1

Before the Broadcast Era: 1900–1910s

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How did radio get started in the United States, and how did it evolve from, first, wireless telegraphy, then wireless telephony and, finally, broadcast radio? Until the mid-1980s, there was minimal serious historiography of radio in general, and early radio in particular. The best known and most widely used source was the first volume in Erik Barnouw's trilogy on the history of broadcasting, *A Tower in Babel* (1966) (discussed in Chapter 20 by Gary Edgerton, this volume). Daniel Czitrom also provided a brief account of this era in *Media and the American Mind* (1982). The only other accounts of radio's "prehistory," when the device was known as wireless telegraphy and was used to transmit Morse code messages, were non-academic and often gushing accounts of the invention in books with titles like *Old Wires, New Waves* (Harlow 1936). Gleason Archer's *History of Radio to 1926*, published in 1938, while containing some important history, offered an overly generous account of the role that the Navy, and especially David Sarnoff, president of RCA, played in radio's early development and was, by turns, untrustworthy or inaccurate. And Rupert Maclaurin provided an early technical history in *Invention and Innovation in the Radio Industry* (1949).

But beginning in 1976, with the publication of Hugh Aitken's *Syntony and Spark* (1976), a technical history of the development of wireless, and followed by his prize-winning *The Continuous Wave* (1985), a new era of wireless and radio historiography began. My own *Inventing American Broadcasting* came out in 1987 – and is discussed in Chapter 21 by Shawn VanCour, this volume – followed by work, primarily on the broadcast era, by Robert McChesney (1993), Susan Smulyan (1994), Michele Hilmes (1997), and others. By the 1990s, two new fields, radio studies and sound studies, had emerged from this work. The majority of work on radio focused on the post-1920s broadcast era.

Why was radio's early history ignored? The "radio boom" of the 1920s seemed so sudden, the diffusion of the device so dramatic, and the entry of voice and music into people's homes without any connecting wires so miraculous (the word most frequently used at the time), that it eclipsed what came before. By contrast, the exchange of the Morse code between wireless operators could seem like an irrelevant prehistory with not nearly the cultural, political, and economic impact of radio. Yet by the 1970s, historians of technology were challenging the notion of technological revolutions, and also taking on the "Eureka" school of invention and its inventor-as-hero narratives that often accompanied such deterministic accounts of technical change. Scholars put

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technological determinism in the cross hairs. Now the emphasis was on technical evolution, and on the early histories of devices that led to seemingly sudden changes. The emphasis also changed from looking at the invention of individual devices – such as the light bulb, for example – to the development of technological systems within which such devices were embedded, refined, and marketed. A key figure in this shift was Thomas Hughes (1983) and the advancement of systems theory in books like *Networks of Power: Electrification in Western Society, 1880–1930*.

The 1970s and 1980s, then, saw the emergence of social constructivism – a focus on the role of struggle, negotiation, rejection, and subsequent new directions as inventors, companies, and everyday users interacted and competed over what final form an invention would take. Each of these social groups might have different technical goals or see different technical problems, and wrestle with them until "closure" is achieved and the thing that used to be the wireless telegraph became the thing people had in their homes: the radio. According to social constructivism, there is no predetermined, natural or inevitable way for devices or machines to evolve; rather, through this process some technical variants survive and flourish while others disappear. It was our job as historians to figure out why. The leaders in this historiographical shift were Trevor Pinch and Wiebe Bijker, whose 1987 edited collection *The Social Construction of Technological Systems* laid out this new theory of technological change. This prompted me as well as others, most notably Hugh Aitken, to study the twenty-five-year "prehistory" that culminated in what came to be called "the radio boom."

So what did we not know about the early history of radio – wireless telegraphy – in the United States? Little had been written about the detailed technical evolution of the invention, the false starts and mis-steps, as well as the major conceptual breakthroughs. A truly detailed history of the business strategies of the fledgling wireless firms that sought to diffuse and profit from the invention was also missing. Erik Barnouw's *A Tower in Babel* (1966) provided crucial information about Marconi's early work and the efforts of Reginald Fessenden and Lee de Forest to compete with him, but given the scope of his three-volume history, Barnouw only devoted thirty-eight pages to this phase of radio's history. The role of the US Navy in shaping the invention's development had been chronicled only in L. S. Howeth's *History of Communications-Electronics in the United States Navy* (1963), a little known book for specialists. And except for David Sarnoff's self-aggrandizing efforts to suggest that he, somehow, was the lone ham operator tracking the tragic fate of the *Titanic*, little had been written about the role of amateur operators ("hams") in shaping the evolution and uses of radio, or about the central role that the *Titanic* disaster and other shipwrecks played in determining the early and groundbreaking regulation of radio and the electromagnetic spectrum. Finally, radio did not enter people's imaginations *de novo* in the 1920s with the "radio boom." Press coverage, often breathless and utopian, of wireless began in the late 1890s and also shaped radio's uses, as well as its regulatory and corporate management.

One of the curses of radio history can be the shortage or absence of sources, especially about what went out "over the air" – or what was then called "the ether" – who heard what, and what they made of what they heard. In the case of radio's early history this is especially true. Radio historians have to be detectives, scouring multiple archives, and sometimes we have to create our own. It turns out that the early inventors produced significant correspondence as they sought to promote and manage their fledging businesses, and an early wireless enthusiast, George Clark, somehow got a hold of all

this correspondence and managed to save it in what came to be known as the Clark Collection. Yet such collections can be hard to learn about or find; Barnouw made no mention of it. I discovered it through Howeth's book, which said the collection was at MIT. It was not. After several inquiries with various MIT references librarians, I finally found one who remembered the collection: it was now at the Smithsonian.

The collection – hundreds of boxes – had not been catalogued and some of it was a mish-mash of RCA press releases intermixed with important memos, so the researcher had to check box after box to find relevant material. (Hugh Aitken and I met this way, both scouring the Clark Collection at, fortuitously, the same time.) But fortunately, much of the correspondence of the early inventors had been filed together, and this proved to be a treasure trove that Aitken and I mined to overlapping but different ends. A historian working through the faded copies of all of this material can be pulled into inventors' often passionate and self-aggrandizing points of view about their positions and contributions. Therefore, as Hugh Aitken reminded me as we compared notes and interpretations for our respective books, "always be skeptical of your sources!"

But I also became interested in the "bottom-up" story of wireless; I did not want to tell only the technical and business side of the story. How was this new device, first known as wireless telegraphy, received? What sense was made of it, what did people think it might do to their lives, to society and culture? How did these understandings and imaginings evolve over time, as wireless itself turned into radio broadcasting? This is where you have to complement the existing archives with those of your own. So even as I was tracking down and visiting institutional archives, I began to create my own, starting with the technical journals of the time such as *Electrical World* and *Scientific American* and moving onto the more popular press. We know that all archives are incomplete, have their own biases based on inclusion, omissions, and point of view, and the ones we make are no exception. But the ones we create can be, and should be, a counterbalance to those created by institutions and by political and corporate elites.

Except for "radio pioneers" who left behind memories of their experiences as amateur operators or broadcast radio's early days, there was, of course, no archive with everyday people's reactions to early radio. So newspapers and magazines had to serve as a proxy for these. But press accounts, first of wireless telegraphy and then later of radio, also played a central role in the social construction of radio in shaping people's expectations of these devices and what they might afford. So the press accounts were also important historical actors on their own. To build that archive, I went through every year of two hoary indexes (then bound in huge volumes) *The Reader's Guide to Periodical Literature* and *New York Times* index from 1896 (when Marconi first demonstrated his device in England) to 1924, when the radio boom was at its height. *Electrical World* was, blessedly, also indexed, so I could find each and every article written about wireless from 1896 up to the 1910s, which provided a detailed technical account of the various inventors, their components, their claims, and challenges to their claims. *Electrical World* in particular featured major debates among inventors and scientists about who had invented which components, how well they really worked, and what technical challenges remained unsolved. This is how you build a time-line. It was through this archive – the one I created – that the past communicated to me about what radio meant to people.

In the following pages, I will lay out the major historical questions about wireless telegraphy, the debates about them, and how they were or were not resolved.

Who Invented Wireless Telegraphy?

Debates – sometimes fierce – about origins, the "true" inventors, and the like surround most inventions; wireless telegraphy is no exception. The British physicist Oliver Lodge, the French inventors (and rivals) Rochefort and Ducretet, the Germans Slaby and Arco, and the Americans Nathan Stubblefield, John Stone Stone, and Nikola Tesla, among others, all either claimed priority or had it ascribed to them. And there were intense technical and business conflict and rivalries among them. But the man who put all the various components together (most of which he did not invent) was Guglielmo Marconi, an Italian-Irish inventor, who had both a technical plan and a marketing vision for the device. As Daniel Czitrom summarizes it in *Media and the American Mind* (1982): "Marconi should be viewed as the crucial innovator in wireless, not as its inventor [because] Marconi achieved the best practical results in wireless communication" (ibid.: 63). This is why, despite passionate claims of technical priority by others, historians have generally acknowledged Marconi as the "inventor" of wireless (Figure 1.1).

Hugh Aitken, for example, while acknowledging in great technical detail the contributions made by others, saw Marconi as a shrewd "translator" of knowledge and expertise between the realms of science, technology, and the economy (Aitken 1985: 20). He emphasized the importance of Marconi's use of vertical antennas as essential to extending transmission distance and, crucially, his gift as an entrepreneur (ibid.: 26, 201–202). It was Marconi who first really publicized the invention through dramatic public demonstrations in Britain and the United States, and who promoted his system as filling a communications gap between ships at sea, ship-to-shore, and island-to-mainland. It was Marconi who combined various transmitting and receiving devices

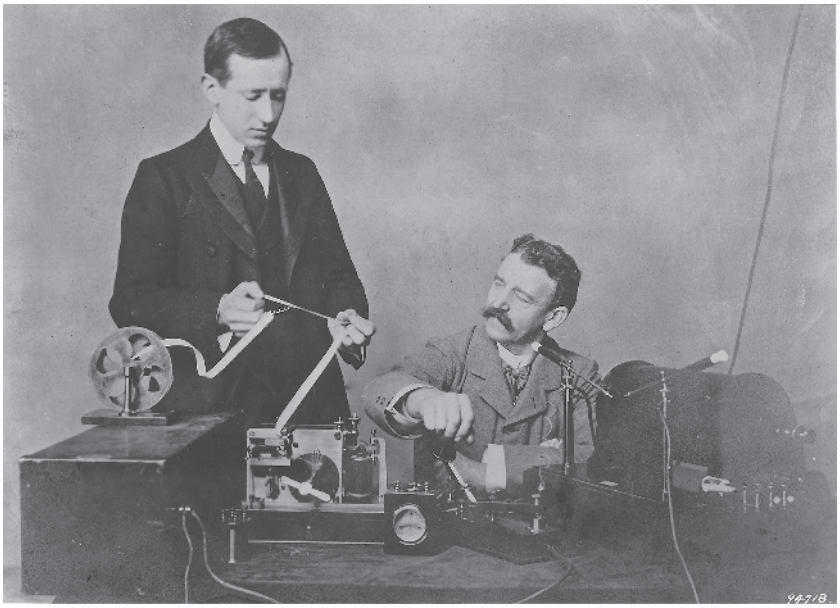


Figure 1.1 Guglielmo Marconi and his assistant George Kemp demonstrating his invention. *Source:* Author's personal collection.

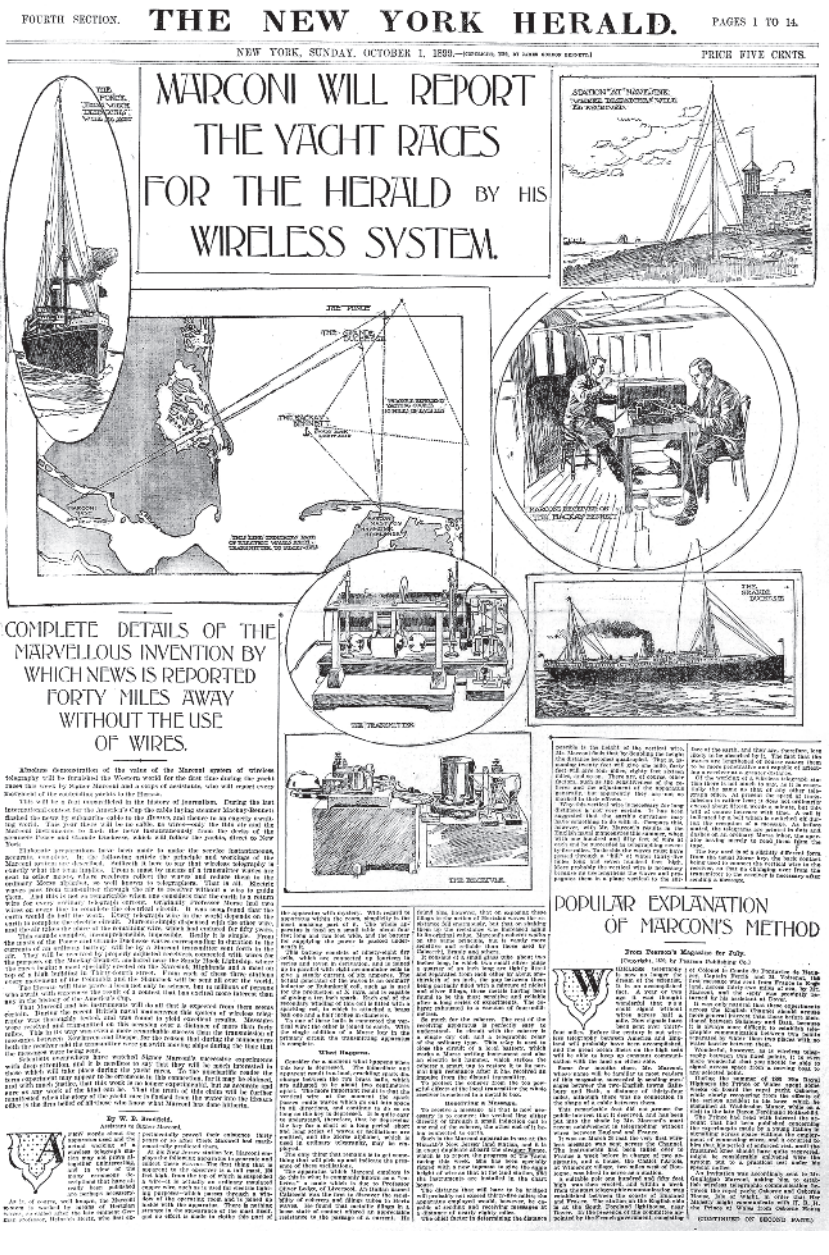
into a system that could send and receive Morse code through the electronic spectrum without connecting wires. Marconi's initial system sent bursts of energy – intermittent waves – through the spectrum onto which dots and dashes were superimposed. And Marconi built a very particular business model, not surprisingly, along the same lines as the telegraph: to provide point-to-point communication between a specific sender and a specific receiver. It was this business model that accounted for the Marconi Company's initial success, and yet also blinded Marconi to radio's eventual, primary use as a one-to-many form of communication. For all these reasons – combining various components into a system that was supported by a canny marketing model that both succeeded and earned for him the title of the device's creator in the press – Marconi retains the "inventor" mantel.

What was the Initial Response to Wireless Telegraphy?

The question of responses to new communications technologies is discursively and historically important because it can shape subsequent uses, applications and even funding models, and involves various institutions and individuals. And often, as Daniel Czitrom in *Media and the American Mind* (1982), Claude Fischer in *America Calling: A Social History of the Telephone* (1992), Jeffrey Sconce in *Haunted Media* (2000), and others have shown, responses can range from utopian – the device will reduce misunderstandings, lead to world peace – to dystopian – the device will invade our privacy, disrupt social relations, further endanger people, and the like. Both kinds of predictions rest on technological determinism. Fischer, for example, found concerns that the telephone might break up old friendships because people would no longer visit each other, and debates about whether the device would make people more active or more lazy (Fischer 1992: 1). One fantasy about wireless, as Czitrom notes, was that it would enable "universal communication" among friends and family separated by space and time and by increased industrialization and urbanization (Czitrom 1982: 67). Thus, it would reduce isolation and loneliness and further cement social relations. And Jeffrey Sconce in *Haunted Media* notes how people saw various electronic media, including radio, as providing entry to a spiritual, paranormal realm. With wireless and radio, one utopian hope was that through the devices, people might be able to commune with long lost relatives and friends. What was important to explore, then, was how the press, the US Navy, rival inventors, corporate interests, and everyday people all responded to the invention and its potential in various ways that contributed to the social construction of this new communications system.

At the invitation of James Gordon Bennett, publisher of the *New York Herald*, Marconi first demonstrated wireless telegraphy in the United States during the America's Cup yachts races of 1899 in New York harbor to show how a ship equipped with the device could send messages to shore about the progress of the race. Because the races were avidly followed and because they were a major media event, Marconi and his device got prominent, front-page coverage. Newspapers were especially keen to explore the invention, because they felt the existing telegraph and underwater cable charges for the transmission of news reports were too high. Despite erratic performance, the *Herald* proclaimed that the wireless bulletins "worked like magic" and trumpeted the experiment a "triumph" (G. H. Douglas 1987: 19). The *New York Times* followed suit,

rhapsodizing about the new ability to "launch our winged words" (ibid.: 23). Marconi was a deft promoter of his device, charming and flattering reporters, and the papers were keen for a competitor to the telegraph and cable companies. They fanned enthusiasm for him and his system. As a result of such press accounts, Marconi became a celebrity, an "inventor-hero" in the mold of Thomas Edison, which boosted his


FOURTH SECTION. THE NEW YORK HERALD. PAGES 1 TO 14.

NEW YORK, SUNDAY, OCTOBER 1, 1899.— PRICE FIVE CENTS.

MARCONI WILL REPORT THE YACHT RACES FOR THE HERALD BY HIS WIRELESS SYSTEM.

COMPLETE DETAILS OF THE MARVELLOUS INVENTION BY WHICH NEWS IS REPORTED FORTY MILES AWAY WITHOUT THE USE OF WIRES.

POPULAR EXPLANATION OF MARCONI'S METHOD

Figure 1.2 The American press was an ardent supporter of Marconi and his invention: *The New York Herald*. *Source:* Author's personal collection.

business and guaranteed fawning press coverage of subsequent (and well-staged) technical achievements. These press accounts also suggested that this could be a profitable new area of technical development, prompting other inventors to enter the field (Figure 1.2).

What Were the Early Technical Challenges for Wireless Telegraphy?

Marconi's, as well as others', early devices sent signals in all directions – that is how radio waves travel – so their destination could not be controlled. Because these were intermittent waves or bursts of energy, the signals weakened or attenuated – like the ripples after a stone is thrown into a pond – as they moved away from the source of transmission. The receiver Marconi used, the coherer, was slow and capricious, detecting some signals and then going dead or picking up noise. So reception was erratic. And there was no tuning. Sir Oliver Lodge had developed a method of tuning he called "syntonic wireless" in 1897. Marconi studied his method and sought to improve upon it, patenting his own method of tuning in 1900. Nonetheless, these weaknesses provided openings for competitors, especially in the United States, who would transform the device into what came to be known as radio.

Hugh Aitken had an especial advantage here in writing about wireless because he was a devoted ham operator and thus had an intimate knowledge of radio's workings. This created challenges for those of us with minimal technical expertise – like me. I had to school myself by reading the technical accounts and debates of the time in publications such as *Electrical World* in a step-by-step fashion and also go to wireless museums to study the technology. It was invaluable to me at the time to go to places like the New England Wireless and Steam Museum in Rhode Island where I got to see various devices demonstrated. Even then, it can be daunting for historians not also trained in science or engineering to do justice to the technical challenges inventors faced and the successes they achieved. (This is an issue Susan Murray also discusses in Chapter 9, this volume.)

How Could You Make Wireless Telegraphy Pay?

This was not an insignificant challenge for wireless entrepreneurs. Because radio waves travel in all directions, anyone with a receiver can pick them up. And if you sold a client a transmitter and a receiver, this would be a one-shot source of revenue. But also, clients did not want to build and staff their own network of wireless stations; the Marconi Company would do that. The business plan Marconi devised was creative, disingenuous, and modeled after the telegraph and telephone companies. He would only lease equipment to clients, providing them access to "the Marconi system," which would include land and shipboard stations and their operators. And he claimed, falsely, that the wireless equipment of his competitors was unable to communicate with his equipment. To ensure this, he imposed a "non-intercommunication rule," whereby Marconi operators on ship or shore would communicate only with other Marconi operators. Only in the event of an emergency would this rule be suspended. Marconi, and then his

American competitors, was also convinced that establishing a transatlantic service for newspapers and businesses could be a significant source of profit (Aitken 1976: 234; G. H. Douglas 1987: 71).

Who Were the Early Adaptors of Wireless Telegraphy?

Newspapers like the *New York Herald* and the *New York Times* considered the prices charged for transatlantic news via the underwater cables to be extortionate, and the cable companies faced no competition. In addition, by the turn of the century, Western Union was one of the country's most resented monopolies, cast as a "monopolistic serpent," for example, by the *New York Times*. So these large, New York-based papers began to adopt wireless to promote stories received by wireless, and to predict – prematurely – the advent of a regular, transatlantic service via wireless, which became increasingly regularized around 1907.

Commercial steamship companies, particularly those like the White Star Line catering to an upscale clientele, especially took note of the invention. In the first decade of the twentieth century these shipping companies began to adapt the device for ship-to-shore and inter-ship communication.

The US Navy, a potentially obvious client, was more cautious, in part because wireless telegraphy had the potential to override a ship commander's authority with orders from someone on shore or on another ship, and the ship commander's autonomy was highly prized. Yet the US Navy did not have a reliable and versatile method of communication that could keep ships in touch with each other (especially for coordinated maneuvers) or with the shore; it relied on line-of-sight flag signaling by day and light signaling by night. But at the turn of the century, the United States, with its interventions and victories in the Philippines and the Spanish–American War, was becoming an imperial power, competing with European countries over foreign possessions and influence. These other navies – British and German, for example – were acquiring wireless and the United States could not afford to fall behind. Yet various naval officials had concerns about the system's reliability, and the cost and restrictions of Marconi's policies – especially his lease-only contract. Here, rival inventors saw an opening. But throughout the first decade of the twentieth century, the Navy began equipping their ships with wireless, establishing shore stations, especially at navy yards in major ports, and training their own wireless operators (Howeth 1963; Aitken 1985; Douglas 1987).

How Did Other Inventors Seek to Challenge and Improve upon Marconi's Device?

Two main competitors in the United States, Reginald Fessenden and Lee De Forest, worked in the first decades of the twentieth century to try to improve upon and compete with Marconi. Fessenden concentrated on transmission and De Forest on reception; they were fierce rivals. And with De Forest in particular, historians have debated about the extent of his technical expertise and contributions (Aitken 1985; Douglas 1987). As Tom Lewis noted in *Empire of the Air* (1991), while De Forest in 1906 introduced the three-element "audion" tube, "his public statements clearly indicated that he did not

understand how it worked" (69). But both men played a central role in seeking to move away from wireless telegraphy – the transmission of Morse code – to wireless telephony, the transmission of music and the human voice.

Prior to Aitken's *The Continuous Wave* (1985) and my own *Inventing American Broadcasting* (1987), there were only limited accounts of the work of these two men, except those they themselves or their partisans offered. Fessenden's wife Helen wrote *Fessenden: Builder of Tomorrows* (1940), and De Forest published a ghost-written book *Conqueror of Space: the Life of Lee De Forest* (1930) and then his autobiography, *Father of Radio* (1950). These were, not surprisingly, highly self-promotional and not terribly reflective about either man's failings. Such accounts can still offer important information, including about thought processes and motivations, hopes and grudges, but they obviously must be taken with the proverbial pinch of salt.

However, the Clark Collection at the Smithsonian Museum, Marconi's papers that I found in his daughter's private collection, along with those those of his companies at the Marconi Co. Ltd. in Chelmsford, England, and the National Archives, which house the records of the US Navy, all provide a mosaic of accounts that the historian must juxtapose and seek to make sense of. How much of the self-aggrandizing accounts by inventors and their advocates about their technical achievements can be trusted? How do those square, say, with records of how naval officials reported the devices actually worked under test conditions? Inventors, in their letters to various actual and potential clients, boasted about performance and service, while a look at naval records in the National Archives reveal keen exasperation with both – and with the attitudes of the inventors. As a historian working in one archive you may find yourself sympathetic to one set of actors and then, when working in another, find yourself sympathizing with a very different set of actors with often conflicting values and goals. Trying to get at historical accuracy involves triangulating – or more – all the accounts you find. Ultimately, something that resembles what you trust to be "the truth" emerges. And, of course, you can still be wrong.

Reginald Fessenden, a professor of electrical engineering hired by the US Weather Bureau to explore the value of wireless telegraphy, focused on transmission and how to produce what would come to be called "continuous waves." Unlike Marconi's transmissions, Fessenden wanted to produce a sustained transmission of the same wavelength that could carry not just intermittent dots and dashes but music and voice also. In 1902, he partnered with two bankers to form the National Electric Signaling Company (NESCO) and the following year began working with General Electric (GE) to develop a machine – the alternator – that could produce continuous waves. Partnering with GE's Swedish engineer Ernst Alexanderson, Fessenden's alternator was a revolutionary machine that helped transform wireless into radio. The alternator was quite complicated and extremely expensive to produce.

On Christmas Eve 1906, Fessenden claimed he had used the alternator to transmit a holiday broadcast of violin music, phonograph records, and a speech from his station on the coast of Massachusetts. While there has been some dispute about whether this transmission occurred, or was actually ever heard by anyone, given the virtually non-existent records from any listeners, and zero press coverage, it is still regarded as the first radio broadcast in US history (Aitken 1985: 74; Douglas 1987: 156; Lewis 1991, 73). Fessenden eventually parted ways with his backers, and Alexanderson at GE continued to improve on the alternator up to and through the First World War, which is why the generator came to bear his name.

Meanwhile, Lee De Forest concentrated on the reception of radio waves, and in 1906 introduced the "audion," precursor to the vacuum tube. Involved in various shady scams to sell bogus stock in fly-by-night wireless companies, De Forest was nonetheless the inventor most dedicated to the concept of broadcasting music, especially to everyday people via radio. As Tom Lewis put it succinctly, despite various failed companies, charges of defrauding investors and violating others' patents, "De Forest placed his emphasis on broadcasting culture to the masses" (1991: 79). With subsequent improvements to and discoveries about the capabilities of the vacuum tube, both by De Forest and by Edwin Armstrong, then working for AT&T, both men observed that the vacuum tube could also be used to generate radio waves as well, a momentous discovery that dramatically reduced the size and cost of radio transmitters. Even then, as Aitken points out, it was not at all clear that De Forest "knew what he was doing" (Aitken 1985: 242) and it was clear that Armstrong did. Tom Lewis, in particular, chronicles the decades-long animosity between De Forest and Armstrong over priority of developing and recognizing the vacuum tube as a radio transmitter as well as receiver.

If Wireless Telegraphy was Socially Constructed, What Other Actors Played a Role in its Evolution?

In addition to the press, steamship companies, the navy, competing inventors, and emerging corporate interests, another group emerged beginning in 1906–7 to make use of the device – amateur operators, eventually referred to as "ham" operators. The discovery that inexpensive crystals could be used to receive wireless signals and the promotion of tinkering with wireless as a fun hobby for boys and young men, led to the rise of a ham radio subculture in the United States, especially in port towns where you might hear ships at sea. The few histories of early radio that did exist prior to the 1980s paid scant attention to the role of amateur operators in shaping the evolution of wireless into radio. The one book that did was Clinton De Soto's *200 Meters & Down: the Story of Amateur Radio*, self-published by the ham organization the American Radio Relay League in 1936. A ham operator himself, De Soto chronicled the rise of the hobby and wireless clubs and also admitted to the mischief and congestion caused by hams when there was minimal tuning and commercial or naval stations wanted to send messages. Estimates of how many there were vary and are hard to corroborate, ranging from tens of thousands to hundreds of thousands, but as De Soto asserted, "it was the ham operator who dominated the air" (De Soto 1936: 28) (Figure 1.3).

Beyond De Soto's book, there was minimal secondary source material in other histories about the amateur operators; one had to go to newspapers and magazines, which, in my case, involved creating my own archive about wireless and popular culture. And what I discovered was that the amateur operator, especially between around 1907 and 1912, had become something of a journalistic fascination, with stories about "boy" heroes mastering the "new wonders of wireless" (Douglas 1987: 187). This led me to explore juvenile literature like *Tom Swift and his Wireless Message*, as well as similar magazine articles aimed at boys, to capture the romance about the hobby that helped propel so many into it. These magazine and newspaper articles especially, however florid, were invaluable sources about the everyday technical and social practices of this crucially important group of hobbyists. And they also revealed how much the popular

Figure 1.3 "Ham" operators, mostly boys and young men, played a central role in the evolution of wireless into radio. *Source:* Author's personal collection.

press latched on to and promoted the hobby that had not really been appreciated before by historians (Figure 1.4).

The hams built their own sets and formed an incipient broadcast network, sharing everything from homework questions to sports scores to technical information. They also formed wireless clubs all over the country with the Junior Wireless Club, Ltd. in New Jersey being one of the first in 1909. That same year Hugo Gernsback, proprietor of an electrical supply store, founded the Wireless Association of America; by 1912, the *New York Times* estimated there were 122 such clubs in the United States (Douglas 1987: 205).

So why did these young enthusiasts matter? First of all, they formed the first, embryonic broadcast network *and* audience. They sent and received messages and eventually some of them experimented with sending voice and music. They eavesdropped on other messages, particularly those sent by the US Navy or ocean liners. Thus, they demonstrated early on that the way Marconi was promoting the device – for point-to-point communications – was too narrow a vision that sought to ignore, even deny, radio's one-to-many affordances. They showed that there was indeed a hunger for, and a fascination with, hearing messages through "the air" without connecting wires.

But their activities also demonstrated quite clearly, as will be discussed in the next sections, that radio transmissions would have to be regulated to actually operate for the public good. In *Ham Radio's Technical Culture* (2007), Kristen Haring sought to provide

Figure 1.4 Wireless operators became national heroes when they used the device to save lives during shipwrecks. *Source:* Author's personal collection.

a broader overview history of ham radio, the centrality of technological "tinkering" and practice to identity formation for some, and the hams' ongoing battles and negotiations with the government as they sought to preserve room for their hobby in the electromagnetic spectrum.

What Regulatory Challenges did Wireless Telegraphy Evoke?

Unlike the telegraph and telephone – which raised their own problems with the proliferation of poles and wires – wireless signals obeyed no boundaries. They traveled across state and national lines and, prior to truly sophisticated tuning and the allocation

of frequencies to stations, could interfere with each other. At the same time, the ability to send rapid messages through "the air" without wires could be of enormous value during emergencies. What role should governments have in regulating who got to transmit what, when and where? Should some entities have priority over others?

What Prompted Regulation?

The answer here is simple: shipwrecks and the activities of the ham operators. Increased ham activity produced escalating congestion and interference, especially given the still crude state of tuning, and while the US Navy had been slow to integrate wireless into its operations at first, by the end of the first decade of the twentieth century, it had begun using the device much more frequently and had established stations in key ports around the country. Bored commercial wireless operators on ship and at shore stations exchanged messages with the hams to pass the time and maintain their skills. Around 1910, various navy wireless operators and officials began complaining about the congestion and more: some hams began sending false or obscene messages to navy operators. They would pose as military officials or commercial operators and dispatch naval ships on all sorts of fabricated missions. The temptation to defy authority was irresistible for some, especially as detection was virtually impossible. And some hams, especially those who had equipment superior to the US Navy's, derided naval operators as incompetent. On top of this, commercial operators from competing firms would also try to interfere with each other's transmissions. The Navy began to press for regulations to govern the conduct of wireless messages, but it was a shipwreck that prompted the first regulation.

Except for fleeting references to the impact of the *Titanic* disaster, little had been written about the role of shipwrecks in shaping early radio legislation. This is where the archive I had built provided invaluable information, because these shipwrecks, and wireless's role in them, had in fact been front-page news.

In January 1909, the White Star liner *Republic*, which was equipped with wireless, collided with the *Florida*, which did not, off the Nantucket coast, and the *Republic* began to sink. Its wireless operator Jack Binns began frantically sending out the emergency signals then in use – CQD (seek you, danger) – until he had to abandon ship. A nearby ship heard the signals and was able to take on all the survivors from both ships. This was instant front-page news, Binns becoming a national hero, and the disaster demonstrating the importance of wireless for saving lives (Douglas 1987: 200–202).

This led to the first regulation of the device, the Wireless Ship Act of 1910, which required that any ship carrying fifty or more people and plying between ports 200 miles or more apart be equipped with wireless apparatus capable of sending and receiving messages over 100 miles, day or night. The legislation did not solve the congestion problem – in fact, it increased it – but it did set an important precedent: wireless was a crucial life-saving device and the electromagnetic spectrum was a common property resource to which all people should have access in times of danger (Douglas 1987: 219–220).

More sweeping regulation followed the *Titanic* disaster in April 1912. After hitting the iceberg, the ship's wireless operator Jack Phillips began sending out distress

signals – both CQD and the more recent SOS. However, some nearby ships were either too far away to respond in time, were much closer but not equipped with wireless, or were equipped with wireless but had only one operator who had gone to bed for the night and thus never heard the distress messages. The closest ship that did get the distress calls, the *Carpathia*, did so only by a lucky fluke: its operator had finished his work but had gone back to the wireless room to verify the time on his clocks with those of other ships. Had he not done so, no help would have arrived until the following morning when even those in the lifeboats were likely to have died. The *Carpathia* was 58 miles from the *Titanic*, so by the time it got to the scene of the disaster three and a half hours later, it could manage to rescue only those in the lifeboats.

But here, interference, blamed on the amateur operators, was also central to the tragic story. Shortly after the distress signals were broadcast, wireless stations along the northeast coast of North America clogged the airwaves with inquiries and messages. Out of this clutter of messages emerged one reading that the *Titanic* had hit an iceberg, but was being safely towed to Halifax, an account that the *New York Times* and the London *Times* reported reassuringly to their readers.

Thus, few were prepared for the next day's horrifying news that the *Titanic* had sunk in less than three hours. One quite plausible explanation was that two different messages accidentally got cobbled together by inexperienced operators, but that was irrelevant: the amateurs were accused of manufacturing the deception and were widely denounced. The magazine *Literary Digest* condemned the false message as cowardly, other publications called for prison terms, and President Taft labeled what was seen as "malicious interference" as "perversion" (Douglas 1987: 229).

Again, my own archive, which included every article in the *New York Times* and those in popular magazines about the disaster, was crucial to appreciating its impact. Most moving were the multiple journalistic accounts (combined with Marconi's own letters to his wife) of the *Titanic* disaster, the wrenching experience of watching loved ones drown, first-person accounts of refusing to let one more person in a lifeboat because it would then sink, and thus watching that person perish, and of how radio saved the lives of the survivors. No existing institutional archive could have conveyed this, and this material showed me the central role that the *Titanic* played in getting the first significant regulation of radio enacted.

The result was prompt and more sweeping wireless regulation. Now the perceived value of the airwaves as a common property resource increased dramatically, and it was a resource the government had to protect and regulate. Under the Radio Act of 1912, ships carrying fifty or more passengers had to have at least two skilled operators so that the equipment could be manned at all times. All operators had to be licensed, stations had to adhere to certain broad frequency allocations, distress signals took priority over all other messages, and the amateur operators were allowed to transmit only on a short wave portion then considered utterly useless.

The law represented a watershed in broadcasting history. The state would assume an important role in assigning property rights in the spectrum, and priority would be given to institutional users such as the Navy and commercial companies. Those property rights would be acknowledged by wavelength or frequency allocations. Indeed, only the Navy and the Marconi Company, which by now had a near monopoly in the United States, and not the amateurs, would truly protect "the people's" interest in safe and effective use of the airwaves. For historians seeking to conceptualize this shift in

thinking about the spectrum as a common property resource, Garrett Hardin's seminal 1968 article, "The Tragedy of the Commons," was essential. When a "commons," such as those in colonial towns, for example, was available to all for grazing their animals, it could become overpopulated by multiple farmers' herds, rendering the commons useless to everyone. Thus, access has to be regulated. This was a significant rethinking about the spectrum (then still known as the "ether") in 1912.

Who Controlled Wireless after the *Titanic* Disaster?

By the 1910s, Fessenden's company, NESCO, had collapsed, the result of ongoing disputes between the inventor and his backers, and the lack of a coherent business strategy among them. Lee De Forest had, between 1904 and 1911, partnered with various corrupt hucksters who set up flamboyant wireless demonstrations, used them as well as press releases and ads to sell bogus stock, and then fled with the money. De Forest was also infringing on Marconi's tuning patents. In 1911 and 1912, Marconi filed suit against De Forest and his latest company, United Wireless, at the same time that the US Post Office investigated and then arrested De Forest and his backers for mail fraud. Marconi took over all the United Wireless holdings, which included approximately 400 ship stations and seventy shore stations. Thus, by 1912, the Marconi Company had virtual monopoly control of wireless telegraphy in the United States. The company did not, however, have control of the technology for continuous wave transmission, which Marconi had eschewed. AT&T acquired the rights to De Forest's audion and continued working to perfect the vacuum tube, while GE now controlled the alternator. Thus, by 1912, a number of the components that would combine to produce radio broadcasting in the 1920s were under corporate control.

When did "Wireless Telegraphy" Become "Radio"?

This is difficult to pin down, but the terms evolved roughly between 1906 and 1920. A new word emerged after Fessenden's and De Forest's experiments with transmitting voice and music: radiotelephony. Radiotelegraphy was used interchangeably with wireless telegraphy and gradually came to replace it to refer to the transmission of Morse code. We do not know who first used the prefix "radio," but practitioners and inventors considered it more precise because it indicated that the waves radiated in all directions. By the 1910s and early 1920s, the shortened word "radio" came to refer to both the transmission of voice and music, as well as to dots and dashes, and the term "wireless" was obsolete (Douglas 1987: xxvii).

What Role did the First World War Play in the Evolution of Radio?

During the 1910s in the United States, Lee De Forest (having narrowly escaped prison) and others began experimenting more frequently with the transmission of voice and music. But with US entry into the First World War in spring 1917, the US Navy took control of all radio stations in the country except those under army control. There was

now an increased demand for radio equipment. Because the Navy controlled the design, purchase, installation, and upkeep of all government radio (except the army's), this centralization led to standardization and improvement of apparatus. The government also imposed a patent moratorium on all suppliers, requiring them to make use of the best components no matter who owned the patent. This required the various companies and suppliers to focus less on marketing strategies and litigation and more on research and development, which led to significant advances in continuous wave technology, especially the vacuum tube, that enabled the transmission of voice and music. Indeed, it was during the war years and under these litigation-free circumstances that the full potential of the vacuum tube was realized.

By the end of the war, the vacuum tube had become a much more sensitive, rugged, reliable, and long-lasting detector of radio waves. But, in addition, it was refined as a small and relatively inexpensive generator of radio waves, which would have enormous consequences in the postwar years. As Hugh Aitken shrewdly noted, "nobody planned to make [De Forest's] audion into a continuous wave transmitter in the first place. And nobody planned to make it the basis for a new industry – public broadcasting … [this was] an unplanned consequence" (Aitken 1985: 552). But the interaction between the improvements to the vacuum tube made before and during the war, and ham operators' experimentation with it immediately after the war, combined to produce something Marconi had never sought to pursue: radio broadcasting (Douglas 1987: 298–299).

What was the First Radio Station in America?

As with priority in invention, there are various claimants to this title. Lee De Forest was, by the mid-1910s, broadcasting music especially from his amateur station in New York City. He provided six-hour coverage of the election results in 1916, when he announced, erroneously, that Charles Evans Hughes had been elected president. Another early broadcaster of voice and music at this time was Charles "Doc" Herrold of San Jose, who used a transmitter illegally hooked up to and drawing power from the streetcar lines of the Santa Fe Railway. Both De Forest and Herrold had ham radio licenses (Douglas 1987: 293). According to various sources, another station in Detroit, 8MK, went on the air in 1920 and eventually became WWJ (Barnouw 1966: 34).[1] So how have historians decided who was "first"? The criterion has been which station was awarded the first commercial license by the Commerce Department, which at that time was the agency with authority to license stations and operators.

The station most widely recognized as the first commercial broadcast station is KDKA in Pittsburgh, originally 8XK operated by the ham operator Frank Conrad, a Westinghouse employee. As Barnouw asserted in 1966, KDKA was the only station in 1920 "licensed to render regular *broadcasting* service," and most historians have followed his lead (Barnouw 1966: 4). Drawing from reminiscences, press accounts, and previous histories, Barnouw laid out the origin story (ibid.: 68–72). During the war, Conrad supervised Westinghouse's manufacture of portable transmitters and receivers for the US Signal Corps. After the war, he resumed his amateur work and began broadcasting phonograph music from his station. Letters started to pour in praising the broadcasts and submitting requests for specific songs. He began to schedule his broadcasts on a regular basis, first on Saturday evenings and soon after that, weeknight performances as well.

By May 1920, the Pittsburgh press reported on the broadcasts, which were now occasionally featuring live performances as well. As Gleason Archer relayed in *The History of Radio to 1926* (1938), a Pittsburgh department store saw this as an opportunity to increase its sales of amateur radio apparatus, so the store ran an ad in the *Pittsburgh Sun* promoting the "wireless concerts" and the fact that the Joseph Horne store had sets on sale that could pick them up. A Westinghouse vice-president, Harry P. Davis, saw the ad and grasped that the ham operators listening to Conrad could be just the tip of the iceberg of an incipient market for radio apparatus (Archer 1938: 200–201). He urged Westinghouse to build a more powerful station for Conrad and the company applied for and received a commercial license in late October 1920, just in time to broadcast the November 2 election results. The "radio boom" was on, with former hams, department stores, newspapers, and the various companies that produced radio components setting up broadcast radio stations.

What Precedents did Wireless Telegraphy and Telephony Set for How Radio would be Regulated, Financially Supported, and Embedded in the American Imagination?

Historians have debated this question as well: how much did these early years, up to 1920, set the template for commercially supported broadcasting, and how much was still up for grabs? In *Inventing American Broadcasting* I argue that by the early 1920s, the template for how radio would be regulated and financed was set, even if the details had not quite been worked out. The Radio Act of 1912 established the government, not private businesses, as the custodian of the airwaves; it would grant licenses to individuals and businesses, and this precedent was the foundation for the Radio Act of 1927 and then the Federal Communications Act of 1934 that established the Federal Communications Commission (FCC). But control of radio technology was firmly in the hands of corporations by 1920, meaning that somehow radio was going to have to turn a profit.

Members of the US Navy in particular had been concerned that the country's wireless system was, at the outbreak of the First World War, under the control of American Marconi, a foreign-owned company. The Navy had taken control of all commercial stations during the war and did not want to see the Marconi Company resume dominance afterwards. Because the Navy retaining control of radio after the war was unpopular with Congress, as well as with the hams and the press, another solution had to be found. Consequently, naval officials began working behind the scenes with officials from GE, which controlled the alternator, to form a new, all-American company that would buy out American Marconi. In 1919, the Radio Corporation of America (RCA) was incorporated. Yet there were crucial patents it did not control – no firm controlled a complete technological system, especially for the transmission and reception of continuous waves. Other firms, most notably AT&T and Westinghouse, entered into cross-licensing agreements with RCA, and these governed what each company would contribute to and profit from the consortium. So now radio was a monopoly (soon to be known as "the radio trust") embedded in interlocking corporate grids.

The formation of RCA truly marked the end of the wireless age and the beginning of the radio age, with monopolistic control over radio technology and access to the

airwaves. Yes, there were hundreds of upstart stations around the country, producing by the middle of the decade massive interference and chaos in the "ether"; so there was not monopoly control of the stations themselves. But oligopoly control would emerge by the 1930s. The government still controlled licensing, but now it was corporate America (along with the military) that had a privileged purchase on the spectrum, which was reaffirmed by both the Radio Act of 1927 and the Federal Communications Act of 1934. RCA would seek to follow the model established by the Marconi Company: create a communications network, seek to monopolize message handling, and sell temporary access to the airwaves to interested clients. Thus, I saw the commercialization of radio, given this corporate control and the need to make it pay, as inevitable and established by the early 1920s, even though the ultimate method for generating profits – advertising – had not yet been imagined.

Robert McChesney, in his excellent *Telecommunications, Mass Media and Democracy* (1993), a history of the activist battle against the hegemony of commercial radio in the late 1920s and early 1930s, disagrees with my argument as being too deterministic and discounting of the hard-fought (yet unsuccessful) rebellion against the hegemony of corporate control. He argues that questions about the structure, financing, and regulation of broadcasting were not truly resolved until the early 1930s. Likewise, Susan Smulyan in her important book *Selling Radio* (1994) also argues against "the notion of commercial inevitability," as she too chronicles the initial and widespread opposition to advertising on the air in the mid- to late 1920s. Thomas Streeter, in his theoretically sophisticated study of the laws and policies governing commercial radio and television, *Selling the Air* (1996), sides with me, also seeing that a "corporate liberal interpretive framework" was indeed in place by 1920, which "led to the triumph of corporate commercialism" (Streeter 1996: 62–63).

Streeter and I are thus a bit more fatalistic about the absorptive powers of capitalism in the United States. While not minimizing the fierce debates about the prospect of advertising entering people's homes – invading a "man's castle" as it was put – without their control or permission, I would still argue that the template for commercially supported radio existed by 1920 and was reinforced by how other dominant media of the times – newspapers and magazines – were also supported.

And this leads me to my final point about the social constructionist approach to technological history. This school of thought was a crucially important intervention because it has helped historians think about the contested nature of invention and innovation, about the struggles, failures, blind spots, and rebellions that lead to new devices and technological systems. But in applying this framework, we must always remember that some actors and institutions have much more power than others, and even if they have to accommodate to the desires and practices of everyday people, lone inventors, technological renegades, or consumers, those with more economic and political power typically dominate the construction process at the end of the day. And these winners can, through their corporate archives, press releases, and commissioned histories, seek to legitimate their victories. So, while social construction does insist that there is no predetermined, inevitable outcome for inventions – and look at how wrong Marconi was, and how right the ham operators were – we must combine this approach with an attention, at least in the United States, to the hegemony of corporate, commercial forces always determined, at the end of the day, to maximize profits.

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Note

1 See at: http://www.michiguide.com/history/am.html; http://detroit.cbslocal.com/2010/06/24/a-brief-history-of-wwj.