwei Jahre später, im Sommer 1921, sendete Pittsburg[h] die ersten Rundfunkkonzerte, und Radio-Amateure stellten mit den von ihnen gebastelten Apparaten die Verbindung zwischen den Vereinigten Staaten und England, die Verbindung über die Ozeane her."

85. Roellinghoff, "Radio im Humor," 80, italics in the original. "Glauben Sie doch den guten Spaßmachern nicht, die Ihnen da was von Marconi oder anderen bedeutenden Rundfunktionären erzählen! Die ganze drahtlose Angelegenheit wurde bereits vor etlichen Jahren von meinem Freunde E. Th. A. Knaller erfunden. Geschehen ist dies so: Knaller kommt eines netten Morgens des Jahres 18** in meine beste Stube gestürzt und schreit schon an der Türe: 'Ahnest du, was mir gelungen ist?' 'Du hast deinen Onkel angepumpt!' freudebebte ich. 'Nein!' entgegnet Knaller sonor und ernst. 'Ich habe soeben erfunden, wie man ohne Draht, Leitungsmasten und dergleichen Zimt telegraphieren kann!' Perplex stammle ich:

The punch line of Roellinghoff's joke hinges on the two-fold meaning of the German verb *erfinden*—to "invent" something, and to "make something up," much like the meaning of "fabricate" in English, though *erfinden* is a much more common verb in German than "fabricate" is in English. The name of the alleged inventor, E. Th. A. Knaller, is a play on the German Romantic author, E. T. A. Hoffmann, "at once a dreamer and media technician," as Friedrich Kittler calls him, famous for his seemingly fantastical stories, several of which feature automata and other mechanical devices.[86] Even in the form of a joke, I would argue, Roellinghoff's lame origin story of the invention of wireless technology highlights a crucial point about the divergence of literature and science in (German) modernity. If German science, understood as "*die deutsche Wissenschaft*," was once taken to encompass both literature and science, embodied by Goethe's work in multiple disciplines, it eventually bifurcated into the human sciences (*Geisteswissenschaften*) and the natural sciences (*Naturwissenschaften*) with the latter assuming the right over the former to provide authoritative statements about the constitution of reality. While scientists can invent things, poets only make them up.

From 1871–1914, as the century of industrial developments came to an end and the new century of physics, chemistry, and electronics began, *die deutsche Wissenschaft* truly flourished as a natural science: by 1889, Heinrich Hertz was being recognized for the discovery of electromagnetic radiation; in 1895, Wilhelm Conrad Roentgen for X-Rays, still called *Röntgenstrahlen* in his honor; in 1900, Max Planck for quantum theory; in 1906, Albert Einstein for developing the theory of special relativity. Within the span of seven years, from 1901 to 1908, Germany put forward 18 Nobel Prize recipients in the fields of physics, chemistry, and medicine. In Wilhelmine Germany, the common stance toward *die deutsche Wissenschaft* was based, for good reason, on a confidence in science and a faith in progress. In the case of wireless telegraphy, however, the spirit of scientific internationalism came into conflict with the demands of national politics, when wireless networks rapidly grew to an international scale, as I have shown in the first half of this chapter. As Paul Forman argues, the ideology of scientific "internationalism" is often predicated on nationalistic foundations: the classical formula whereby the nation participates in the fame of a scientist spares the scientist from the conflict of advancing his research and advancing the interests of the nation.[87]

Early expressionist literature sought to bring to light these internal contradictions of both (German) science and pretensions to internationalism. Even in Wilhelmine Germany, there were still plenty of skeptics of *Wissenschaft* in general and of *die deutsche Wissenschaft* in particular—Christian Morgenstern, for one, a poet who was part of the literary and philosophical circle around Fritz Mauthner. In anticipation of Max Weber's

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'Knaller! Wenn das die Wahrheit ist, bist du der größte Mann der Jahrhundertwende!' Da sagt Knaller: 'Wer redet von Wahrheit? Ich sag' doch: ich hab's eben *erfunden*!'"

86. Friedrich A. Kittler, *Discourse Networks, 1800/1900*, trans. Michael Metteer and Chris Cullens (Stanford University Press, 1992), 105.

87. Paul Forman, "Scientific Internationalism and the Weimar Physicists: The Ideology and Its Manipulation in Germany after World War I," *Isis* 64, no. 2 (1973): 151–80.

diagnosis of increasing professionalization in the form of "Wissenschaft als Beruf" (Science as a Vocation, 1917), Morgenstern asked the then-unheard of question: "What is this 'science' of today really, with what right do the hundred thousand industrious workers each call their own field *the* science?"[88] As a contribution to the (meta-)science of literature, Morgenstern published the poetry collections *Galgenlieder* (Gallows Songs, started 1895; published 1905), and *Palmström* (1910).[89] These works sought to enrich the world of science with a number of literary inventions, attributed to Palmström and Korf, two stand-ins for the author. Their inventions included reading glasses powered by the text one is currently reading; a clock with two hands that can tell the time not only forwards but also backwards; a modern light show; and several communications and distribution media.[90] Fed up with the topos of telemedia overcoming space and time, Korf recommended, "Just read the newspaper from the day after tomorrow." In similar fashion, recognizing the need for a digestible news format, he also "invented a mid-day paper, which, after you've read it, you're full."[91] Through these inventions, Morgenstern was demonstrating the ability of literature to function, once again, as a science capable of producing its own knowledge.

Though Morgenstern never filed patents for any of these inventions—as far as I have been able to determine—the *Reichspatentamt* did grant patents for similar inventions around the same time.[92] After the German patent office was established in Berlin in 1877, the number of registered patents grew every year, from 5,949 in 1878, including a patent for a perpetual motion machine, to roughly 45,000 in 1909.[93] As late as 1930, writing in the section of his essential physics textbook on the principle of the conservation of energy, which "one can also call the principle of the impossibility of a perpetual motion machine," Wilhelm Westphal would still feel the need to emphasize that "the German patent office no longer accepts registrations for patents that concern a supposed perpetual motion machine."[94] In a popular handbook on *Das deutsche Patentrecht* (German patent law, 1906), Felix Damme explained that the reason why a perpetual motion machine cannot be patented, despite meeting the condition of commercial usefulness, is due to either a

88. Qtd. in Ernst Kretschmer, *Die Welt der Galgenlieder Christian Morgensterns und der viktorianische Nonsense* (Berlin: Walter de Gruyter, 1983), 29. "Was ist denn eigentlich diese 'Wissenschaft' von heute, mit welchem Rechte nennen sich hundertaussend fleißige Arbeiter auf ihrem Felde 'die Wissenschaft'?"

89. Christian Morgenstern, *Alle Galgenlieder: Galgenlieder, Palmström, Palma Kunkel, Gingganz*, ed. Margareta Morgenstern (Wiesbaden: Insel-Verlag, 1947).

90. See Kretschmer, *Die Welt der Galgenlieder Christian Morgensterns*, 64–76.

91. Qtd. in Kretschmer, *Die Welt der Galgenlieder Christian Morgensterns*, 68. "Lesen Sie doch die Zeitung von übermorgen." "Korf erfindet eine Mittagszeitung, welche, wenn man sie gelesen hat, ist man satt."

92. See ibid., 76.

93. See ibid.; cf. Christian Kassung, "Patent und Amt: Die Wissensgeschichte einer Behörde im deutschen Kaisserreich," in *Bildtelegraphie: Eine Mediengeschichte in Patenten (1840–1930)*, ed. Albert Kümmel-Schnur and Christian Kassung (Bielefeld: Transcript, 2014), 53–76.

94. Wilhelm H. Westphal, *Physik: Ein Lehrbuch für Studierende an den Universitäten und Technischen Hochschulen* (Berlin: Springer-Verlag, 1930), 40. "Man kann ihn daher auch als den Saltz von der Unmöglichkeit eines perpetuum mobile bezeichnen. Das Reichspatentamt nimmt Patentanmeldungen, welche ein angebliches perpetuum mobile betreffen nicht mehr an."

discrepancy between the "solution" (Lösung) presented and the "task" (Aufgabe),[95] or to the patent register's mistaken conception of the device.[96] While Morgenstern was working out the internal contradictions in the concept of German science, another author from Mauthner's circle, Paul Scheerbart, would take up the internal contradictions of patents in a novella about the invention of a perpetual motion machine.

In a short text preceding the publication of the novel, Scheerbart questioned the authority of science in a fashion similar to Morgenstern.[97] Hopping sprightly onto a table, an "old man," identified later as the "director of a scientific laboratory" (Herr Laboratoriumsdirektor), clears his throat and delivers a speech: "I maintain that Europeans and especially the Germans esteem their famous men of science too much, much too much! Whenever one of them expresses a halfway reasonable opinion or has invented something imposing, he immediately becomes an 'authority.' Unfamous people say to themselves, 'The man once did or said something reasonable, so everything he has to say will probably be reasonable too.'"[98] As an example of the tendency to create authorities out of questionable scientific figures, the director of the scientific laboratory mentions the German physicist Julius Robert von Mayer, who helped formulate the law of the conservation of energy. Without doubting the validity of the law itself, the speaker remains skeptical about its applicability to the question of creating a perpetual motion machine, pointing out that Mayer himself allegedly worked on developing one for at least three years, and declared it impossible only since he was unable to create the machine himself. His conclusion, "If a load goes down, it must be taken up again, so it cannot work perpetually if it goes down," does not rule out another possibility for the speaker. "However, it is still possible that this load approaches the earth."[99] The problem, for the laboratory director, is that physicists are unable to extricate themselves from the study of the earth and everything within its atmosphere. Doing so, according to the speaker, would allow them to observe the strange perpetual attraction of the earth from outer space, a perspective that Scheerbart would attempt to adopt in his other fantastical works known as "astral literature."[100]

There is a tension in all of Scheerbart's work between the lofty heights of philosophical fantasy and the grounded perspective of satire and critique. After finishing

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95. Felix Damme, *Das Deutsche Patentrecht: Ein Handbuch für Praxis und Studium* (Berlin: O. Liebmann, 1906), 148.

96. Ibid., 289.

97. Paul Scheerbart, "Das Perpetuum Mobile: Leipzig, bei Ernst Rowholt," *Die Zukunft* 18.47 (August 20, 1910), 263–64, repr. as "Vorwort," in *Meine Welt ist nicht von Pappe: Ein Paul Scheerbart Lesebuch* (Berlin: Parthas, 2012), 8–10.

98. Ibid., 8. "Ich behaupte, dass die Europäer und besonders die Deutschen ihren berühmten Männern der Wissenschaft allzu viel Hochachtung entgegenbringen; allzu viel! Wenn einer eine halbwegs vernünftige Ansicht geäußert oder etwas Imposantes erfunden hat, wird er gleich eine 'Autorität'. Die Unberühmten sagen sich: Der Mann hat mal was Vernünftiges vorgebracht, also wird alles, was er sonst noch sagt, wahrscheinlich auch vernünftig sein."

99. Ibid., 9. "Geht eine Last herunter, so muss sie wohl wieder hinaufgehoben werden, also kann sie nicht perpetuierlich wirken, wenn sie heruntergeht." "Es ist aber doch möglich, dass diese Last sich dem Erdboden nähert."

100. Paul Scheerbart, *Lesabéndio: An Asteroid Novel* [1913], trans. Christina Svendsen (Cambridge, MA: Wakefield Press, 2012).

the speech, the learned scientist gets down from the table and drinks three cognacs, at which point Scheerbart's narrative voice intervenes: "Then I said, 'My esteemed Herr Laboratory Director, I completely agree with you and I've also been working for two and a half years to invent a transportable load motor that functions perpetually only through the support of a weight. I believe I've done it. In any case, I've written a book about it, which has appeared under the title *The Perpetual Motion Machine* with twenty-six drawings, through Rowohlt's Press in Leipzig and can be acquired in bookstores for fifty pfennig.'"[101] The scientist congratulates the author, as one would any other scientific authority, presumably on the invention of the perpetual motion machine, though, on closer inspection, perhaps more for the publication of the book.[102]

At the heart of Scheerbart's *Das Perpetuum Mobile: Die Geschichte einer Erfindung* (The Perpetual Motion Machine: The Story of an Invention, 1910),[103] is not only the dual meaning of *Erfindung* as a scientific and literary contrivance, but also that of *Geschichte* as a "story" and a "history." Composed as a series of journal entries interrupted by short-form fiction, the book seems to document his two-and-a-half-year-long work on the machine in his laboratory cum laundry room. The journal entries end in July 1910, when Scheerbart claims to have had his invention patented at the Reichspatentamt at Gitschiner Straße 97 in Kreuzberg, Berlin. Seeing, however, as there is no evidence—as far as I'm aware—of a patent ever having been registered, the provocative ending of *Das Perpetuum Mobile* must be a comment on the nature of patents. In my reading, the penultimate sentence is a comment on patents as a locus of scientific authority, situated precariously between the real and the imaginary: "On 12 July of the year 1910, after introducing a new factor, I succeeded in flawlessly solving the problem. Alas, I can say nothing about it without invalidating its registration at the patent offices of various governments. But I did arrive at a satisfying conclusion."[104] Breaking this purported silence, the first edition of the book includes diagrams of the machine, as would be submitted in a patent application. In my reading, the "satisfying conclusion" that the author reaches at the end of the book was, in fact, the end of the book itself.

In a sense, Scheerbart did invent a perpetual motion machine, though not a literal device that would overturn the law of the conservation of energy. *Das Perpetuum Mobile* is rather a literary system capable of generating endless stories and possible futures. For

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101. Scheerbart, "Vorwort," 9–10. "Da sagte ich: 'Sehr geehrter Herr Laboratoriumsdirektor, ich bin durchaus Ihrer Ansicht und ich habe mich auch zwei Jahre und ein halbes hindurch bemüht, einen transportablen Lastmotor, der nur durch Auflage eines Gewichtes perpetuierlich funtioniert [sic], zu erfinden. Ich glaube, dass mir's gelungen ist. Jedenfalls habe ich ein Buch darüber geschrieben, das unter dem Titel 'Dass [sic] Perpetuum mobile' mit sechsundzwanzig Zeichnungen bei Ernst Rowohlt in Leipzig erschienen und für eine Mark und fünfzig Pfennige im Buchhandel käuflich zu erwerben ist'."

102. This reading is supported by the fact that Scheerbart's short text announcing the publication of the novel appears in the "self-advertisement" (Selbstanzeigen) pages of *Die Zukunft*, where it functions as a meta-comment on the nature of literary advertising.

103. Paul Scheerbart, *Das Perpetuum Mobile* (Leipzig: Rowohlt, 1910); translated by Andrew Joron as *The Perpetual Motion Machine: The Story of an Invention* (Cambridge, MA: Wakefield Press, 2011).

104. Scheerbart, *The Perpetual Motion Machine*, 83. "Am 12. Juni des Jahres 1910 gelang es mir, nach Einführung eines neuen Faktors das Problem tadellos zu lösen; leider muß ich darüber schweigen, da sonst die Anmeldung bei den Patentämtern der verschiedenen Staaten hinfällig werden würde. Aber zu einem befriedigenden Schluß bin ich gekommen."

Scheerbart, the idea behind the machine was elegantly simple: "I named this story 'The Weight-Driven Cogwheel.' I told myself: the work of attraction exerted by the Earth is perpetual, and this perpetual force of attraction may be transformed, through a system of wheels superimposed on one another, in perpetual motion."[105] The success of the invention was largely irrelevant for its inventor: "Whether the wheel worked or didn't work was a matter of lesser importance to me. No importance at all, really."[106]

Scheerbart's penultimate journal entry, right before the revelation of his success at the patent office, provides a good indication of the project's intention: "What's remarkable is that, in fact, everything on the Earthstar always comes down to something very funny. Anyway, we should never forget this comical aspect at every turn—then we won't so easily lose sight of the humor."[107] In my reading, then, *Das Perpetuum Mobile* is a meta-statement about the function of literature, physics, and engineering as scientific systems. This reading is even suggested in Ottomar Starke's book jacket illustration for the first edition, which depicts the author's hand reaching into his own cranium as if a botched version of *The Thinker*. In similar fashion, Scheerbart's book is itself a perpetual motion machine, the text generating itself and its author through a process of *autopoesis*, the Romantic ideal of self-definition through poetics.

Tele-Everything

> The fact that we cannot telegraph the pattern of a man from one place to another seems to be due to technical difficulties, and in particular, to the difficulty of keeping an organism in being during such a radical reconstruction. It is not due to any impossibility of the idea.
> —Norbert Wiener

Building on these poetics of invention, the idea of wireless communication as a means of "getting in touch" would be taken *ad extremis* in Mynona's "Idee vom Ferntaster" (Idea for a telehaptor, 1913).[108] Often compared in his day to Kafka and once called the "Charlie Chaplin of German philosophy" (Charley Chaplin der deutschen Philosophie),[109] Salomo Friedländer, adopting the pen name Mynona, was a poet cum philosopher in the nineteenth-century tradition, though with a finger on the pulse of the

105. Ibid., 8. "'Durch Gewichte bewegtes Zahnrad' nannte ich die Geschichte. Ich sagte mir: die Anziehungsarbeit der Erde ist eine perpetuierliche, und diese perpetuierliche Anziehungsarbeit läßt sich durch aufeinander gestellte Räder in perpetuierliche Bewegung umsetzen." The word *story* (Geschichte) is used here, as elsewhere in the book, in place of the word *machine*.

106. Ibid., 61. "Ob das Rad nun ging oder nicht ging—das mußte nach dem Gesagten für mich von untergeordneter Bedeutung sein. Es kam wirklich gar nicht darauf an."

107. Ibid., 83. "Merkwürdig ist es doch, daß auf dem Stern Erde eigentlich Alles immer auf etwas sehr Komisches hinausläuft. Jedenfalls sollten wir dieses Komische an allen Ecken und Enden nie vergessen—dann wird uns der Humor nicht so leicht abhanden kommen."

108. Mynona (Salomo Friedländer), "Idee vom Ferntaster," *Der Sturm* 4, no. 170–71 (July 1913). Originally published in the main expressionist journal *Der Sturm*, "Idee vom Ferntaster" was also published in Friedländer's *Rosa, die schöne Schutzmannsfrau* and later incoporated into *Bank der Spötter* and *Graue Magie*.

109. See Mynona (Salomo Friedländer), *Prosa,* ed. Hartmut Geerken and Detlef Thiel, vol. 2 of *Gesammelte Schriften* (Herrsching: Waitawhile, 2012), 460.

Berlin avant-garde and an eye to the latest technological developments. In seeming anticipation of Marshall McLuhan's conception of media as "extensions of man," with telegraphy extending the hand that writes, telephony the ear that hears, and television the eye that sees, Mynona's telehaptor would extend sensation even further through a form of telehaptics. Seeing as the wireless transmission of audiovisual data involves invisible waves in the electromagnetic spectrum, Mynona reasons, then it should be possible for haptic vibrations to propagate in the same manner as light waves or sound waves. Although it may seem easy to dismiss Mynona's idea of the telehaptor as a wild fantasy, I argue that his combination of philosophy and fantasy actually contains a deeper point, not only about communication ideals but also about the language of scientific prediction. Surprisingly, the subject of Mynona's text may not have been entirely of his own fantasy.[110] In fact, the closing lines of "Idee vom Ferntaster" anticipate the objection that the proposal is pure fantasy with the following tirade: "What? Light waves and such rubbish are supposed to propagate rapidly—and haptic vibrations are not? Are you crazy? Or are you perhaps only the dumb goose who only goes with officers? You disaster!"[111] Who could even begin to argue with that?

At the start of this short essay, first published in the foundational German Expressionist journal *Der Sturm*, Mynona imitates the prophetic voice of engineers, and imagines the development of telecommunications in a future so perfect that it spills over into the present:

> Now then, we have the telegraph, the telephone, the television is as good as done and ready-to-go, and all that is left to wait for is telehaptics, the telehaptor, the teletoucher. What use is the entire [oeuvre of H. G.] Wells, if he shrinks back from this idea? But the matter is much more miserable than one might suspect: we are *lost* if we do not learn how to telehapt. As long as our sense of touch is frozen as if in stone, and only its refinements, vision, smell, and hearing, are free to roam around in the world, we will remain pitiful prisoners. But there is no reason to weep! We need some words of encouragement. Some things are not found only because nobody ever has the idea to look for them. The thought of telehapting the sense of touch, once grasped, will have to be realized.[112]

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110. See, for example, Victor Loos, "Der technische Impresario," which decried the sensational reports about a purported American invention, "wireless electric smelling" (*das elektrische Riechen ohne Draht*), and its uncritical reception in Austrian journals; on a similar theme as Mynona's in Guillaume Apollinaire's "La toucher à distance" (Touch at a distance), see Stephen Kern, *The Culture of Time and Space: 1880–1918* (Cambridge, MA: Harvard University Press, 2003), 74–75. However, there is no evidence that Mynona was aware of these texts.

111. Mynona (Salomo Friedländer), "Idee vom Ferntaster," 67. "Was? Lichtwellen und solches Gelumpe sollten sich rapide fortpflanzen – und haptische Vibrationen nicht? Sind Sie verrückt? Oder sind Sie vielleicht zufällig die dumme Gans, die nur mit Offizieren geht? Sie Unsal!"

112. Ibid., 66, italics in the original. "So haben wir denn Telegraphie, Telephonie, der Fernseher ist so gut wie fix und fertig. Und nur die Telehaptie, der Telehaptor, der Ferntaster läßt noch auf sich warten. Was nutzt uns der ganze [H. G.] Wells, wenn er vor dieser Idee zurückschrickt? Aber die Sache steht ja viel kläglicher, als man argwöhnt: wir sind *verloren* wenn, wir das Telehaptieren nicht lernen. Solange unser Getast wie versteinert festsitzt, und nur seine Verfeinerungen, das Gesicht, der Geruch, das Gehör ihren freien Ausflug in die Welt machen, sind wir armselige Gefangene. Aber wir wollen nicht gleich weinen!

In my analysis, the structure of this passage can be read as a literary travesty of wireless predictions commonly found in engineering trade publications (e.g., Ayrton's primal scene of wireless communication): first, there is a review of the state of current technology, to be completed by the invention of one new device, which is already in the offing; next comes a statement of the urgency of the problem and the consequences for ignoring it; finally, the author offers a solution, and here is where the force of the passage sets in. While most wireless fantasies proceed from the invention of something to a general idea, Mynona proceeds in precisely the opposite direction: the only reason the telehaptor has not been invented yet, putting aside the questions or whether it would even be useful, practical, or technically possible, is that nobody has thought to invent it. Simply having the idea of telehaptics, it would seem, would suffice for its realization.

In a contemporary review of Mynona's work, the Austrian chemist, writer, and journalist Paul Hatvani, who was the one to compare Mynona to Chaplin, makes a similar observation that is crucial for understanding Mynona's "Idee vom Ferntaster:" "We know Mynona's fantasy, at once unrestrained and bound to knowledge of the times. It is directly pedantic in its logic; it never leaves the ground of philosophical thought; Mynona always proceeds deductively from the idea to arrive at the thing. He is, one could say, a reverse Platonist. He once invented the telehaptor; the preconditions were the telephone and the identity of the sense organs."[113] Indeed, Mynona deduces the idea of the telehaptor from the wireless transmission of telegraphy, telephony, and television, all of which rely on electromagnetic waves at different frequencies in the electromagnetic spectrum. His point about the sense organs is that they are not *yet* identical, and, in this respect, his telehaptor provides a philosophical and poetic reflection on the nature of embodiment. Quoting Hamlet, Mynona writes: "*there lies the rub*! My vision reaches as far as the Milky Way, my hearing potentially for miles, my smell unfortunately into the toilet of the lyrical poet […] But I can only taste and touch my dears when I have them right next to me (which, by the way, heaven forbid!)."[114] While the senses of sight, hearing, and smell can operate at a distance, Mynona suggests, the sense of touch remains localized on the surface of the skin. This is what will become the philosophical problem of "remote perception" (*Fernwahrnehmung*) in the Gestalt psychology of the time—not the problem of extrasensory perception (ESP), but the epistemological question of

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Man muß ein paar Worte der Ermutigung sprechen. Manches wird nur deshalb nicht gefunden, weil man gar nicht auf den Gedanken kommt, es zu suchen. Der Gedanke, das Getast zu telehaptieren, einmal gefaßt, wird sich realisieren müssen!"

113. Paul Hatvani, "Der Schöpfer," *Prager Presse* 137 (August 13, 1921), repr. in Mynona (Salomo Friedländer), *Prosa*, vol. 2 of *Gesammelte Schriften*, 459. "Man kennt die hemmungslose, doch an die Zeiterkenntnisse gebundene Phantasie Mynonas. Sie ist geradezu pedantisch in ihrer Logik; sie verläßt den Boden der philosophischen Überlegung niemals; Mynona geht immer wieder deduktiv von der Idee aus, um zum Ding zu kommen. Er ist, sozusagen, ein umgekehrter Plantoniker. Er hat einmal den Ferntaster erfunden; Voraussetzung waren der Fernsprecher und die Identität der Sinnesorgane."

114. Mynona (Salomo Friedländer), "Idee vom Ferntaster," 66–67. "*Also there lies the rub*! Mein Gesicht reicht milchstraßenweit, mein Gehör unter Umständen meilenweit, mein Geruch unglücklicherweise bis in das W. C. des Lyrikers [….] Aber schmecken und tasten kann ich all die Lieben nur, wenn ich sie ganz dicht bei mir habe (wovor mich übrigens der liebe Gott noch lange bewahren möge!)."

whether the process of perception requires immediate contact between the senses and the object of perception. Sight, hearing, and smell, in other words, are tele-senses, whereas touch does not seem capable of operating at a distance.

At several points in the text, the prophetic voice of the engineer, addressed to a universal future, is interrupted by a different, even more polemic voice, addressed to a cast of characters straight out of Heinrich Zille's Berlin "Milljöh" (milieu).[115] As if in answer to the question most commonly asked by the interlocutors in wireless predictions, "Where are you," Mynona writes:

> I am not now in Bessarabia, I am here in the place where some people with a healthy digestive system always ask: "What is the German's fatherland?" Take them…
>
> Yes, the cuckoo sometimes sings too prettily, Frau Werner—What I wanted to say just now: "I am here! But I am not everywhere…apart from…apart from…apart from my little—touch?"[116]

In subverting the exotic locations usually provided in answer to the question "Where are you" (e.g., "at the bottom of the coal mine, or crossing the Andes, or in the middle of the Pacific"), Mynona critiques the heated nationalist discourse on the eve of World War I, as evident in his reference to Ernst Moritz Arndt's patriotic song, "Des Deutschen Vaterland" (1814) and his further references to Bessarabia and Burma in the text. In the same turn, Mynona makes a philosophical point about the primal scene of wireless communication: "When somebody asks me where I am, the implication is that he is really asking where I can be felt. For I could just as well be seen, heard, smelled somewhere else."[117] In other words, there is a deictic dimension to the question "Where are you," since it implies the respondent being, "Not here," or, to formulate it in Mynona's terms, "Not where you could touch, taste, smell, or sense me." Ultimately, this is what makes the sense of touch so resistant to technological instrumentalization: "Yes, this heavy and clumsy touch! We have to pry it out, thaw it out, pull it through wires, and finally send it wirelessly into every distance. How easy!"[118]

Those interested in how the telehaptor might work may be disappointed to find that there is only one brief mention of a possible procedure in Mynona's "Idee vom Ferntaster:" "Simply stand naked—as, where we are not mistaken, God made you—on some kind of scales, whose counterpart at the target of your destination will react

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115. See Mynona (Salomo Friedländer), *Grotesken,* ed. Hartmut Geerken and Detlef Thiel, vol. 1 of *Gesammelte Schriften* (Herrsching: Waitawhile, 2015).

116. Mynona (Salomo Friedländer), "Idee vom Ferntaster," 66, ellipses in the original. "Ich bin jetzt nicht in Beßarabien, ich bin hier an dem Orte, von dem einige Leute mit gesunder Verdauung immer wieder fragen: Was ist des Deutschen Vaterland? Hole sie…Ja, der Kuckuck, der singt manchmal zu schön, Frau Werner – Was ich doch gleich sagen wollte: ich bin hier! Aber ich bin nicht überall…bis…bis…bis auf mein bisschen – Getast?"

117. Ibid., 67. "Es geht aus allem hervor, wenn einer fragt: wo bin ich? Daß er dann eigentlich meint: wo bin ich zu tasten. Denn gesehen, gehört, gerochen könnte er auch anderswo werden."

118. Ibid. "Ja, dieses klobige Getast! Man muß es loseisen, auftauen, auf Drähte ziehn und schließlich drahtlos in alle Ferne schicken. Wie einfach!"

accordingly: at the flick of a switch everything about you that is tactile and can be weighed will be telehaptically transferred! Soon, we'll be able to telehapt clothing too; for the time being, the telehaptor resists…shamefully!…anyone who is not stark naked."[119] The only description of the device turns out to be more of a description of its limitations, namely, the fact that the telehaptor is unable to transmit clothing—a trope that recurs in many depictions of teleportation. As Hans Rindisbacher points out, relating Mynona's grotesques to the context of a changed concept of the body around 1900, the subject is literally dissolved in sensory processes, and can only telehapt naked.[120] In pointing out this limitation, I would add, Mynona is making an observation that is similar to Kleist's point about the materiality of communication, discussed in my previous chapter, though Mynona develops it into a critique of ethics rather than politics. For Mynona, the telehaptor is "the ideal of all means of transport…and so healthy, so amusing, so modern, that it promises to have a directly refreshing effect especially in the field of erotics, which up to now have been somewhat…awkward."[121]

The inventor of the telehaptor is none other than Professor Abnossah Pschorr, a fictive scientist modeled after the contemporary philosopher Ernst Marcus who appears for the first time in "Idee vom Ferntaster" and returns throughout Mynona's work. Along with the telehaptor, Professor Pschorr is credited with the invention of "the teleolfactor, the telegustator, the teleheater or telecooler respectively, etc.," and even the "teletictor, an apparatus for telebirth."[122] Several years later, Mynona will remind readers of the inventor in another short essay "Der Stereograph oder: Die kinetische Automodellierung" (The stereograph, or, kinetic automodeling, 1916/19): "Professor Abnossah Pschorr is no stranger to my countless readers: he invented, as they will remember, the 'telehaptor', which would have certainly been playing the decisive moment in the war now, if it had been introduced."[123] The passage alluded to here from "Idee vom Ferntaster" is

119. Ibid., ellipses in the original. "[S]tellen Sie sich einfach nackt, wie Sie, wo wir nicht fehlgehlen, Gott erschaffen hat, auf ne Art Wagschale, deren Zwilling am Ziel Ihrer Bestimmung schwankt: Im Handumdrehen ist alles, was an Ihnen tastbar, wägbar ist, hindurchtelehaptiert! Man wird nächstens auch die Kleider mitschicken können; vorläufig sträubt sich der Ferntaster…schamhaft!…gegen alles nicht Splinterfasernackte!"

120. Hans J. Rindisbacher, *The Smell of Books: A Cultural-Historical Study of Olfactory Perception in Literature* (Ann Arbor: University of Michigan Press, 1992), 224.

121. Mynona (Salomo Friedländer), "Idee vom Ferntaster," 67, ellipses in the original. "[D]as Ideal aller Beförderungsmittel…und so gesund, so amüsant, so modern, daß er in Sonderheit auf dem bisher etwas…?…umständlichen Gebiet der Erotik direkt erfrischend zu wirken verspricht."

122. Ibid. "Wie dem auch sei, der Ferntaster, der ja selbstverständlich, wie Professor Abnossah Pschorr mir mitzuteilen die Güte hatte, den Fernriecher, Fernschmecker, Fernwärmer resp. –Kälter usw., in sich einbegreift […] Teletiktor, eine Ferngebärapparat."

123. Mynona (Salomo Friedländer), "Der Stereograph oder: Die kinetische Automodellierung," *Neue Jugend* 1.8 (August 1916), *Der Einzige* 1.20 (June 1, 1919) and (June 15, 1919), repr. in Mynona (Salomo Friedländer), *Grotesken*, vol. 1 of *Gesammelte Schriften*. "Professor Abnossah Pschorr ist meinen zahllosen Lesern längst kein Fremder mehr: er hat ja, wie sie sich erinnern werden, den 'Ferntaster' erfunden, der jetzt im Kriege sicherlich das ausschlaggebende Moment gespielt hätte, wenn er bereits eingeführt worden wäre."

presumably the one about "the (not yet introduced) forced telehapting! Here we could fire off entire regiments of obnoxiousness to Timbuktu."[124]

In the short essay on "Der Stereograph," Mynona makes it clear that it is not the *skin* or the *body* that is sent via wireless, but rather *vibrations*, or electromagnetic waves, which are taken to create the sense data of perception: "Pschorr has succeeded in sending the sense of touch, i.e., the vibrations which create the sensation of touch, in a manner similar to light waves and other waves, through lenses, which naturally are not made of glass, but of a peculiar elastic, chemically complex material whose formula will remain a trade secret for the time being."[125] If light waves are the stimulus for vision, Mynona reasons, then other electromagnetic waves are the stimulus for the sense of touch, and, by extension, they too can be analyzed into their various sine-wave components and transmitted wirelessly as are modulated waves of electromagnetic radiation in telegraphy or telephony. However, the stereograph operates according to a different principle than the telehaptor: "While the telehaptor was about conducting the sense of touch on wires, so to speak, the objects of the sense of touch here remain in place; they are merely copied through the 'stereographs' at a particular other place in a plastic mass, a kind of tone prepared in a particular way, and indeed, even plastically, in the same size as that dependent on the lens—i.e., analogously to photography, here it operates…photo-plastically."[126] The idea of photoplastic art would resonate throughout the work of the Berlin-based avant-garde in the 1920s, as will be examined in my next chapter. Ultimately, the main thought running through Mynona's texts on telehaptics is about the unattainable desire for ubiquitous telepresence.

Conclusion: Literary Invention

In light of the fact that we are not all literally "getting in touch" with each other, what are we to make of Mynona's idea of telehaptics, of Scheerbart's astral literature, and of Morgenstern's provocations of *die deutsche Wissenschaft*? All of these literary "inventions" seem to pale in comparison to the significance of the historical "invention" of wireless telegraphy, documented in Brunngraber's *Der tönende Erdkreis*. However, if the latter now seems only to provide a nostalgic look back on a historical period that is already over, the others offer a glimpse of a possible future that never was.

One line of thinking about the constellation of literature, invention, and realism was already pursued, in explicit connection to the idea of a telehaptor, in Alexander Moszkowski's short essay "Von den Wundern und Plundern der Technik" (On the

124. Ibid. "[D]ie (noch nicht eingeführte) zwangsweise Telehaptierung! Da könnte man ganze Regimenter von Widerwärtigkeiten mit Eins ins Pfefferland feuern und rach den Absendeapparat ruinieren."

125. Ibid. "Dem Pschorr ist es gelungen, das Getast, also diejenigen Schwingungen, welche die Empfindung des Getasts erregen, ähnlich wie Licht- und andere Strahlen durch Linsen zu schicken, die natürlich nicht aus Glas, sondern aus einem eigentümlichen elastischen, chemisch sehr kompliziert zusammengesetzten Material bestehen, dessen Formel zunächst Fabrikgeheimnis bleibt.

126. Ibid., ellipses in the original. "Während es sich beim Ferntaster darum handelt, das Getast sozusagen auf Drähten in die Ferne zu leiten, bleiben die Gegenstände des Getasts hier an ihrer Stelle; sie werden durch den 'Stereographen' an einer bestimmten andern Stelle in einer plastischen Masse, einer besonders präprierten Art Ton, lediglich kopiert und zwar eben plastisch, in derjenigen Größe, die von der Größe der Linse abhängig ist—also analog zur Photographie wird hier…photoplastisch operiert."

wonders and blunders of technology, 1922). Incidentally, this satirist and cultural critic, who was famous at the time for his publication of *Einstein: Einblicke in seine Gedankenwelt* (Insights into Einstein's intellectual world, 1920), the first biography of this theoretical physicist and the first work to popularize the theory of relativity, was a particular target of Mynona's animosity.[127] Reflecting on the reification of the machine, Moszkowski writes, "Say, Technology, if you have created, built and constructed the most powerful means of amplification for the eye and the ear—why don't you create something for the other senses? Why do you leave smell, touch, and taste in their originary states without at least helping strengthen them? […] There is no attempt to create the technology, not even the words: micro-smeller, tele-taster, tele-feeler."[128] In other words, the reason that there are no attempts to create technology for extending the senses of smell, taste, and touch, according to Moszkowski, is that there is no *need* for it: "Technology waits for the call of need, of urgency, and the atrophied senses are not calling, since the human brain has told them for centuries that they are the paradigm of perfection. And as long as this misconception reins, technology will remain doomed to be unfruitful for the unredeemed senses."[129] An invention, in this line of thought, fulfills a social function.

To this conception of invention as a solution to a social problem, Morgenstern, Scheerbart, and Mynona would each provide a different kind of response. Morgenstern might emphasize the plurality of science, the different solutions provided by different disciplines, even if some of them may claim to be *the* authoritative meta-science. Developing this idea, Scheerbart would point to literature's potential to fulfill a different social function, namely, the need for humor, irony, and critical reflection. Through autopoesis, literature not only forms the author but also informs readers and the tradition of literature itself. Mynona, who would probably never deign to debate with Moszkowski, might claim that the formulation of the problem is backward: instead of proceeding from the invention of each new technology and trying to deduce the need it fulfills, he would proceed from the idea to the technology itself.

However, another possible response to the question of telehaptics would be that we *have* realized it, albeit in a slightly different sense. This is suggested by Marshall McLuhan's conception of media as *translators*: "By putting our physical bodies inside our extended nervous systems, by means of electric media, we set up a dynamic by which

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127. Moszowski's biography in no way met with Einstein's approval, and in Mynona's novel *Graue Magie*, he sharpens the critique, describing "Ein Trialog zwischen Aribert Neinstein, seiner schwärmerischen Anbeterin Alexandrine Moszkowska und Sucram," the latter a pseudonym for the philosopher Ernst Marcus, with whom Mynona allied himself.

128. Moszkowski, "Von den Wundern und Plundern der Technik," 117–18. "Sage doch, Technik, die du für Auge und Ohr die wirksamsten Verstärkungsmittel schufst, baust und konstruierst, – warum schaffst du nichts Ähnliches für die übrigen Sinne? Warum läßt du Geruch, Gefühl und Geschmack im Urzustande, ohne ihnen im mindesten zu einer Stärkung zu verhelfen? […] "Kein Anlauf hierzu existiert, nicht einmal das Wort: der Mikro-Riecher, der Fern-Schmecker, der Tele-Fühler fehlen im Register, und es ist zu bezweifeln, ob sie jemals den Weg aus der Ahnung in die Wirklichkeit finden werden."

129. Ibid., 118. "Denn die Technik wartet auf den Anruf der Not, des Bedürfnisses, und die verkümmerten Sinne rufen nicht, nachdem ihnen das Menschengehirn seit allen Jahrhunderten eingeredet hat, sie wären Muster der Vollkommenheit. Und so lange dieser Irrglauben regiert, wird auch die Technik im Gebiet der unerlösten Sinne zur Unfruchtbarkeit urteilt bleiben."

all previous technologies that are mere extensions of hands and feet and teeth and bodily heat-controls […] will be translated into information systems."[130] For McLuhan, the sense of "'touch' is not skin but the interplay of the senses, and 'keeping in touch' or 'getting in touch' is a matter of a fruitful meeting of the senses, of sight translated into sound and sound into movement, and taste and smell."[131] In translating the human senses into electromagnetic technology, McLuhan argues, the sense of touch represents the final frontier of the electronic era, on the one hand, and a return to a pre-electronic era, on the other, a return to touch as "common sense" or the *sensus communis*: "This image of a unified ratio among the senses was long held to be the mark of our *ratio*nality, and may in the computer age easily become so again."[132] Or, to speak with Mynona, the idea of telehaptics still precedes, logically and historically, the thing itself.

The idea of being anyone, anything, anywhere, thereby overcoming the limitations of the human body, seems to transcend identity politics. In my analysis, however, the real obstacle inherent in virtual reality, in which teleportation is taken to represent the ultimate boundary of wireless transmission, is not only technical, as Norbert Wiener famously claimed, but also conceptual. Challenging the rhetoric of virtual reality requires shifting the terms of the debate from the bodies at the end of connections to the body of connection mediating between them, from the people at the ends of a wired or wireless transition, to the time and space of the wired or wireless connections between them. Having examined the historical and cultural logics giving rise to a functional and symbolic order of wireless communication, the endpoint of which is arguably ubiquitous telepresence, I will examine a limit case of wireless transmission, at the boundary between energy and information, in the next chapter. The emergent order of wirelessness surpasses the histories of science, technology, communication, and even literature that seek to contain it. In "becoming media," to borrow Joseph Vogl's phrase,[133] electromagnetic waves were not only a medium of *communication*, as would be the case with wireless telegraphy, or of *distribution*, as would be the case with the radio, but also one of *conversion*, as was the case with avant-garde experiments in intermedial television.

130. McLuhan, *Understanding Media*, 57.

131. Ibid., 60.

132. Ibid., italics in the original.

133. Joseph Vogl, "Becoming-Media: Galileo's Telescope," trans. Brian Hanrahan, *Grey Room* 29 (2008): 14–25.

CHAPTER FOUR

The Wireless Spectrum: The Discovery of Electromagnetic Radiation and Intermedial Television

While the "invention" of wireless telegraphy provoked literary interventions in the equation of reality with the technological development of machines, as I argued in the previous chapter, the "discovery" of electromagnetic radiation on which these inventions were predicated seemed to many authors at the turn of the twentieth century to be a sign of an even deeper epistemic change. Over the course of the long nineteenth century, the longstanding suspicion that "there is more to the world than meets the eye" was repeatedly confirmed through one advance in physics, mathematics, and engineering after the next. Scientific experiments revealed the existence of natural phenomena beyond the range of human perception, such as X-rays, radio waves, and other forms of electromagnetic radiation, thereby also lending credence to psychic and occult beliefs, such as telepathy, teleportation, and communication with the dead. If space was once thought to be filled with the all-encompassing ether, one's immediate environment, and even one's own body, was now thought to be saturated with imperceptible electromagnetic phenomena. Even though these phenomena existed beyond the range of human perception, the new media of photography, phonography, and wireless telegraphy, like the scientific measuring instruments many of the new media were based on, were shown to be capable of inscribing, transmitting, and processing these imperceptible phenomena, which encouraged speculation about their potential application to physical research and artistic experiments.[1] What all of this seems to have amounted to was the creation of what one might be tempted to call an "electromagnetic episteme." Yet, even if modern wireless technology differs substantially from pre-modern techniques of signaling without wires, do the experiences of these worlds actually differ? To what extent, in other words, would the "new human being" (der neue Mensch) at the heart of early twentieth-century social utopias differ from the "old human being"?

These questions are the subject of a running debate in Robert Musil's *Der Mann ohne Eigenschaften* (The Man Without Qualities, 1930–43). After starting out debating whether or not the practice of fishing is an anthropological constant, the bohemian couple Walter and Clarisse eventually comes to the topic of modern communication. When she attempts to paraphrase some thoughts on this subject from Ulrich, the mathematician cum mystic who is the novel's protagonist, Clarisse, who is presented throughout the novel as slightly neurotic, cannot stop laughing:

1. See Anthony Enns and Shelley Trower, eds., *Vibratory Modernism* (London: Palgrave Macmillan, 2013).

> He says things have become more complicated meanwhile. Just as we swim in water, we also swim in a sea of fire, a storm of electricity, a firmament of magnetism, a swamp of warmth, and so on. It's just that we can't feel it. All that finally remains is formulas. What they mean in human terms is hard to say; that's all there is.
>
> I've forgotten whatever I learned about it at school, but I think that's what it amounts to. Anybody nowadays, says Ulrich, who wants to call the birds 'brothers,' like Saint Francis or you, can't do it so easily but must be prepared to be cast into a furnace, plunge into the earth through the wires of an electric trolley, or gurgle down the drain with the dishwater into the sewer.[2]

Even though the metaphors are mixed in the act of paraphrasing, the message is clear: communication, and by extension, the category of the human, is now distributed across a vast technological network, and all that remains of culture are formulas, diagrams, and technological devices. What separates Saint Francis and the birds, or humans from animals, is an abyss of imperceptible electromagnetic forces. With usual clarity, Robert Musil had already raised what would become a perennial question in (German) media theory—namely, that of a media-technological a priori.

Along these lines, in a case directly applicable to wireless transmission, media theorist Bernhard Siegert argues that the invention of the vacuum tube created an epistemic rupture in the materiality of communication, from an order of media based on the "combination of the cultural techniques speaking, writing, drawing, and counting" to one based on signal processing and technologies capable of "rectifying, amplifying, modulating, oscillating, digital switching."[3] According to Siegert, the world is no longer a function of the subject of perception and cultural codes, but rather of electronic data processing: "Things are de-materialized, they are penetrated with a signal intelligence that models and reigns over space as a function of electronic tube switches."[4] Despite the overtones of Kittler's "technological a priori" and the undertones of Heidegger's "*Seinsgeschichte*," Siegert's identification of this epistemic change raises productive questions about the materiality of wireless technology. This approach may appear to

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2. Robert Musil, *The Man Without Qualities*, trans. Sophie Wilkins and Burton Pike (New York: Knopf, 1995), 65. "Er sagt, das hat sich seither sehr verwickelt. So wie wir auf dem Wasser schwimmen, schwimmen wir auch in einem Meer von Feuer, einem Sturm von Elektrizität, einem Himmel von Magnetismus, einem Sumpf von Wärme und so weiter. Alles aber unfühlbar. Zum Schluß bleiben überhaupt nur Formeln übrig. Und was die menschlich bedeuten, kann man nicht recht ausdrücken; das ist das Ganze. Ich habe schon vergessen, was ich im Lyzeum gelernt habe; aber irgendwie stimmt es wohl. Und wenn einer heute, sagt er, so wie der heilige Franziskus oder du zu den Vögeln Bruder sagen wolle, dann dürfe er sich's nicht bloß so angenehm machen, sondern müsse sich auch entschließen können, in den Ofen zu fahren, durch die Leitungsstange einer Elektrischen in die Erde zu springen oder durch eine Abwaschvorrichtung in den Kanal zu pritscheln."

3. Siegert, *Passage des Digitalen*, 391. "Sie [d.h., die Röhre] bildete die an der Kombination der Kulturtechniken Sprechen, Schreiben, Zeichnen und Rechnen orientierte Ordnung der Medien ab auf eine an der Verarbeitung von Signalen selber orientierten Ordnung: Gleichrichten, Verstärken, Modulieren, Oszillieren, digital Schalten."

4. Ibid., italics in the original. "Die Dinge entmaterialisieren sich, sie werden von einer *signal intelligence* durchdrungen, die den Raum als Funktion elektronischer Röhrenschaltungen modelliert und durchwaltet."

foreclose any possible alliance between media studies and literary and cultural studies. However, a media-technological a priori and the ontological characteristics of different periods should not be taken as a given, but rather as precisely that which needs to be researched, as Siegert would probably agree.

At once material and yet imperceptible, the ontology of electromagnetic radiation presents challenges for approaching wireless transmission through the currently popular approaches to the materiality of communication.[5] Where, in the end, might the materiality of wirelessness be located? Although there are material apparatuses, such as receivers, detectors, and spark-gap transmitters for modulating and demodulating electromagnetic radiation into various forms of information, these only cover the two ends of a wireless connection, ignoring what comes between them. Between the transmitter and the receiver, there is also the channel itself—namely, the physical medium of electromagnetic radiation, which is, in a sense, a medium of media. Electromagnetic radiation exists everywhere, not only in the form of radio waves, which serve as the physical medium for wireless transmissions, but also in the form of microwaves, infrared, light, ultraviolet radiation, X-rays, and Gamma rays, which serve as the physical media for most other forms of modern storage, transmission, and processing.[6] Having focused thus far on the application of electromagnetic radiation to the purposes of signaling at a distance without wires, the focus of this chapter will be on other possible uses of electromagnetic radiation and on the formation of the electromagnetic spectrum over and against the dominant order of the ether.

The questions of what electromagnetic waves are and of how knowledge about them can be produced are crucial for understanding the physics of wireless media, introduced in the previous chapter. While interpretive constructs like "telecommunications," "broadcasting," and even "transmission" often seem to predetermine what electromagnetic waves can do, making them appear to be solely made for the purposes of one-to-one communication at a distance, of the one-to-many dissemination of information, or of the transfer of signals between two stations, the physics of wireless media also contain a number of other possibilities. In this chapter, after examining the ontology and epistemology of the wireless spectrum through a close reading of Heinrich Hertz's theoretical writings, I will then focus on their affordances through a comparative analysis of physical research on the human body as a form of wireless station and avant-garde experiments in intermedial television as a form of energy conversion. Before television became synonymous with the transmission of moving images in an endless flow of content programmed for national audiences, it also meant, to many avant-garde artists and physical researchers, the conversion of light into energy and vice versa. The materiality of television was primarily located in the chemical element selenium and its industrial preparation as a photocell, commonly known at the time as the "electric eye."[7]

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5. For a recent, righly skeptical overview of the materiality turn, see Jonathan Sterne, "'What Do We Want?' 'Materiality!' 'When Do We Want It?' 'Now!,'" in *Media Technologies: Essays on Communication, Materiality, and Society*, ed. Tarleton Gillespie, Pablo J. Boczkowski, and Kirsten A. Foot (Cambridge, MA: MIT Press, 2014), 119–28.

6. See Seitter, *Physik der Medien*.

7. For more nuanced theories of television, though not of television as energy conversion, see Lorenz Engell, *Fernsehtheorie* (Hamburg: Junius, 2011).

While many of these early twentieth-century avant-garde experiments are commonly understood as a form of "visual music," I argue that they are better understood as responses to the consolidation of the electromagnetic spectrum as a collection of diverse physical phenomena differing only in terms of their frequencies and wavelengths. Television, in this sense, is a limit case of wireless transmission, since wireless energy differs from wireless signals in that the latter are modulated to contain information.

As a form of electromagnetic radiation, the radio waves that enable a variety of wireless services belong to a small portion of the electromagnetic "spectrum," the range of all possible frequencies and wavelengths over which electromagnetic radiation extends. The "wireless spectrum" or "radio spectrum" spans the frequencies from roughly 8.3 kHz, the low frequencies exceeding audible phenomena, to 3,000 GHz, the high frequencies approaching visible phenomena. For the purposes of telecommunications, the wireless spectrum is usually divided according to usage through the creation of "bands," or small sections of frequencies in which different channels are grouped together on the basis of similarities among wireless services. Allocating similar services in the same band is supposed to prevent interference, for example, by dedicating non-overlapping bands to broadcasting, mobile radio, and navigation devices. The borders of these bands are determined on the basis of the most up-to-date research in high-frequency physics, or Funktechnik. Scientific diagrams known as "band plans" show the orderly division of the spectrum into various channels, but not the historical negotiations bound up with this division. As the eminent radio scholar Hugh Aitken once pointed out, "the continuity of the electromagnetic spectrum, from radio waves up through visible light, which we now take for granted, was a matter of theoretical speculation only in Hertz's time."[8] To better understand this situation, Aitken proposed a project on the history of the electromagnetic spectrum, the "story of how we learned to think about the physical world in a new way by inventing the concept of the electromagnetic spectrum. And, having invented that idea, how we used it to explore areas of the spectrum not previously known, and how we made those spectral domains serve human ends."[9] Though Aitken passed away before the project could be undertaken, Zita Joyce addressed a portion of the project in her dissertation, covering the English-language discourses of the radio spectrum and setting aside the remainder of the spectrum for future research. My contribution, focusing on late nineteenth- and early twentieth-century German sources, is to think across the spectrum, comparing the formation of the radio spectrum with other sections of the electromagnetic spectrum and examining the historical formation of the spectrum as such.

Over the course of the long nineteenth century, the electromagnetic spectrum was gradually developed through scientific research, and sorted according to increasing frequency and thus decreasing wavelength. In doing so, the physical reality of an open system of infinite electromagnetic phenomena was transformed into a closed system subject to regulation and management. At the same time, the order of the electromagnetic spectrum came to supplant the order of the ether. Starting in the 1860s, the mathematical

8. Hugh G. J. Aitken, *Syntony and Spark: The Origins of Radio* (Princeton: Princeton University Press, 1985), 75n2.

9. Qtd. in Zita Joyce, "Creating Order in the Ceaseless Flow: The Discursive Constitution of the Radio Spectrum" (PhD diss., University of Auckland, 2008), 6.

equations formulated by the Scottish physicist James Clerk Maxwell to describe the relationship between electricity and magnetism still counted on an infinite number of possible frequencies for electromagnetic waves, all of which traveled at the speed of light, meaning that they all belonged to the same spectrum. The Maxwell Equations led not only to the proofs of the existence of radio waves by 1889, X-rays by 1895, and Gamma-rays by 1910, but also to other alleged discoveries of phenomena like Carl Reichenbach's Odic force and René Blondlot's N-rays, both of which were subsequently proven to have been misconceptions. In physics, this research had to be cleared away, yet it continued to serve as a source of inspiration for art, literature, philosophy, and parascientific research. The main questions for these experiments and speculations were about the development of a corresponding organ that would be able to process electromagnetic phenomena, and the application of electromagnetic waves as a means of converting among different forms of energy, such as light, heat, and sound. During the same period at the turn of the twentieth century in which the wireless spectrum was being divided up and portioned out for the purposes of wireless communication at the international telegraphy conferences discussed in the previous chapter, it also provided many parascientific researchers and avant-garde artists with a figure of unity inspiring attempts to convert between different forms of energy and information.

From Ether to Spectrum

At the end of the nineteenth century, the ontology of electromagnetic radiation, at once material and yet imperceptible, fueled the already deep-seated crisis of perception with implications for both scientific research and media aesthetics. Having verified the existence of electromagnetic radiation in his laboratory experiments of 1886–89, thereby validating Maxwell's Equations predicting the constitution of an electromagnetic spectrum, Heinrich Hertz was justifiably celebrated in the scientific community, receiving numerous awards and lecture invitations. One of these invitations was for the keynote address at the 62nd annual meeting of the German Association for the Advancement of Natural Science and Medicine in Heidelberg on September 20, 1889.[10] In his eloquent and accessible lecture "On the Relations Between Light and Electricity," which would become the most quoted in his oeuvre, Hertz made the following epistemological statement, which would prove foundational not only for the development of modern physics but also for a number of other scientific disciplines in subsequent years: "I must confess that it is not easy to speak of these matters in a way at once intelligible and accurate. It is in empty space, in the free ether, that the processes which we have to describe take place. They cannot be felt with the hand, heard by the ear, or seen by the eye. They appeal to our intuition and conception, scarcely to our senses. Hence we shall try to make use, as far as possible, of the intuitions and conceptions which we already possess."[11] If everything that "cannot be felt with the hand, heard by

10. Hertz, "On the Relations Between Light and Electricity." For a reading of the lecture as a turning point in Hertz's thoughts about the ether, see, Joseph F. Mulligan, "The Aether and Heinrich Hertz's *The Principles of Mechanics Presented in a New Form*," *Physics in Perspective* 3 (2001): 144.

11. Hertz, "On the Relations Between Light and Electricity," 314. "Nicht leicht ist es freilich, von diesen Dingen zugleich verständlich und völlig zutreffend zu reden. Die Vorgänge, von welchen wir

the ear, or seen by the eye" had traditionally been banished from the domain of physics to the realm of metaphysics, then it might seem impossible to establish a modern science around the study of imperceptible, and therefore non-observable phenomena. Hertz's provisional solution to this problem consisted in proceeding from intuition and mental images.

The subject of Hertz's lecture "On the Relations Between Light and Electricity," as he emphasized at the outset, was not the newly invented electric light bulb, but rather the relations between electricity and light as natural phenomena. In particular, Hertz defended the contested claim that light is not a particle, but a form of electric—or, in today's terminology, electromagnetic wave that belongs to the same spectrum as a number of other natural phenomena. "I am here to support the assertion," Hertz said confidently, "that light of every kind is itself an electrical phenomenon—the light of the sun, the light of a candle, the light of a glow-worm," thereby affirming his allegiance with the Maxwellian theory of light and electricity as different appearances of the same phenomenon across a continuous electromagnetic spectrum.[12] While the claim that there will not be light unless there is electricity is self-evident in the case of the electric light bulb, it was the opposite case that interested Hertz, the claim that there will not be electromagnetic waves unless there is a physical medium for them to travel in. "Take away from the world electricity, and light disappears," Hertz said again with confidence, much more confidence than in any of his other works, "remove from the world the luminiferous ether, and electric and magnetic actions can no longer traverse space."[13] As one of Hertz's followers, the English physicist and wireless pioneer Oliver Lodge would succinctly put it, "Waves we cannot have, unless they be waves in something."[14] Ultimately, the ether was an aid, like the spirits and angels before it, for explaining the phenomenon of action at a distance, the means by which one object can act upon another.[15] In the nineteenth century, theories of electromagnetism as action at a distance, in which electric and magnetic forces propagate instantaneously through space, were increasingly abandoned in favor of field theories, according to which fields of forces propagate at a finite velocity through the ether. In general, the ether was not taken to be identical with empty space but rather to fill space. Considered to be the physical medium underlying a chain reaction of physical connections, the ether was the dominant medium of electromagnetic radiation, even after the wave theory of light became more well-established and even after Einstein's formulation of the theory of special relativity, well

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handeln, haben ihren Tummelplatz im leeren Raume, im freien Ather. Diese Vorgänge sind an sich unfassbar für die Hand, unhörbar für das Ohr, unsichtbar für das Auge; der inneren Anschauung, der begrifflichen Verknüpfung sind sie zugänglich, aber nur schwer der sinnlichen Beschreibung. So viel wie möglich wollen wir daher versuchen, an die Anschauungen und Vorstellungen anzuknüpfen, welche wir schon besitzen."

12. Ibid., 313. "Die Behauptung, welche ich vor Ihnen vertreten möchte, sagt geradezu aus: Das Licht ist eine elektrische Erscheinung, das Licht an sich, alles Licht, das Licht der Sonne, das Licht einer Kerze, das Licht eines Glühwurmes."

13. Ibid. "Nehmt aus der Welt die Elektricität, und das Licht verschwindet; nehmt aus der Welt den lichttragenden Äther, und die elektrischen und magnetischen Kräfte können nicht mehr den Raum überschreiten."

14. Oliver Lodge, *The Ether of Space* (London: Harper, 1909), 2.

15. See Peters, *Speaking into the Air*, 79–80, 101–3.

into the early twentieth century, thereby functioning as a "medium of modernity" (Medium der Moderne).[16]

In the lecture "On the Relations Between Light and Electricity," Hertz asked three main structuring questions, the first two concerning the ontology of light and electricity, the third addressing the problem of scientific verification. While Hertz's first question, "What, then, is light?" received the straightforward answer, "it is a wave-motion,"[17] his second question, "What, then, is electricity?" had to be reformulated in terms of the question "Is there such a thing as electricity? Cannot electrical phenomena be traced back, like all others, to the properties of the ether and of ponderable matter?" Given that the existence of the ether was still controversial, Hertz ultimately put the question aside, stating that "We are far from being able to answer this question definitely in the affirmative."[18] Most of Hertz's lecture was devoted to a third question about the problem of scientific verification, which appears in the form of an objection to Hertz's own research into electromagnetic phenomena, namely, the question of why, if electromagnetic radiation is a ubiquitous natural phenomenon, it had not been discovered earlier. Working through various formulations of the rhetorical question, Hertz asks: "Was it then so difficult to prove that electric and magnetic forces need time for their propagation? Would it not have been easy to charge a Leyden jar and to observe directly whether the corresponding disturbance in a distant electroscope took place somewhat later? Would it not have sufficed to watch the behaviour of a magnetic needle while some one at a distance suddenly excited an electromagnet? As a matter of fact these and similar experiments had already been performed without indicating that any interval of time elapsed between the cause and the effect."[19] The primary aim of Hertz's experiments was not to measure the velocity of electromagnetic propagation, nor to show that it was equal to the speed of light, but simply to prove that it was finite.[20] Beyond this concern, the problem that Hertz was driving at was an epistemological problem—namely, the direct observation of electromagnetic phenomena.

16. Albert Kümmel-Schnur and Jens Schröter, eds., *Äther: Ein Medium der Moderne* (Bielefeld: Transcript, 2007).

17. Hertz, "On the Relations Between Light and Electricity," 314. "Was ist denn das Licht? Seit den Zeiten Young's und Fresnel's wissen wir, daß es eine Wellenbewegung ist."

18. Ibid., 315. "Was ist denn die Elektricität? […] Für den Fachmann hat die Frage zunächst die andere Form: Giebt es denn überhaupt Elektricitäten? Lassen sich die elektrischen Erscheinungen nicht wie alle anderen Erscheinungen allein auf die Eigenschaften des Athers und der ponderabeln Materie zurückführen? Wir sind weit davon entfernt, darüber entschieden zu haben, diese Frage bejahen zu können."

19. Ibid., 320. "War es denn wirklich so schwer, nachzuweisen, dass elektrische und magnetische Kräfte Zeit zu ihrer Ausbreitung brauchen? Konnte man nicht eine Leydener Flasche entladen und direkt beobachten, ob die Zuckung eines entfernten Elektroskopes etwas später erfolgte? Genügte es nicht, in gleicher Absicht auf eine Magnetnadel zu achten, während man in einiger Entfernung plötzlich einen Elektromagneten erregte? In der That hat man diese oder ähnliche Versuche früher auch wohl angestellt, ohne indessen einen Zeitunterschied zwischen Ursache und Wirkung wahrzunehmen."

20. See Aitken, *Syntony and Spark*, 63.

Hertz was not the first to generate electromagnetic waves in the radio frequency spectrum, nor was he the first to detect them in a laboratory.[21] Although we are surrounded by electromagnetic radiation, visible light was the only known part of the electromagnetic spectrum for most of recorded history. Only in the nineteenth century did various scientific researchers become aware that there was some unknown phenomenon causing inexplicable results in some of their experiments, though the occurrences were usually dismissed as limit cases of induction.[22] By the 1880s, it was already known that electrical discharges from a coil that is interrupted by a spark gap will create electrical vibrations, and thus show electrical sparks at the gap. When Hertz was examining sparks during his first experiments, he discovered accidentally that a second coil, even if it was not charged electrically, would still show sparks whenever it was brought near the first one. The sparks seemed to leap across the gap, appearing in a space where there should not have been anything.[23] In summing up his experiments, Hertz emphasized the importance of this unexpected visual evidence: "In carrying them out we are decidedly working in the region of optics [….] Starting with purely electrical phenomena we have gone on step by step until we find ourselves in the region of purely optical phenomena." Following this line of inquiry, the British Maxwellians discussed in my previous chapter devoted their work to optical media.

When describing his own experimental method for making electromagnetic radiation visible, Hertz emphasized the necessity of *experience*, of trial and error, for the success of his experiments: "The method had to be found by experience, for no amount of thought could well have enabled one to predict that it would work satisfactorily. For the sparks are microscopically short, scarcely a hundredth of a millimetre long; they only last about a millionth of a second. It almost seems absurd and impossible that they should be visible; but in a perfectly dark room they are visible to an eye which has been well rested in the dark. Upon this thin thread hangs the success of our undertaking."[24] To make these microscopic sparks visible, Hertz used a simple homemade experimental apparatus: to create electromagnetic waves, he used an induction coil and a Leyden jar; to detect them, he used a spark gap between two brass spheres. The sparks were difficult to see, and required that he perform his investigations in a darkened room. Having seen the sparks, Hertz struggled to find the language to describe them.[25]

Out of this first-hand experience of the difficulty of producing visible evidence of an invisible phenomenon, Hertz would make the surprising turn from experimental physics

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21. See Elihu Thomson, "Curious Effects of Hertzian Waves," *Electrical Engineer* 18, no. 322 (July 4, 1894): 1; Süsskind, "Hertz and the Technological Significance of Electromagnetic Waves"; Aitken, *Syntony and Spark*, 49.

22. See John Joseph Fahie, Letter "Wireless Telegraphy: To the Editor of the Electrician"; Vivian J. Phillips, *Early Radio Wave Detectors* (New York: P. Peregrinus, 1980).

23. See Hagen, *Das Radio*, 26–39.

24. Hertz, "On the Relations Between Light and Electricity," 322. "Denn die Funken sind mikroskopisch kurz, kaum ein hundertstel Millimeter lang; ihre Dauer beträgt noch nicht den millionten Teil der Sekunde. Es erscheint unmöglich, fast widersinnig, dass sie sollten sichtbar sein, aber im völlig dunkeln Zimmer für das geschonte Auge sind sie sichtbar. An diesem dünnen Faden hängt das Gelingen unseres Unternehmens."

25. See Hagen, *Das Radio*, 8.

to theoretical mechanics, devoting the last three years of his life to writing *Die Prinzipien der Mechanik in neuem Zusammenhange* (The Principles of Mechanics Presented in a New Form, 1894), a work arguably intended as an attack on the nature and functions of the ether.[26] In the book, Hertz indicated the path from the traditional physics of mechanics to the modern one of electrodynamics through a claim that would come to be known in German as his *Scheinbildtheorem*, a general proposition about perception and representation. According to this theorem, mental images and symbols of natural phenomena, though only having the ontological status of *Scheinbilder* (apparent images), still correspond to the natural world. In a radical gesture, Hertz ruled out perception as the primary source of knowledge, and synthesized the methods of perception into a process of completing mental images.[27]

In the introduction to his *Principles of Mechanics*, Hertz formulated the Scheinbildtheorem as follows: "We form for ourselves [interior] images [*innere Scheinbilder*] or symbols of external objects; and the form which we give them is such that the necessary consequents of the images in thought are always the images of the necessary consequents in nature of the things pictured. In order that this requirement may be satisfied, there must be a certain conformity between nature and our thought. Experience teaches us that the requirement can be satisfied, and hence that such a conformity does in fact exist."[28] Wolfgang Hagen calls these "three relatively harmless sentences with the force to revolutionize epistemology."[29] The epistemological implications of Hertz's experiments are arguably even greater than their contribution to the discipline of physics or their application to wireless communication.

To describe the difficulty of producing evidence for his experiments, at the end of his lecture "On the Relations Between Light and Electricity," Hertz used the metaphor of the "summit of the pass" (Passhöhe), a vantage point from which the regions of empirical experimentation and scientific theory each become visible.[30] From this lofty vantage point, the field of optics appears "as a small appendage to the great domain of electricity" (ein kleines Anhängsel am Gebiete der Elektricität), or what we would today call the electromagnetic spectrum:

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26. See Mulligan, "The Aether and Heinrich Hertz's *The Principles of Mechanics Presented in a New Form*."

27. On Hertz's Scheinbildtheorem, see Daniel Gethmann, "Innere Scheinbilder: Von der Ästhetik der Elektrizität zur Bild-Konzeption der Erkenntnis," in *Evidenz – "... das sieht man doch!,"* ed. Rolf F. Nohr (Münster: LIT Verlag, 2004), 125–61.

28. Heinrich Hertz, *The Principles of Mechanics Presented in a New Form* [1894], ed. Hermann von Helmholtz, trans. D. E. Jones and J. T. Walley (New York: Macmillan, 1899), 67. "Wir machen uns innere Scheinbilder oder Symbole der äußeren Gegenstände, und zwar machen wir sie von solcher Art, daß die denknotwendigen Folgen der Bilder stets wieder die Bilder seien von den naturnotwendigen Folgen der abgebildeten Gegenstände. Damit diese Forderung überhaupt erfüllbar sei, müssen gewisse Übereinstimmungen vorhanden sein zwischen der Natur und unserem Geiste. Die Erfahrung lehrt uns, daß die Forderung erfüllbar ist und daß also solche Übereinstimmungen in der Tat bestehen."

29. Wolfgang Hagen, *Das Radio*, 8. "Drei vergleichsweise harmlose Sätze von epistemologisch revolutionärer Kraft."

30. Hertz, "On the Relations Between Light and Electricity," 324–325.

> We perceive electricity in a thousand places where we had no proof of its existence before. In every flame, in every luminous particle we see an electrical process. Even if a body is not luminous, provided it radiates heat, it is a centre of electric disturbances. Thus the domain of electricity extends over the whole of nature. It even affects ourselves closely: we perceive that we actually possess an electrical organ—the eye. These are the things that we see when we look downwards from our high standpoint. Not less attractive is the view when we look upwards towards the lofty peaks, the highest pinnacles of science. We are at once confronted with the question of direct actions-at-a-distance.[31]

On the one hand, the eye is conceived as an electrical organ, a sensor or receptor of natural phenomena; on the other hand, the ether is conceived as a medium enabling apparent action at a distance—these are what would come to inform physical research on the human body as a wireless station and contemporaneous avant-garde experiments with intermedial television.

Figurations of Wireless

> One more organ or one less organ in our machine would have given rise to a kind of eloquence, a different kind of poetry.
> —Montesquieu

Even though electromagnetic radiation can be found almost anywhere on earth, it cannot be perceived directly. Since human beings do not possess a sense organ that corresponds to the perception of either electricity or magnetism, electromagnetic radiation must first be converted into a form that the human senses can process in order for its presence to be revealed. In one respect, the human senses function in analogy to wireless devices, in that they are capable of analyzing complex electromagnetic signals into their sine-wave components, as the Dutch theoretical physicist Hendrik Lorentz, who shared the Nobel Prize in Physics in 1902, emphasized in his lectures on *Sichtbare und unsichtbare Bewegungen* (Visible and invisible movements, 1902): "Both of our sense organs that put us into the position of receiving a mental image [*Vorstellung*] of our surrounding world, the sense of hearing and the sense of sight, both receive their impressions in that they take into themselves the rapid movements going here and there, which come from the outside."[32] For example, the human ear can differentiate high

31. Ibid., 326. "Wir erblicken Elektricität an tausend Orten, wo wir bisher von ihrem Vorhandensein keine sichere Kunde hatten. In jeder Flamme, in jedem leuchtenden Atome sehen wir einen elektrischen Prozess. Auch wenn ein Körper nicht leuchtet, so lange er nur noch Wärme strahlt, ist er der Sitz elektrischer Erregungen. So verbreitet sich das Gebiet der Elektricität über die ganze Natur. Es rückt auch uns selbst näher, wir erfahren, daß wir in Wahrheit ein elektrisches Organ haben, das Auge. Dies ist der Ausblick nach unten, zum Besonderen. Nicht minder lohnend erscheint von unserem Standpunkte der Ausblick nach oben, zu den hohen Gipfeln, den allgemeinen Zielen. Da liegt nahe vor uns die Frage nach den unvermittelten Fernwirkungen überhaupt."

32. Hendrik Antoon Lorentz, *Sichtbare und unsichtbare Bewegungen*, trans. Georg Siebert (Braunschweig: Friedrich Vieweg & Sohn, 1902), 35. "Die beiden Sinnesorgane, die uns mehr und besser als andere in den Stand setzen, eine Vorstellung von der uns umgebenden Welt zu bekommen, das

frequencies from lower frequencies thanks to the cochlea, which decomposes sound waves into sine waves of varying frequencies. The eye, too, is able to differentiate between various frequencies of light waves (e.g., the colors in the spectrum of visible light). This selective perception is a form of filtering, resembling that in scientific and technological devices (e.g., tuning a radio to the signal for a particular transmitter filters out the signals of all the other transmitters on different frequencies). "For this reason," Lorentz explained, "the theory of vibrations [*Schwingungen*] is important for anyone who wishes to give an account of how we perceive things, as well as of the conclusions we may draw from our perceptions."[33] The problem, however, is that in order to provide this account of perception, "we immediately leave visible movements and come to an area where the power of imagination [*Einbildungskraft*] and theory have to be our guide,"[34] an approach that resonates strongly with Hertz's Scheinbildtheorem.

If the wireless spectrum, by definition, begins only above the threshold of human hearing and it ends only below the threshold of human vision, the ontological definition of the spectrum creates an epistemological distinction between the audible and the inaudible, as well as the visible and the invisible. Human beings are not supposed to be able to hear or see electromagnetic waves, and yet technological devices are easily capable of doing so. In the same turn, the definition of the wireless spectrum also reinforces a distinction between the internal and the external, as well as the natural and the artificial. Electromagnetic waves are supposed to exist outside the human body, and are not supposed to be produced by human beings, and yet the human body is also capable of functioning, in a sense, as a wireless station. At the turn of the twentieth century, the perception of electromagnetic waves was often associated directly with a human sense organ, either one that had once existed and had long since atrophied or one that had yet to develop.

In a lengthy passage in his highly influential *Beiträge zu einer Kritik der Sprache* (Contributions to a critique of language, 1901–2), for example, Fritz Mauthner articulated the concept of the "contingency of the senses" (Zufallssinne) in relation to a missing "sense of electricity" (Sinn für Elektrizität).[35] The first question Mauthner seeks to resolve in formulating his concept of the contingency of the senses is the classical philosophical problem of the number of the human senses. "We possess five or rather six senses," writes Mauthner in a continuation of this tradition. "By comparing their messages with each other, we arrive at the insight that each one of our sense organs only perceives a limited portion of the area that we believe we master through this sense

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Hörorgan und das Sehorgan, erhalten beide ihre Eindrücke dadurch, dass sie schnelle hin und her gehende Bewegungen, die von aussen kommen, in sich aufnehmen."

33. Ibid. "Daher ist die Lehre von den Schwingungen für jeden von Wichtigkeit, der sich von der Art und Weise Rechenschaft geben will, wie wir wahrnehmen, sowie von den Folgerungen, die wir aus unseren Wahrnehmungen ziehen dürfen."

34. Ibid., 35–36. "Wenn wir jetzt, allerdings grossenteils nur in flüchtiger Übersicht, an diese Kapitel der Physik herantreten, so verlassen wir alsbald die sichtbaren Bewegungserscheinungen und kommen auf ein Gebiet, wo uns die Einbildungskraft und die Theorie leiten müssen."

35. Fritz Mauthner, *Zur Sprache und zur Psychologie*, vol. 1, *Beiträge zu einer Kritik der Sprache* (Stuttgart: J. G. Cotta, 1901), 353–415; on Mauthner's concept of "Zufallssinne," see Gershon Weiler, *Mauthner's Critique of Language* (Cambridge: Cambridge University Press, 2009), 59–70.

organ."[36] The human ear, for example, is limited to the perception of sounds "from 16.5 [Hz] to roughly 16,500 vibrations,"[37] but there are clearly frequencies that exist outside of this range of human perception. Were these frequencies beyond the threshold of human audition to be called "inaudible sounds" (unhörbare Töne) in analogy to the "invisible rays of sunlight" (unsichtbaren Strahlen des Sonnenlichts), Mauthner suggests, then this would reveal "people's superstitious belief in words" (den Wortaberglauben der Menschen). In other words, only excerpts of frequency ranges in the vast electromagnetic spectrum are perceptible, and only sometimes does one sense start to function outside of the corresponding range of another sense. According to Mauthner, our senses have been trained to distinguish between electromagnetic waves to the extent that we cannot imagine things differently: "The training of our contingent senses to distinguish these vibrations is so instinctively strong, our senses [are] nothing more than the training to particular kinds of vibration (energies), that we cannot even imagine an organism without this kind of training."[38] In "Die schlecht trainierte Seele," (The Badly Trained Soul, 1923), the avant-garde artist Hans Richter would make a strikingly similar call to retrain the senses through the use of abstract film as a scientific and aesthetic instrument, drawing on then-current physical and physiological research testing the human body's limits of perception.[39]

The order of wirelessness is not only electromagnetic but also biological, or, more precisely, electrophysiological.[40] In some cases, the human body functioned quite prosaically as a substitute for wireless technology, as when it took the place of a wireless component—namely, the antenna. Starting around 1900, scientists demonstrated that the human body could be substituted for an antenna of the same length and capacity.[41] Even though the human body is not as good of a conductor as are metals, this is offset by the fact that a high-frequency current only penetrates the skin a fraction of a millimeter. Wireless messages were even transmitted through space by connecting one human body to the positive side of a spark gap, and another human body to one terminal of the coherer.

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36. Mauthner, *Zur Sprache und zur Psychologie*, 1:372–373. "Wir besitzen fünf oder vielmehr sechs Sinne. Durch Vergleichung ihrer Mitteilungen untereinander gelangen wir zu der Einsicht, das jedes einzelne von den Sinnesorganen nur einen beschränkten Teil des Gebietes wahrnimmt, welches wir durch dieses Sinnesorgan zu beherrschen glauben."

37. Ibid., 1:373. "[V]on sechzehneinhalb bis etwa zu sechzehneinhalbtausend Schwingungen."

38. Ibid., 1:374. "Die Einübung unserer Zufallssinne auf die Unterscheidung dieser Vibrationen ist so instinktmäßig stark, unsere Sinne so sehr nichts als eben die Einübung auf bestimmte Vibrationsarten (Energien), daß wir uns einen Organismus ohne solche Einübung gar nicht ausdenken können."

39. Hans Richter, "Die schlecht trainierte Seele," [1923], in *G: Material zur elementaren Gestaltung* [1923–26], ed. Hans Richter and Marion von Hofacker (Munich: Der Kern, 1986), 44–47; repr. as "The Badly Trained Soul" in *G: An Avant-Garde Journal of Art, Architecture, Design, and Film, 1923–1926*, ed. Detlef Mertins and Michael W. Jennings, trans. Steven Lindberg and Margareta Ingrid Christian (Los Angeles: Getty, 2010), 146–47.

40. See A. K. Fiala, "Elektrophysiologische Zukunftsprobleme," *Der Deutsche Rundfunk* 2 (1924): 889–92, 966–68, 1035–36, repr. with commentary in *Medientheorie 1888–1933: Texte und Kommentare*, ed. Albert Kümmel and Petra Löffler (Frankfurt am Main: Suhrkamp, 2002), 138–55, 177–209.

41. "The Human Body as a Wireless Telegraph Transmitter and Receiver," *Scientific American* 94, no. 7 (February 17, 1906): 154.

With the rise of the radio in the 1920s, the notion of the human body as a wireless station was linked to many disproven nineteenth-century experiments about the relation of telegraphy and telepathy, which were taken up with renewed vigor. A summary of this parascientific research can be found in Fritz Kunze's article on "Der menschliche Körper als Sender" (The human body as a transmitter, 1926).[42] In the article, Kunze, who had become famous as a sports reporter on Weimar radio stations, intervenes in the modernist discourse of mass suggestion, connecting the political will to power to a longer tradition of occult research. Kunze laments the abandonment of Carl Reichenbach's theory of an "Odic force" (Od-Strahlen), René Blondlot's theory of "N-rays" (N-Strahlen), and similar research that had been rejected as unscientific. Since "human beings do not possess any organ capable of perceiving these [electromagnetic] phenomena," Kunze observes, artificial organs must compensate for the deficiency of the senses. "Our electric ear is the radio, our magnetic sense the compass. We have presumably lost our natural senses for such phenomena, or at least our consciousness of these senses."[43] While Kunze's characterization of media as substitutes for the senses may seem to anticipate Marshall McLuhan's seminal understanding of media as "extensions of man," I would situate Kunze's remarks more in the context of the nineteenth-century discourse of "organ projection," starting with the well-worn analogy between the nervous system and the telegraph system and culminating in Sigmund Freud's famous description of the mediatized human being as a "prosthetic God."

Ernst Kapp coined the concept of "organ projection" (*Organprojektion*) in the second chapter of his *Grundlinien einer Philosophie der Technik* (Principles of a philosophy of technology, 1877), a work that informed Arnold Gehlen's idea of the "human being as a creature of defects" (Mensch als Mängelwesen), and paved the way for both a cultural philosophy of technology and an anthropology of technology.[44] Drawing on the etymology of the Greek word *organon* as an "instrument," "tool," and "sense organ," Kapp argued that all techniques and technologies are extensions of the human body. "For, the handle is an extension of the arm, the stone is an ersatz for the fist" (Denn der Stiel oder die Handhabe ist die Verlängerung des Armes, der Stein der Ersatz der Faust.) Although Kapp presumes the isomorphism of technology and the human body, he reverses the usual analogy between the two, arguing that the construction of a camera obscura is analogous to that of the eye, in "that it is a mechanical reproduction of what is

42. Fritz Kunze, "Der menschliche Körper als Sender," *Funk* 3 (1926): 67–68, repr. with commentary in *Medientheorie 1888–1933: Texte und Kommentare*, ed. Albert Kümmel and Petra Löffler (Frankfurt am Main: Suhrkamp, 2002), 233–37.

43. Ibid. "[V]on Natur aus besitzt der Mensch kein Organ, das ihn befähigt, diese Erscheinungen wahrzunehmen; er hat weder einen Sinn für Elektrizität noch für Magnetismus. Diese mußte er sich erst künstlich schaffen. Sein jetziges elektrisches Ohr ist das Funkgerät, sein magnetischer Sinn der Kompaß. Die natürlichen Sinne dafür sind wahrscheinlich verlorengegangen, oder zumindest das Bewußtsein dieser Sinne."

44. Ernst Kapp, *Grundlinien einer Philosophie der Technik: Zur Entstehungsgeschichte der Cultur aus neuen Gesichtspunkten* (Braunschweig: G. Westermann, 1877), 29. The subtitle of the work indicates the deep time of cultural history under consideration.

projected unconsciously from the eye."[45] Discussing what he calls the already well-established analogy between the nervous system and the telegraph system, Kapp concludes that "nerves are the cable installation of the animal body, telegraph cables are the nerves of human beings."[46]

While the formal parallels between nerves and cables may be clear, at least in a cross section illustration in Kapp's text, those between the human body and wireless technology are less evident. Hence, when Carl du Prel attempted to transfer the theory of organ projection from the *wired* telegraph system to the *wireless* telegraph system, the body took on a transcendental dimension: "Vibrations proceed from every atom in the world to every other atom. Our senses perceive only a portion of these vibrations; yet it is conceivable that, unknown to us, another apparatus of perception exists for the other part. Furthermore, all matter transmits its own vibrations; this is proven by spectral analysis. But we can also conceive, as a form of transcendental organ projection, an extrasensory spectral apparatus, through which chemical qualities can be perceived, as actually happens with somnambulists."[47] These vibrations are what would be mobilized in experiments in *Psychotechnik* throughout the 1920s.

In an article on "Der Mensch als Wellensender" (The human being as a wave transmitter, 1927/28), Alfred Gradenwitz emphasized the psychotechnical experiments of "two young Berlin-based physicists, Arno Brasch and Kurt Urban […] who grasp the problem somewhat further and who have the procedures and apparatuses of modern wireless technology at their full disposal."[48] Through the use of a new amplifier, Brasch and Urban showed that the human body acts as a transmitter, and the heart sends out electric fields in the rhythm of the heart beat, the same observation that informed Hans Richter's avant-garde program of using of abstract film to re-train the "badly trained soul."[49] Brasch and Urban also conducted further experiments concerning the health effects of electromagnetic radiation on animals (birds, rabbits, etc.), which suggested that electromagnetic radiation affects their appetites and that overexposure can be fatal. Ultimately, Brasch and Urban's experiments centered on the faculty of orientation in

45. Ibid. "[D]aß sie [i.e., the camera obscura] das von dem Organ [i.e., the eye] aus unbewußt projizierte mechanische Nachbild desselben sei, mittels dessen Unterstützung die Wissenschaft nach träglich in die Vorgänge der Gesichtswahrnehmungen habe eindringen können."

46. Ibid. "Die Nerven sind Kabeleinrichtungen des tierischen Körpers, die Telegraphenkabel sind Nerven der Menschheit."

47. Carl du Prel, "Theorie des Fernsehens," *Sphinx* 14 (1892): 321–35, repr. with commentary in *Medientheorie 1888–1933: Texte und Kommentare*, ed. Albert Kümmel and Petra Löffler (Frankfurt am Main: Suhrkamp, 2002), 45. "Von jedem Atom der Welt zu jedem anderen finden Schwingungen statt. Einen Teil dieser Schwingungen nimmt die sinnliche Erkenntnis wahr; es ist aber denkbar, daß uns unbewußt, auch für den andern Teil ein Wahrnehmungsapparat besteht. Jeder Stoff sendet ferner seine eigenen Schwingungen aus; das beweist die Spektralanalyse. Wir können uns aber als transzendentale Organprojektion sehr wohl einen übersinnlichen Spektralapparat denken, durch den die chemischen Qualitäten wahrgenommen werden, wie es bei den Somnambulen thatsächlich geschieht, was Berzelius und Reichenbach durch ein sehr merkwürdiges Experiment bewiesen haben."

48. Alfred Gradenwitz, "Der Mensch als Wellensender," *Das Leben* 5, no. 5 (1927): 83. "[Z]wei jungen Berliner Physikern, den Herren Arno Brasch und Kurt Urban vorgenommenen Versuche, die das Problem etwas weiter fassen und denen die Verfahren und Apparate der modernen Funktechnik im vollen Umfange zur Verfügung stehen."

49. Richter, "Die schlecht trainierte Seele."

migratory birds and "the fact that migratory birds, as experience shows, lose their faculty of orientation when they are near large wireless stations."[50] Even if human beings do not possess a sense organ for the perception of electromagnetic radiation, the next closest thing seemed to be evident in other species of the animal kingdom.

Giving Form to the Formless

In direct response to this physical research on the human body as a wireless station, a strange newspaper clipping appeared under the title "Das kurzwellige Leben" (Shortwave life, 1926) in a special issue of the avant-garde magazine *G – Materialien zur elementaren Gestaltung* (G: Materials for elementary form-creation).[51] The clipping, excerpted from the mainstream *Vossische Zeitung*, introduced the French scientist Georges Lakhovsky and his "research into the origin of life" (Forschungen über den Ursprung des Lebens). While the details of Lakhovsky's research are omitted in the excerpt, the results of his experiments are strongly emphasized: "The basis of organic existence is infinitely shortwaves at infinitely high frequency. The combination of an immense number of waves of various shortness—voilà, that is life."[52] According to Lakhovsky, each cell functions in analogy to a wireless station, receiving and transmitting various signals. Accordingly, apparent differences between organisms such as birds and human beings are only the result of their "*Abstimmung*," a word used here in the sense of "tuning," as one might use a radio dial to lock in on a radio station amidst all the static. Depending on whether an organism is tuned correctly or incorrectly, according to Lakhovsky, the organism's respective states of health can be determined: a signal would correspond to health, and noise to disease. Lakhovsky's greatest invention, a medical device developed in collaboration with Nikolai Tesla and called a "multi-wave oscillator," even promised to cure cancer by means of electromagnetic waves. In 1926, however, Lakhovsky's research interests still focused, as did many of his contemporaries discussed in the previous section, on the perception of electromagnetic radiation in the animal kingdom. Just as a migratory bird can orient itself with the help of a "goniometric device" (goniometrischen Apparat), claimed Lakhovsky, all that remains for people is "to

50. Gradenwitz, "Der Mensch als Wellensender," 84. "Dieselben Versuche werfen auch auf die bisher noch so rätselhafte Zugvögelfrage ein interessantes Licht. Schon der Umstand, daß gewisse für die Richtung des Magnetischen Erdfeldes maßgebende Linien. Die sogenannten Isoklinen, ungefähr in gleicher Richtung verlaufen wie der Flug der Zugvögel, läßt das Vorhandensein elektrischer Einwirkungen vermuten. Aber auch die weitere Tatsache, daß Zugvögel wie die Erfahrung lehrt, in der Nähe großer Funkstationen ihr Orientierungsvermögen verlieren, deutet auf die Richtigkeit dieser Annahme."

51. "Shortwave Life," [1926], repr. in *G: An Avant-Garde Journal of Art, Architecture, Design, and Film, 1923–1926*, ed. Detlef Mertins and Michael W. Jennings, trans. Steven Lindberg and Margareta Ingrid Christian (Los Angeles: Getty, 2010), 218. The *G* magazine was published by the German filmmaker Hans Richter in collaboration with El Lissitzky, Werner Graeff, Frederick Kiesler and Mies van der Rohe. Contributors included Hans Arp, Walter Benjamin, Theo van Doesburg, Viking Eggeling, Naum Gabo, George Grosz, Raoul Hausmann, John Heartfield, Ludwig Hilbersheimer, El Lissitzky, Piet Mondrian, Antoine Pevsner, Man Ray, Ludwig Mies van der Rohe, Ernst Schön, Kurt Schwitters, and Tristan Tzara.

52. Ibid., translation modified. "[D]ie Grundlage des organischen Daseins [sind] unendlich kurze Wellen, deren Schwingungszahl unendlich hoch ist. Die Kombination von einer Unzahl von Wellen verschiedener Kürze – voilà, das ist das Leben."

build an apparatus that is able to pick up these infinitely short waves."[53] In other words, one might be able to orient oneself in the world with the help of this machine, as does a homing pigeon. In this respect, Lakhovsky's work followed a logic of continuity, and insisted that organic differences were the result of a difference in *degree* rather than *kind*. In short, the biological differences between the species of aves and homo sapiens are reduced to a minor difference in terms of the frequencies of electromagnetic radiation taken to constitute organic life.

Significantly, the clipping on "Shortwave Life" did not refer to electromagnetic waves in general, but only to short waves. Through a kind of Dadaistic word processing, the excerpt even mentioned "waves of different shortness" (Wellen verschiedener Kürze) instead of the expected waves of different lengths (i.e., wavelengths). Until the 1920s, wireless transmission was based almost exclusively on low-frequency, longwave electromagnetic radiation because these waves occupied a wider bandwidth, making reception easier, though also causing problems of interference and interception. For this reason, there was a shift toward high-frequency, shortwave transmission starting in the mid-1920s. In this context, the report on "Shortwave Life" would have represented the cutting-edge of wireless technology. Furthermore, it is important to note that the technological desideratum in the clipping about Lakhovsky's research is not a *transmitting* apparatus but a *receiving* apparatus: electromagnetic waves are perceived here to be a given fact of organic life that did not need to be not *generated* but only *modified* by techniques such as electric induction.

The search for a receiving apparatus that would enhance, complement, or replace human beings' lacking sense organs occupied not only physicians, engineers and electrical technicians in the first decades of the twentieth century, but also many avant-garde artists, who were busy conducting intermedial experiments with light and sound. The appearance of the report on "Shortwave Life" in a special issue of the magazine *G* on "Film," is not only an indication of the avant-garde's interest in the then-new medium. It also suggests a means of re-thinking the common classification of film as a *visual* medium. I argue that one main strand of the avant-garde—the Dadaists and international constructivists coming together to form the G-Group—understood film, photography, and television not in terms of the common opposition between image-based media and sound-based media, supported on the division of the human senses, but as *optical* media, meaning physical media operating along a common electromagnetic spectrum.[54] In the *G* magazine, published by the German filmmaker Hans Richter in collaboration with El Lissitzky, Werner Graeff, Frederick Kiesler, Mies van der Rohe, and many others, there are further scientific newspaper clippings, next to the expected apodictic manifestos, that are again newly contextualized in a kind of Dadaistic word processing. The report on "Shortwave Life," for example, was situated in a suggestive constellation of different texts: to the left, there is a reproduction of Marcel Duchamp's movable discs; above, a sketch from Viking Eggeling preliminary work on absolute film; and to the right, on the facing page, a photograph by Man Ray entitled "Die neue Landschaft" (The new

53. Ibid. "[E]inen Apparat zu bauen, mit dem man diese unendlich kurzen Wellen empfangen könnte."

54. See Friedrich A. Kittler, *Optical Media: Berlin Lectures 1999*, trans. Anthony Enns (Malden, MA: Polity, 2009).

landscape). The constellation is not about the usual relationships among the arts, such as those between music and painting, but more about the concept of *Gestaltung* as an intervention into the relationship between nature and technology. Duchamp's hypnotic spirals, Lakhovsky's organic orientation apparatus, Eggeling's rhythmization of a natural object and Ray's photograph of a pile of film strips as a mountain range—all of these can hardly be understood as audiovisual experiments; this suggestive constellation corresponds much more to the principle of "vibratory modernism."[55]

The main challenge of physical media for the avant-garde was the following paradox: the apparently *natural* force of electromagnetic radiation manifested itself only as noise, and information could only be created *artificially*.[56] In many intermedial projects, nature was viewed as a source of energy—even as the *Urenergiequelle*—and, consequently, many avant-garde artists thought that they needed only to find a way to exploit this already existing energy source through various conversion techniques. As an artificial energy source, however, electromagnetism created the opposite of what was a dominant theme of aesthetic discourse around 1900—namely, *Gestalt*, an organic, well-organized whole perceived to be greater than the sum of its parts. Electromagnetic radiation, by contrast, was a prime example of something *gestaltlos*, a thing that definitely existed, as Hertz's experiments had shown, but existed beyond the limits of appearance and perception, as his Scheinbildtheorem emphasized. In the first two decades of the twentieth century, the search for what Hegel famously called the "form of formlessness" (*Gestalt der Gestaltlosigkeit*) became a common topic in spiritualistic discourses, suggesting occult, synesthetic states of perception and new, universal visual languages. By the 1920s, the international constructivists in the avant-garde G-Group would take up this problem of form and formlessness in a different manner. As evident in the title of their magazine *G – Gestaltung*, the group focused on material practices of creating new forms in their urgent search to found their intermedial experiments on a more general basis of the *Elementare*.

At the heart of many members of the group's work was a problematic assumption about the impact of technology on perception. "Why are we unable to paint images today like Botticelli, Michelangelo, or Leonardo and Titian?" ask two members associated with the G-Group, Raoul Hausmann and Viking Eggeling, in their "PRÉsentismus" manifesto (1921), thereby situating their avant-garde program in terms of the widespread "death of art" discourse. "Because human beings have completely changed in terms of our consciousness, not only because we have the telephone and the airplane and the electrical piano or the turret lathe, but because our entire perception [*Psychophysis*] has been changed through this experience."[57] In response to this perceived change, Hausmann and

55. Enns and Trower, *Vibratory Modernism*.

56. For further discussion and examples of avant-garde negotiations of this paradox, especially in music, see Kahn, *Earth Sound, Earth Signal*.

57. Raoul Hausmann and Viking Eggeling, "PRÉsentismus: Gegen den Puffkeismus der teutschen Seele [1921]," in *Bilanz der Feierlichkeit: Texte bis 1933*, ed. Michael Erlhoff, vol. 1 (Munich: Edition Text + Kritik, 1982), 24–30. "Warum können wir heute keine Bilder malen wie Botticelli, Michelangelo oder Leonardo und Tizian? Weil sich der Mensch in unserem Bewußtsein vollkommen verändert hat, nicht nur weil wir Telefon und Flugzeug und elektrisches Klavier oder die Revolverdrehbank haben, sondern weil unsere ganze Psychophysis durch die Erfahrung umgewandelt ist."

Eggeling announced the formation of a new art that would mobilize the accuracy of the natural sciences to fight the "Germanness of the German soul" (*Puffkei'smus der teutschen Seele*): "We demand electrical, scientific painting! The waves of sound and light and electricity only differ from each other in terms of their wavelengths and frequencies!"[58] In this formulation, Hausmann and Eggeling developed the expressionist critique of *die deutsche Wissenschaft* discussed in my previous chapter, into a call to obliterate the boundaries between *Geisteswissenschaften* and *Naturwissenschaften*.

Over the next few years, as Hausmann's understanding of the equivalencies of light waves and sound waves developed, the measurements he provided for their wavelengths and frequencies became even more precise. In an essay on "Optophonetik" (Optophonetics, 1922), Hausmann writes: "Our tones vibrate from roughly 32 [Hz], starting at the range of singing, to 41,000, in the musical tones; light vibrates from 400 billion per second of the slowest red to the 800 billion of violet, in the perceptible scale of colors red, orange, yellow, blue, green, violet."[59] The following year, Hausmann would record the numbers again, not only re-specifying the range of frequencies, but even more significantly expanding the spectrum to include warmth and the medium of the ether: "What sound or noise is, to our ear, are processes of vibrations from 16 per second to ca. 20,000 per second; light is created for us through vibrations between 760 billion and 360 billion per second. Building on the fact that acoustics, optics, and electrotechnics are essentially different in terms of their vibration frequencies (but are generally manifestations of energy transfer), procedures can be created to transform one form of energy into the other."[60] On the one hand, Hausmann conceived of light, sound, and heat as part of the same continuous spectrum undergirded by the physical medium of the ether; on the other hand, he perceived a gap between them thanks to their differing frequencies, and it was in this very gap that he sought to deploy his avant-garde creations.

In fact, an important ontological difference is responsible for this gap between light and sound, and for our impression of the gap—an ontological difference that Hausmann and many others tended to overlook. Although light and sound are both waves with physical characteristics like frequencies, amplitudes, and wavelengths, sound is a *mechanical* wave that requires a physical medium for propagation, whereas light is an

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58. Ibid. "Wir fordern die elektrische, naturwissenschaftliche Malerei! Die Wellen von Schall und Licht und Elektrizität unterscheiden sich nur durch ihre Länge und durch ihre Schwingungsanzahl voneinander!"

59. Raoul Hausmann, "Optophonetik," [1922], in *Sieg, Triumph, Tabak mit Bohnen: Texte bis 1933*, vol. 2 (Munich: Edition Text + Kritik, 1982), 50–57. "Unsere Töne, von Gesang angefangen, schwingen von 32 ungefähr bis 41.000 in den musikalischen Tönen, das Licht schwingt von 400 Billionen pro Sekunde des langsamsten Rot bis zu den 800 Billionen des Violett, in den von unseren Augen erfassbaren Farbenskalen Rot, Orange, Gelb, Blau, Grün und Violett."

60. Raoul Hausmann, "Vom sprechenden Film zur Optophonetik," [1923], in *G: Material zur elementaren Gestaltung* [1923–26], ed. Hans Richter and Marion von Hofacker (Munich: Der Kern, 1923), 72. "Was für unser Ohr Schall oder Klang ist, sind Schwingungsvorgänge von 16 pro Sekunde bis ca. 20000 pro Sekunde; das Licht wird für uns hervorgerufen durch zwischen 760 Billionen und 360 Billionen Schwingungen pro Sekunde. Auf der Tatsache, daß Akustik, Optik und Elektrotechnik wesentlich durch ihre Schwingungsfrequenzen unterschieden sind (allgemein aber nur verschiedene Erscheinungsformen von Energieübertragungen sind), lassen sich Verfahren gründen, die eine Energieform in die andere zu verwandeln."

electromagnetic wave that can be transmitted even in a vacuum. Conflating these two categories of waves explains the interest of many artists in the ether as a medium of transmission. However, there is a further implication of the ontology of light and sound that is even more significant for understanding early avant-garde experiments with energy transfer and conversion: even though sound cannot be converted *directly* into light, it is still possible to convert mechanical energy *indirectly* into electromagnetic energy. Essentially, one needs only an energy converter, commonly known as a transducer or transformer, which was at the heart of Hausmann's work on a device he called the "optophone."[61] Although Hausmann's work on the device is often understood as a search for "visual music," I argue that it was actually a conception of intermedial television—not television in the sense of "seeing at a distance," but rather television as a form of energy conversion.

In their "PRÉsentismus" manifesto, Hausmann and Eggeling called not only generally for a form of electrical, scientific painting, but specifically for the creation of a new monumental art through the installation of large energy transformers in cities: "At night, giant light dramas will be performed against the heavens, in color, and during the day, these transformers will be changed over to sound waves that make the atmosphere thunder."[62] Even though Hausmann and Eggeling's description of these energy transformers may seem to be an early instance of solar energy, their program was primarily aesthetic. The transformers do not provide cities with any additional energy but rather convert existing energy into spectacles of sound or light. As support for the feasibility of this system, Hausmann and Eggeling explicitly reference the "sound experiments of the American and German wireless stations" (Tonexperimenten der amerikanischen und deutschen Funkstationen), in general, and the successful research of Thomas Wilfred, a pioneer of light art, in particular. However, another implicit intertext, crucial for understanding their work but not yet recognized in scholarship, can be found in the popular German scientific writings of the period. In their own description of an "optophone" (Optophon), for example, Artur Fürst and Alexander Moszkowski also mention the possibility of using it to convert the weather: "Let's turn the receiver device to the firmament! Thunder and lightning exchange roles there. Lightning becomes audible optophonetically, thunder resolves in optical phenomena. Sound images [*Klangbilder*] will resolve the movements of thunder clouds, the rainbow, flickering northern lights, the phases of the moon, the changes of the stars."[63] Hausmann, Eggeling, Fürst, and Moszkowski were all reading, and only sometimes citing, the same source, a

61. On Hausmann's optophone and contemporary scientific knowledge, see Arndt Niebisch, *Media Parasites in the Early Avant-Garde: On the Abuse of Technology and Communication* (New York: Macmillan, 2012), 160–69.

62. Hausmann and Eggeling, "PRÉsentismus," 27–28. "Nachts werden riesige farbige Leuchtdramen sich an unserem Himmel abspielen und tags werden diese Transformatoren auf Tonwellen umgestellt, die die Atmosphäre zum Tönen bringen!"

63. Ibid. "Richten wir den Empfangsapparat gegen das Firmament! Da tauschen Blitz und Donner ihre Rollen. Der Blitz wird optophonisch hörbar, der Donner löst sich in Lichterscheinungen auf. Die Gewitterwolken in ihrer Bewegung, der Regenbogen, das zuckende Nordlicht, der in Phasen dahinsegelnde Mond, der Wandel der Gestirne werden Klangbilder auslösen."

now forgotten book on a possible future of electric television, Maximilian Plessner's *Die Zukunft des elektrischen Fernsehens* (The future of the electric television, 1892).[64]

Intermedial Television

The largest historical area of early twentieth-century European avant-garde experiments across media is commonly understood through the category of "visual music," a term coined in 1912 by the British art critic Roger Fry to describe Wassily Kandinsky's abstract paintings.[65] Today, the concept still appears frequently in scholarship, for example, in the name of the "Center for Visual Music" in Los Angeles. Paradigmatically, the former director of the Institute inscribed its mission into a longer tradition: "Since ancient times artists have longed to create with moving lights a music for the eye comparable to the effects of sound for the ear."[66] In this respect, I would emphasize that the universal and transhistorical aspect of research on visual music needs to be historicized through comparisons with artistic research and criticism of the early twentieth century, which reflected a shifting understanding of the new electromagnetic order of things. In "Der Ruf nach Kunst" (The call for art, 1913), for example, Hermann Häfker described modern media technologies in terms of pointing "the way to fix and to multiply the sensory impressions that are created by 'waves' of a physical nature, so that people made these waves—the optical and acoustic ones—themselves into a fixed material and were able to 'inscribe' them."[67] While Häfker focused on the well-established medium of photography as a means of exploiting light waves and the phonograph as a means of exploiting sound waves, others focused on a speculative medium that now represents a "road not taken" in the history of television.

Many of the predictions for electric television at the time sought legitimacy through ties with a longer tradition. In *Die Kunst in tausend Jahren* (Art in a thousand years, published 1910; revised 1921), for example, Alexander Moszkowski presented television as the realization of an ancient dream, not of seeing at a distance, but of converting between two distinct physical phenomena: "The electric television opens the possibility, dreamed of since primeval times, of building a bridge between sound and light, or, to establish the most audacious expression for it, of converting images into sounds and sounds into images directly."[68] In a similar fashion, Hausmann attempted to legitimate his

64. Maximilian Plessner, *Die Zukunft des elektrischen Fernsehens*, vol. 1 of *Ein Blick auf die großen Erfindungen des 20. Jahrhunderts* (Berlin: Dümmler, 1892).

65. Roger Fry, "The Allied Artists," *The Nation* (August 2, 1913): 676–77, repr. in *A Roger Fry Reader*, ed. Christopher Reed (Chicago: University of Chicago Press, 1996), 150–53; Malcolm Cook, "Visual Music in Film, 1921–1924: Richter, Eggeling, Ruttman[n]," in *Music and Modernism, c. 1849–1950* (Newcastle, UK: Cambridge Scholars Publishing, 2011), 206–28.

66. William Moritz, "Towards an Aesthetics of Visual Music," *ASIFA Canada Bulletin* 14, no. 3 (December 1986), http://www.centerforvisualmusic.org/TAVM.htm.

67. Hermann Häfker, "Der Ruf nach Kunst," in *Kino und Kunst* (Mönchen-Gladbach: Volksvereins-Verlag, 1913), 5–11. "[M]an kam jetzt auf den Weg, diejenigen Sinneseindrücke, die durch 'Wellen' physikalischer Natur erzeugt werden, dadurch festzuhalten und zu vertausendfachen, daß man diese Wellen – die optischen und die akustischen – sich selbst in festem Stoffe fangen und 'aufschreiben' ließ."

68. Alexander Moszkowski, *Die Kunst in tausend Jahren: Betrachtungen und Prognosen* [1910], repr. ed. Hansjörg Walther (Frankfurt am Main: Libera Media, 2015), 27. "Der elektrische Fernseher öffnet die seit Urzeiten erträumte Möglichkeit, zwischen Schall und Licht eine Brücke zu schlagen, oder um gleich

own intermedial experiments by positioning them as the apex of a long tradition: "If the ancient occult sciences talked about how light and sound belong together, then modern technology provides proof of it in the form of photographed music, the optophone, and the research concerning living beings' sense of space."[69] The name Moszkowski and Hausmann give to the apparatus at the heart of this new art based on the conversion of light into sound and vice versa, is the "optophone," at times equivalent to "electric television." As Moszkowski explains, electric television is not *television* in the sense one might expect: "The apparatus we want to use to trick nature into giving up the greatest mysteries of art admittedly does yet exist. But it is, in principle, the same as the electric television, for which the experiments of [Jan] Szczepanik, [Ernst] Andersen, [Ernst Walter] Ruhmer and [Arthur] Korn's telephotography have laid the practical foundations. We stand here on the cusp of a magic that seems capable of unlocking new mysteries of art."[70] For Moszkowski, the most salient feature of electric television was not the extension of vision, nor the remote transmission of images, as today remain the most common understandings of the medium. The television was understood to be a conversion device, capable of "bridging the gap" between two distinct physical phenomena—that is, "converting images into tones and tones into images directly."

Only 10 years after the first edition of Moszkowski's untimely meditations was published, an expanded edition appeared under the title *Der wankende Parnass* (Wavering Parnassus), referring to the unsteady ground of poetry and the arts in the age of industrial modernity, an event ironically accompanied by a book tour. In attendance at a reading on May 4, 1921 was none other than the Austrian journalist Joseph Roth who commented in a review for the *Berliner Börsen-Courier* on the section of Moszkowski's book on "Sonic visions and visual sounds" (Hörbilder und Sehklänge): "The idea that it might be possible to translate light-based phenomena into sound waves and, conversely, sounds into light-based phenomena or images, is grotesque and funny. The fact that art would then look different is self-evident. I, for one, do not want to be alive in a thousand years and hear the trees turning green in spring."[71] It is easy to imagine how

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den verwegensten Ausdruck dafür festzustellen, Bilder in Klänge und Klänge in Bilder direkt zu verwandeln."

69. Hausmann, "Optophonetik," [1922], 53. "Sprechen die alten geheimen Wissenschaften davon, daß Licht und Ton zusammengehören, so würde die moderne Technik einen Beweis dafür liefern, in der fotografierten Musik, in dem Optophon und in der Forschung, die sich auf das Raumgefühl der Lebewesen bezieht."

70. Moszkowski, *Die Kunst in tausend Jahren*, 26. "Der Apparat, durch den wir die Natur zur Herausgabe größter Kunstgeheimnisse überlisten wollen, ist der zwar noch nicht vorhandene, aber im Prinzip gänzlich unbezweifelte, durch die Versuche Szczepaniks, Andersens, Ruhmers und die Fernphotographie Korns auf praktische Grundlage gestellte elektrische Fernseher. Wir stehen hier hart an der Schwelle eines Zaubers, der neue Geheimnisse der Kunst zu erschließen befähigt erscheint. Er öffnet die seit Urzeiten erträumte Möglichkeit, zwischen Schall und Licht eine Brücke zu schlagen, oder um gleich den verwegensten Ausdruck dafür festzustellen, Bilder in Klänge und Klänge in Bilder direkt zu verwandeln."

71. Joseph Roth, "Moszkowski und Hildesheimer," *Berliner Börsen-Courier* (May 5, 1921), repr. in *Das journalistische Werk*, ed. Klaus Westermann, vol. 1, *1915–1923* (Kiepenheuer & Witsch, 1989), 915. "Die Vorstellung, daß es gelingen könnte, Lichterscheinungen in Schallwellen zu übersetzen und umgekehrt Klänge in Lichterscheinungen bzw. Bilder, ist grotesk und lustig. Daß dann die Kunst ein

Moszkowski's prognoses could have provoked such a reaction: his book focuses on exotic physical phenomena, such as light waves and sound waves, instead of the more familiar artistic products, such as opera, concerts, paintings, and books. Moszkowski's predictions about the future convertibility of images and sounds are even uncannier on account of his references to contemporary experiments in physics and electrotechnics. However, such statements and reactions are typical of an entire range of early twentieth-century criticisms that emphasized the arts' common characteristics and structures instead of their different procedures and effects.

Why, then, did Moszkowski, Hausmann, and others place their hopes for the new optophonetic art form in electric television? Moszkowski mentions the work of Jan Szczepanik, who patented the telectroscope; Ernst Andersen, who invented an alternator; Ernst Walter Ruhmer, who pioneered work on the photographone; and Arthur Korn, who was involved in early telephotography. After supporting his predictions about the development of electric television on these pioneering inventors, Moszkowski concentrates on one particular physical medium: "It suffices to remind you of the medium of the selenium cell, which offers a different degree of resistance corresponding to different degrees of exposure to light."[72] Discovered in 1817 and named after Selene, the ancient Greek goddess of the moon, selenium (Se) is a non-metallic element, belonging to the sulfur and tellurium family, with semiconducting properties.[73] Although selenium is almost a non-conductor of electricity in its natural state, it becomes a conductor after being annealed and will exhibit larger resistances than that of copper. In other words, the electrical resistance of selenium changes when it is exposed to light.

The discovery of these photoelectric properties of selenium—or, more precisely, a preparation of the element known as the "selenium cell" or "photocell"—initiated a great deal of interest and research activity in "seeing by electricity" or "distant vision," which would become the dominant paradigm of research into transmitting images at a distance in the early twentieth century. Selenium also had an extraordinary range of industrial applications, outlined in Ernst Ruhmer's *Das Selenium und seine Bedeutung für die Elektrotechnik* (Selenium and its meaning for electrical engineering, 1902).[74] Despite

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anderes Aussehen haben würde, selbstverständlich. Ich möchte nicht nach tausend Jahren leben und die Bäume im Lenz grünen hören."

72. Moszkowski, *Die Kunst in tausend Jahren*, 26. "[E]s genügt, an das wunderbare Medium der Selenzelle zu erinnern, die, verschiedenen Graden der Belichtung entsprechend, verschiedene Leitungswiderstände für den elektrischen Strom darbietet."

73. On the discovery of the photo-electric effect of selenium, see Burns, *Communications*, 197–99; on the invention of the selenium cell, 488–99; on its implementation in early optical telephony systems, 199–204; cf. Stefan Rieger, "Licht und Mensch: Eine Geschichte der Wandlungen," in *Licht und Leitung*, ed. Lorenz Engell, Bernhard Siegert, and Joseph Vogl (Weimar: Universitätsverlag Weimar, 2002), 61–71.

74. Ernst Ruhmer, *Das Selen und seine Bedeutung für die Elektrotechnik mit besonderer Berücksichtigung der drahtlosen Telephonie* (Berlin: Harrwitz, 1902). Among the wide range of applications for the selenium cell in the laboratory and everyday life are in photography, as a photometer (17–18); as a self-activated shutter mechanism (18); in teleradiophony (18–19); in telephotography (19–23); in television (23–26); in relays (26–27); in automatic ignitions (27–29); in telegraphy (29); as a voltmeter (29–30); in an apparatus for copying patterns using jacquard machines (30); and in machines for sorting coffee beans into light and dark varieties (30–31), a technique that could also be used to sort cigars

Ruhmer's hopes, seventeen years later "selenium did not however fulfill the expectations that people rightly attached to this material. The reason for this is its inertia. It does not work promptly and it is soon overtaxed—then it goes on strike and no longer shows its beautiful tricks."[75] Even though some researchers worked on improving the selenium cell, most looked for another material with similar properties that would work better for the same function, only eventually coming up with lasers after World War II. Due to the fact that it can differentiate not only between the intensities of light but also the colors, selenium was often called the "electric eye,"[76] the material manifestation of what Hertz described in his lecture "On the Relations Between Light and Electricity."

Hausmann also called attention to the properties of the photocell in his essays on "Optophonetik" (Optophonetics, 1922) and "Vom sprechenden Film zur Optophonetik" (From the talking film to optophonetics, 1923), which put him directly in dialogue with Moszkowski's 1910/1921 passages on the "Optophon" through their common reading of a little known book, Maximillian Plessner's *Die Zukunft des elektrischen Fernsehers* (The future of electric television, 1892). Both Moszkowksi and Hausmann cite the same passage from Plessner's book, though in Hausmann's quotation, the inventor's surname is given, in a typo, as "Plenner," which is probably the reason other scholars have overlooked this crucial connection: "In the course of acoustic transformation, the form [*Gestalt*] of a square must call forth a different sonic image [*Tonbild*] than does that produced by a circle or a triangle, a cube must sound different than a sphere or a prism."[77]

Even though Hausmann and Moszkowski both quote the same passage from Plessner's book on electric television, their responses to it are strikingly different. Arguing that optophonetic reproduction is a long step from the sound film, Hausmann criticizes Plessner for espousing the same kind of "*Naturalismus*" as the *Tonbildfilm*, i.e., the assumption of correspondences between the natural world and artistic representations of it, a naturalism that is no longer relevant since music and non-moving art are taken to be no longer relevant. "We have to find new laws that are valid for us, a new functionality for both [arts, i.e., music and painting]. We have to determine, in a foundational manner, the aspects in which form-functionality belongs to the intensities of vibration, in order to succeed in passing from the contingent to a new compulsory understanding of form."[78] In other words, it is not enough, according to Hausmann, to

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(31); selenium could also be used to open and close shutters automatically (31); the main use, however, is for wireless telephony (31–55).

75. "Das übertriumpfte Selen," *Edel-Erden und –Erze* 1, no. 16 (May 1920): 180. "[H]at das Selen aber leider nicht jenen Erwartungen entsprochen, die man in diesen Stoff zu setzen berechtigt zu sein schein. Und daran ist seine Trägheit schuld. Es arbeitet nicht gerne prompt und ist überhaupt bald überanstrengt—, dann streikt es und zeigt seine schöne Kunststücke nicht mehr."

76. Christoph Ries, *Das Selen* (Diessen: J. C. Huber, 1918), 10.

77. Moszkowski, *Die Kunst in tausend Jahren*, 26–27; Hausmann, "Vom sprechenden Film zur Optophonetik," 74; Plessner, *Die Zukunft des elektrischen Fernsehens*. "Die Gestalt eines Vierecks muß bei akustischer Verwandlung ein anderes Tonbild hervorrufen, als das von einem Kreise oder Dreieck gewonnene, ein Würfel muß anders klingen als ein Kegel oder Prisma."

78. Hausmann, "Vom sprechenden Film zur Optophonetik," 74. "Wir müssen also neue, für uns gültige Gesetze, eine neue Funktionalität für beide [Künste, d.h. Musik und Malerei] finden. Wir müssen

assume that circles, squares, and triangles will begin to talk in our language or produce some natural music on their own. Instead, Moszkowski and Hausmann both describe the same experiment in hacking a television transmission by forcing light rays to produce or modulate currents in a wire. If a telephone is then connected to the wire, it will receive this modulated energy and make it perceptible by transforming it into sound. What the "receiver station" (Empfangsstation) receives as an image will be intercepted by the "mediating apparatus" (Zwischenapparat) as sound. If, instead of a single image, a series of moving images are transmitted, the result will appear "in a sequence of sounds, in moved forms creating sounds" (in einer Folge von Tönen, in tönend bewegter Form).[79]

These attempts to make different vibration intensities perceptible with the optophone as a form of electric television, finds an unexpected corollary in Hans Richter and Viking Eggeling's early work on abstract film. The logic of a continuum—not only between light and sound, but also between different forms of organic life—was an important foundation for their attempts to incorporate the *Elementare* into art, and thereby transform our capacity for sensory perception. Sensation is not ultimately formless and structureless, says Richter in his manifesto on "The Badly Trained Soul" but rather "a process as precisely organized and mechanically exact as thinking" (ein ebenso präzise organisierter und mechanisch exakter Prozeß wie Denken).[80] Against the alleged lawlessness of sensations, Richter here proposes his own conception of the transformative aspects of art inspired by the lawfulness of physics.

My argument is that early twentieth-century experiments in intermedia were spurred on by avant-garde artists' gradual realization that invisible phenomena formed a continuous spectrum with visual phenomena, and therefore, that it was possible to convert between one and the other, thereby creating a new form of art that would solve the crisis of perception and bring about the "new human being" (der neue Mensch). Over the course of the long nineteenth century, the discoveries of X-rays, wireless, and other electromagnetic phenomena gradually came to be mapped onto a continuous spectrum. This conception of different physical phenomena as belonging to a spectrum is a condition of possibility for the direct conversion of light waves into sound waves. If they are understood as part of the same spectrum, then differences between them are reduced to nothing more than differences in frequency or wavelength, as the clipping on "Shortwave Life" emphasizes. This created a conflict between the ontology of waves—conflating the mechanical and the electromagnetic—and their phenomenology: even though we do not experience sound as a wave, we know that it has something in common with light. On the one hand, the unification of the electromagnetic spectrum through the addition of invisible light created a sense of continuity; on the other hand, the separation of the senses through physical and physiological research created a sense of discontinuity. What was perceived at the time to be a gap between light and sound has long since been

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die Zugehörigkeit der Formfunktionalität zu den Schwingungsintensitäten in einer grundlegenden Weise ermitteln, um über das Zufällige zu einer neuen Formverbindlichkeit zu gelangen."

79. Hausmann and Moszkowski's descriptions of the experiment are the same except for Hausmann's mention the newly invented "electric arc lamp" (*Bogenlampe*). He adds that adding a solar cell will make tones being recorded onto a filmstrip appear in strips of various intensities and widths, which could be transformed back into sounds. See Hausmann, "Optophonetik," 53.

80. Richter, "The Badly Trained Soul," 146.

filled. These intermedial experiments with the electromagnetic spectrum arose at the same time as the spectrum was being divided up for public consumption with the advent of wireless telegraphy. Eventually, the wireless spectrum was closed off, divided up into various bandwidths, and either sold in various auctions or assigned through other regulatory practices. Once seen as a seemingly inexhaustible natural resource, the spectrum became an economic and political resource in the order of wireless telegraphy.

Conclusion: Energy and Information

Though electromagnetic channels transmit immaterial information and not matter itself, the implication that the transport of objects is radically different from that of information often met with resistance in art, literature, and philosophy, as evident in Kleist's *Bombenpost*, Mynona's *Ferntaster*, and Hausmann's *Optophon*. In the early twentieth century, the idea that telegraph wires and radio waves transmit diseases was the common subject of many jokes. Even the Austrian philosopher Ludwig Wittgenstein remarked, "The philosophers who believe that you can extend your experience in thought, as it were, should remember that you can transmit a speech through the telephone, but not the measles. Similarly, I cannot experience time as limited, merely because I want to, or the field of vision as homogenous, etc."[81] Despite increasing awareness of the immateriality of information, the possibility of contagion through circulation remained a concern of the radio discourse in the 1920s, and is at the heart of a short essay by another associate of the G-Group.

Kurt Schwitter's "Radio (Eine Anregung, den Radioapparat produktiv auszunutzen)" (A Stimulus to make the Most Productive Use of Radio, 1934) describes the media hype surrounding a fictitious radio broadcast that will never take place.[82] Against the backdrop of the heightened media competition among film, radio, and newspapers throughout the twenties, Schwitter's essay suggests a means of productively using the media through an imaginative exploration of each of their unique potentials.[83] The essay begins with the matter-of-fact announcement: "It was known that the strongest man in the world was planning to broadcast over the radio,"[84] a seeming fulfillment, as Wolf Kittler argues, of Christian von Ehrenfels's male fantasies.[85] In the days leading up to the much-anticipated event, while everyone else is clamoring to secure a radio receiver to listen to the broadcast, the narrator remains nonplussed, ignoring the hype surrounding the radio in favor of the cinema. Despite making plans to attend the movies, the narrator struggles to find a date and finds that nobody will accompany him.

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81. Ludwig Wittgenstein, *Zettel*, qtd. in Kittler, "Kurt Schwitters," 124. "Die Philosophen, die glauben, daß man im Denken die Erfahrung gleichsam ausdehnen kann, sollten daran denken, daß man durchs Telefon die Rede, aber nicht die Masern übertragen kann. Ich kann auch nicht die Zeit als begrenzt empfinden, wenn ich will, oder das Gesichtsfeld als homogen, etc."

82. Kurt Schwitters, "A Stimulus to Make the Most Productive Use of Radio," in *Radiotext(e)*, ed. Neil Strauss and Dave Mandl, trans. Louis P. Kaplan, *Semiotext(e)* 6, no. 1 (1993): 18–19.

83. An interesting intertext would be Hans Traub, *Zeitung, Film, Rundfunk: Die Notwendigkeit ihrer einheitlichen Betrachtung* (Berlin: Weidmann, 1933). However, it remains unclear when Schwitters text was published; on the possible publication dates, see Kittler, "Kurt Schwitters."

84. Schwitters, "A Stimulus to Make the Most Productive Use of Radio," 18.

85. Kittler, "Kurt Schwitters," 122.

The story takes a turn when, the following day, there is a surprising report about the previous evening's broadcast: "Now, on the very next day, the news circulated in the press that the athlete Mr. Soandso had not broadcast over the radio that evening because he had felt out of sorts suddenly. His little brother, the well-known Lilliputian Mr. Suchandsuch, had broadcast over the radio in his place. This was an awful disappointment. There was not one eye that remained free of tears. It was simply too terrible. All women of all nations sobbed in a heartbreaking manner."[86] The audience of the radio broadcast cannot distinguish between the strongest man in the world and the weakest man in the world based only the disembodied voice of the radio. Only in retrospect, after reading of the deception in the newspaper, do they lament. Even though another broadcast by the strongest man in the world is announced for the following day, "There was just no sense of urgency anymore."[87]

The entire events of the story repeat themselves after nine months with a slight variation. Instead of the strongest man broadcasting over the radio, a sermon is planned, though it is drowned out by the sounds of mass hysteria: "In this way, a splendid sermon that should have been disseminated via radio that very evening by Pastor Animus on the spread of sexual diseases was lost amid the general level of groans and cries. At first, I did not know what was wrong because there was nothing posted other than the announcement of Animus's sermon. But I read reports in the newspaper from all over that it would be a difficult night for women. And, on another morning, there were these birth announcements!"[88] All the women in the world, apparently impregnated with the radio broadcast by the Lilliputian ("all the women had been bitten in the leg by the little stork by means of an electronic wave transmission"), give birth to dwarfs.[89] Schwitter's short essay is punctuated with one last final report from the newspapers: "The next morning, there was dementia in the papers. The report that the strongest man had been out of sorts at that time was a hoax. In this simple way, the strongest man would have hoped yet again to have an audience for his lecture. But it was now too late, and it didn't help anymore. The children had all become dwarves, and they remained so. How the beloved imagination works!"[90]

After Schwitter's short essay, there is an editorial note about a "printing mistake: Of course, it ought to say 'should' [singular *sollte*]."[91] The printing mistake refers to the following line in the story: "A splendid sermon that should [plural *sollten*] have been disseminated via radio that very evening by Pastor Animus on the spread of sexual diseases was lost amid the general level of groans and cries." The grammatical joke is somewhat lost in translation: in the plural, the modal verb *sollten* in the line above modifies the plural noun "sexual diseases"; in the singular, it modifies the singular noun "sermon". The moral of Schwitter's fable, then, is that the *productive* use of the radio, as

86. Schwitters, "A Stimulus to Make the Most Productive Use of Radio," 19.
87. Ibid.
88. Ibid.
89. Ibid.
90. Ibid.
91. Ibid.

the title has it, lies in *conception*.[92] Ultimately, Schwitter's insight is that a mistake, or "misconception," can be corrected in print, but there is no way to correct one in the radio.

In the media competition among radio, film, and newspapers, the ontology of wireless transmission, based on ephemeral electromagnetic radiation, created the problem, diagnosed in Schwitter's story, that transmissions verging on "real-time" are impossible not only to archive but also to amend. As I have argued in this chapter, the materiality of wirelessness can be located not only in various technological devices but also in the medium connecting them—the physical medium of electromagnetic radiation, which enables a wide range of potential wireless services from information transmission to energy transfer. Having examined the ontological and epistemological implications of the "discovery" of electromagnetic radiation in this chapter, the next chapter will focus on their further significance in the specific case of the antenna. While the antenna is usually taken to be a technological device that mediates between the transmitter and the receiver at the beginning and the end of a wireless transmission, I argue that it can be understood as a medium in another sense—namely, mediating between the invisible medium of electromagnetic waves and the modern politics of visibility. Originally a scientific instrument used to detect the presence of electromagnetic radiation, the antenna would eventually become a highly visible symbol of modern urban infrastructure, a clear sign of the emergent order of wirelessness.

92. See Kittler, "Kurt Schwitters," 122.

CHAPTER FIVE

In Praise of the Antenna: A Celebration of Wireless Infrastructure

In 1909, the Eiffel Tower was saved from demolition, after the temporary structure's twenty-year permit was about to expire, due, in part, to the installation of an antenna.[1] Against detractors, Gustav Eiffel repeatedly emphasized not only the tower's design, safety, and beauty, but also its functional value as an aid to scientific research. The height of the tower made it useful for research in meteorology and aerodynamics, as well as for experimental trials in wireless telegraphy. As early as 1898, Eiffel had glimpsed the tower's potential utility for wireless experimentation, inviting French radio pioneer Eugène Ducretet to experiment with placing a transmitter on it. Only in 1903, however, was he able to convince Gustave Ferrié of the French Corps of Engineers to install a more permanent wireless telegraph apparatus, and only because Eiffel funded it at his own expense. In the year Captain Ferrié began spending his days atop the tower sending wireless signals, a committee was convened to advise on tearing it down. The committee conceded that some still found the tower to be an eyesore, though it also acknowledged the tower's proven value to meteorology, aviation, and telegraphy, and the structure was allowed to remain intact. By 1909, the Eiffel Tower's military radiotelegraph station was completed, and in the next two years, it would provide the first regular time signal transmission service, the first wireless links with dirigibles, and the first wireless transmissions to airplanes. As a symbol of wireless transmission, the Eiffel Tower also came to serve as the subject of an entire genre of modernist poetry including Guillaume Apollinaire's "Zone" (1913) and Blaise Cendrars's "La Tour" (The tower, 1910), in turn provoking German Expressionist Alfred Richard Meyer to remark, "I glow deep and white / I am the Eiffel Tower" (Ich glühe tief und weiß: / Ich bin der Eiffelturm!), a phrase that would eventually become the title of Ywan Goll's first collection of poetry, *Ich bin der Eiffelturm* (I am the Eiffel Tower, 1924).[2]

In this chapter, I analyze the development of the antenna during the pre- and early history of broadcast media, in order to historicize the astonishment and wonder expressed about wireless technology in the period before radio towers became symbols of national broadcasting. In film and media studies, the consensus remains that early astonishment over wireless technology was largely fueled by two competing imaginaries: wireless technology was conceived as an emancipatory medium of universal, democratic communication, on the one hand, and as an oppressive medium of automation and control,

1. See Jill Jonnes, *Eiffel's Tower: The Thrilling Story Behind Paris's Beloved Monument and the Extraordinary World's Fair That Introduced It* (New York: Penguin, 2009).

2. See Tim Conley, "'Hive of Words:' The Transnational Poetics of the Eiffel Tower," *Modernism/Modernity* 17, no. 4 (November 2010): 765–77.

on the other.[3] These competing imaginaries were eventually codified in the model of national broadcasting, the one-to-many address of a unified audience with the potential either to enlighten the masses or to mobilize them for violence. The most recognizable symbol of this paradigm would eventually become the iconic image of concentric circles radiating out from the tip of an upright antenna into empty space. However, before antenna towers became synonymous with classical broadcasting in the 1920s (radio) and the 1950s (television), the antenna was primarily an experimental device that helped produce knowledge about the nature and properties of a recently discovered physical phenomenon—the electromagnetic waves discussed in the previous chapter. These experimental aspects of wirelessness have only come into focus relatively recently, as the monumental antenna towers that were constructed throughout the twentieth century have now ceased to serve their originally inteneded function.

Before the eventual application of antennas to transmitting and receiving devices in the mass media of radio and television, antennas were also used as finding devices for experiments in physics and meteorology. In Wilhelmine Germany, the main source of funding for the development of wireless technology was the government and the military: advances in the emerging field of "signals intelligence" (i.e., intercepting, monitoring, and interpreting wireless signals) eventually brought wireless technology out of the laboratory and into the field. As part of their transition from experimental devices to communications supports, antennas were hoisted into the air in an effort to increase signal range, thereby inspiring thinking about the "groundedness" of modern experience in modernist art, architecture, and literature. In the previous chapter, I argued that the early attraction of wireless technology was to be found less in the potential of propagating a message among a mass audience and more in the possibility of harnessing a transcendent force that was understood to be beyond the visible spectrum and yet an essential part of nature. In this chapter, I develop this claim for the specific case of the antenna and argue that the development of antennas from improvised experimental devices into monumental symbols of national broadcasting sheds light on the challenging politics of visibility inherent in the order of wirelessness.

The Tower as Medium

> A world before the creation of man. In many places it is impossible to guess in what era one is. [Later on…] a sign that the Creation has already taken place is a lighthouse, somewhere else an American radar station.
> —Max Frisch, *Man in the Holocene*

If the understanding of *media* in film and media studies is still based largely on the paradigm of the book, especially in terms of the primacy of the visual, Lorenz Engell and John Durham Peters propose a different metonymy for media in the form of the tower.[4]

3. Völker, *Mobile Medien*; Daniels, *Kunst als Sendung*; Paul Young, "A Cinema without Wires," in *The Cinema Dreams Its Rivals: Media Fantasy Films from Radio to the Internet*, (Minneapolis: University of Minnesota Press, 2006), 49–72.

4. Lorenz Engell, "Sinn und Sinnlichkeit (Turm und Taste): Über Fern- und Nahmedien," in *Ausfahrt nach Babylon: Essais und Vorträge zur Kritik der Medienkultur* (Weimar: VDG Weimar, 2000), 305–24;

As Engell argues, a traditional tower is a medium, even though "it does not transmit anything, nor store anything."[5] These functions would change, I would add, with the construction of wireless stations and radio towers. Peters, on the other hand, views towers as media in the sense of Marshall McLuhan's "extensions of man," as something that "stand between heaven and earth, height and expanse, the sacred and the secular, and they are primal extensions of our eyes and ears."[6] In both cases, the tower is conceived as a medium primarily in the sense of a machine or mechanism for distancing and for seeing, which produces and organizes two different views: the view from the top of the tower onto the surrounding area; and the view from below onto the tower. This symmetrical structure has an effect on media space in terms of both horizontal and vertical distances.

As a medium, the tower initially organized visible space, and later, abstract space, because it defined the spatial range of the gaze and later the range of wireless transmission. Out of one's immediate surrounding space, a tower creates what Engell calls a "zone of visibility" (Zone der Sichtbarkeit), which is especially apparent with lighthouses, but applies to all towers.[7] In carving out this zone of visibility, the tower creates a difference between the inside and the outside, between light and darkness, between civilization and barbarism, and between the center of the zone, in which the tower itself stands, and the periphery of the zone surrounding the tower. In addition, the tower opens up a unified perspectival view and forms surfaces in a territory. All of this applies not only to the view from above at the top of the tower, but also to the view from below onto the structure. Every gaze on the tower is encompassed by the zone of visibility, which circumscribes a sphere of belonging to the inner space of the tower. Insofar as the tower focuses and centralizes the view from below, life under it is a life under constant virtual or actual surveillance, yet it is also a life in a community with all the others who live within the zone of visibility.[8] Thus, the tower is also a metonymy for classical mass media: a radio tower creates a "coverage zone," defining the constitution of an audience in national broadcasting.

Like every machine and every medium, a tower is also an artifact, the product of cultural techniques and technologies, since creating a tower requires not only labor but also artistic skill.[9] Building a tower is a form of organizing knowledge and social processes: once towers are finished, they become permanent symbols of a society's goals and accomplishments. At the very least, a tower indicates the capital used to construct it, as well as the other costs that went into its construction, as for example, the social costs in the case of the Tower of Babel or those of the competition, continued today, to create the tallest building in the world. The technological condition of building towers also

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John Durham Peters, "Calendar, Clock, Tower," in *Deus in Machina: Religion and Technology in Historical Perspective*, ed. Jeremy Stolow (New York: Fordham University Press, 2013), 25–42.

5. Lorenz Engell, "Sinn und Sinnlichkeit (Turm und Taste)," 315. "Der Turm überträgt nichts und speichert nichts, ihn als Verlängerung des menschlichen Körpers zu betrachten, als steingewordenen Riesen, wäre eine Naivität. Dennoch ist er zweiffellos ein Medium, ist er in Sonderheit eine Maschine der Distanzierung und des Sehens."

6. John Durham Peters, "Calendar, Clock, Tower," 41.

7. Engell, "Sinn und Sichlichkeit (Turm und Taste)," 315.

8. Ibid., 315–316.

9. Ibid., 317.

indicates how one medium always depends upon another: high-rises only became possible after the invention of the electric elevator, and radio towers only after the invention of the antenna wire. The functional principles of towers get continued in successive generations and similar forms of media, from the Tower of Babel to the Pharos of Alexandria; from to the development of beacon fires to the optical telegraph, the semaphore, the telegraph pole, the telecommunication tower, and the radio beacon. The family resemblances extend from the radio and television tower to the ordinary antenna, which today still marks the highest point of every high-rise, even if it no longer serves a function.[10]

For McLuhan, the antenna was not an "extension of man" in the sense of extending hearing or vision, but rather as "extension of our physical powers" in the creation of different media environments. "In the age of information, it is information itself that becomes environmental," he writes in an essay on "The Relation of Environment to Anti-Environment" (1966), published two years after his seminal formulation of media as "extensions of man" in *Understanding Media*. "The satellites and antennae projected from our planet, for example, have transformed the planet from being an environment into being a probe."[11] For McLuhan, modern artists' frequent references to figures of satellites and antennas are also indications of a shift from consumerism to experimentation: "Whereas the package belongs to the consumer age, the probe belongs to an age of experimenters."[12] This age of experimentation, I argue, was the period of the pre-history of national broadcasting in which the antenna functioned in a variety of scientific, aesthetic, and experimental contexts. During this period, the first permanent large-scale wireless stations were constructed. The architectural and conceptual forms they assumed, which were largely determined by functional considerations, are strikingly different from the iconic forms of radio and television towers that would later develop into symbols of national broadcasting.[13]

From Wireless Stations to Radio Towers

The Nauen Transmitter Station (Grossfunkstelle Nauen), constructed in 1906 only 40 km west of Berlin, quickly became a *Sehenswürdigkeit* for residents of the nearby metropolis, even though, as one might expect from wireless technology, there was practically nothing to see there.[14] At the time, the entire station consisted of only a small

10. Ibid., 318.

11. Marshall McLuhan, "The Relation of Environment to Anti-Environment," [1966], in *Media Research: Technology, Art and Communication*, ed. Michel Moos (New York: Routledge, 2014), 118.

12. Ibid.

13. To some extent, the history of the Nauen Transmitter Station, discussed in this chapter, is a microcosm of trends in the history of wirelessness: from 1906 to 1912, it functioned as a research station; during World War I, it was run by the German navy; from 1918 to 1931, Transradio AG used it for wireless telegraphy; in 1932, the German Reichspost took it over and used it to distribute propaganda; during World War II, it was again used for naval communications; after being disassembled in 1945, the central building was used to store potatoes until 1955, when shortwave antennas were installed; from 1959 to 1990, it was used for Radio Berlin International (RBI), a multi-lingual radio program; from 1990 to 2011, it was used by the Deutsche Welle; since then, it has been out of commission.

14. In the first three years of operation alone, the Nauen Transmitter Station attracted over 10,000 visitors, due largely to its proximity to Berlin. For a history of the station with a focus on Hermann

wooden-framework house situated beside a large latticework mast that functioned as the support for an antenna wire being used for research on the properties of electromagnetic waves. Nevertheless, this sight struck one visitor, a recent graduate of the Technische Hochschule Berlin who had given up on engineering to become a journalist following a brief stint in Paris, as truly remarkable:[15]

> There is suddenly, in the middle of the unspeakably flat Märkisch landscape that sprawls for miles in horrifying silence, a quite thin, very high tower, erected like a harsh exclamation point. It rises up a hundred meters, sticking out considerably above many church spires. Attached to the top of this tower is a web of wires that spreads out in every direction, and that, seen from below, resembles a very delicate spider's web. From above, the web of wires contracts and expands in the most manifold connections and interlacings, until its last branch terminates in a row of low steel masts that are positioned in a circle at a distance of 300 meters around the tower. This web is called an antenna, and it is the true master of the universe.[16]

Against the backdrop of a European landscape still devoid of skylines like those developing contemporaneously in America, the obvious reference point for conveying the height of the wireless station is that of nearby "church spires," not only the tallest landmarks in Europe built prior to the twentieth century, but, even more significantly, the dominant symbols of power and authority in this Protestant-dominated region of Prussia. By the end of this report on the Nauen Transmitter Station, wireless technology takes over a quality traditionally ascribed to the divine: "It is nearly omniscient: it knows everything that happens in the ether."[17]

Throughout this chapter of Artur Fürst's book on *Die Wunder um uns* (The wonders around us, 1911), it is unclear who, or what, will earn the title of "master of the universe"

Muthesius's 1920 re-design of the central hall, see Michael Bollé and Georg Frank, *Die Grossfunkstation Nauen und ihre Bauten von Hermann Muthesius* (Berlin: Arenhövel, 1996).

15. Though almost entirely forgotten today, Artur Fürst (1880–1926) would become one of the most well known and widely read reporters on science and technology during the Weimar Republic. After studying mechanical and electrical engineering under Alois Riedler and Adolf Slaby at the Technische Hochschule Berlin, Fürst went on to compose numerous Feuilleton articles while serving as an editor of the *Berliner Tageblatt*, in addition to his immensely popular scientific books including *Das Buch der tausend Wunder* (The book of a thousand wonders, 1916) and his four-volume *Das Weltreich der Technik* (The global empire of technology, 1923–27). Despite his popularity during his own lifetime, Fürst quickly fell into obscurity after his books were banned by the National Socialist regime due to his Jewish background.

16. Artur Fürst, *Die Wunder um uns: Neue Einblicke in Natur und Technik* (Berlin: Vita, 1911), 12–13. "Da steht inmitten der unsäglich platten märkischen Landschaft, die meilenweit in erschreckender Tonlosigkeit sich erstreckt, plötzlich, wie ein barsches Ausrufungszeichen aufgerichtet, ein ganz dünner, sehr hoher Turm. Er steigt hundert Meter in die Höhe, überragt also sehr viele Kirchtürme noch ganz bedeutend. An die Spitze dieses Turmes ist ein Gespinst von Drähten geknüpft, das von dort nach allen Seiten hin ausstrahlt und sich, von unten gesehen, wie allerfeinstes Spinngewebe ausnimmt. Von dort oben zieht das Drahtnetz mit den mannigfachsten Verknüpfungen und Verschlingungen hinaus und hinunter, bis seine letzten Ausläufer an einer Reihe von niedrigen eisernen Masten enden, die in einer Entfernung von dreihundert Metern im Kreis um den Turm gestellt sind. Dieses Netz heißt die Antenne, und es ist der eigentliche Beherrscher des Weltraums."

17. Ibid., 20. "Es ist beinahe allwissend: ihm wird alles kund, was im Aether sich abspielt."

(Die Beherrscher des Weltraums), as the chapter title has it: the station's operator, the antenna, or wireless technology in general. At first, the antenna is described as the "servant" (Helfer) and the operator as its "master" (Meister), but then, through the reversal in the above passage, the antenna becomes the "true master of the universe," since the telegraph operator's gestures only "serve" (dienen) to load it with electricity for a shorter or longer amount of time. Arguably, however, the journalist here proves himself to be the "true master of the universe," insofar as his description of the Nauen Transmitter Station captures the multi-dimensional aspect of the tower as a medium, first as it is seen from below, then from above.

Significantly, Fürst's treatment of these "masters of the universe" does not end after his eyewitness account of the Nauen Transmitter Station. It also includes a second-hand report on recent experiments with "a motorboat whose movements are controlled from the shore."[18] What ties these two seemingly disparate phenomena together is not only the motif of maritime communication (the Nauen Transmitter Station having been used to help relay a transatlantic message),[19] but also that of remote control—the ability to create effects of apparent action at a distance, so astonishing, at the time, that it led to ascriptions of omnipotence on par with those of omniscience. "It is a very strange, truly astonishing sight to see the unmanned boat gliding through the water so sure of its goal," Fürst reported on the experimental demonstrations of motorboats that were being carried out on the Dutzendteich in Nuremberg and the Wannsee near Berlin; many observers even became "as frightened as if Hauff's ghost-ship were passing by."[20] By referencing Wilhelm Hauff's *Geschichte von den Gespensterschiff* (Story of the ghost ship, 1825), a re-working of the Flying Dutchman myth in an Islamic context, Fürst's account of these experiments with remote-controlled motorboats takes up Romanticism's human-machine discourse, and transposes the figure of the navigator in Hauff's story, who, even after death, continues to steer his ship by being nailed to its mast, to that of the remote control operator, no longer bound to his machine but free to control it at a safe distance from the shore. "The astonishing thing about this remote control boat is that the navigator on the shore […] can control various electrical circuits completely according to his own will"—namely, by pressing buttons on his controller to turn, to stop, or to sound a warning signal.[21] In other words, the remote control operator is understood here to be a present absence, a divine quality also ascribed to the telegraph operator at Nauen who delivers a

18. Ibid., 18. "[E]in Motorboot […], dessen Bewegungen vom Ufer aus gelenkt werden." Elsewhere, Fürst refers to the device as a "Fernlenkboot," though he does not use the common expressions *Fernsteuerung* or *Fernbedienung* for "remote control."

19. The chapter begins with an account of the steamship "Bosnia," which was the first to transmit a wireless telegraph from Nauen to the port of New York, roughly 5,200 km away. The ship remained in contact with the Telefunken station at Nauen for its entire voyage, and it kept receiving news updates that it passed on to crew and passengers.

20. Fürst, *Die Wunder um uns*, 18. "Es ist ein ganz seltsamer, sehr erstaunlicher Anblick, das Boot ohne Bemannung so zielsicher durch das Wasser gleiten zu sehen, und die nichteingeweihten Insassen vorüberfahrender Dampfer oder Segeljachten müssen bei keinem Anblick wohl nicht weniger erschrecken, als wenn plötzlich Hauffs Gespensterschiff an ihnen vorüberglitte."

21. Ibid. "Das Überraschende an diesem Fernlenkboot ist, daß der Steuermann am Ufer durch die Beeinflussung des einen Fritters, den er naturgemäß nur benutzen kann, also durch eine einzige Stromschlußstelle, die verschiedene Stromkreise ganz nach seinem Willen zu schließen vermag."

message without being present at its destination. Ultimately, both the figure of the telegraph operator and that of the remote control operator are characterized by their ability to effect apparent action at a distance, usually at the push of a button, thereby exercising their will from a distanced and secure position of knowledge and power.

In attributing omniscience and omnipotence to wireless technology, Fürst's attempt to rekindle a sense of these "wonders around us," as the title of his book has it, is representative of the widespread tendency in the late nineteenth and early twentieth century to ascribe qualities of the divine to emerging technology,[22] a tendency due largely to the sense of astonishment and wonder that were generated by what were then "new media." Among recent studies of media change, Tom Gunning's work on astonishment stands out for interrogating the predication of modernity on innovation and technology—and, by extension, the common narrative of modernity's response to technology as that of an inevitable movement from unfamiliarity and wonder to familiarity and habituation.[23] For Gunning, astonishment does not arise primarily from our unfamiliarity with new technologies, but rather "from the prophetic nature of new technologies, their address to a previously unimagined future."[24] This prophetic address, in contrast to the past-oriented concept of familiarity, lies in the fact that while only some technologies may succeed in altering the shape of the future, every technology contains the potential to inaugurate a new era. Gunning's concept of astonishment is especially useful for understanding the early response to wireless technology: before the theory of electromagnetic waves underlying wireless technology could be developed and before the first successful transmitters were even built, the early response to wireless technology was dominated by widespread speculation about its vast implications for creating possible worlds, manifest in various wireless topoi.

What makes the response to antenna towers in terms of omniscience and omnipotence so interesting is how bluntly they visualize the invisible mechanisms of power and control that saturate modern communications infrastructures. Today, most such infrastructures are invisible, partly in an attempt to heighten the end-user's sensation of seamless connectivity, and due partly to the fact that communications infrastructures have generally become private rather than public services. In the early twentieth century, on the other hand, cities tended more to "celebrate their infrastructure," and many nations

22. See Günther Schatter, "Glaube als Sendung: Mediale Metaphern für Allgegenwart und Allmacht," in *9. Buckower Mediengespräche 2005: Die Medien und die Gretchenfrage* (Munich: Kopaed, 2006), 57–66. The divine qualities included "omnipresence, latent independence from time and space, flexibility, infinitude, immortality, present absence, absoluteness, and a form of play with all possibilities" (Allgegenwart, latente Orts- und Zeitunabhängigkeit, Flexibilität, Nicht-Endlichkeit und -Sterblichkeit, anwesende Abwesenheit, Absolutheit, Spielform mit allen Möglichkeit, etc.).

23. See Tom Gunning, "An Aesthetic of Astonishment: Early Film and the (In)credulous Spectator," *Art and Text* 34 (Spring 1989): 31–45. In this earlier work, Gunning seemed to suggest that avant-garde strategies of *Verfremdung* could reawaken us to the potential of technology.

24. See Tom Gunning, "Re-Newing Old Technologies: Astonishment, Second Nature, and the Uncanny in Technology from the Previous Turn-of-the-Century," in *Rethinking Media Change: The Aesthetics of Transition*, ed. David Thorburn and Henry Jenkins (Cambridge, MA: MIT Press, 2003), 56. In this more recent work, Gunning proposes, in lieu of strategies of Verfremdung, that we cultivate a more naïve attitude to the historical study of media change, thereby combatting the narrative of "disenchantment" through learned naiveté.

began constructing landmarks to broadcasting.[25] The Nauen Transmitter Station attracted over 10,000 visitors in its first three years of operation alone, including not only the journalist Artur Fürst but also Kaiser Wilhelm II and such visiting dignitaries as Chulalongkorn, the King of Siam. Just as nineteenth-century postcards often paid tribute to smokestacks as signs of industrial progress, producing strange images of smog-covered destinations, twentieth-century postcards often featured antenna towers as signs of a region's communications prowess. Interestingly, the postcard would become a crucial medium for amateur radio in the form of QSL cards, objects exchanged in confirmation of the receipt of a transmission usually depicting scenic vistas along with technical details about signal strength.[26]

The early twentieth-century celebration of wireless infrastructure was perhaps nowhere more evident than in what Tim Conley calls the modernist genre of "wireless poetry," a genre of transnational poems that thematized the connections between wireless technology and poetic subjectivity. While these poems have often been read superficially as a sign of enthusiasm for the new medium of radio, Conley productively suggests that "to observe hyperbole within these poems, even as a primary characteristic, is only to begin to acknowledge the extent of the excitement felt by those who contemplated radio towers such as the Eiffel and understood them to be capable, as [the Polish avant-garde poet] Julian Przybos put it, of "liberat[ing] thought from matter."[27] In other words, just as wireless technology seemed capable of freeing transmissions from their dependency on wires, providing a possible solution to Marxist materialism, so too did a poetics based on wireless technology seem capable of freeing thought from its dependency on language. The preferred subject in the genre was, by far, the Eiffel Tower, the "useless and monstrous" construction that was only barely saved from demolition in 1909, after its 20-year permit had expired, due to the addition of an antenna that made it a functional structure. With the rapid proliferation of antenna towers, the mid-1920s saw poets increasingly turning away from this international symbol to local subjects.

Among the many odes to the Berlin Radio Tower (Berliner Funkturm), a structure modeled after the Eiffel Tower and constructed from 1924 to 1926, Karlernst Knatz's "Natur und Geist" (Nature and spirit, 1926) stands out for its engagement with the tradition of German Idealism, describing the tower as a "modern wonder without equal […] the product of human labor, and yet a sign of the unity of nature and spirit."[28] For Knatz, this "unity of nature and spirit" was to be found primarily in how wireless technology created a signal out of noise: a "hurricane of ghostly waves thundered around

25. This is William Mitchell's phrase for how mundane or ugly objects in an urban landscape usually get dressed up through advertisements or decorations. See William J. Mitchell, *Me++: The Cyborg Self and the Networked City* (Cambridge, MA: MIT Press, 2003).

26. For an overview of QSL cards, see Wolf Harranth, *Aus den Schätzen der QSL-Collection* (Berlin: Theuberger, 1996). The DokuFunk Archiv in Vienna, Austria currently hosts one of the largest collections of QSL cards.

27. Conley, "'Hive of Words'," 768.

28. Karlernst Knatz, "Natur und Geist," [1926], in *Radio-Kultur in der Weimarer Republik: Eine Dokumentation*, ed. Irmela Schneider (Tübingen: Gunther Narr, 1984), 41. "Moderne Wunder ohnegleichen, / der Turm, der magisch aufwärts weist – / des Menschen Werk, jedoch ein Zeichen / der Einheit von Natur und Geist."

the steel giant and became clear in sound, mystically through the law of numbers."[29] In fact, the perceived immateriality and ephemerality of broadcast signals actually gave the Berliner Funkturm an advantage over traditional monuments in Knatz's eyes. "Berlin's aged towers all look up to their big brother," writes Knatz. "Defiant, young, not weighed down by history, creation and symbol of our times, it captures our spirit [*vergeistert*, a play on *verkörpert*, "embodies"], the landmark to a new humanity."[30] Transitory, light, and oriented to the present—the actual qualities of transmission appeared to be the very same as the ideal qualities required of "the new human being" (der neue Mensch). Raoul Hausmann's "Mechanischer Kopf" (Mechanical head, ca. 1920), a sculpture of this new human being as Dada cyborg, latched on to the understanding of antennas as sensory appendages affixed to the human head. In Hausmann's sculpture, the human antenna is represented by a ruler, the measurement of distance, which serves as a reminder of both the long-distance transmissions of wireless telegraphy and the use of antennas as scientific instruments for detecting the invisible medium of electromagnetic waves.

At the Berliner Funkturm's dedication on September 3, 1926, Hans Bredow, the director of the *Reichs-Rundfunk-Gesellschaft*, read a different ode to the tower, Hans Brennert's "Dem neuen Roland" (To the new Roland, 1925). Like Knatz's poem, Brennert's ode treats the structure as a symbol of the New Berlin, though it additionally makes the event of the Funkturm's dedication into a celebration of the city's communications infrastructure. The main conceit of Brennert's poem is that the Berliner Funkturm does the same symbolic work for creating a sense of collectivity in the New Berlin that the statues of the *Nagelmänner* did in the Old Berlin.[31] In fact, *Schwarzhören*, or listening to the radio illegally without a subscription, was a huge problem in the early days of broadcasting in the Weimar Republic. In 1924 alone, the year of the first nationwide broadcasts in Germany, the number of subscribers grew exponentially from around 1580 in January to over 100,000 by July and 548,749 by December, due largely to the addition of new broadcast stations and public radio exhibitions. During this period of hyperinflation, however, many listeners still opted not to pay the registration fee for their radio sets.[32] Ultimately, Brennert's poem implied that donations to the new Roland—mobilizing peaceful democratic culture rather than the machinery of war—should be made in the form of subscriptions to public radio.

While wireless poems like Knatz's and Brennert's index the visibility of communications infrastructures in the 1920s, other poems recognized evident parallels between antenna towers and church towers, thereby reflecting on a shift in the visualization of power and authority through architectural structures. For Arnold Zweig, the Berliner Funkturm represented a possible union between modern industry and

29. Ibid. "Orkan von geisterhaften Wellen / umwittert den Gigantenstahl / und löst in Laut, in silberhellen, / sich mystisch durch Gesetz der Zahl."

30. Ibid. "Kühn, jung, beschwert nicht von Geschichte, / Geschöpf und Sinnbild dieser Zeit, / vergeistigt er sich fein im Lichte, / Wahrzeichen neuer Menschlichkeit."

31. Part of a propaganda campaign during the First World War, the Nail Men were iron statues—for example, of Roland, the legendary medieval figure of Germanic military strength—into which citizens would hammer iron nails at the cost of 10 Pfennig per nail, the proceeds going to the war campaign.

32. For these numbers and a discussion of Schwarzhören, see Daniel Gilfillan, *Pieces of Sound: German Experimental Radio* (Minneapolis: University of Minnesota Press, 2009), 79.

universalizing, religious aspirations. Like Knatz and Fürst, the tower appeared to Zweig to be a visualization of invisible wireless technology: "The fact that you touch the ether, radio tower, that you were erected as a visible conception in order to make our waves pulsate out into the powerful universe, that fact, radio tower, is what makes you so beautiful in the first place."[33] An object of desire, the tower seemed to "conceal a secret but not so much so that we cannot fumble around at it with both of our primary senses, the mathematical and the religious."[34] Along these lines, Zweig situated the modern marvel in the lineage of towers discussed above: "You, radio tower, stand completely under the sign of man; for your beauty, like that of music, truly comes from the intersection of mathematics and religion, no differently than the beauty of the great cathedrals, which were mathematics and religion, and so goes back through the ages to the mathematical, religious beauty of Egyptian pyramids, Greek halls to the gods and Chaldean terrace temples."[35] Although the association of sacred buildings and communication ideals can be traced back to the Egyptians, the Greeks, the Chaldeans, or, in the Christian tradition, the myth of the Tower of Babel, sacred buildings actually first began to be re-purposed as signal stations en masse during the development of optical telegraphy in the wake of the French Revolution.[36] In 1902, only five years after Adolf Slaby and his assistant Georg von Arco had installed the first antenna system for wireless telegraphy in Germany on the clock tower of the Church of the Redeemer at Sacrow near Potsdam,[37] Guillaume Apollinaire remarked that Cologne Cathedral could stand to be similarly modernized by having priests hang a telegraph wire between its two towers, thereby making it into a lyre whose extravagant hymns would be carried by the wind up to heaven.[38] Arguably, the close association of sacred buildings and communication

33. Arnold Zweig, "An den Funkturm, den Nachbarn." *Die Funkstunde* (January 6, 1927): 60, repr. in *Literatur und Rundfunk, 1923–1933*, ed. Gerhard Hay (Hildesheim: Gerstenberg, 1975), 209. "Denn dass du an den Äther rührst, Funkturm, dass du als sichtbare Zeugung aufgerichtet bist, um ins mächtige All die Wellen des Menschen auszupulsen, das erst, Funkturm, macht dich ja so schön."

34. Ibid., 210. "[S]ein Geheimnis nicht so streng verschließt, daß wir nicht mit unseren beiden Hauptsinne, dem mathematischen und dem religiösen, daran tasten könnten."

35. Ibid. "So stehst du, Funkturm, ganz und gar im Zeichen des Menschen; denn deine Schönheit, wie die der Musik, löst sich ja aus der Überschneidung von Mathematik und Religion nicht anders als die Schönheit der großen Dome, die Mathematik und Religion waren, und so durch die Zeiten zurück bis zur mathematisch-religiösen Schönheit ägyptischer Pyramiden, griechischer Götterhallen und chaldäischer Terrassentempel."

36. See Schatter, "Glaube als Sendung"; cf. Engell, "Sinn und Sichlichkeit (Turm und Taste)." Some notable examples are as follows: in 1792, Claude Chappe used church towers as the supports for semaphores that would be visible from corresponding towers via telescope, thereby creating the first practical system for optical telegraphy; in 1931, Marconi switched on the lights at the Corcovado statue of Christ the Redeemer in Brazil using a wireless signal from Rome, three years before he would even be invited to visit the city; even Hallgrímskirkja, the largest church in Iceland, constructed from 1945 to 1986, functions as a wireless transmitter station.

37. Interestingly, the memorial plaque at the site of the first German wireless broadcast, created by Hermann Hosaeus in 1928 and hung over the entrance to the campanile combines the iconography of Atlas with that of the crucifixion, a triumphant Christ figure holding up the world and surrounded by lightning bolts that evoke the Telefunken logo.

38. Guillaume Apollinaire composed the patchwork poem "Le Dôme de Cologne" (1902) during his stay in the Rhineland as a tutor. The images from this poem are related to those in "Zone" and in *Calligrammes*.

ideals became secularized in the common understanding of antenna towers as transcendent structures.

Pre-Historical Antennas

Due to the iconic stature of wireless stations, constructed in order to become "landmarks to a new humanity," as Knatz put it in his ode to the Berliner Funkturm, there was a widespread tendency to equate the architectural structures, *antenna towers* or *antenna masts*, with the technological artifacts, *antenna wires*. However, the technology and its architectural support are designed to serve two different functions: antennas are designed to detect or to radiate energy, and they are, in fact, the very first objects to have ever been created explicitly for this purpose;[39] antenna towers are designed to elevate these wires into an aerial position, thereby increasing their signal range. Terminologically, the difference between the technology and its support is evident in an alternative term for the antenna still used in British English, *aerial*, as well as in the early twentieth-century German variants *Luftdraht* (aerial wire) and *Luftleiter* (aerial conductor). Recognizing this fundamental difference between the technology and its architectural support would help make better sense of the early twentieth-century fascination with these objects.

The most iconic form of antenna remains that popularized and, even more significantly, patented, by Guglielmo Marconi: a simple upright steel wire. However, early antennas took on a surprising variety of forms, and the inspiration for these designs came from a wide range of fields, including wired telegraphy, meteorology, biology, and aviation. Marconi, inspired by the analogy between wired and wireless telegraphy, was the first to ground one pole of the antenna, thereby harnessing the power of the earth for communication, just as telegraphers had done with wired telegraphy; Alexander Stepanovich Popov, inspired by the lightning rod, used a coherer and a long, thin wire in experiments for his lightning detection device; George Minchin, inspired by parallels with insect antennas, also used a long wire for his receiver, though he called it a "feeler"; and Admiral Henry B. Jackson attached wires, which he called "wings," probably in analogy to the semaphore telegraph, to the coherer.[40] Apart from experiments using antennas to radiate electromagnetic energy, there were also experiments with induction-based telegraphy and with optical telegraphy using semaphores, which have been examined in previous chapters. One of the most interesting attempts to find a medium capable of wireless transmission came in the form of "hydrotelegraphy." From around 1899 to 1901, Karl Ferdinand Braun, the physicist who would eventually share the Nobel Prize with Marconi in 1909, conducted experiments using jets of water as antennas, which proved to be less effective than those made out of copper wires but were still useful for sending an emergency signal if a ship's antenna was destroyed. However, ever since electromagnetic waves came to be the dominant medium for sending wireless transmissions, any antenna used for producing or for detecting the presence of

39. See Phillips, *Early Radio Wave Detectors*.
40. See Hong, *Wireless*, 23.

electromagnetic radiation, has basically been a wire.[41] Although a radio can be powered wirelessly, using the energy generated by electromagnetic fields, it still relies on wires for its construction.[42]

Nothing drives home the point that antennas themselves are only wires better than what were commonly known as "loop aerials" or "frame antennas," basically a piece of wire wound multiple times around a wooden frame. Although frame antennas have long since fallen out of fashion, they were once the favored form of antenna among amateur radio enthusiasts, as well as the military, since they are so easy to assemble and disassemble. Due to the nature of their construction, these antennas are highly directional, which means that the supporting frame would itself need to rotate in order to be able to transmit in various directions or to receive signals from multiple stations.[43] Alternately, rather than rotating an antenna, thereby producing spatial differences in electromagnetic fields, a directional antenna can be created by modifying a transmission pattern over time, as Braun did in 1905, creating the first "phased array antenna." This manner of exploiting electromagnetic changes over time makes the phased array antenna a precursor of radar, smart antennas, and multiple-input, multiple-output (MIMO) broadcasting.

As Fürst recognized after another visit to Nauen in 1924, the invention of a directional antenna had three massive implications for the implementation of wireless technology en masse, though not necessarily in the form of broadcasting.[44] A directional antenna would be able to avoid interference from other transmitters, even if they were transmitting on the same frequency, so long as their signals did not come from the same direction as the desired transmitter. It would allow the position of a station to be determined, even without knowing anything about that station—in effect, opening up a new application for antennas as competitors with compasses in the then-emerging field of radiodetermination, consisting of the subfields of radiolocation and radionavigation. Most importantly, however, a frame antenna could compensate for the lack of duplex service in wireless telegraphy, and only duplex service would allow wireless telegraphy to be monetized, since two stations would be able to remain connected to each other and thus report any problems they might have with reception. Prior to the invention of the transistor, every antenna had to be set up as either a transmitter or a receiver, which meant that there was no such thing as "always on" technology. The expensive transmitting stations being constructed at the time were not able to be used constantly: they would need to stop transmitting while they, or any antennas nearby, were receiving, because if two antennas were placed next to each other, the receiving antenna would pick up the transmitting antenna that was right next to it rather than the desired signal at a distance.

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41. As these inventors quickly recognized, the antenna was initially tasked with performing too many functions (e.g., generating energy, radiating energy, directing energy toward a target). Each of these functions was gradually assigned to a different wireless component.

42. See Jaffe, "Inventing The Radio Cosmopolitan," 19. "Going wireless requires a lot of wire. To build a crystal radio, you need a wire coil, an antenna, and a ground wire—in addition to a very thin wire encased in germanium diode."

43. By rotating, loop aerials were able to become a form of radio compass: if a ship was lost in fog or a storm, it could be traced based on records of two or three different locations.

44. Fürst, *Im Bannkreis von Nauen*, 86–96.

Just as the upright monopole antenna used in Marconi's experiments with wireless telegraphy remains the most iconic form of antenna, the most iconic form of antenna support remains the iron latticework structure used in Eiffel's design of the tower located on the Champ de Mars in Paris. However, the main structures used to support antennas in early experiments with electromagnetic waves were not the massive, monumental, permanent landmarks that we can easily recognize today, but rather light, temporary, often mobile supports. Before the dominant supporting structure for antennas came to be that of a latticework mast, various structures were tried out as supports for elevating antenna wires into the air and stabilizing them in that position, including kites, balloons, masts, and poles. In fact, the first transatlantic wireless telegraph transmission, Marconi's famous "S," was transmitted from a temporary fan aerial to a distant kite. Although the single-wire antenna gradually declined in popularity as more effective antenna designs emerged, it found a new use as a receiving antenna in airplanes. Strangely, early airplane antennas consisted of a 40 m long wire, weighted at the bottom with a metal ball, which hung down below the plane and had to be reeled in using a windlass before landing.

During wartime, finding supports for antennas required creative measures due to the limited availability of construction materials. During World War I, the smokestacks of factories in Germany were transformed into transmitting antennas; and in America, there were experiments to turn trees into receiving antennas, which succeeded in receiving messages from Nauen, Poldhu, Lyon, and Paris. In fact, many of the radio towers constructed in Germany in the early twentieth century were made out of wood and not metal, which not only solved the problem of electroshock, but also made better use of many regions' natural resources. The world's tallest wooden lattice tower existed briefly in Mühlacker (190 m, 1934–45), and dozens of wooden antenna towers, ranging from 30 m to 170 m in height, were constructed in Germany between 1930 and 1945.[45] It should come as no surprise, then, that Friedrich Kittler would call World War II a "transmission war" and World War I a "storage war."

This trend in re-purposing structures as antenna supports shows that antenna *towers* are not necessarily the only available supporting structures for antennas. As Artur Fürst realized thirteen years after his first visit to Nauen, "it would be false to call these supports for aerial wires *towers*," in spite of the visual resemblance of their silhouettes, since, in architectural terms, "they are nothing other than *masts*."[46] The structural difference between a mast and a tower, as Fürst points out, is that "a tower stands up freely on its foundation; a mast has a simpler foundation that, in and of itself, does not

45. The wooden antenna towers were constructed at Munich-Stadelheim (75 m, 1926–30s), Kaiserslautern (60 m, 1926–45), Flensburg (90 m, 1928–57), Heilsberg [Lidzbark Warminski] (102 m, 1930–35), Zeesen (70 m, 1931–39), Ismaning (163 m, 1932–83), Zorawina (140 m, 1932–90), Berlin-Tegel (165 m, 1933–48), Freiburg-Lehen (107 m, 1933–45), Utbremen (90 m, 1933–39), Langenberg (160 m, 1934–45), Hamburg-Billstedt (145 m, 1934–49), Heiligenstock (107 m, 1934–65), Koblenz (107 m, 1934–65), Wiederau (150 m, 1935–53), Nuremberg-Kleinreuth (124 m, 1935–61), Heilsberg (115 m, 1935–40), Trier (107 m, 1935–48), Utlandshörn (65 m, 1935–77), Verbert-Langenberg (45 m, 1935–45), Heusweiler (35 m and 31 m, 1935–45), Reichenbach (100 m, 1937–45), and Cuxhaven (50 m, 1937–67).

46. Fürst, *Im Bannkreis von Nauen*, 95–96, emphasis added. "Es wäre falsch, diese Träger der Luftdrähte als Türme zu bezeichnen. Sie sind in Wirklichkeit nichts anderes als Maste, wenn auch solche von höchst ungewöhnlicher Länge."

provide enough resistance to the wind," therefore requiring the addition of supporting ropes, commonly known as "guys" in nautical terminology.[47] As Fürst goes on to explain, a mast usually rests on an articulated joint that is able to be rotated about a steel ball, and were it not connected to its supporting ropes, it would immediately fall over at the first gust of wind. A mast's supporting ropes and articulated joint allow it to move with the wind and to distribute the force of the wind equally across all the supporting lines. Ultimately, these purely functional characteristics of the structures designed to support antennas, along with the projected and actual characteristics of antenna wires themselves, were what sparked the imagination of many, as antenna designs started showing up in modernist art and architecture.

Wireless Architecture

Since radio waves are propagated on a portion of the electromagnetic spectrum invisible to the naked eye, they were commonly perceived to be immaterial, which created problems for visualizing the proper place of wireless media in the public sphere. Part of the problem is that the only visible aspects of wireless technology, usually perceived to be the quintessential medium without a medium, are terminals that cannot convey any tangible sense of what actually occurs in a wireless transmission between these endpoints. Between the terminals that provide a wireless connection exists only empty space, or, the ether, as it was conceived of in late nineteenth- and early twentieth-century scientific discourses. Since the ether was, by definition, immaterial and beyond the purview of empirical verification, attempts to construct representations of broadcasting in the public sphere often turned to the most monumental materials available. Just as early maps of the electromagnetic spectrum were patterned on the idea that the immaterial ether could be divided up as though it were any other material resource, the construction of antenna towers generally followed traditional practices of monumentalism in a race to produce (inter)national symbols of aerial domination. Emblematically, Vladimir Tatlin's unrealized Monument to the Third International (1919–20) presented, as Joe Milutis puts it, the "invisible congress of a new electronic nationalism through its combination of a sculpture, radio tower, and cultural center," while traditional monuments that had been transformed into broadcasting stations, including the Eiffel Tower (built 1887–89; telegraph relay station starting in 1906), the Empire State Building (built 1930–31; NBC broadcasts starting in 1931), and even the statue of Christ the Redeemer at Corcovado (built 1922–31; illuminated wirelessly by Marconi at the opening ceremony in 1931), all "promised the radio city as a modern city of God to which all cities should aspire."[48]

To many observers in the early twentieth century, wireless stations resembled traditional monuments, as the race to build a transmitter capable of the greatest broadcasting distance—at the time, a task equivalent to that of constructing the highest

47. Ibid. "Ein Turm steht frei aufragend auf seinem Fundament; der Mast hat einen einfacheren Unterbau, der allein nicht genügt, ihm ausreichende Widerstandsfähigkeit gegen den Winddruck zu geben. Deshalb müssen zur Erhöhung der Standfestigkeit Halteseile angefügt werden."

48. Joe Milutis, *Ether: The Nothing That Connects Everything* (Minneapolis: University of Minnesota Press, 2006), 96.

possible supporting structure—ran in parallel to the race to build the world's tallest building. An illustration in the August 1919 issue of *Telefunken-Zeitung* compares the size of the antenna towers at Nauen in 1906 and 1914 to that of the Eiffel Tower (24 m, 1889), Cologne Cathedral (157 m, 1248–1880), and the Berlin Victory Column (67 m, 1864).[49] In addition to demonstrating the relative height of these towers, the illustration also reveals the thinness of the structures at Nauen and their additional spatial requirements. For an isolated setting like Nauen, space would not have been an issue; but for urban settings like Berlin or Paris, putting up an antenna mast created debates among residents, leading to the creation of antenna laws. Lastly, the illustration of the size of the antenna towers at Nauen in comparison to the size of traditional monuments also demonstrates a fundamental tension between permanence and ephemerality in the construction of antenna towers. Not one but two antenna towers went up in Nauen in the span of eight years, the second being required after the first was destroyed in a storm, and the tower built in 1914 being replaced again in 1920 with a more efficient model. Thus, even though antenna towers were patterned, to some extent, on traditional forms of monumentalism, I would emphasize the difference in terms of their longevity: monuments are usually symbols of permanence, an extension of the past into the future, whereas the construction of antenna towers, a response to a present need, is always more ephemeral.

Even though the architecture of wireless stations represented a continuation of traditional monumentalism for many observers in the early twentieth century, it represented a radical departure from traditional architectural limits for international constructivist artists and architects. As Sigfried Giedion observed in 1928, the silhouettes of these new structures may have resembled traditional monuments, but the impetus for their construction represented a movement away from the surface—of buildings and of the earth itself—as the focal point of architecture. According to Giedion, this blurring of surface and depth extended to a blurring of the categories of inside and outside: "By their design, all buildings today are as *open* as possible. They blur their arbitrary boundaries. Seek connection and interpenetration."[50] The modern aesthetic experience of urban architecture can be found, for Giedion, "in the air-flooded stairs of the Eiffel Tower, better yet, in the steel limbs of a *pont transbordeur*."[51] The suspended latticework structure, much like suspended antenna wires, created a new frame for viewing the city: "Through the delicate iron net suspended in midair stream things, ships, sea, houses, masts, landscape, and harbor. They lose their delimited form: as one descends, they circle into each other and intermingle simultaneously."[52] In other words, the latticework structure of the Eiffel Tower, an aerial bridge, or an antenna mast served as a visual screen that transformed the urban landscape: a passerby would no longer look *at* these monumental constructions but right *through* them.

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49. "Grösse der Türme der Telefunken-Gross-Station Nauen im Vergleich zu bekannten Bauwerken" in *Telefunken Zeitung* 17, no. 3 (August 1919): 51.

50. Sigfried Giedion, *Building in France, Building in Iron, Building in Ferroconcrete*, trans. J. Duncan Berry (Los Angeles: Getty, 1995), 91.

51. Ibid.

52. Ibid.

The same latticework structure that, according to Giedion, causes the objects of perception to become abstract and merge together, becomes a metaphor for historical methodology in Walter Benjamin's *Passagenwerk* (Arcades Project, 1927–40). Quoting the above passage from Giedion's *Bauen im Frankreich, Bauen in Eisen, Bauen in Eisenbeton* (Building in France, Building in Iron, Building in Ferroconcrete, 1928), Benjamin turns Giedion's phenomenological description into a historical imperative: "In the same way, the historian today has only to erect a slender but sturdy scaffolding—a philosophic structure—in order to draw the most vital aspects of the past into his net."[53] While the latticework structure functions as a screen in Giedion's analysis of urban experience, filtering out objects and distancing them from the observer, it serves as a net in Benjamin's historiography, ensnaring whatever objects come into its path and bringing them closer to the historian. As Benjamin goes on to explain, "just as the magnificent vistas of the city provided by the new construction in iron […] for a long time were reserved exclusively for the workers and engineers, so too the philosopher who wishes here to garner fresh perspectives must be someone immune to vertigo—an independent and, if need be, solitary worker."[54]

One such solitary worker, though not entirely immune to vertigo, climbed the Berlin Radio Tower in order to take a series of photographs. László Moholy-Nagy's "Vom Funkturm" (From the radio tower, 1926–29), may seem to visualize Siegfried Giedion's description of urban experience, providing an aerial gaze on the surrounding landscape through the latticework of the antenna tower, which would confirm the abstraction of objects and the viewer's alienation from them. However, for Moholy-Nagy, this kind of "bird's-eye perspective" was actually supposed to provide orientation, as I argued in the previous chapter, and to open up a new understanding of architecture. "For the airplane pilot," as Moholy-Nagy puts it, "the bird's eye perspective on the landscape is a possibility for orientation. Soon everyone will have to become familiar with the views from above in nature and in representation."[55]

If architecture had been historically characterized by the slow accumulation of building materials from the ground up, as El Lissitzky reflected in 1923, then the new structures being built as supports for antennas seemed to represent an alternative possibility of construction that would proceed from the air down.[56] Thinking about the Nauen Transmitter Station, El Lissitzky seems to have had an epiphany: the articulated

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53. Walter Benjamin, *The Arcades Project*, trans. Howard Eiland and Kevin McLaughlin (Cambridge, MA: Belknap, 2002), 459. "So hat auch der Historiker heute nur ein schmales, aber tragfähiges Gerüst – ein philosophisches – zu errichten, um die aktuellsten Aspekte der Vergangenheit in sein Netz zu ziehen."

54. Ibid. "Wie aber die großartigen Ansichten, die die neuen Eisenkonstruktionen von den Städten gewährten […] auf lange hinaus sich ausschließlich den Arbeitern und Ingenieuren erschlossen, so muß auch der Philosoph, der hier die ersten Aspekte gewinnen will, ein selbständiger, schwindelfreier, wenn es sein muß einsamer Arbeiter sein."

55. László Moholy-Nagy, *Von Material zu Architektur* [1929] (Mainz: F. Kupferberg, 1968), 201. "Für den Flugzeugführer ist heute die Vogelperspektive der Landschaft eine Orientierungsmöglichkeit. In der nächsten Zukunft werden die Sichten von oben in Darstellung und Natur einem jeden geläufig sein müssen."

56. El Lissitzsky, "Wheel–Propeller–and What Will Follow: Our Form-Production Is a Function of Our System of Movement," [1923], in *G: An Avant-Garde Journal of Art, Architecture, Design, and Film, 1923–1926*, ed. Detlef Mertins and Michael W. Jennings, trans. Steven Lindberg and Margareta Ingrid Christian (Los Angeles: Getty, 2010), 106.

joint supporting the antenna mast did not belong to traditional architecture at all, but rather to the modern machinery of transportation, the "wheel, propeller, and what will follow:" "*Nauen*: The 250-meter-high antenna tower stands on a single point. The Egyptian pyramid has been overcome. The flying human being is at the limit. At the limit of the old conceptions, the old form-creation, the old state of society. A new energy has to be liberated that will give us a new system of movement (e.g., a movement that is not based on friction, that provides an opportunity to hover in space without moving.)"[57] El Lissitzky's dream of hovering, gliding, and floating above the earth—all in a stable manner that, in contrast to the (Italian Futurist) dream of flight, did not require takeoff or landing—is as much a social utopia as an architectural utopia. It was ultimately a search for equilibrium, the balance of opposing forces, in an attempt to overcome inevitable friction.

El Lissitzky's search for this kind of frictionless system, encouraged by the articulated joint of the Nauen Transmitter Station, found a counterpart in Friedrich Kiesler's utopian blueprints for the construction of a "Stadt in der Luft" (City in the air, 1923–26). Significantly, Kiesler's "Stadt in der Luft" was installed as a "mobile," and it is not too farfetched to imagine that Alexander Calder's famous kinetic sculptures were similarly informed by the equilibrium of hanging antenna wires. Kiesler's rather primitive mobile deployed what he called the "Leger- und Träger System," a system of horizontal and vertical pieces of painted wood that were used to hang various pieces of artwork. This system was intended not only to alter the viewer's experience of the objects in the installation space, which "can no longer be grasped simultaneously but only successively,"[58] but even more so to produce an experience of a metropolis that could float in space. Ultimately, El Lissitzky's and Kiesler's explorations of possibilities to break away from ground, inspired by the lightness of antenna wires and their structural supports, were part of a larger loss of faith in the "grounded" perspective that was perceived to have been irremediably tainted by World War I. At the same time, they could also be read as part of an alternative history to that of classical broadcasting—not the universalizing gesture of broadcasting as a form of one-to-many address, but rather the hope of creating a personalized community of many-to-many connections.

Radar and Disaster

Though many-to-many connections are often touted as an emancipatory form of network topology, one problematic implementation of them is in the form of radar. In contrast to the asymmetrical model of broadcasting, transmitter stations are, in a certain sense, identical to receiver stations in the model of radar: impulses are sent out and reflected from the target object; the time interval it takes allows the distance between them to be determined.[59] Radar is based on a measurement technique invented harmlessly in 1904 when Christian Hülsmeyer put a Marconi transmitter on the shore of the Rhine,

57. Ibid.

58. Friedrich Kiesler, "Die Stadt in der Luft," [1926], in *G: Material zur elementaren Gestaltung* [1923–26], ed. Hans Richter and Marion von Hofacker (Munich: Der Kern, 1986), 44–47. "[N]icht mehr simultan, sondern nur sukzessiv erfasst werden.

59. See Seitter, *Physik der Medien*.

which only sent out one pulse, reflected back to it from the metal hulls of passing ships. This, as Friedrich Kittler argues, is how distances are measured during wartime.[60] According to Kittler, radar not only gave rise to color television but also created the essential thing about computer electronics—its discreteness.[61] Arguably, wireless telegraphy and not radar, created the first discrete signals in the electromagnetic field, though radar's significance is still massive. In World War II, radar devices were already starting to be built out of silicon crystals, and computer development after the war was able to piggyback on this development and introduce the structure of radar into integrated circuit boards.

Radar was developed to such a great extent during World War II because it could be used to determine the exact position of moving targets. After the RAF's air raid on Berlin in 1940, Adolf Hitler ordered the construction of massive anti-aircraft towers known as "flak towers" (*Flaktürme*) to defend the capital from further attacks. Three of these structures were positioned around the outskirts of Berlin to create a triangle of anti-aircraft fire that covered the center of the city. Each complex actually consisted of two towers, always built in pairs, working together: a G-Tower (*Gefechtsturm*), or combat tower; and an L-Tower (*Leitturm*), or command tower. Connected via cable for reasons of security, the one tower would target, and the other would shoot. The command tower had a radar installation with a large dish, usually the gigantic *Würzburg-Riese*, which could be retracted behind a thick dome to prevent damage in the event of an air raid. Designed by the architect Friedrich Tamms with Hitler even making some sketches for them, the flak towers in Berlin were built rapidly within a period of six months. Eight such complexes would eventually be constructed in the cities of Berlin (3), Hamburg (2), and Vienna (2). As media philosopher Walter Seitter reflects, "It may be the case that wireless represses architecture. But these 'ground stations' were able to increase in terms of their massiveness, their need for security, and their resemblance to fortresses and bunkers. Their groundedness and their levelness. The more upper levels there are, the more lower levels there are."[62] In addition to their function as anti-aircraft stations, the flak towers served several other functions at the end of the war, as they become civilian air-raid shelters as well as storage spaces for artworks, such as parts of the famous Pergamom altar. After the war, there were plans either to convert the flak towers into representative objects with decorative facades or to simply destroy them. However, the demolition of the towers turned out not to be feasible without threatening their immediate surroundings, due to their monumental construction materials, and many of the towers remain intact to this day.

60. See Kittler, *Optical Media*, 202, 216–22.

61. See Friedrich A. Kittler, "Computer Graphics: A Semi-Technical Introduction," trans. Sara Ogger, *Grey Room*, no. 2 (Winter 2001): 30–45.

62. Seitter, *Physik der Medien*, 374. "Es mag sein, daß der Funk die Architektur zurückdrängt. Aber diese 'Bodenstationen' dürften dann an Massivität, an Sicherheitsbedarf, an Festungs- und Bunkerhaftigkeit eher zunehmen. An Bodenhaftigkeit und Untergeschoßhaftigkeit. Je mehr Obergeschosse und andere Geschosse – umso mehr Untergeschosse."

Conclusion: The Antenna Vanishes

In retrospect, from our vantage point at the end of the era of classical broadcasting, the fact that antennas today no longer function primarily as vehicles for transmitting and receiving analog broadcasts should serve as a reminder that antennas were not originally designed solely for communication, but also for detecting, registering, and measuring the newly discovered scientific phenomenon of electromagnetic radiation. In this respect, antennas helped create further awareness of the existence of imperceptible electromagnetic phenomena, thereby throwing into question assumptions about the binary of nature and technology.[63] The original significance of antennas lay in their ability to detect and to manipulate the natural phenomenon of electromagnetic radiation.

As soon as antennas were raised into the air in order to increase the range of wireless signals, the antenna became the subject of a discourse about the place of communications infrastructure in the public sphere, as well as an object of aesthetic contemplation that informed the concepts of "groundedness" and "aeriality" among modernist artists and architects. Even though "going wireless" was supposed to solve many of the social and political problems inherent in wiring (e.g., crossing the sea, crossing national borders, etc.), the creation of an international wireless infrastructure actually brought about unexpected problems, especially in terms of the visibility of wireless technology in the public sphere. Given Europe's traditionally flat landscape, the vertical dimension of antenna stations remained a main point of contention, bringing about new regulations governing the possibility of erecting antennas in urban spaces and leading to intense negotiations between the vanguards of modernity and the traditional owners of the highest buildings around. Even though antenna towers were celebrated as "landmarks to a new humanity" in tandem with the rise of national broadcasting, they were eventually displaced and concealed from public view with the decline of this model, where they remain today.

At the height of the national broadcasting era in 1951,[64] Ernst Jünger was able to view the dense network of antennas already covering the globe as a sign of the panic and automatism created by an overabundance of information: "The need to digest information multiple times a day is already a sign of angst; the imagination grows and becomes paralyzed in escalating cycles. All these antennas in megacities are like hairs standing on end. They provoke demonic encounters."[65] As Jünger's mythopoetic account of the antenna reveals, the deep time of the antenna is tied to elemental, mythical, and spiritual forms of harnessing the power of nature, exemplified by the lightning rod. Like the lightning rod, the antenna often brings up a metaphysics that haunts desires or fears of harnessing the power of the beyond. For Jünger, a widespread and generalized fear, manifest in his image of antennas as "hairs standing on end," is all that stands in the way

63. My argument here follows Kahn, *Earth Sound, Earth Signal*.

64. On the periodization of the "network era," see Amanda D. Lotz, *The Television Will Be Revolutionized*, 2nd ed. (New York: New York University Press, 2014).

65. Ernst Jünger, *Der Waldgang* (Frankfurt am Main: Klostermann, 1951), 48. "Schon das Bedürfnis, mehrere Male am Tage Nachrichten aufzunehmen, ist ein Zeichen der Angst; die Einbildung wächst und lähmt sich in steigenden Umdrehungen. All diese Antennen der Riesenstädte gleichen dem gesträubten Haar. Sie fordern zu dämonischen Berührungen heraus."

of realizing an existentialist ideal of freedom. In an age of ideologies and of increasing technocracy, physical and psychical survival depend, for Jünger, on finding a new location of freedom—or what he terms the "forest" (*Wald*), a mystical site of rest and contemplation that can exist everywhere, even in a city. But if antennas once functioned as signposts of paranoia, technocracy, and information overload, thereby indicating a possible path to this heterotopia, then what might play that role after antennas have disappeared entirely?

CONCLUSION

The Wireless World, ca. 2000

Nothing today says "wireless" quite like this little symbol: three curved lines sit atop a little point.[1] Due to the increasing size of the curves and the space between them, an illusion of movement arises: it appears almost as though a wireless transmission were being sent out into space. Animated versions of the wireless symbol, which serve as functional indicators of signal strength on digital interfaces, refer implicitly to this movement: one wave after the next will light up in proportion to the increasing strength of a received signal. As the waves seem to move through space, they become larger and larger, reaching not only one intended recipient but any number of unknown receivers who might together form a network. Like ships passing in the night, the members of a wireless network are not to be found at the end of a cable, but rather at unknown coordinates in the "electromagnetic ocean."[2] Unlike the coordinates of wired networks, the location of a wireless station is not given by the structure of a wireless network itself: a wireless station must first be made "discoverable," as any network administrator knows, and it is precisely this attraction of discovery that forms a constituent part of both amateur radio and radio astronomy. Whether researching an uncharted region of outer space or establishing a connection with an unknown conversation partner, wireless communications often deal with extremely large distances. Perhaps the waves in the wireless symbol will continue to grow, crossing any imaginable boundary and overcoming any conceivable distance. Omnipresence, overcoming borders, and universal accessibility—these common impressions of wireless connectivity are what the wireless symbol makes visible.

Today, the wireless symbol can be found anywhere wireless networks are available—cafés, restaurants, hotels, airports, tourist attractions, and all kinds of public spaces; in short, everywhere, as the offers of "free Wi-Fi" are increasingly becoming the norm. If "going wireless" was a watchword a decade ago, the world already seems to have "gone wireless." What, then, was the order of wirelessness before it became so commonplace? If wirelessness today remains a fleeting sensation at the edges of perception, it was once at the center of a nexus of aspirations and possible futures. Before wireless transmission became synonymous with broadcasting in the mass media of radio and television, before it was even implemented in the long-distance, point-to-point connections of wireless telegraphy, the order of wirelessness cut across scientific, aesthetic, and experimental contexts, as this study of the early and pre-history of national broadcasting has demonstrated. While the teleology of wirelessness may seem to be the radio, television, or even wireless telegraphy, I have argued that this is not necessarily the case. Just as

1. For a more detailed analysis of the wireless icon, see Erik Born, "A Little History of the Wireless Icon," Palais des Beaux Arts Wien, last modified June 3, 2015. http://palais-des-beaux-arts.tumblr.com/post/121094302570/a-little-history-of-the-wireless-icon/

2. This phrase is borrowed from Slaby, *Entdeckungsfahrten in den elektrischen Ozean*.

there were various techniques of signaling at a distance before the "discovery" of electromagnetic radiation, so too were there alternate uses of electromagnetic radiation after their application to wireless transmission in the "invention" of wireless telegraphy. The emergence of wirelessness was not only the product of scientific inventions and technological advancements, but also, in a sense, that of poetic invention. Ultimately, the order of wirelessness exceeds the histories of literature, of communication, and of science and technology that seek to contain it. The antenna, for example, is not only a technological artifact, a medium of communication, and the subject of a genre of poetry, but also a symbolic means of negotiating the politics of visibility and invisibility at the heart of modernity. Understanding wirelessness, in this sense, reveals sea changes in the deep time of wireless media when various possibilities still seemed wide open.

What is commonly taken today to be *the* wireless symbol is actually only one of many symbols that have been used in connection with different generations of wireless technology. In a trend similar to current advertisements for "free Wi-Fi," cafés in the 1920s advertised "free radio," not with waves but with a lightning bolt, a symbol also found in many early company logos. Reflecting on visible signs of "wireless Vienna" (das drahtlose Wien), one commentator observed in 1924:

> The antenna network is not the only visible sign of the spread of radio. On the street, you can see advertising boards everywhere with the freshly painted zigzag sign of the lightning bolt, as an ideogram for radio; in the display windows of a wide variety of shops—even those that otherwise had nothing to do with electrical engineering, you see radio devices. The sounds of radio concerts resound not only in the radio amateur's home, but also in the demonstration rooms of radio dealers, even already in some coffee shops. Another sign of the popularity of radio is that two coffeehouses, in the fourth and seventh districts, have adopted the name "Radio."[3]

While the lightning bolt could evoke the speed and power of electricity, as well as the sparks emitted from early wireless transmitters, the image of waves in the wireless symbol captures the omnidirectionality of broadcasting, as a transmission might emanate out from a single point in the etymological sense of "radio."[4]

Even though waves are now more prevalent than lightning bolts, there is still no standard symbol for wireless technology. There are only standardized symbols for corporate wireless brands and for various wireless components on technical circuit

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3. "Das drahtlose Wien," *Radiowelt* 1, no. 15 (1924): 4. "Das Antennennetz ist aber nicht das einzige sichtbare Zeichen der Verbreitung des Radio. Auf der Straße erblickt man überall frischgestrichene Tafeln mit den roten Zickzackzeichen des Blitzfunkens, als Sinnbild des Radio, in Auslagen der verschiedensten Geschäfte – auch solcher, die mit der Elektrotechnik sonst keinen Zusammenhang hatten – sieht man Radioapparate ausgestellt. Die Klänge der Radiokonzerte ertönen nicht nur in den Heimen der Radioamateur, sondern auch in Vorführungsräumen der Radiohändler, sogar auch bereits in einigen Kaffeehäusern. Ein Zeichen der Popularität des Radio ist es auch, daß zwei Kaffeehäuser des IV. und VII. Bezirkes den Namen 'Radio' angenommen haben."

4. Wireless devices no longer create sparks, at least not since World War I, as was the case with spark-gap transmitters. Wireless, as we know it, means "Funken ohne Funken" to use Karl Ferdinand Braun's famous phrase.

diagrams. What is commonly taken to be the standard wireless symbol—"the wireless icon," as it is known for its appearance in digital interfaces—only became popular due to its use for marking the received signal strength of local area networks. The familiar wireless icon differs significantly from seemingly related trademarks like Wi-Fi and Bluetooth, which mobilize different origin stories: Wi-Fi references the symbol for yin and yang; Bluetooth references the rune for Harald "Bluetooth" Gorms, the medieval king who united Denmark and Norway. Both of these origin stories evoke a claim to interoperability: just as these mythological symbols seem to unify competing elements, the computer protocols that use these symbols claim to unify competing standards and to offer compatibility among various devices, systems, and protocols. The popular wireless icon makes a different claim: the propagation of waves in the form of concentric circles should call to mind the model of broadcasting, which was dominant throughout the twentieth century, though almost already extinct in the twenty-first century. While the popular wireless icon depicts only one wireless station, wireless networks usually consist of multiple stations that can be connected to each other in many different ways. The structure of these connections does not necessarily conform to the materiality of electromagnetic radiation, as the structure of a wired network, by comparison, would generally conform to the materiality of the cables connecting individual stations. In a wireless network, on the other hand, the connections among different stations always have to be created, not "out of the ether," but out of the materiality of electromagnetic waves, the physical medium underlying many different media.

The popular wireless icon also enables a different reading of the history of wirelessness, which would differ significantly from the history of mass media. At first glance, the icon may primarily evoke images of broadcasting, but it also represents an elegant compromise in the depiction of a medium that would be completely incomprehensible without this kind of visual translation—namely, electromagnetic waves. A physical phenomenon that results from the interaction of electric currents and magnetic fields, electromagnetic radiation exists everywhere, not only in the form of radio waves, which serve as the medium of wireless transmissions, but also as microwaves, infrared, light, ultraviolet radiation, X-rays, and Gamma rays. Since no human sense organ is capable of perceiving electromagnetic waves directly, they need to be converted or translated into some other form if we are to know anything about them at all. Using even a tiny area of the electromagnetic spectrum for transmitting information requires further technical operations, such as modulation and demodulation, which make up the domain of Funktechniken. These operations work on a portion of the electromagnetic spectrum with frequencies from roughly 3 Hz to 3,000 GHz, commonly known as the wireless or radio spectrum. As a hybrid object, the wireless spectrum was not only disclosed and ordered through discoveries in physics throughout the long nineteenth century and made into an object of international regulation during the formation of telecommunications in the early twentieth century. It was also a site of experimentation.

The aim of my historical work on literature, science, and wireless technology is to put the popular rhetoric of media revolution, found in claims about the "death of broadcasting" in the wake of the "digital transition," in dialogue with historical examples of media change. From this perspective, media change is revealed to be a more complex

process, often more a matter of evolutionary stages than revolutionary moments. At the same time, my research seeks to acknowledge the fact that media have changed over time, and mechanical or digital technologies of information storage, transmission, and processing are largely incomparable with older practices of mediation. To address this bind, my research is in dialogue with scholarship on *Kulturtechniken*, or cultural techniques and technologies, a field still better known in Germany than in the United States.[5] The main insight of cultural techniques, overcoming previous accusations of "technological determinism" as well as debates about the validity of a technological a priori, is that there are no media as such.[6] Media only arise through techniques, inherited through culture, that govern common activities like reading, writing, and counting. These techniques, in turn, give rise to the distinctions at the heart of culture, such as inner and outer, signal and noise, or sacred and profane. Cultural techniques, in other words, are the medial practices that establish links in chains of human and non-human actors. In developing this approach, my research contributes to the field of German media studies a counterweight to work on new (visual) media, on the one hand, and a method for dealing with mediality in historical contexts that are presumed to be unmediated, on the other.

More specifically, my work on the historical emergence of wirelessness engages with a growing body of scholarship in Anglo-American media theory that has developed to deal with the problem of the visibility of infrastructures. Only when infrastructures malfunction do they receive public attention; otherwise, one of the defining characteristics of infrastructure is invisibility. With wireless technology, this invisibility is only partly due to the medium of transmission: even though the channel used in wireless transmission is itself invisible, the same need not be true of wireless infrastructures. As media theorist Lisa Parks observes, "We describe ourselves as a 'networked society' and yet most members of the public know very little about the infrastructures that support such a designation—whether broadcasting, web, or wireless systems."[7] For Parks, our widespread ignorance of networking technology is primarily a function of the increasing invisibility of that technology in the public sphere. Today, the cellular boom has created an increasing need for antenna stations with the result that many are disguised as natural objects, while others are jettisoned out of cities: mobile antennas are increasingly packaged inside, rather than outside, of consumer electronics; antennas are shot into orbit on satellites; cellular towers are driven out into the suburbs, or hidden in plain sight inside sailboat masts, barn silos, bell towers, flag poles, church spires, or summit crosses; and artificial structures are designed to resemble natural objects, such as the strange case of "antenna trees."[8] The displacement of technology and the emphasis on immaterial infrastructures, as Peter Schaefer adds, "promote a

5. See Siegert, *Cultural Techniques*.

6. See Eva Horn, "Editor's Introduction: 'There Are No Media.'" *Grey Room* 29 (2007): 6–13.

7. Lisa Parks, "Around the Antenna Tree: The Politics of Infrastructural Visibility," *Flow* 9, no. 8 (2009), http://flowtv.org/2009/03/around-the-antenna-tree-the-politics-of-infrastructural-visibilitylisa-parks-uc-santa-barbara/

8. See ibid.; cf. S. Sreevidya, and N. Subramanian "Aesthetic Appraisal of Antenna Towers," *Journal of Architectural Engineering* 3 (2003): 102–8.

teleological narrative of physically connected data transfer systems progressing to lighter, cleaner networks that are increasingly disconnected from the natural world."[9]

Today, many advocates of wireless convergence believe that wireless infrastructures will eventually replace their wired counterparts, thereby increasing access, reducing costs, and removing the necessity of a material support for digital technology. Though we may have long seemed headed for a wireless age, it remains highly unlikely that wired and wireless networks, two distinct conceptual and historical phenomena, will ever fully converge in a common *wireless* architecture, due primarily to the scarcity of desirable frequencies in the radio spectrum.[10] To counter these assumptions, media theorists like Parks and Schaefer have recently taken to showing the material underpinnings of what are usually perceived to be immaterial technologies. After exposing the common governmental practice of concealing infrastructures inside "antenna trees," Parks has drawn on fieldwork and historical maps showing "signal territories" with the aim of increasing technological literacy about network infrastructures.[11] Adopting a similar approach, Nicole Starosielski has examined the history of undersea fiber-optic cables in *The Undersea Network*, a book accompanied by an interactive digital mapping utility.[12] Operationalizing Adrian Mackenzie's theory of wirelessness, Jussi Parikka has illuminated the critical engineering practices informing the Weise 7 group's wireless devices.[13] Many of these strands were brought together in a special issue of *Amodern* on "Network Archaeology," which made a plea for expanding the field of media archaeology from objects and artifacts to include the study of networks and the history of connections.[14] In *Tubes: A Journey to the Center of the Internet*, journalist Andrew Blum helped popularize some of this work with a mixture of reporting on data centers, underground fiber-optic cables, and the engineers who construct and operate them.[15] In German, the title of this book was translated as *Kabelsalat: Wie ich einem kaputten Kabel folgte und das Innere des Internets entdeckte*.

To these studies, I add that significant historical alternatives to today's strategies of concealment and displacement can be found in previous attempts to come to terms with the place of wireless technology in the public sphere. In many respects, what I would call "Wilhelmine Wireless" was a response to what Tom Standage calls the "Victorian Internet."[16] My main argument here is that even though wirelessness may itself seem invisible, the same is not necessarily true of wireless infrastructures. Since modern wireless telecommunications rely on the invisible medium of electromagnetic waves, they were unable to draw on the dominant iconography of network infrastructure, such as cables, switches, and transmitters, commonly found in representations of wired systems.

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9. Schaefer, "Dematerialized Infrastructures," n.p.

10. See William H. Lehr and John M. Chapin, "On the Convergence of Wired and Wireless Access Network Architectures," *Information Economics and Policy* 22, no. 1 (2010): 33–41.

11. Parks, "Earth Observation and Signal Territories."

12. Nicole Starosielski, *The Undersea Network* (Durham, NC: Duke University Press, 2015).

13. Jussi Parikka. "Critically Engineered Wireless Politics." *Culture Machine* 14 (2013): 1–26.

14. "Network Archaeology," ed. Nicole Starosielski, Braxton Soderman, Cris Cheek, special issue, *Amodern* 2 (2013). http://amodern.net/issues/amodern-2-network-archaeology/

15. Andrew Blum, *Tubes: A Journey to the Center of the Internet* (New York: Ecco, 2012).

16. Standage, *The Victorian Internet*.

However, wireless infrastructures remained "visible" in another sense—namely, in that they were a highly symbolic means of negotiating the modern politics of visibility. At once material and invisible, wireless media ultimately encourage us to rethink the common visual and conceptual paradigm of what it means to be modern.

Media convergence, too, is itself a topos common to transitional periods when the stability of an established medium seems threatened by the introduction of another medium capable of performing a similar function. From the 1890s to the 1910s, wireless transmission was generally conceived as a replacement for its wired counterparts, as evident in the media topos of a wireless age. By the 1920s, when considering the question of media convergence, many commentators drew the conclusion that wireless technology would not simply replace wired technology. Though fascinated by the contemporary "wireless craze" (drahtlosen Wahnsinn), in 1925, Paul Fischer did not assume that wireless transmission would necessarily relegate the wire to the dustbin of history. Rather, "The lines with and without wire will continue to exist next to each other, just like the railroad, which runs on tracks, does alongside free-moving cars. Newspapers, too, will not suffer any loss due to the radio, just as the telegraph and the telephone have not made sending letters superfluous."[17] In retrospect, Fischer's comments about the survival of railroads and the postal service may appear somewhat naive. However, they also contain a crucial insight about media change that resonates surprisingly well with more recent studies of media change: "From this perspective, the new medium—radio—does not replace the preceding one, but rather adds to [*ergänzen*] the old medium, which then continues to exist alongside it with a different function."[18] Immobile means of transportation like the railroad assume a different function within a transportation system that includes mobile means like the automobile, as does wired transmission within a communications system that includes wireless.

As Kurt Riemenschneider emphasized, again in 1925, the application of wireless technology makes sense not only for telecommunication, where it performs a similar function to wired transmission, but also in a variety of other cases where the installation of wires would be impractical or impossible, such as radiolocation and radionavigation, emergency distress signals at sea, wireless services in the air, time signal services, and the distribution of particular news services like entertainment radio. For Riemenschneider, however, wireless technology could never fully replace wired communication, because supply would eventually be outpaced by demand: "Only a relatively narrow band of disturbance-free waves exist," which cannot cover the "need for international communications."[19] Today, the caveat would have to be added that the problem is not

17. Paul Fischer, *Die drahtlose Telegraphie und Telephonie: Ihre Grundlagen und Entwicklung* (Leipzig: Teubner, 1925), 104. "[D]ie Linien mit und ohne Draht nebeneinander bestehen bleiben werden, ebenso wie die Eisenbahn, die auf Schienen läuft, neben den freibeweglichen Autos. Auch die Zeitungen werden durch den Rundfunk keine Einbuße erleiden, ebenso wenig wie der Telegraph und das Telephon den Briefverkehr überflüssig gemacht haben."

18. Ibid. "Das neue Medium – der Rundfunk – löst aus dieser Perspektive also nicht das vorhergehende ab, sondern ergänzt dieses, welches dann mit einer anderen Funktion neben ihm bestehen bleibt."

19. Kurt Riemenschneider, *Drahtlose Telegraphie und Telephonie: Ihre geschichtliche Entwicklung vom Feuertelegraphen bis zur Hochfrequenzmaschine* (Berlin: Richard Carl Schmidt, 1925), 293. "[N]ur ein verhältnismäßig schmales Band störungsfreier Wellen vorhanden."

necessarily the mutual interference of stations, nor the availability of broadcasting channels per se, but rather the availability of *desirable* frequencies in the radio spectrum. With this caveat, Riemenschneider's conclusion remains valid: wired and wireless will "effectively complement [*ergänzen*] each other."[20]

In 1935, Heinrich Werner Bronk summarized the debate about "whether cable or wireless will emerge as the victor out of their mutual competition," and sided with the then-current consensus, namely, "that cable and wireless do and must complement [*ergänzen*] each other."[21] What spoke against the idea of wireless convergence, for Bronk, was primarily the observation that wires keep being installed for intercontinental undersea traffic, a trend that continues today. Even though long-distance wireless transmission had advanced to the point where it was no longer restricted to night-time operational hours due to the presence of favorable atmospheric conditions during that time of day, several limitations were still inherent in the communications technology itself. Admittedly, "the practically unlimited range and omnidirectional propagation of electromagnetic waves make it possible to send a message without any relay stations 'to everyone,'" whether on the land, the sea, or in the air. However, the use of wireless as a medium of universal broadcasting came along with several drawbacks, which needed to be curtailed: "What is important is that the circular effect of wireless telegraphy, which is undesirable for many purposes, can be limited to various zones (e.g., short-waves, directional antennas) and the secrecy of wireless messages can be achieved sufficiently (e.g., the 'Enigma' cipher machine; the Siemens Schnellschreiber)."[22] Shortly after this observation, these two machines, the Hellschreiber and the Enigma machine, would become the driving forces of National Socialist wireless politics during World War II, enabling the coordination of Blitzkrieg on all fronts. Not all wireless futures necessarily materialized in the form of a utopia, and yet there remain fragments of utopian potential in every wireless future that never came to pass.

"Going wireless" involves not only the elimination of wires, but also the production of electromagnetic waves. The main argument at the heart of this work is based on a similar observation made by the cultural pessimist and philosophical anthropologist Helmuth Plessner in "Die Utopie in der Maschine" (The utopia in the machine, 1924). In the year of the first nationwide radio broadcasts in Germany, Plessner was already able to view a future of wireless technology from the perspective of the deep time of the media: "We think that after the radio and airplane things will soon stoop, humanity will have had enough and put the toys of accelerated tempo in the museums of the nineteenth, of the twentieth century, […] that everything will one day have an end, the human being already

20. Ibid., 295. "[G]egenseitig wirkungsvoll [...] ergänzen."

21. Heinrich Werner von Bronk, *Über die geographische Bedingtheit des elektrischen Weltnachrichtenverkehrs* (Berlin: Thormann & Goetsch, 1935), 11. "Immer wieder Anlaß zu Erörterungen hat die Frage gegeben, ob Kabel oder Funk als Sieger aus einem gegenseitigen Wettbewerb hervorgehen werden. Heute gilt allgemein, daß Kabel und Funk einander ergänzen werden und müssen."

22. Ibid., 12. "Wichtig ist, daß die für viele Zwecke unerwünschte Zirkularwirkung der drahtlosen Telegraphie zonenmäßig beschränkt (Kurzwellen, Richtstrahler) und die erforderliche Geheimhaltung heute ausreichend erzielt werden kann (Chiffriermaschine 'Enigma', Siemens-Schnelltelegraph)."

having been driven too far away from his essential center."[23] Though not intended as a comment on wireless technology, Plessner's reflection on the figures of "the circle" and "the line" registers the crucial shift from wireless telegraphy, as a point-to-point connection, to omnidirectional broadcasting, as a radial transmission, still evident today in the popular symbol for Wi-Fi: "The symbol of the communal human being is the circle, the completion of fullness and order in being, the work. These people know how to connect themselves to Antiquity, the Middle Ages. Whatever serves the circle despises the line, perpetual forward motion, the lack of a present [*Gegenwartslose*, alternately, "the lack of presence"], action, pushing, bumping, building and tearing down, achievement, progress."[24] For Plessner, the group most attracted to the circle at the time was the (Catholic) socialist youth of the Weimar Republic, who were attempting to create a new form of community against the machine's ethos of (Protestant) work and progress. To Plessner, only two paths to redemption from the pressures of industrialization, rationalization, and mechanization seemed possible: the "grandiose destruction of the machine," the already dated tenant of the Luddites; or, the "development of its inner principles of work into qualitatively higher types of machines, which will set more people free precisely because they will replace them, and leave the rest of people to greater oversight and responsibility for their operation."[25] The utopia of machines, then, would put an end to alienated labor through a new form of self-production, exemplified by the natural production of electromagnetic radiation, in contrast to the exploitation of other natural energy reserves.

For Plessner, the shift from wired to wireless transmission signaled a greater shift in anthropological history. Going wireless served as a sign, not of overcoming space and time through telecommunications, nor of uniting the world through a form of global connectivity, but of the increasing penetration of nature with imperceptible technology:

> For a century, human beings have been systematically transforming the power sources of existence, emancipating themselves more and more from the particular, localized energy deposits that force them to ruthless depletion, and developing deeper sources of energy in the elements of matter that are present and the same everywhere.

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23. Helmuth Plessner, "Die Utopie in der Maschine," [1924], in *Schriften zur Soziologie und Sozialphilosophie*, vol. 10 of *Gesammelte Schriften*, ed. Günter Dux et al (Frankfurt am Main: Suhrkamp, 1980), 31. "Wir denken, es werde bald hinter Radio und Flugzeug und Unterseebooten aufhören, die Menschheit werde genug haben und die Spielzeuge des Eiltempos in die Museen des neunzehnten, zwanzigsten Jahrhunderts stellen […] Alles werde einmal ein Ende haben, der Mensch sei zu sehr von seiner wesentlichen Mitte aus religiöser Zentrierung abgetrieben. Warum Fernhörer, Fernseher die ganze Welt gewinnen, wenn man Schaden an seiner Seele nimmt."

24. Ibid., 32. "Alles was zur Gemeinschaftswelt hin will, verachtet die schlechte Unendlichkeit des immer und ins Endlose Fortschreitens, Weitergehens, das sich in ewig unlösbare Aufgaben Stürzen. Das Symbol des Gemeinschaftsmesnchen ist der Kreis, die Vollendung Fülle und Ruhe im Sein, das Werk. Er weiß sich der Antike, dem Mittelalter verbunden. Was dem Kreis dient, verachtet die Linie, das ewig sich aus sich Fortspinnende, das Gegenwartlose, die Rastlosigkeit, das Tun, Drängen, Stoßen, Bauen und Einreißen, die Leistung, den Fortschritt."

25. Ibid., 36–37. "[G]randiose Zerstörung der Maschine oder Entfaltung ihrer inneren Arbeitsprinzipien zu qualitativ höheren Maschinentypen, die mehr Menschen freigeben, weil ersetzen, und dem gebunden Rest größere Übersicht und Verantwortung bei ihrer Bedienung überlassen."

> Technology is steadily intensifying in that it passes over to an ever purer penetration of the natural cycle of energy with the human cycle, to an ever greater release of human beings from unused expenses of energy, to an ever more regular accompaniment of humanity through nature. In this way, for example, *wires are disappearing, and in their place, electric waves themselves provide for the transmission of energy*. The bourgeois ideology of progress is only very limitedly prepared for this utopia in the machines, this driving self-production of an always new, eternal future, since naturally it affects the private capitalistic basis of their existence.[26]

In preparing for this utopia of the machine, exemplified by the energy universally available in electromagnetic radiation, the task then set by Plessner, as in many early twentieth-century socialist utopias, is to pave the way for "the new human being" (der neue Mensch). There is no way to escape the machine and return to the fields, as Plessner points out: "They are not letting us go, and we are not letting them go. With mysterious violence, they are in us, we are in them."[27]

26. Ibid., 37–38, emphasis added. "Seit einem Jahrhundert verändert der Mensch systematisch die Kraftquellen seiner Existenz, emanzipiert sich mehr und mehr von bestimmt lokalisierten Energievorkommen, in denen er Raubbau zu treiben gezwungen ist, und erschließt sich tiefere Energiequellen in den überall gegenwärtigen und gleichen Elementen der Materie. Stetig intensiviert sich die Technik, indem sie zu immer reinerer Durchdringung des natürlichen mit dem menschlichen Energiekreislauf, zu immer größerer Entlastung des Menschen von unnützen Kraftaufwänden, zu immer planmäßigerer Mitführung des Menschen durch die Natur übergeht. So etwa verschwinden die Drähte, an deren Stelle die elektrischen Wellen die Übertragung der Energie selbst besorgen. Auf diese Utopie in den Maschinen, auf diese treibende Selbstproduktion einer stets neuen, sich ewigen Zukunft ist die bürgerliche Fortschrittsideologie nur sehr bedingt eingestellt, da natürlich ihre privatkapitalistische Existenzbasis davon betroffen werden wird."

27. Ibid., 38. "Sie geben uns nicht frei und wir geben sie nicht frei. Mit rätselhafter Gewalt sind sie in uns, wir in ihnen."

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