Engineering the 'Statistical Control of Business': Malcolm Rorty, Telephone Engineering, and American Economics, 1900-1930

Thomas A Stapleford

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Abstract:

Malcolm Rorty is best known to historians of economics as the primary organizer and founder of the National Bureau of Economic Research. This essay situations Rorty's interest in economics against the backdrop of his early career in telephone engineering at American Telephone & Telegraph. I argue that distinct structural features of telephone engineering in general, and AT&T in particular, created overlaps between the practices engineering and economics, and also opened space for Rorty to craft a broader vision for the "statistical control of business" through quantitatively informed management.

Introduction

In 1922, Malcolm C. Rorty, an assistant vice-president with American Telephone & Telegraph (AT&T) published a slender volume on *Some Problems in Current Economics* (Rorty 1922). As Rorty explained in the preface, "the substance of the present volume of essays on industrial economics is taken almost without change from a series of economic, financial, and statistical studies undertaken by the writer as an incident to his connection with a large public utility organization [i.e., AT&T]." A few years earlier, Rorty had played a central role in establishing what would become one of the major institutions in economics: the National Bureau of Economic Research (NBER). According to one early tribute, Rorty was *the* founder of the NBER: it was Rorty who developed the initial idea of a multi-partisan organization that would generate consensus, non-partisan research; Rorty who enlisted Wesley Mitchell, Edwin Gay, and other economists; Rorty who reached out to various

* Correspondence may be addressed to Thomas A. Stapleford, 215 O'Shaughnessy Hall, Notre Dame, IN 46556, tstaplef@nd.edu. I am very grateful for the comments of participants at the 2019 HOPE conference and especially for those of my two anonymous reviewers whose insights and suggestions made this a much stronger essay. I also owe particular debts to archivists Sheldon Hochheiser (AT&T Archives) and Renee Pappous (Rockefeller Archive Center) for their help in locating materials and general advice, and to Karen Russell for sharing the final draft of her excellent forthcoming book, *Promoting Monopoly*.

executives and foundation officials to gain their support; and Rorty who eventually raised the necessary funds "single-handed" (Stone 1945, 5–10, esp. 10).

Rorty's interest in economics would have been difficult to predict from his early career. Graduating from Cornell University in 1896 with degrees in mechanical and electrical engineering, Rorty first worked as a lineman on the construction of an ambitious electrical transmission line from Niagara Falls to Buffalo, New York. One year later, he joined the New York Telephone Company as an installer's assistant, and he spent the next twenty-five years moving between various Bell system affiliates and AT&T. (AT&T was originally established to handle long-distance connections for the local and regional Bell affiliates; in 1899 it became the parent company for the entire Bell system.) Well into the early 1910s, Rorty would have described his professional role as "engineering". So how did this erstwhile engineer become closely involved with economics?

To understand this transition, I find it helpful to draw upon the theoretical concept of a *practice*.[1] As I use the term, a practice refers to a collection of actions that have been rendered intelligible by understanding them as aiming at some goal (*telos*). Critically, for our purposes, any set of actions can simultaneously be re-narrated (re-understood) as aiming at different goals. For example, my actions right now can situated within the practice of writing English prose (goal: construct prose that is comprehensible and elegant to other readers of English) but also within the practices of history (goal: making a contribution to the field of history as I and my colleagues understand it) and of being a faculty member at a research university (goals: strengthen the scholarly reputation of the university and fulfill my contractual obligations to the university). It is precisely this ability to re-narrate actions – to situate them within different practices – that enables overlap between those practices and allows us to understand the same set of actions as being part of multiple fields. Of course, it also creates the possibility for tensions. Precisely because a set of lower-level actions can be re-narrated as serving different ends, those ends might pull practitioners in conflicting directions. Or again, as these larger social practices change, overlaps that once existed may disappear.

To return to Rorty, the development of telephone engineering at AT&T created a context whereby the actions of an engineer could be re-narrated as economics, and vice-versa. Moreover, both could be equally situated as contributions to a new field, the "science of business." At the center of the science of business were a series of lower-level practices such as standardized

[1] I have elaborated on my concept of a practice in Stapleford (2017); for a more general treatment, see Nicolini (2013)

accounting, surveys, tabulation, graphical presentation, curve fitting, correlation, and so forth – all of which could loosely grouped as part of a fourth emerging field, statistics. It was precisely the overlap between these larger social practices that enabled Rorty to move fluidly between multiple professional roles: from being a linesman on the Niagara Falls transmission project, to modeling demand for telephone service as a "commercial engineer", to spearheading the creation of the NBER, to being Chief Statistician for AT&T, and finally to being a prominent executive within the telephone industry. That movement culminated in the development what Rorty called the "statistical control of business activity" (1923) – the use of data collection and statistical analysis to illuminate both the internal workings of a firm and external market conditions in order to guide executive decisions.

It was no accident that this vision and professional mobility emerged from within the practice of telephone engineering at AT&T. The engineering departments in the Bell system had cultivated employees who were primed to use mathematics to analyze complex systems. Initially focused on the human use of telephone networks, telephone engineers such as Rorty soon turned these same techniques – the collection of quantitative data, their graphical presentation, the construction of simplified models – in directions that would overlap with economics. First, AT&T engineers began forecasting consumer demand. The telephone industry (like railroads before them) featured capital-intensive, geographically fixed assets that created a premium on projecting future demand. In AT&T's early days, that task was handed by default to the engineers responsible for designing local Bell Telephone systems, who not surprisingly found it natural to construct mathematical models to predict market behavior. Second, AT&T's quasi-monopoly status from the 1910s – 1970s created pressure for rationalization both within the company (as a tool for creating profits by improving operating efficiency) and as a persuasive strategy (as AT&T had to justify its rates and policies to regulatory bodies and the public). The "statistical control of business" looked in both directions. On the one hand, it presented markets as dynamic but rule-governed systems whose fluctuations could be partially predicted and thereby incorporated into business planning. On the other, it depicted the actions of statistically guided firms as rational and efficient.

It was an engineer's view of management and markets, much as Veblen (1921) had suggested. Nonetheless, by the 1920s, Rorty chose to narrate this view as a triad of business, economics, and statistics, leaving out engineering. In this respect, Rorty perhaps proved prescient: though the roots of "statistical control" may have lain in engineering, the key technical discipline for a science of business would be statistics.

Projecting Demand for Telephone Service

The strongest, early overlaps between the practice of engineering and that of economics in the United States came in the late nineteenth century through large civil engineering projects that required engineers to think carefully about fixed costs, operating costs, and future revenues as part of their design decisions – indeed, in some cases as the crucial factors. Railways were the first example of what eventually would be called "engineering economics" (Lesser 1969), but similar design problems existed in electrical power and new communications systems such as telegraphs and telephones: companies had to invest substantial capital into extensive technological systems that would be fixed in specific geographic locations. One critical component of those calculations involved market analysis: because these systems represented long term investments that could not easily be relocated, companies faced intense pressure to identify both current and future demand for service in various areas.

Today, we would think of this as a project in market research, but there was no such field in the late nineteenth century (Wells 1999, 41–49). Instead, engineers stepped into the gap. In many ways, this was a logical move: whether in railways, telegraphs, electrical systems, or telephones, engineers were responsible for designing, selecting, and installing the equipment that would form the network. Since the technical capabilities of the equipment also placed important constraints on the system, engineers would have to play a central role in the network design. Moreover, they were one of the few groups of employees with experience using quantitative data for design decisions through basic techniques such as graphing and extrapolation.

The telephone industry in particular faced a thorny set of problems: there were no comparable existing technologies, and the engineers had to make both macro-level decisions about inter-city connections and micro-level choices about how to organize city-wide networks. In this respect, AT&T and its Bell affiliates confronted challenges that were faced independently by railroads (city-to-city connections) and electrical power companies (intra-city networks). Fortunately, the scale and integration of the Bell system also made it possible to develop and share techniques for grappling with these problems.

In 1892, AT&T's Engineering Department established a toll data bureau under Thomas Doolittle, who collected call data from local Bell companies and created a model that predicted service demand based on expected population growth (Miranti 2002, 739). Data collection and

extrapolation were familiar practices for Bell system engineers, who used the practices to make inferences in other network design decisions as well. In this same period, for example, Bell engineers began collecting data on call volume at hourly intervals, as well as duration for long distance calls, hoping to use that data to estimate the ideal number of trunk lines (i.e., lines between switchboard exchanges) to minimize delays without creating excess capacity (Wilkinson 1956, 796–98).

Unfortunately, Doolittle's efforts to estimate demand for telephone service struggled, both because his census population data was soon outdated and because he had ignored the effects of household income (Miranti 2002, 739). But Malcolm Rorty would soon take the project further. After working on the Niagara transmission line, Rorty had joined the New York Telephone Company (a Bell affiliate) in 1897, moving from installer's assistant to switchboard repairman to "wire chief" (essentially the supervisor for operating and maintaining a telephone network and its equipment).[2] In 1899, he moved to American Bell in Boston (then the controlling company for Bell system) where the archival records show that he initially worked on inspecting equipment at Bell affiliate switchboard exchanges and assessing the manufacturing processes at Western Electric (the Bell subsidiary responsible for constructing its telephone equipment).[3] But Rorty soon put the mathematical skills he had honed at Cornell to work on new problems.

In 1902, Rorty collaborated with a fellow engineer, W. F. Patten, to overhaul Doolittle's approach to estimating future demand for telephone service. Like Doolittle, Rorty and Patten took population to be the primary driver of overall telephone service in a city, suggesting that engineers should expect the total number of telephone stations in a city to be roughly 10 percent of the population. To estimate future population, Rorty and Patten divided cities into three categories – those with a slowing rate of growth, those with a steady linear increase, and those growing or shrinking geometrically – and assigned a separate extrapolation technique to each. For intra-city planning, they recommended subdividing urban areas into residential and business districts, each of which could be expected to expand in specific ways. Service demand in business districts was predicted to increase in parallel with the square root of the city's population. But the residential districts were further split into three categories based on income: high income (projected to demand full service); mid-income (50 percent service); and low income (5 percent).[4] By explicitly linking

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[2] These details on Rorty's early career come from Rorty (1920).

[3] See correspondence between Rorty and Hammond Hayes in 21-06-03, folder 04, and Hayes to Joseph P. Davis, 12 April 1901, 137b-06-07, folder 04, both in AT&T archives.

[4] W. F. Patten and Malcolm Rorty, "Note on Development Plan," pp. 1-5, encl. in Joseph P. Davis to Frederick P. Fish, 28 August 1902 , 137-09-01-14, AT&T Archives.

demand for telephone service to income, Rorty and Patten made a crucial departure from Doolittle's population-based model and set AT&T on a path to examining the growth and distribution of household income, eventually creating overlaps with economics.

For Rorty, the shift from installing or assessing equipment to creating predictive mathematical models seems to have sparked his imagination and opened new career paths. One year later, he analyzed AT&T call data and partnered with two other engineers to write a lengthy memo on the "Application of the Theory of Probability to Traffic Problems" in which the team created sixteen carefully drawn graphs that allowed users to estimate the probability of various call volumes within intervals as small as thirty seconds. From these, Rorty showed how you could address various practical system design problems.[5] The project drew an enthusiastic response from traffic engineers across the Bell system (Anonymous 1905) and led to Rorty's appointment as traffic superintendent for Pittsburgh within Pennsylvania's Central District Telephone Company that same year (Rorty 1920).

Rorty and Patten's proposal for projecting telephone demand initially faced a cooler reception from upper management. While recognizing the crude nature of Rorty and Patten's model, AT&T's lead engineer, Joseph Davis, could see the promise of supplementing qualitative judgments with formal rules. He forwarded Rorty and Patten's notes to AT&T's president, Frederick P. Fish, whose response indicated the ambiguous place of mathematical models in managerial decisions at the turn of the century. Fish praised the "distinctly scientific" character of Rorty and Patten's method, but also conceded that he was "hardly able to say how complete or accurate" the results might be. Indeed, Fish's short response suggests that he was genuinely impressed with the engineers' work but also entirely unsure what to do with it or how much faith to place in the projections, contenting himself with sharing the "pleasure" he derived from "see[ing] work of this sort."[6]

If Fish saw the engineers' efforts as an interesting experiment, his successor, Theodore N. Vail, took a much stronger line. Inefficient overexpansion led to the near-collapse of AT&T in the financial panic of 1907, with the company only saved by the intervention of a group of bankers led by J.P. Morgan. Morgan brought back Vail, AT&T's first president, to resurrect its fortunes, and Vail soon began bolstering the company's quantitative resources. In 1909, he formed a Statistical Division within AT&T's central offices to gather information about independent telephone

[5] M. C. Rorty to Joseph P. Davis and attachment, 22 Oct. 1903, Box 1360, AT&T Archives.
[6] Fish to Davis, 4 September 1902 , 137-09-01-14, AT&T Archives.

companies (i.e., Bell competitors) and internal data on the Bell affiliates.[7] Sometime in 1910, Vail recalled Rorty from the Central District company to help organize a Commercial Engineering Department within AT&T (Rorty 1920).

In broader usage, "commercial engineering" could refer to everything from estimating costs and potential revenues for a project (much like the engineering economics) to developing new markets for products to the full suite of "commercial" activities entailed by running an engineering firm. Within AT&T, commercial engineering initially had a tight focus, charged with expanding the analysis of telephone demand that Rorty and Patten had pursued eight years earlier. As explained in an internal memo (likely from sometime in 1910 – 1912, and possibly written by Rorty himself), the Commercial Engineering department was responsible for producing a "Development Study" for each community that would "show the number and distribution of subscriber's lines, private branch exchange trunks and power circuits required for the most desirable telephone development in any community fifteen or twenty years hence," as well as "the probable rates of calling and percentages of trunking [use of trunk lines] in different parts of the community." With the Development Study in place, the traffic and plant engineers could then create a "Fundamental Plan" that would describe the equipment and network needed to meet the demand projected by the Development Study. In addition to this long-term planning, each year the Commercial Engineering would project an annual "Forecast of Year's Growth" focusing on service expansions and resulting gross revenue. These estimates, the memo recognized, required technical engineering knowledge, but also went beyond that, encompassing "large questions of business administration, judgment and foresight."[8]

In these early steps, therefore, AT&T's commercial engineers were already beginning to overlap with the practices of business management; indeed, the very title "commercial engineering" implied such multivalence. Simultaneously, though, in attempting to estimate future demand, the Commercial Engineering department was undertaking a task that could readily be categorized as part of the practice of economics. Nonetheless, it was a different approach than the work that dominated economics in the 1910s: whereas economists focused on estimating demand curves, showing how demand would change with price (Morgan 1991, 133–89), AT&T's commercial engineers were trying to predict how structural changes in population and household income would affect demand

[7] Seymour L. Andrew, "The Work of the Chief Statistician's Division," pp. 3, 7, *General Accounting Conference* (1921), 185-03-01, folder 01, AT&T Archives.
[8] "The Telephone Plant – Department Responsibilities in Connection with its Design and Construction," pp. 1, 2-3, 140-04-01, folder 02, AT&T Archives.

for telephones at a given price. What initially drew Commercial Engineering, and Rorty, into much closer overlap with the practice of contemporary economics was AT&T's fraught and delicate status as a privately owned, near monopoly.

Fair rates, economic facts, and the formation of the National Bureau of Economic Research

In its earliest days, the Bell companies used their patents to maintain a *de facto* monopoly on American telephony. After those patents expired in 1894, however, the company faced an explosion of competition. More than three thousand new telephone companies formed in the next decade, and Bell's market share fell to almost fifty percent by 1910 (Vietor 1994, 168–70).

When Theodore Vail was installed as AT&T's new president after the company's near bankruptcy in 1907, he took swift action to restore the company's dominance. Beginning in his 1907 *Annual Report*, Vail proclaimed the company's new doctrine of "One System, One Policy, Universal Service," arguing that telephone service should be an integrated system controlled by a single company, thereby allowing all customers to connect with each other efficiently (Mueller 1997, 96–103). Rather than having rates set directly by market competition, Vail conceded that subscription costs would require some degree of "public control" from an expert commission, "provided that it is independent, intelligent, and considerate," and that such a commission would recognize the need for "fair rates" through a careful analysis of costs and a "fair return" on investment (AT&T 1908, 18, 16). Over the next several decades, the federal government ceded AT&T a regulated monopoly on telephone service throughout much of the United States, a monopoly that only began to crumble in the 1950s before collapsing entirely with the forced divestiture of the Bell companies in 1984 (Vietor 1994, 167–233).

AT&T's unusual status as a national, quasi-monopoly created distinct pressures that would push the firm to engage with economists and economic practice. First, AT&T had justify its private ownership. If telephone service formed a natural monopoly, as Vail insisted, why not make it a government controlled enterprise? Second, aside from these general arguments, AT&T had to justify the rates it charged customers, to show that they were "fair" (in Vail's terms), equivalent in some sense to what would prevail in a competitive market. Moreover, as a national company with regional affiliates, AT&T faced regulatory oversight at both the federal level (like railways) and within individual states (like electrical power companies). But if AT&T's position as a national monopoly created challenges, its extraordinary scale also created distinct advantages, namely the resources and

manpower to develop its own economic expertise to meet those regulatory challenges. At the center of AT&T's efforts was the Commercial Engineering Office, and though the National Bureau of Economic Research did not grow directly from those projects, it nonetheless fit squarely into the approach to political economy that the company espoused.

The roots of these ties lay in AT&T's response to the end of its patents. The Bell companies initially reacted to the explosion of competition by closing off their system: independent companies who wished to connect to Bell exchanges had to become *de facto* Bell franchisees, using Western Electric equipment (i.e., Bell equipment) and eschewing connections to other independents. After the 1907 financial crisis, Vail adopted a more liberal approach, sublicensing non-competing independents (i.e., companies operating in areas that Bell did not serve) without requiring Bell equipment or tightly restricting connections to non-Bell exchanges. The result was a fourfold increase in interconnecting telephones in two years and just shy of tenfold by 1914, encompassing two-thirds of all independent telephones (Mueller 1997, 107–10). Simultaneously, AT&T began acquiring independents that were competing with established Bell companies in urban areas. From 1907 to 1913, the number of cities with a population over 5,000 that had competing telephone companies fell from 59 percent to 37 percent (Mueller 1997, 111–12).

Not surprisingly, the Bell System's rapid expansion provoked a fierce backlash. According to Milton Mueller, by 1913, "AT&T was mired in lawsuits regarding rates or antitrust issues in almost every state," the federal government was preparing litigation, and Congress was considering nationalizing long-distance lines (Mueller 1997, 129). From Vail's perspective, these lawsuits undoubtedly appeared as just one piece of a broader series of threats to corporate capitalism that accelerated after the 1907 financial crisis, from the clamor for government intervention (whether Roosevelt's anti-trust campaigns or Woodrow Wilson's demand for regulated "New Freedom") to growing union power, violent strikes, and socialist protests (Dubofsky 1994, 38–51; Adams 1966). Small wonder, then, that in 1912 Vail gathered "some of the largest financial interests of this country" (including John D. Rockefeller, Jr. and J. P. Morgan) to strategize. In the account of one participant, Vail proposed "a sort of publicity bureau" that would correct the "misinformation" about economic matters that (in Vail's view) plagued the "middle and lower classes on which the demagogues chiefly prey[]."[9]

[9] Jerome Greene, "Principles and Policies of Giving: Memorandum," Rockefeller Foundation Draft Report 12 (1913), pp. 16, 15, folder 163, box 21, SG 3.1, Rockefeller Archive Center.

Vail probably envisioned something like AT&T's earlier work with one of the first public relations firms (actually called the Publicity Bureau), which had written pro-Bell articles and placed them in newspapers across the country in the early years of the twentieth century. Vail had terminated AT&T's contract with the Publicity Bureau in 1908, but only because he was internalizing some of the same functions within AT&T, even hiring away the Publicity Bureau's main agent for the account, James Ellsworth (Russell forthcoming, chs. 3 & 4). Whereas the Publicity Bureau had focused on AT&T's battle with independent telephone companies, Vail's new venture, what one historian has called "the first, most persistent, and most celebrated" corporate public relations campaign in US history, would aim to insulate the company from antitrust attacks by promoting a positive image of AT&T's allegedly "natural" monopoly (Marchand 1998, 48–87, esp. 48; Russell forthcoming). By uniting with Rockefeller, Morgan, and other corporate magnates to subsidize a general economic publicity bureau, Vail undoubtedly hoped to complement the specific AT&T campaign with broader economic arguments.

Vail's compatriots, however, could reach no consensus on whether the proposed bureau would merely publicize what Vail implied was well-established economic knowledge or whether it would conduct new research, and the project ultimately went nowhere (Grossman 1982, 61–76). But although Vail failed to get his independent publicity bureau for economic analysis, he had his own internal resource: the Commercial Engineering Office. Around this same time (per a later account), Vail directed Commercial Engineering "to keep informed as to all movements toward public ownership in the United States and other countries in general, and toward public ownership of public utilities in the Unites States in particular, to advise the executives of the Company as to the significant developments in these fields, and to be prepared to furnish pertinent information on this subject."[10] Along with tracking efforts to promote government control of utilities, Commercial Engineering also began compiling a "Brief of Arguments Against Public Ownership" in a binder containing one-hundred-plus pages of "related statistics and quotations from economic and other authorities" that AT&T would distribute across the country for use in articles, speeches, and community debates about public ownership (Kielbowicz 2009, 682).[11]

[10] Andrew, "The Work of the Chief Statistician's Division," p. 4, *General Accounting Conference* (1921), 185-03-01, folder 01, AT&T Archives. Per Andrew, AT&T started these efforts in 1912, though they seem to be an extension of a project begun by AT&T statistician Walter S. Allen in 1902 (Russell forthcoming, ch. 3).
[11] Quotations are from the copy of the "Brief" held at the University of Michigan library.

Vail's program paid big dividends in 1913 when AT&T faced a federal antitrust investigation and perhaps the strongest threat to a public takeover in its history. In the midst of the antitrust investigation, Rep. David Lewis (Maryland) began working with the U.S. Postal Service to prepare a proposal for federal ownership of American telegraph and telephone services as part of the postal system (a common arrangement in several European countries). Per an early account from the *New York Times*, Lewis had been working "secretly" at the Post Office Department for some time gathering extensive data on U.S. and European systems, eventually bringing "voluminous tables to the White House" and leaving President Woodrow Wilson "greatly impressed by Mr. Lewis's ability to marshal his facts" (New York Times 1913a). After the release of the proposal, and just days before a major Congressional speech by Lewis, AT&T reached a settlement with the Department of Justice in which the company would divest its controlling interest in Western Union (the major U.S. telegraph company) and open its long-distance lines to independent companies. Lewis, however, was not deterred, and gave a lengthy speech drawing on his detailed studies to persuade his colleagues that privately owned American telephone and telegraph services were inefficient and exploited consumers (New York Times 1913b; 1913c; 1913d).

AT&T's Commercial Engineering Department provided the empirical backbone to the company's response. By this time, Malcolm Rorty had left department: beginning in 1912, he had been part of a committee exploring how to integrate the Bell system with Western Union's network of telegraph offices. In the summer of 1913, he had shifted to an executive position within Western Union, becoming "Manager, Joint Telephone Services" and eventually an assistant to Vice-President Belvidere Brooks.[12] In his absence, the new top staff member in Commercial Engineering took the lead: Chester I. Barnard.

Born in 1886, Barnard had studied economics at Harvard for three years. However, financial constraints drove him to leave Harvard for AT&T without a degree in 1909. Courtesy of a family connection to AT&T executive Walter Gifford, Barnard found a position in AT&T's new Statistical Division under Gifford's leadership, where his broad classical education (including reading multiple languages) and training in economics proved a major asset for the Division's core task of gathering and analyzing information about foreign telephone and telegraph services and domestic Bell

[12] For Rorty's work on integrating AT&T and Western Union, see minutes and memos from January 1912 – fall 1913 in 126-09-02, folder 07, AT&T Archives. On Rorty's appointment to Western Union, see (*Telegraph and Telephone Age* 1913). In May 1914, he was appointed assistant to Belvidere Brooks, Vice-President, Commercial Department (*Telegraph and Telephone Age*, May 1, 1914, p. 249; June 16, 1914, p. 348). By October, he had left the company, and was presumably back at the Bell system.

competitors (Wolf 1961; Scott 1992, 61–67). At some point in the early 1910s, Barnard transferred to the Commercial Engineering Department, becoming a counterpoint to the engineer Rorty: an economist who had moved into the overlapping world of commercial engineering.

Barnard's response to Lewis's arguments, issued as Commercial Bulletin no. 7, drew on all the resources collected by the Statistical Division and Commercial Engineering over the preceding years. The report was a rhetorical tour-de-force, containing fifty-six pages of close critique of Lewis's claims, jam-packed with statistics and supported by seven additional appendices and nearly two-hundred endnotes to various journal articles, government reports, company bulletins, and letters from across Europe and the U.S. The basic argument of Barnard's analysis was that Lewis had misunderstood both the data that he cited and the intricacies of telephone and telegraph operations. When corrected, a purely "statistical treatment of the subject" led to "general conclusions which are directly contrary to those reached by Mr. Lewis," namely that the privately owned American telephone and telegraph services were more efficient than public counterparts and provided lower rates for customers (Barnard 1914, esp. 1). Per a retrospective account, the work of the Commercial Engineering Office "was exceedingly useful" in combatting the "agitation" led by Lewis.[13]

Rorty, who at the time was still working at Western Union, does not appear to have been directly involved in responding to Lewis. But the broad questions posed by AT&T's position were inescapable for anyone like Rorty who was now part of the company's management. For example, when Rorty returned to AT&T's New York offices later in 1914, he became involved in a long-running debate about reduced rates for nighttime calls. Everyone agreed that reduced night rates would cost Bell affiliates money; the question was how much, and whether the loss would be outweighed by the public relations benefit of voluntarily making reductions that might otherwise be ordered by regulatory bodies. Rorty worked with Barnard's commercial engineers on several empirical studies to devise a rate schedule that Rorty felt would strike an appropriate balance.[14]

Sometime during this same period, Rorty struck up a friendship with Nahum I. Stone, a Russian-born economist with socialist leanings who had worked as a statistician in the U.S. government and was at the time a consultant for labor arbitration and various industrial investigations (Fabricant 1984, 3–4; New York Times 1966). Per Stone's retrospective account, the

[13] Andrew, "The Work of the Chief Statistician's Division," p. 5, *General Accounting Conference* (1921), 185-03-01, folder 01, AT&T Archives.
[14] See correspondence in 125-06-01, folder 04, AT&T Archives, especially letters of 10 July 1915, 28 August 1915, 23 December 1915, 30 August 1916, 21 October 1916, 3 March 1917, and 9 March 1918.

two met as dueling experts in several New York hearings, though the details are hard to verify (Stone 1945, 5).[15] Regardless, the catalyst for their friendship was Stone's lengthy and critical review in the *Intercollegiate Socialist* of the economist Scott Nearing's (1915) book on the distribution of income in the United States (Stone 1916).

Rorty was impressed that a "radical" like Stone would evince so much integrity and care in statistical analysis, even at the expense of a potential political ally, and so he invited Stone to lunch, marking the beginning of a long friendship. Per Stone's account, Rorty lamented the lack of agreement "on the purely arithmetical question of what part of the national income goes to each element of society" (the very subject of Nearing's recent book and a core question in debates over socialism) and suggested creating "an organization that devoted itself to fact finding on controversial economic subjects of great public interest" (Stone 1945, 6). Stone concurred, and after brainstorming about potential collaborators, Rorty enlisted the economists Edwin Gay (Harvard) and Wesley Mitchell (Columbia), offering to provide AT&T data on "a complete classification of families according to rents paid and rental value of properties occupied for the majority of cities of over 50,000 population in the United States" (Stone 1945, 6–7).

Whether by luck or previous knowledge, Gay and Mitchell were an inspired choice: when Vail had proposed forming a "publicity bureau" back in 1912, Jerome Greene at the Rockfeller Foundation had suggested a rival plan for a research bureau and had enlisted Gay as an ally. Gay, working with a small committee arranged by the Foundation, had suggested Mitchell as the director. The program went nowhere at the time, derailed by internal divisions within the Foundation. (Grossman 1982, 61–76). But when approached by Rorty, both economists quickly agreed, and with Rorty courting business leaders and funding, they formed the "Committee on the Distribution of Income." Though plans were temporarily suspended by the war, Rorty returned with gusto after the armistice, raising the necessary money and spearheading the foundation of the NBER at the December 1919 meeting of the American Economics Association in Chicago.

The extant documentation does not give much direct insight into Rorty's motivations, but placed in the context of his experience within the telephone industry, his actions make a great deal

[15] Stone reports first meeting Rorty at the hearings of the New York State Factory Investigating Commission, created in the wake of the infamous 1911 "Triangle fire." Stone did testify at those hearings; Rorty does not appear in the official transcripts. (He could, of course, have attended the hearings.) Stone dates their second encounter to a consultation before the Mayor's Unemployment Committee; the committee did not publish transcripts or summaries, so this cannot be verified. Stone and Rorty did serve on the U.S. Chamber of Commerce Committee on Statistics and Standards in late 1915, which issued a sharp critique of U.S. trade statistics (New York Times 1916).

of sense. First, as we saw earlier, AT&T's need for market research meant that its commercial engineers had experience and expertise in gathering and analyzing economic data. It is striking (though not surprising) that the data Rorty offered to Gay – details on household rent data and property values in large cities – were precisely the data that AT&T was using as a proxy for household income in order to project demand for residential telephone service.

Second, Theodore Vail's vision of AT&T as a lightly regulated monopoly that would offer "fair rates" in exchange for "fair returns" resonated perfectly with Rorty's belief in the purportedly neutral, quantitative economic facts that could be produced by the future NBER. In Vail's depiction, "fair rates" were not a matter for negotiation; they could be calculated from the extensive statistical data gathered by AT&T's Commercial Engineering department and its statistical division. Moreover, such calculations would not be merely a hypothetical dream; the entire premise of Vail's approach rested upon the company's ability to present quantitative arguments that could withstand close scrutiny in regulatory hearings. It is telling that the mix of professionals who formed the early boards of the NBER – business leaders, labor officials, lawyers, academic economists – reflected precisely the group of experts who frequently appeared in legislative or commission hearings on industrial matters.

How deeply Rorty had imbibed that vision became apparent in his 1922 volume, *Some Problems in Current Economics*. The book began as a series of pamphlets (printed between 1920 and 1922) "to be distributed primarily to executives and other employees of the telephone industry."[16] In turning the pamphlets into a book for a general audience, Rorty kept the main text largely intact but replaced discussions of the telephone industry with nearly identical commentaries on public utilities. On that topic, Rorty repeated Vail's line: wages in utilities should mimic "comparable occupations" in the same localities, returns to capital should be "reasonably comparable" to those in other industries, and rates should be set accordingly (keeping in mind actual costs and depreciations). In short, regulating utilities simply required gathering economic statistics (14-17).

But Rorty's core argument went well beyond the economics of utilities. The book opened with a folksy anecdote about a West Virginian feud headed for "shootin's, an' murders, an' burnin's for three generations" that was defused when a diplomatic judge gathered the antagonists for a conversation about their disagreements and helped them recognize that their disagreements did not warrant wanton violence. The "point of this incident" for "the present economic situation," Rorty

[16] The original printed pamphlets can be found in 127-09-03, folder 07, AT&T Archives. Quotation from the "Prefatory Note".

explained, was a parallel need for "a clear dividing line between what should be the basis for a feud and what the basis for a temperate and constructive difference of opinion." This "clear dividing line" would come from a "full and dispassionate understanding of the real facts," especially about wages, production, and the distribution of national income. The book culminated in a fourth chapter on "Some Pertinent Statistics" about these topics, which then led naturally to the conclusion, "Facing the Facts" (Rorty 1922, 11–13, esp. 12–13).

Against the backdrop of the recent Russian revolution and the American Red Scare, Rorty's reference to a violent "feud" between "employer and employee" was clear. The contrast between a "feud" and a "constructive difference of opinion" marked the distinction in Rorty's mind between Bolshevik revolutionaries and a socialist like Nahum Stone, between intransigent ideology and the self-critical empiricism that he envisioned for NBER. Indeed, in a 1917 address to the American Statistical Association, Rorty argued that a "true and widespread knowledge of income distribution" would undercut "the extremist and the I.W.W. [Industrial Workers of the World] agitator" (Rorty 1917, 796). Likewise, in an early fund-raising letter for the still-nascent NBER, Rorty touted the potential value of the proposed bureau for "a campaign of education in opposition to Bolshevism in this country."[17]

If Rorty believed that "Facing the Facts" could defuse revolutionary tendencies, he also upheld the NBER's new tradition of gathering a politically diverse group of experts to scrutinize those facts. Although the book was not an official NBER publication, Rorty thanked Gay, Mitchell, and the prominent socialist Harry W. Laidler (who had commissioned Stone's 1916 book review and served on the NBER board) for "helpful comments and pertinent criticisms." Perhaps most remarkably, Rorty shared the pamphlets with "certain of his more radical friends,…inserting the substance of their comments as footnotes" in the published book. Most of these, he explained, had come from "a specially well-informed and temperate socialist" (likely Stone), and some turned into lengthy commentaries running across multiple pages (Rorty 1922, 8–9).

That Rorty could find common ground with socialists like Laidler or Stone is no surprise, for neither Rorty nor anyone else associated with the monopolistic AT&T could be a radical promoter of free markets. Rorty's book had two dominant analogies for what he called "our present industrial

[17] Rorty to Max Farrand, 9 August 1919, Series 18, Box 223, folder 2099, Commonwealth Fund Papers, Rockefeller Archives Center. Stone and the labor members of the planning committee objected to any direct ties to the anti-Bolshevik campaign; see Stone to Frey, 19 August 1919, and Frey to Rorty, 22 August 1919, both in the same folder.

organization." The first, an "industrial" or "economic machine", was perhaps natural for an engineer. Rorty conceded that the current machine had "periodical partial breakdowns," but that it would be foolish "to condemn the whole machine because of a dirty spark plug or a choked gasoline feed, or to hammer blindly at the mechanism in the hope that a chance blow or turn of the wrench will remedy the difficulty." The better option was to learn "how the present machine works and how to adjust it and keep it in good running order" (Rorty 1922, 59–61).

But Rorty's second analogy highlighted a different set of associations. He began with a contrast between the "highly individualistic state" of classical liberalism (which protected "individual liberties" but was "incapable of successfully directing the administration of large public or semi-public enterprises") and the "highly socialistic state" (which "sacrifice[s]…individual liberty and individual energy"). As a possible "compromise between these two extremes," Rorty proposed "the organization of the human body," where "the brain thinks, reasons, and plans—but although it is served by the vital organs, it has no control over their routine operations," that is, basic autonomic functions like breathing or digestion (Rorty 1922, 44–47). In this analogy, the brain was the federal and state governments, while the "vital organs" were "our great corporations" (48). If individualism left the body uncoordinated and undirected, socialism would be "like a man who was compelled to order each heart beat and each breath by an effort of the will" (47-48).

For public utilities, Rorty conceded that some "small saving" might result from government ownership, but this "would not be much more than offset by the wastes that seem to be inseparable from governmental operation of complicated enterprises." As he insisted, "*the question of capital ownership is, in itself, of minor importance, and the controlling point of view must be that of efficiency of operation and adequacy of service*" (Rorty 1922, 51, emph. in original). Provided that the governmental "brain" deployed its regulatory power according to the kinds of neutral facts Rorty was offering, leaving "our great corporations" in private hands would bring efficiency and innovation (57-58). It was a vision that paralleled the voluntary corporatism championed by America's most famous engineer in the early 1920s, Herbert Hoover, who was simultaneously leading the Department of Commerce to collaborate with the NBER to mitigate the economic inefficiencies of business cycles through voluntary corporate planning based on economic statistics (Alchon 1985).

In all these respects, *Some Current Economic Problems* synthesized Rorty's experience in both AT&T and the NBER. Of course, in working with Stone to establish the NBER, and in helping to lead it over its first decade, he was acting on his own behalf rather than as an official agent of AT&T; indeed, in 1923, Rorty left AT&T for the International Telephone and Telegraph Company

while retaining his role in the NBER. Yet it is highly unlikely Rorty would have offered AT&T's data on household rents without Vail's approval, and it is equally clear that the vision for the NBER resonated perfectly with how Vail and likeminded executives understood the regulation of monopolies: grounded in neutral facts about the larger economy (wages, returns to capital, shares of national income) that had passed through the purifying fire of experts representing various economic and political interests. In this respect, it is no surprise that AT&T and its affiliates were the largest corporate donors to the NBER in its early years.[18]

From Commercial Engineering to Statistics: Business Cycles at AT&T

If one intersection between AT&T telephone engineering and the NBER lay in the form of the NBER – its dedication to producing impartial economic facts that could both constrain debates in political economy and guide the "fair" regulation of a privately owned monopoly – a second lay in the core intellectual content of the NBER's work for its first several decades, namely the study of business cycles. Business-cycle research had close ties to forecasting and hence to one function of the Commercial Engineering Department that we examined earlier: producing an annual "Forecast of Year's Growth" to guide immediate decisions about investment and expansion. But in the aftermath of the First World War, this work was placed in a new institutional context: statistics rather than commercial engineering.

When Rorty returned to AT&T after the war (having reached the rank of colonel by serving in the Ordinance Department and then as head of the Supplies Accounting Section of the General Staff), he was appointed as Chief Statistician (Rorty 1920). While taking the role, however, Rorty also absorbed some of the previous functions of Commercial Engineering. By 1921, the Statistical Division was a broad operation with eight different sections. Telephone Statistics and Foreign Telephone & Telegraph Statistics continued the work of monitoring AT&T domestic competitors and international peers while also maintaining internal data on Bell system operations and its

[18] AT&T and Western Electric gave $2,500 combined to the NBER from 1922 through 1923, the only years with detailed donation records in the archives. The next closest contributor was J.P. Morgan at $1,500. Records of the Carnegie Corporation, III.A, box 243, folder 7, Rare Book and Manuscript Library, Columbia University. For an account that posits greater continuity between Vail's 1912 proposal for a "publicity bureau" and the NBER, see Cook (2017, 255–63). However, Grossman (1982) shows that the early plans for an economic research bureau were rejected by proponents of the "publicity" model in Rockefeller circles. Certainly, the $2,500 AT&T gave to the NBER in 1922-1923 pales in comparison to the $250,000 per year Vail had originally offered for a publicity bureau. See Rockefeller, Jr., to Gates, 27 July 1912, pp. 1-2, Office of the Messrs. Rockefeller, Series F, Box 18, folder 143, Rockefeller Archives Center.

employees. The latter was aided by a Special Statistical Analyses section intended to study aspects of Bell operations. In a sign of the division's general role as an information clearinghouse, it also maintained the corporate library and the Photostat services. Finally, the Statistical Division pulled two functions from Commercial Engineering: Public Ownership (dedicated to monitoring and intervening in debates about public ownership of utilities) and Economic & Financial Statistics (analyzing and using these data for internal decisions and public arguments). To this, Rorty added a new section on Statistical Methods, which, as the name implied, focused on the "origination and application of statistical methods," including "Probability, Sampling, Correlation," and so forth.[19] The entire division was a massive operation: by 1923, it employed twenty-eight main staff members and close to sixty clerks, secretaries, and messengers.[20]

The study of business cycles intersected the work of Economic & Financial Statistics, as well as Statistical Methods. Rorty's general views on business cycles – presented in *Some Problems in Current Economics* and recycled in internal presentations by the Statistical Division – followed fairly conventional lines: overexpansion leading to higher interest rates and high prices, followed by a reactive contraction. Rorty hoped that timely restrictions on credit would prevent overexpansion, though he recognized the challenges of implementing that practically (Rorty 1922, 73–84).[21] For the individual firm, the solution lay not in preventing fluctuations but anticipating them, and that became the task of Economic & Financial Statistics.

In 1918, the Statistical Division began publishing a monthly "Summary of Business Conditions in the United States." Much of the thirty-plus page report contained summary tables and charts of various financial and trade statistics compiled from other sources. But the "Summary" also included several time-series graphs charting various indices as a percentage of their "normal" levels. The most basic of these was titled "General Business," being "a composite of important indices of business activity" running from 1903 to the present. As the accompanying text explained, each time series had been adjusted in three ways: (1) deflated by a price index; (2) removal of "long-term growth" trends; and (3) adjustment for seasonal variation (AT&T. Office of the Chief Statistician

[19] Andrew, "The Work of the Chief Statistician's Division," pp. 3-13, esp. 11, General Accounting Conference (1921), 185-03-01, folder 01, AT&T Archives.
[20] See Comptroller's Department organizational chart, appended to General Accounting Conference (1923), 185-03-01, folder 02, AT&T Archives.
[21] Andrew, "The Work of the Chief Statistician's Division," follows Rorty's account, including the use of a diagram from his book. See pp. 16-22.

1921, 12).[22] In the eyes of the AT&T statisticians, the latter two steps effectively defined the "normal" levels; any remaining fluctuations in the time series were thus deviations from normal.

Developing and improving the "General Business" index and its components became the responsibility of the Statistical Methods section, led by Donald Belcher (a mathematician). Although we do not have the full details of how the section made its adjustments to the raw data, the more general discussions were sophisticated[23] and clearly aware of relevant contemporary literature; when explaining to business executives about the need to adjust data for seasonal variation, for example, Rorty referred them to Warren Person's work in the *Review of Economic Statistics* (Rorty 1920). Perhaps for that reason, the Statistical Division was also not naïve about the limits of quantitative analysis; as Rorty's successor as Chief Statistician, Seymour Andrew, put it in 1921, "much of the output of [Economic & Financial Statistics] is necessarily in the form of reasoned judgment of a qualitative character based on incomplete data,"[24] and the monthly "Summary" gave equal space to narrative assessment of business conditions from division staff and local Bell affiliates. In Rorty's assessment, "There is…no complete substitute for that instinctive knowledge, or 'feel,' of a business that comes in time to the experienced executive, and this knowledge, in combination with a relatively simple statistical analysis, will produce results that cannot be secured from the most elaborate sets of figures when the practical touch is lacking" (Rorty 1923, 158)

All told, the "Summary of Business Conditions" was a remarkable monthly publication – unique for the time period, so far as I am aware. Though other "business barometers" and forecasting services proliferated after the war (including the Harvard Economic Service), AT&T's monthly "Summary" was the most elaborate internal analysis from a private corporation.[25] The "Summary" was made possible both by the scale of AT&T (which allowed it to house such a large Statistical Division) and its long tradition of data gathering and market analysis through the Commercial Engineering Office. In that context, it should be no surprise that Rorty was one of the founding members of the Econometric Society in 1930 – dedicated to the intersection of economics, mathematics, and statistics – or that Belcher and Seymour Andrew (Rorty's successor as Chief Statistician) would join in the first year. Still, the affiliation of Belcher and Andrew –

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[22] The "Explanatory Note" first appears in the March 1921 summary; however, the description appears to match previous usage.
[23] Cf. Belcher, ""Discussion of Statistical Analysis and its Application to Certain Phases of the Telephone Business", General Accounting Conference (1921), 185-03-01, folder 01, AT&T Archives.
[24] Andrew, "The Work of the Chief Statistician's Division," p. 13, General Accounting Conference (1921), 185-03-01, folder 01, AT&T Archives.
[25] On the history of forecasting, see Friedman (2014).

statisticians rather than engineers – pointed to an important realignment in which the older overlap between the practices of commercial engineering and economics would be replaced by a new configuration of economics, statistics, and management.

Engineering, Economics, and the Statistical Control of Business

By the late 1910s, two key domains in which AT&T commercial engineering had once overlapped with economics (market forecasting and debates about public ownership of utilities) had been re-categorized as part of a general Statistical Division. Outside of the central office, this break was not so sharp: the Commercial Engineering Department of Southwestern Bell, for example, produced several "Economic Surveys" that analyzed the telephone market and its potential growth in its region in the late 1920s (e.g., Holsen 1927). For Rorty himself, though, the old category of commercial engineering had been completely subsumed by a new and more general practice, the "statistical control of business" that he promoted in talks and essays (e.g., Rorty 1920; 1923).

Rorty's own career had jumped fully onto the executive pathway: in 1921, he became Vice President of Bell Telephone Securities; in 1922, he returned to AT&T as an assistant vice-president; and in 1924, he became Vice President of the International Telephone & Telegraph Company. His vision for the "statistical control of business" thus formed a synthesis of his past experience and current responsibilities. At its heart, he explained, the "essence of statistical control" involved "picturing of a whole business, so that the essentials stand out sharply from the mass of detail" (Rorty 1923, 166). The task of the statistician, as he explained in another essay, was fundamentally inference: "Accounts are a systematic record and summary of what has happened. Operating statistics should show exactly *where* it has happened, *why* it has happened, and *who* or *what* is responsible" (Rorty 1920). The scope was broad – involving "personnel and wage studies" (what we might regard as human resources), budget projections (accounting) and topics that intersected closely with economics, such as "market and price analyses" and, above all, "general business forecasts" (much of which drew on the work of AT&T, with a reference to the Harvard Economic Service and the research of the NBER) (Rorty 1923). This new role demanded someone familiar with the practices of statistics, of economics, and of a given business (156).

The remainder or Rorty's career exemplified the power of that overlap. In 1930, he was elected president of the American Statistical Association (ASA); in 1934, he became president of the American Management Association, a post he held until his early death in 1936. Throughout this period, he continued to write about economics while also being the ASA's appointed director for the

NBER from 1924 onwards and serving terms as the NBER treasurer, president, and chairman of the board. This triple intersection of statistics, management, and economics in the telephone industry was not unique to Rorty. Donald Belcher, the mathematician who had ran the Statistical Methods section within the Statistical Division, would later become comptroller and then treasurer for AT&T, and would also serve on the NBER Board of Directors in the 1940s and 1950s. Even in the mid-1920s, Belcher's list of research areas for Bell system statisticians sounded nearly identical to tasks taken up by economists: "the problems of supply and price trend of raw materials; manufacturing costs; distributing costs; markets and market structures; labor supply; wages; living costs; interest rates; the future trend of wages, prices, and interest rates; [and] the cyclical ebb and flow of present and future general business conditions" (Glover 1926, 425).

But Belcher, of course, had never been an engineer. Nor did Rorty's essays from the 1920s and 1930s make reference to his engineering past; he spoke of statistics, executive decision-making, and economics, but not engineering. That absence is striking because the early 1920s were the very moment in which American engineers, led most visibly by Herbert Hoover, were promoting themselves as experts in efficient management for both business and government (Layton 1986, chs. 7 & 8). Veblen (1921) had similarly predicted that engineers' professional obsession with eliminating inefficiency through careful design would lead them to challenge bankers and more traditional capitalists for control of the modern industrial economy (Knoedler and Mayhew 1999). And indeed, Rorty's vision for the "statistical control of business" shared close similarities with the contemporaneous push for "scientific management" led by the Taylor Society, a movement that also had its origins in engineering (Chandler 1977, 272–81) and which had its own ties to institutional economics and to the NBER (Bruce and Nyland 2001).

Yet, Rorty's decision to emphasize statistics over engineering was prescient. In truth, the lower-level practices linking engineering to both economics and management involved data collection and mathematics: graphing, curve-fitting, regression, simple mathematical models, and so forth. Thus there was no reason that someone like Belcher, a mathematician with no substantive engineering experience, could not pursue those practices equally effectively. Indeed, Rorty's predecessor as Chief Statistician at AT&T was a perfect model of the intersection Rorty envisioned. Walter S. Gifford, a 1905 graduate of Harvard, had started as a clerk at Western Electric before Vail tapped him to be chief of AT&T's new Statistical Department. Gifford parleyed that experience into a leading role in U.S. wartime planning before returning to AT&T as comptroller, then vice-president, and eventually president from 1925 – 1948 (Marshall 2000).

Nonetheless, Veblen may have been correct that patterns of action and thought enculturated in engineering settings predisposed engineers to employ mathematical practices towards particular ends, namely the characterization, analysis, and control of complex systems. It was surely no accident, for example, that scientific management and cost-benefit analysis both developed among engineers, or that key pioneers in statistical testing worked in applied agriculture (Ronald Fisher) or quality control for industrial processes (William Sealy Gosset). Although the mathematical practices could be separated from these origins, the decision to apply them as tools for control arose in specific institutional contexts that habituated such goals.

Indeed, the potential of AT&T's Commercial Engineering Office in this regard is well-illustrated by Rorty's one-time subordinate, Chester Barnard, who had led AT&T's response to David Lewis's campaign for government ownership of the telephone system. Trained in economics, Barnard spent over ten years in commercial engineering before making his own jump to the executive ranks, becoming assistant vice-president of the Pennsylvania Bell company in 1922 and then president of New Jersey Bell in 1927. In 1938, he published *The Functions of the Executive* (1938), a text widely heralded as one of the pioneering works in the study of managerial organization. Herbert Simon called the book "a major influence upon my thinking about administration," and thanked Barnard for his "extremely careful critical review" of Simon's preliminary draft of *Administrative Behavior* (1947, xv–xvi), the book that helped Simon earn his Nobel Prize.

By the late 1910s, the fecundity of AT&T's Commercial Engineering Office had come to an end as Rorty absorbed several of its broader functions into the Statistical Division. Yet the decline of Commercial Engineering was not the end of the intersection between economics and the practice of telephone engineering. Perhaps serendipitously, the early 1920s also saw the formation of Bell Labs, a joint venture between AT&T and Western Electric which would forge a new set of ties to economics around a different set of lower-level practices: the operations of probability theory to systems analysis and decision making (Klein 2000; Miranti 2005). Four members of Bell Labs involved with these projects would become early members of the Econometric Society (Harold Dodge, Thornton Fry, R. L. Jones, and Walter Shewhart). Later in the postwar era, Bell Labs would launch the *Journal of Economics and Management Science* intended "to encourage and support research in the issues and problems of regulated industries" (Garlinghouse 1970, 3). It was a new era for the interlocking of engineering, economics, and business, founded on a different set of overlapping practices, and yet both the pressures and resources that produced it would have been very familiar to Malcolm Rorty.

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