Bancroft Gherardi and the Monopoly Bell System: Pioneers in Information Technology Standardization

Andrew L. Russell
College of Arts & Letters, Stevens Institute of Technology
arussell@stevens.edu

Note: This is a pre-print version of a paper that was published in Toni Carbo and Trudi Bellardo Hahn, eds., *International Perspectives on the History of Information Science and Technology* (Medford, New Jersey: American Society for Information Science & Technology, 2012).

Abstract

This paper analyzes standardization within the American telephone monopoly, the Bell System. The key figure in this history is Bancroft Gherardi, who was AT&T's Vice President and Chief Engineer from 1920 to 1938. It examines Gherardi's role in the production of standards for use inside the Bell System, as well as standards that were necessary for technologies that spanned the boundaries of the Bell System. In both cases, Gherardi emerges as a pioneer in information technology standardization—as much for his organizational and diplomatic contributions as for merely technical contributions. If we understand Gherardi and his views on standardization in the Bell System, we can develop a more nuanced understanding of the productive tension between innovation and standardization, and therefore arrive at a richer appreciation of the possibilities for innovation in large technological systems.

Introduction

All users of information technologies have an intuitive grasp of the importance of *standards*: they help us to connect our various devices to one another, thus producing *network effects* and providing the very essence of *connectivity* that characterizes our 21st century Information Age. Standards also have important strategic functions in information technology more generally because they fix and normalize previous advances and, consequently, provide a platform for subsequent innovation. It is difficult to overstate the strategic importance of standards and the standardization process, just as Woodward and Bernstein were advised to "follow the money" to get to the bottom of the Watergate scandal, historians of information technology should "follow the standards" to understand the deep inner workings of the information technology industries.

In this paper I will examine the standardization strategies of one of the most important institutions in the history of information science and technology: the American Bell Telephone System. The term "Bell System" refers to the combined entities of the American Telegraph and Telephone Company (AT&T, responsible for overall system coordination), Western Electric (responsible for manufacturing), Bell Labs (responsible for research and development), and the regional Bell operating companies (responsible for providing local telephone service). The Bell System, as recent books by Richard John (2010) and John Gertner (2012) remind us, dominated American telecommunications from the first decades of the 20th century until its divestiture in the early 1980s. During this time it carefully cultivated and maintained an image as a civic-minded monopoly, one that was guaranteed steady profits in exchange for its provision of reliable and high-quality telephone service for millions of Americans.

Thanks to this arrangement, Bell System executives were able to provide generous funding for Bell Labs, which in turn became a famous source of innovation in the fields of electronics and telecommunications. The history of Bell Labs—and its place within the broader Bell System—provides a fascinating puzzle for historians of information science and technology, and for scholars of innovation more generally. The puzzle is this: how was the Bell System able to cultivate so many theoretical and practical breakthroughs (the transistor, information theory, etc.) in Bell Labs, but unable (or unwilling) to deliver innovative products quickly to its users? Explanations abound. Some emphasize what they consider to be the arrogance of Bell executives, who protected their monopoly by convincing federal regulators to outlaw competition. Others point to structural factors in a monopolized industry structure, such as the lack of incentives to develop products in a rapid or entrepreneurial fashion. These explanations—articulated time and again throughout the 20th century by the Bell System's critics—allege that the Bell System was simply playing the part of a robber baron-type monopolist bent on stifling outside innovations, overcharging users, and preserving its dominant position (FCC, 1939; Henck and Strassburg, 1988; Coll, 1986; Temin with Galambos, 1987; Lipartito, 2003).

Although they contain seeds of truth, these explanations misconstrue the way that the Bell System operated. In the process, they also propagate misconceptions about the nature of large technological systems and the relationship between the act of invention (in Bell Labs) and the social process of innovation (implementation throughout the Bell System). Their most glaring oversight is their failure to appreciate how Bell System managers and engineers deployed new inventions into a nationwide system (Galambos, 1992). Beyond the *technical* challenges of telephony, innovation in the Bell System was an extraordinarily complex *organizational* challenge. Because they were working within the constraints of such a large system, it was impossible for Bell System engineers to pursue a romanticized style of entrepreneurial, disruptive, or radical innovation. Instead, innovation in the Bell System needed to adhere to a rational and systematic plan, but yet be flexible enough to work within the diversity of local telephone systems around the country. Here is where standardization emerged as the essence of the process by which engineers transformed a novel singularity into a mundane artifact or practice. This dynamic—the tension between innovation and standardization—is not unique to Bell System. It is common in all information technology networks, and indeed all large sociotechnical systems that rely on standards to reconcile diversity and facilitate interconnection.

My history departs from the familiar narratives of heroic invention inside Bell Labs, and examines instead what happened *after* Bell Labs—namely, the managerial challenges of integrating new technologies into a rational and orderly system. Standardization helped Bell System executives and engineers to confront the difficulties and contingencies they faced in bringing their vision of "Universal Service" to fruition. I emphasize strategic choices made by Bell System executives and engineers in order to judge their actions on their own terms, rather than judging them against an idealized and perhaps romanticized notion of free-flowing innovation.

The paper proceeds in two main sections, followed by a brief conclusion. First, I examine standardization as an *internal* organizational strategy by focusing on the career of Bancroft Gherardi, AT&T's Vice President and Chief Engineer from 1920-1938.

During his tenure as Chief Engineer, Gherardi supervised a vast program of standardization throughout all branches of the Bell System, including Bell Labs (research), Western Electric (manufacturing), AT&T (long distance and system architecture), and the 22 regional Bell operating companies throughout the United States.

Standardization in the Bell System, contrary to popular conceptions of hierarchical management, was not simply a matter of executives handing down orders to subordinates. Instead, standards were the product of a dialectical process between the executives in the engineering departments in New York and the engineers who worked in Western Electric and the Bell operating companies throughout the country. AT&T published its standards in New York, but correspondence among Bell System engineers in the 1920s shows that ideas often came from the Bell System's rank-and-file and were transmitted up the organization chart. Gherardi's systematic approach to standardization became a defining characteristic of the monopoly Bell System. Gherardi therefore should be regarded as a pioneer in information technology standardization because he established the organizational capabilities and coordination mechanisms to integrate radical innovations into a national system, all while preserving system reliability and stability for millions of telephone users.

In the second main section I focus on standardization activities that took place *across the boundaries* of the Bell System. Again, Gherardi's actions as AT&T's Chief Engineer in the 1920s and 1930s were pioneering. As a necessary complement to their comprehensive program of internal standardization, Gherardi and his colleagues devoted increasing amounts of time in the 1920s and 1930s to trade associations, engineering societies, and industrial standards committees. They did so because they recognized that even a dominant monopoly like the Bell System was not and could not be completely isolated from external technologies. For example, Gherardi became involved personally in the mid-1920s with the problems of inductive interference that occurred when telephone lines were in close proximity to electrical power and electrical light lines. Seen in this context, telephone wires became "boundary technologies," at once vital for the Bell System and, frustratingly for AT&T executives, beyond the grasp of their monopoly jurisdiction. Gherardi responded to this and similar organizational challenges by instilling—and embodying—a new attitude toward cooperation with engineers outside the Bell System.

In contrast to the many historical accounts of information science and technology that chronicle novel and spectacular inventions, ideas, and theories—particularly those at Bell Labs—I argue that historians should pay more attention to strategies and institutions that facilitated the transformation of remarkable inventions into the unremarkable technologies of daily life. When we turn our attention from the novel to the mundane, we will see that Bancroft Gherardi and the thousands of engineers who set standards for the Bell System should be recognized as pioneers in information technology standardization—and thus key actors in the worldwide adoption of the formative innovations of the Information Age. We may also find more general lessons for current and future information networks that, inevitably, will need to manage the dynamic tension between innovation and standardization.

"The Engineering of the Present": Standardization within the Bell System

In histories of the Bell System before World War II, Bancroft Gherardi's role is obscured by the accomplishments of his peers, especially Frank Jewett and John Carty;

but he takes center stage when we examine telephone history from the vantage point of standardization. Gherardi was a paradigmatic "organization man" and a thoughtful professional who, according to Bell Labs President Oliver Buckley (1957, p. 157), was "a great engineer… one of the most eminent engineers of his time."

Gherardi began his career as a telephone engineer in 1895, and quickly earned a reputation for his skillful and diligent work. In 1901 he became Chief Engineer of the New York and New Jersey Telephone Company, where he presided over a phase of rapid technological and organizational change: the company grew from 30,000 telephones in 1901 to over 110,000 in 1906. Gherardi was particularly adept at working within the constraints of a large, complex, and relentlessly expanding technological system. He thrived in the midst of Bell's systematic and scientific approach to engineering, and demonstrated his abilities in a number of projects including extensive studies of telephone traffic, the creation of new floor plans for central offices, experiments to test cable durability and safety, and the creation of technical standards for switchboard components and signal transmission (Buckley, 1957; *Bell Telephone Quarterly*, 1938; *New York Times*, 1941).

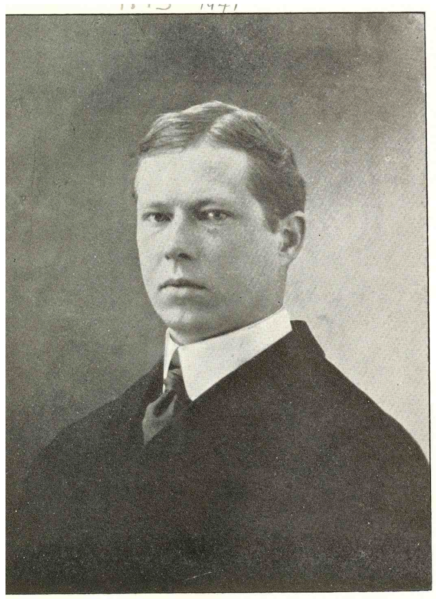


Figure 1: Bancroft Gherardi, [1906].
Source: Box 1133, "Gherardi, Bancroft – Biography – 1873-1941," AT&T Archives, Warren, New Jersey.

In 1909 Gherardi was promoted to AT&T Engineer of Plant Development and Standardization, responsible for these areas throughout the entire Bell System. In this capacity, Gherardi worked closely with AT&T Chief Engineer John J. Carty, and Frank Jewett, a Ph.D. physicist whom Carty had moved to New York as a research manager for Western Electric. The triad of Carty, Jewett, and Gherardi developed an effective partnership as they guided the technological trajectory of the Bell System over the next thirty years. Experience taught them that system-wide harmonization required a flexible managerial approach. As Western Electric engineer J. L. McQuarrie noted (1915) at a technical summit of Bell engineers in 1915, "it is not the policy of the A. T. & T. Company to use force in compelling the [operating] companies to follow their standards." Instead, persuasion and consensus were the preferred tactics: "I think their policy is to set up their cases in such a manner that the [operating] companies will see for themselves that that is the thing they ought to do."[1] Subsequent technical meetings, such as a 1916 conference chaired by Carty and Gherardi on telephone transmission, provided venues where Bell managers and engineers could debate, exchange information, and establish consistent, system-wide practices and procedures (AT&T, 1916).

Changes in AT&T's corporate organization between 1918 and 1920 propelled Gherardi into a commanding role over standardization throughout the Bell System. While Carty and Jewett directed their attention to the American mission in World War I, Gherardi remained in New York and assumed a less publicly visible role as Acting Chief Engineer of AT&T. When Harry Thayer became AT&T's new President in June 1919, he promoted Gherardi to Chief Engineer of AT&T and promoted him again in 1920 to Vice President of AT&T—the two positions that Gherardi held until his retirement in 1938 (Buckley, 1957).

Gherardi assumed the role of Chief Engineer at the beginning of a new technological and organizational era for AT&T. At the beginning of Gherardi's tenure, he and Thayer split the Engineering Department into two new departments—the Operations and Engineering Department and the Development and Research Department. The purpose of this reorganization, according to Thayer, was to allow Bell engineers to "differentiate in our work between the *engineering of the present* and the *engineering of the future*" [emphasis added] (Thayer, 1925, p. 6).

Gherardi's Infrastructure for Standardization

[1] The tension between centralized control and regional autonomy also is a central theme of Lipartito (1989).

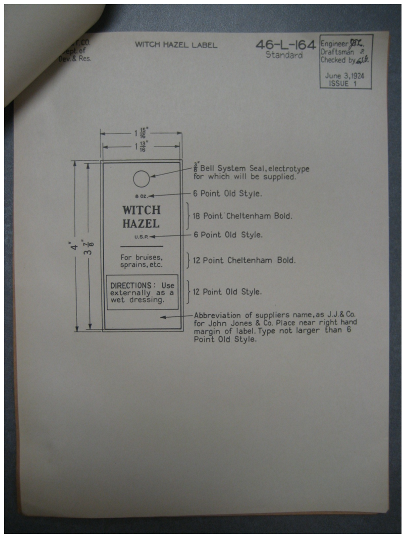
Under Thayer's reorganized hierarchy of Bell System engineers, Carty and Jewett turned to the engineering of the future—first in the Development and Research Department and, in 1925, in the newly created and much-celebrated Bell Labs. Gherardi took over the less glamorous duties of the engineering of the present within the Department of Operations and Engineering. His jurisdiction was vast: he directed hundreds of engineers who collectively were responsible for developing engineering methods, operating plans, and methods for analyzing and comparing different types of service. Gherardi's staff also was responsible for advising the technical staffs of the other units of the Bell System (including Western Electric, the regional operating companies, and the Long Lines division) as well as for the overall technical coordination of the System.

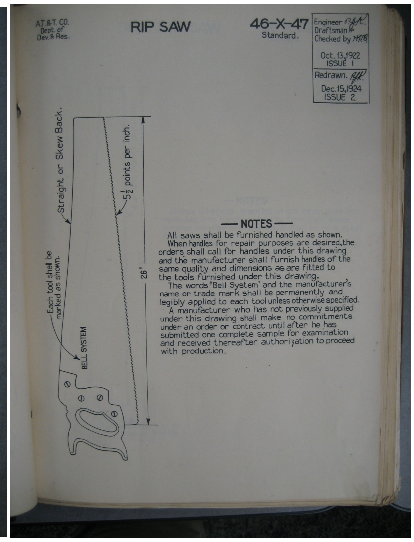
Standardization was Gherardi's primary tool to manage complexity. His experience taught him that standards were not simply technical prescriptions; rather, they documented years of experimentation and provided a record of the technical know-how and organizational capabilities of thousands of individuals who worked for the Bell System. This principle was widely understood by leading Bell System engineers well before Gherardi's promotion to Chief Engineer in 1919. Jewett (1915) summarized the prevailing view in 1915, when he declared that "a standard piece of apparatus or a standard practice at any time so far as the Bell System is concerned represents the best total of all the experience of all concerned."

In order to collect, standardize, and circulate their combined experience, Bell System engineers experimented with methods of documentation and correspondence. In 1905, AT&T Chief Engineer Hammond Hayes began to use the term "General

Engineering Circular" (GEC) at the top of technical correspondence shared among around two dozen recipients, including engineers at Western Electric and the chief engineers of regional Bell operating companies. Some GECs were requests for comments on issues such as underground construction in central offices; others described field experiments conducted in one part of the country; still others were draft proposals for standard designs for manhole frames and covers, private branch exchanges in apartment buildings, insulation and other protection from electric shock, and mountings for telephone jacks. Between 1905 and 1914, over 400 GECs (copies of which are preserved in the SBC Archives and History Center, San Antonio, Texas) had been exchanged amongst Bell System engineers.

By the time Gherardi became AT&T's Chief Engineer in 1919, GECs regularly referred to "Engineering Specifications" that AT&T began to distribute throughout the Bell System in 1918. Many GECs appeared simply as cover letters to Specifications that explained their origins and clarified their intended uses. Bell System engineers published and circulated thousands of Specifications for the widest imaginable variety of items—not only the core technologies for telephone transmission, but also for all sorts of ancillary things including porcelain knobs, shellac, shellac thinner, machine bolts, medical supplies such as a rhubarb-soda mixture, witch hazel, ammonia inhalants, and so on.





Figures 2 and 3: AT&T Specifications for Witch Hazel bottles and Rip Saws, circa 1924.

Source: Collection 5 Bell System, RG 4 Corporate Functions, Box 10.

Thousands of Specifications (or "AT&T Standards") published in the 1920s and 1930s were the product of a dialectical process between the executives in the engineering departments in New York and the engineers who worked in Western Electric and the Bell operating companies throughout the country. A typical example of this dialectical process can be seen in an exchange of letters among Gherardi and the Presidents of the Bell operating companies. In May 1922, Gherardi (1922a) asked the Presidents to "make a special review" of any

> Bell System standards and methods of construction, maintenance and operation which will be as economical as practicable consistent with good and continuous service and adequate durability… Nothing could be more helpful to us here than frank criticism from those using the standards. We want to leave nothing undone which if done might produce better and more economical results.

Throughout the summer of 1922, Gherardi was flooded with responses from Bell operating company Presidents and Chief Engineers on a predictably wide range of topics, such as plant construction, pole line specifications, insulating sleeves, hand lanterns for manhole and repair use, different varieties of wood for pole construction, and billing methods. In August, Gherardi wrote again to thank his colleagues for their replies so far, and announced that subsequent discussion would take place at a week-long AT&T "Conference to Discuss Economy and Efficiency in Operation" planned for October. The Conference was the fourth such national conference of Bell System technical staff that had been held since 1915, all with the intention of facilitating better communication and nurturing a stronger sense of "team work"—in effect, to imagine and produce a more cohesive and efficient community—amongst telephone workers working under the Bell umbrella (Gherardi, 1922b; Gherardi, 1922c).

These surviving documentary traces—General Engineering Circulars, Bell System Specifications, memoranda between Gherardi and presidents and chief engineers at the various Bell operating companies, and published proceedings of Bell technical conferences—do not support a top-down interpretation of standardization in the monopoly Bell System. They indicate the complexity of the processes of system-wide innovation and standardization, and rule out the very possibility of a clean and simple linear model of research and development in the Bell System in which Bell Labs invented new things, Western Electric mass-produced them, and AT&T directed the operating companies to adopt them. Gherardi was no 20th-century robber baron; he was an earnest and determined executive who struggled to maintain clear lines of communication under conditions of almost unimaginable complexity.

Gherardi's legacy is registered in a literal sense in a new publication series, the Bell System Practices, that documented the Bell System's internal standards. According to a history of the Bell System Practices published in *Bell Telephone Magazine* (Covey, 1952), standardization became firmly and finally embedded in the culture of the Bell System under Gherardi's close supervision. "In the decade following World War I," the article begins, "there were more developments in the Practice situation than in any other similar period in Bell System history." The program of standardization that Gherardi developed throughout the Bell System was thorough, nearly to the point of obsession. By 1929, AT&T had created standards for an astonishing variety of functions, including telephone plant design, underground cables, raw materials, manufacture, distribution, installation, inspection, and maintenance of new equipment, business and accounting methods, non-technical supplies (such as office furniture, appliance, janitors' supplies, cutlery, and china), and provisions for safety, health, and even sleet storms (Gherardi and Jewett, 1930; Osborne, 1931). By the 1980s, the index alone of the Bell System Practices filled 969 pages; the volumes filled over 80 cubic feet.

Standards provided a means for coping with the increasing scale, scope, and complexity of the Bell System. During Gherardi's tenure as Chief Engineer between 1920 and 1938, the number of telephones in Bell System grew from 7.7 million to over 19 million. Gherardi responded to this era of unprecedented growth by institutionalizing a style of standardization that privileged deliberation over dictate, stability over change, evolution over evolution, and order over chaos. These two decades, not by coincidence, were the first decades of the Bell System's development into a mature, regulated monopoly with a national reach and enough capital to invest in curiosity-driven research at Bell Labs. The essential point from this history is that Gherardi's approach to innovation—in quite a contrast to the famed researchers who worked in Bell Labs (Gertner, 2012)—rejected a no-holds-barred pursuit of technological advances. Because his position as Chief Engineer required him to consider the system-wide implications of any new technology or procedure, Gherardi often used standardization as means to *slow* and *tame* innovation. In the toolkit of a skilled engineer and manager like Gherardi, standardization was a strategy not just to integrate state of the art technologies into a large system, but also to *discipline* and *master* the rate of change.

Standardization Across the Boundaries of the Bell System

Gherardi and his subordinates would have preferred to treat telephone transmission as a closed system that was insulated from outside forces and therefore more easily predicted and controlled. But the reality was more complex. Gherardi recognized that the Bell System was open to outside forces that he could not control by means of the vast managerial hierarchy under his command. Here, as in other areas, Gherardi learned to succeed: he explored the outside factors that introduced problems and inefficiencies into his system and, over time, he learned to experiment with organizational strategies to attack critical problems and extend order.

Throughout its early history, AT&T did not encourage its engineers to collaborate openly in standards committees organized by industry trade associations or professional societies. For the most part, AT&T leaders believed that their competitive advantages flowed from keeping the company's patents and practices closed and secretive. Their insular attitude began to change in the years before the First World War. One indication of the change may be seen in a speech at the 1915 conference of Bell System engineering and manufacturing personnel, in which Western Electric's Henry Albright asked his colleagues to reconsider the potential benefits of professional activities outside the Bell System. "Through such associations," Albright (1915) suggested,

> the company obtains recognition for its principles and achievements; its worth and position in the community are better known; the quality of its scientific work and its efficiency in production becomes better known and our customers and friends learn to better appreciate our pioneer work in the development of the art of telephony.

AT&T engineers quickly learned that "outside" cooperation could generate strategic and technical advantages for AT&T, in addition to the social and civic benefits that Albright promoted. One good example of the technical benefits of cooperation was evident in AT&T's efforts to address inductive interference generated by the close proximity between telephone lines and the overhead electrical lines power companies, lighting companies, and railroad companies.

Telephone engineers had long been familiar with interference, such as "crosstalk" (speech from one conversation was audible in another) and "babble" (unintelligible background noise), that resulted from placing telephone circuits in close proximity (Fagen, 1975). In the mid-1910s, however, Bell System engineers became increasingly concerned with new sources of electrical interference that originated from the proliferation of parallel and intersecting current-carrying wires. This type of "inductive interference" was deeply problematic because it undercut one of the central technical objectives of Bell System engineers: to increase the efficiency and sensitivity of transmission equipment.

The first cooperative efforts to address the problem of inductive interference occurred under the auspices of the California Railroad Commission. In a 1919 report, the Commission's Joint Committee on Inductive Interference—consisting of and funded by representatives from the telephone, power, and railroad industries—identified some "guiding principles" for preventing interference, including standards for minimum distance between power lines and communication lines as well as design and construction rules for apparatus. However, the report's authors also acknowledged the complexities of inductive interference and underscored the need to conduct further studies of the scientific and practical aspects of the problems at hand.

For his part, Gherardi warned Bell System engineers that the "greatest difficulty in obtaining adequate protective and remedial measures against inductive interference" was that the problem was not entirely under their control. The most promising solution, Gherardi (1919) proposed, "consists in getting the power companies sufficiently interested in the problem and in convincing them that the protective measures asked for are necessary and reasonable." To accomplish this, Gherardi saw fit to begin a "campaign of education on this subject." He urged his colleagues in the Bell operating companies to make sure that "those of your engineers whose particular duty it is to deal with this subject," were prepared to "discuss it convincingly with power company representatives."

In his public statements, Gherardi did not frame his approach as a "campaign of education," as he did when writing to his subordinates throughout the Bell System. Instead, he emphasized the importance of cooperation between power and telephone engineers as a way to avoid costly and uncertain litigation to establish exclusive rights-of-way and ownership of wooden poles. Gherardi personally directed AT&T's cooperative campaign. Beginning in 1921, Gherardi led the Bell System's involvement in two *ad hoc* Joint General Committees: one with the Association of American

Railroads, and the other with the National Electric Light Association (NELA). Cooperation continued in 1922, when NELA and the Bell Telephone System created a Joint Development and Research Subcommittee to investigate further the problems of inductive interference. They also created a Special Committee on the Joint Use of Poles in February 1923 to begin negotiations toward joint pole agreements between NELA's member companies and the operating companies of the Bell System.

At the same time, Gherardi continued to advance his strategy of intra-company education. In January, he arranged for engineers in the Department of Development and Research to conduct a six-week "course of instruction" on inductive interference, so that Bell employees in the "Engineering or Plant Departments directly responsible for the technical handling of inductive interference work" could "familiarize themselves with all the technical information" available to AT&T's most expert engineers. Gherardi attached a detailed six-page outline of "Notes for Inductive Interference School," with a characteristic (if unnecessary) reminder that he would "like to receive any suggestions" for the "proposed scope of the course" (Gherardi, 1923a).

By 1924, the Bell-NELA Joint Committee joined with representatives from the electric and steam railroad industries to form a new group, the American Committee on Inductive Coordination. Gherardi was the group's Chairman; Robert Pack, a respected power engineer and active member of NELA, was one of three Vice-Chairmen. Together, the two men presented a report on the committee's work to a general session of the NELA convention in May 1926. Pack began by noting the committee's publication of "Principles and Practices for the Joint Use of Wood Poles" and some progress toward procedures for dividing the costs incident to inductive coordination (Gherardi and Pack, 1926). Gherardi and Pack (1926, pp. 191-193) added a deft diplomatic touch to the committee's verbal report. He remarked,

> I can feel that there has been a closer and closer bond between us… We have put further and further behind us the proposition that inductive coordination was a problem to fight about, and we have more and more fully accepted the view that inductive coordination was a problem to work out together, quite a different attitude from fighting it out.

Subsequent reports from NELA's Inductive Coordination Committee indicate that earlier tensions between the power and telephone companies had been reduced to a matter of cooperative research and routinized solutions. The 1926 report noted (Phelps, 1926, pp. 851-852), "In contrast with the experience of previous years, the one now closing has been singularly free from controversy and threatened court actions." Gherardi, reflecting on the group's work in 1928, confirmed that their turn from conflict to collegiality had borne fruit. He declared (Gherardi, 1928, p. 50), "we came to the conclusion that 10 per cent of our problem was technical and 90 per cent was to bring about between the people on both sides of the question, a friendly and cooperative approach."

Although these *ad hoc* committees generated standards and recommended practices (such as satisfactory distances between electrical wires connected to the same poles), they did not solve the underlying scientific and technical problems associated with inductive interference. Nor did they need to. Cooperative organizations such as the Joint General Committees and American Committee on Inductive Coordination created organizational means for defusing a potentially costly confrontation between some of the most powerful corporations in American industry. Through this new approach—most visible in the rhetorical shift from "inductive *interference*" to "inductive *coordination*"—

they redefined their once-confrontational relationship as a matter that could be managed through collaborative research and cooperative standardization.

Gherardi and the American Engineering Standards Committee

Gherardi's enthusiasm for cooperative solutions to difficult technical and organizational problems foreshadowed his growing commitment to the cause of industrial standardization. By the late 1920s Gherardi's faith in engineering cooperation, combined with his longstanding interest in technical standardization, led him to become deeply involved with the activities of the American Engineering Standards Committee (AESC), a group which exists today as the American National Standards Institute (ANSI).

At first, the Bell System participated in the AESC in a very limited way. It did not contribute to any AESC projects until 1921, when it sent an engineer to only one committee, "Symbols for Electrical Equipment of Buildings and Ships" (AESC, 1921). Its involvement with the AESC began in earnest in 1922, when the Bell Telephone System formed the Telephone Group (together with its nominal partner, the United States Independent Telephone Association) and became a dues-paying Member Body of the AESC (AESC, 1923).[2] By the end of 1927, dozens of Bell System engineers were involved in the work of twenty-one AESC sectional committees, such as committees that created standards for manhole frames and covers, tubular steel poles, safety codes, methods for testing wood, direct-current rotating machines, induction motors and machines, and drafting room drawings (AESC, 1928). Each of these projects dealt with technologies that lay at the boundaries between the telephone business and other

[2] AT&T engineers, consistent with their company's dominant technical and business position, were far more active: for example, in 1927 AT&T sent engineers to 21 committees; USITA engineers participated in 9.

industries. They each were important (or in some cases vital) for the operation of the Bell System, but, unlike standards for telephone transmission or equipment, they were not subject to AT&T's monopoly control.

Gherardi's personal involvement with the AESC grew as the organization reached a turning point in 1928. In response to increasing amounts of interest from all aspects of industry—not just engineers—the AESC made fundamental changes to its structure and process, and reconstituted itself as the American Standards Association (ASA) in July 1928. Gherardi served as a member of the ASA Board of Directors from 1929 to 1935, was elected ASA President in 1931 and 1932, and played a key role in the ASA Underwriters' Fund, which raised hundreds of thousands of dollars for ASA coffers by soliciting direct contributions from industrial firms (*New York Times*, 1929; ASA, 1929; *New York Times*, 1930a; Serrill, 1930; *New York Times*, 1930b).

Figure 4: Bancroft Gherardi, [1938].
Source: AT&T Archives and History Center, Warren, NJ

Under Gherardi's leadership in the 1920s and 1930s, AT&T engineers joined dozens of consensus standards committees. Their experiences in these committees were as diverse as the standards they sought to influence. In many of these committees, such as those that set standards for wood poles and acoustic terminology, work proceeded harmoniously and without incident. In other cases, such as the battles for control of radio transmission, the standards-setting process became a lightning rod for scientific, technical, and political controversy (Reich, 1985; Slotten, 2000). Sometimes AT&T participated in narrowly-focused institutions, such as the American Institute of Electrical Engineers, American Society for Testing Materials, and National Electric Light Association; other times it sent executives and engineers to larger and more bureaucratic bodies such as the ASA and the International Electrotechnical Commission (Osborne, 1931).

Amidst this variety, Gherardi and his engineers effectively learned a valuable overarching lesson: they could use industry standards committees to solve critical problems with the telephone system that AT&T could not solve on its own. Moreover, standards committees provided avenues for AT&T to throw its weight around in American industry, politics, and society. The standardization process could be painfully slow over the short term, and mostly inconvenient for anyone who wished to rush innovation in a system context. Over the long term, however, widespread industrial standards generated efficiencies and made industrial life simpler. Gherardi learned that the process also had tremendous—albeit imprecise and somewhat unpredictable—strategic potential for his employer.

Conclusions

Because historians and their readers in the general public tend to be preoccupied with heroic tales of invention, they have missed the historical significance of AT&T Vice President and Chief Engineer Bancroft Gherardi, the engineers he supervised, and their establishment of standards for one of the largest and most complex technological systems of the 20th century. Gherardi's career is fascinating in its own right, but has been overlooked because he was not one of the carefree inventors in Bell Labs that historians tend to celebrate (Gertner, 2012). Nevertheless, Gherardi was a great engineer who rose up the echelons of the Bell System and the American engineering establishment. In the latter decades of his career, he was inducted into the National Academy of Sciences, served as President of the American Institute of Electrical Engineers, and was awarded the prestigious AIEE Edison Medal in 1932 "for his contributions to the art of telephone engineering and the development of electrical communication" (*New York Times*, 1932).

In addition to these accomplishments, his style of system innovation and standardization established a pattern for the Bell System, and arguably for every subsequent company that competes in information network markets. Gherardi consolidated the approach of his predecessor Chief Engineers, who rejected a break-neck pace of development in the telephone art. Gherardi tempered AT&T's utilization of radical or disruptive innovations in favor of a steady, dialectical, and incremental approach. This was not neither an act of arrogance nor an inevitable response to the challenges that the Bell System faced; rather, it was a calculated strategic decision that prioritized stability and reliability over inventiveness and daring. Gherardi embedded this value choice within complementary regimes of standardization that sought to stabilize technologies and procedures both *within* the Bell System and *across the boundaries* of the Bell System—no small feat, as the above examples demonstrate.

When modern-day critics decide that their highest value is unfettered innovation, they should also realize that they are implicitly rejecting the tradeoff that Gherardi and his colleagues made so carefully. Such a realization might provide more reason to revisit the history of information science and technology within the Bell System: not merely to celebrate the spectacular achievements in Bell Labs during the "Great Age of American Innovation," but also to understand the broader systemic forces and choices that made the Bell style of innovation work.

References

Albright, H. F. (1915). The business activities and relations of members of engineering and manufacturing departments outside the Western Electric Company. *Western Electric Company, Manufacturing and Engineering Conference.* Chicago: Bell Telephone System.

American Committee on Inductive Coordination (1925). *Bibliography on inductive coordination*. New York: American Committee on Inductive Coordination.

American Engineering Standards Committee Year Book (1921). New York: American Engineering Standards Committee.

American Engineering Standards Committee Year Book (1923). New York: American Engineering Standards Committee.

American Engineering Standards Committee Year Book (1928). New York: American Engineering Standards Committee.

American Standards Year Book (1929). New York: American Standards Association.

American Telephone and Telegraph Company. (1916). *Telephone transmission: Meeting of the technical representatives of the Bell System*.

Bancroft Gherardi dies; Phone Pioneer, 68. (1941, August 16). *New York Times*.

Bancroft Gherardi wins Edison Medal. (1932, December 12). *The New York Times*, 11.

Bell Telephone Quarterly (1938). Notes on recent occurrences: Bancroft Gherardi retires as A.T.&T. Vice President and Chief Engineer after a distinguished career of 43 years of Bell System service.

Buckley, O. E. (1957). *Bancroft Gherardi, 1873-1941: A biographical memoir.* New York: Published for the National Academy of Sciences by Columbia University Press.

Coll, S. (1986). *The deal of the century: The breakup of AT&T.* New York: Simon & Schuster.

Covey, A. B. (1952). The Bell System's best sellers. *Bell Telephone Magazine*, Summer, 90.

Executives to direct standards body. (1929, July 8). *The New York Times*, 36.

Fagen, M.D., ed. (1975). *A history of engineering and science in the Bell System: The early years*. New York: The Laboratories.

Federal Communications Commission (1939). *Investigation of the telephone industry of the United States.* Washington, DC: Government Printing Office.

Galambos, L. (1992). Theodore N. Vail and the role of innovation in the modern Bell System. *Business History Review,* 66, 95-126.

Gertner, J. (2012). *The idea factory: Bell Labs and the great age of American innovation.* New York: Penguin Press.

Gherardi heads standards group. (1930, December 12). *The New York Times*, 17.

Gherardi, B. (1919). Final report of the Joint Committee on Inductive Interference and General Order No. 52 of the Railroad Commission of the State of California. GEC 901, April 29. SBC Archives and History Center, San Antonio, Texas.

Gherardi, B. (1922a). Memo to George McFarland, May 10, Collection 3 Pacific Telesis Group, SBC Archives and History Center, San Antonio, Texas.

Gherardi, B. (1922b). Memo to George McFarland, August 22, Collection 3 Pacific Telesis Group, SBC Archives and History Center, San Antonio, Texas.

Gherardi, B. (1922c). Conference of personnel group. *Bell Telephone Quarterly* 1 (July), 39-43.

Gherardi, B. (1923a). Memo to J. C. Nowell, January 20. SBC Archives and History Center, San Antonio, Texas.

Gherardi, B. (1923b). Memo to J. C. Nowell, March 1. SBC Archives and History Center, San Antonio, Texas.

Gherardi, B. (1928). Discussion at Pacific Coast Convention. *Transactions of the American Institute of Electrical Engineers*. 47, 50.

Gherardi, B. & Jewett, F. B. (1930). Telephone communication system of the United States. *The Bell System Technical Journal* 9, 1-100.

Gherardi, B. & Pack, R. F. (1926). Report on Joint General Committee, Bell System and N. E. L. A. *National Electric Light Association Proceedings* 83: 191-193.

Henck, F. W. & Strassburg, B. (1988). *A slippery slope: The long road to the breakup of AT&T.* New York: Greenwood Press.

Jewett, F. (1915). Discussion of Mr. McQuarrie's paper. *Western Electric Company, Manufacturing and Engineering Conference.* Chicago: Bell Telephone System.

John, R. R. (2010). *Network nation: Inventing American telecommunications.* Boston: Harvard University Press.

Lipartito, K. (1989). *The Bell System and regional business: The telephone in the south, 1877-1920.* Baltimore: The Johns Hopkins University Press.

Lipartito, K. (2003). Picturephone and the Information Age: The social meaning of failure. *Technology & Culture* 44, 50-81.

McQuarrie, J. L. (1915). Discussion of Mr. McQuarrie's paper, *Western Electric Company, Manufacturing and Engineering Conference.* Chicago: Bell Telephone System.

Osborne, H. S. (1931). The fundamental role of standardization in the operations of the Bell System,"*American Standards Association Bulletin*. September, 3-16.

Phelps, H. S. (1926). Report on Inductive Coordination Committee. *National Electric Light Association Proceedings*. 83: 851-852.

Plan to Enlarge Standards Work. (1930, January 5). *The New York Times*, N21.

Railroad Commission of the State of California (1919). *Inductive interference between electric power and communication circuits: Selected technical reports with preliminary and final Reports of the Joint Committee on Inductive Interference* *and Commission's General Order for Prevention or Mitigation of Such Interference.* Sacramento: California State Printing Office.

Reich, L. S. (1985). *The Making of Industrial Research: Science and Business at GE and Bell, 1876-1926*. New York: Cambridge University Press.

Serrill, W. J. (1930). President's Report. *American Standards Year Book*. New York: American Standards Association.

Slotten, H. R. (2000). *Radio and television regulation: Broadcast technology in the United States, 1920-1960*. Baltimore: The Johns Hopkins University Press.

Temin, P. with Galambos, L. (1987). *The fall of the Bell System: A study in prices and politics.* New York: Cambridge University Press.

Thayer, Harry B. (1925). The development of development and research. *Bell Telephone Quarterly* 4, 6.