OBJECTIVITY AND ADVOCACY: PROBABILITY THEORY AND CAPITAL COSTING AT THE BELL SYSTEM, 1913-1941

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ABSTRACT

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This dissertation, an historical case study, investigates how the Bell Telephone System blended knowledge of depreciation and probability theory both to develop a managerial accounting policy and to serve as a means for controlling debate before government regulators in the early twentieth century. This research shows that by combining statistics and accounting, the Bell System created a system for estimating capital cost expiration that was firmly grounded in mathematical science. The firm developed methodologies that used averaging techniques as a way to determine trends in asset life that were obscured by random fluctuations in actual retirements. The resultant smoothing of annual expenses also helped reduce the perception of risk, thus providing an economic benefit to the firm. At the same time, complexity derived from the application of probability theory gave the telephone company significant advantages in regulatory debates with adversaries trained primarily in accounting and law. In addition, the advanced mathematics also functioned as a knowledge barrier which inhibited potential encroachments by regulators on corporate prerogatives.

This study extends the body of literature on managerial accounting by documenting an early use of statistical tools to understand firm resources. This study also expands our understanding of the acquisition and use of knowledge within the firm. Some

of the most interesting findings look at the contextual nature of knowledge. Thus, in the pro-business atmosphere of the 1920's, the firm was left alone to develop its knowledge base and design applications that were in its own best interests. With the crisis of the Depression, the relationship between the firm and business changed, and regulators demanded examination of the equity issues related to AT&T's depreciation practices. This resulted in changes to the rate base calculations, but the basic depreciation policies of the Bell System remained unchanged.

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Chapter 1 – Objectivity and Advocacy

1. Introduction

This work is an historical study of an organization's acquisition and application of managerial accounting, focusing on the innovative integration of two bodies of specialized knowledge - accounting and probability theory - at the Bell Telephone System. By the 1920s[1], the Bell System had combined accounting and probability theory to develop a scientific basis for measuring capital costs, applying statistical theory derived from actuarial science to calculate depreciation expense for approximately half of Bell's fixed assets[2]. This initiative, which represented an early industry effort at accounting standardization, occurred more than a decade before the American Institute of Accountants (forerunner of the modern-day American Institute of Certified Public Accountants) established its Committee on Accounting Practice (1937) and began issuing its Accounting Research Bulletins in 1939 (1991). In contrast to the AIA, the Bell accounting efforts addressed specific methodological problems presented by their businesses. The accounting standardization the Bell system advocated was driven by their business needs, not from a perceived need to rationalize general accounting theory. Their presentations to and arguments before the ICC[3] more closely resembled legal advocacy

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[1] The Bell Telephone system in the 1920s consisted of three principal elements: American Telegraph and Telephone (AT&T), Long-Lines, and Western Electric Manufacturing. AT&T, the parent company, was based in New York and controlled the Long-Lines Division, which specialized in long-distance service. Long-Lines also served as the holding company for the regional operating companies that provided local and toll service in state markets. The Western Electric Manufacturing Company was a captive supplier of telephone equipment and apparatus to the system. In 1925, AT&T formed Bell Telephone Laboratories, Inc. to conduct research and provide technical support to the operating and manufacturing subsidiaries.

[2] In testimony before the ICC, L.G. Woodford, Bell cost engineer, stated that fixed assets were divided into four groups for depreciation purposes; two of these groups, comprising 51% of total fixed assets, used mortality table information as a source of depreciation estimates (Testimony of Witnesses for Bell System Companies; Docket No. 14,700: Depreciation Charges of Telephone Companies 1928)

[3] The Mann-Elkins Act of 1910 extended regulatory authority of the ICC to interstate pipeline and communications companies, bringing the Bell System within its purview. The administration of President Franklin D. Roosevelt transferred oversight authority over the telephone industry to the Federal Communications Commission (FCC) in 1934.

arguments than they did the later AIA bulletins which reflected an attempt to build consensus on accounting matters of import to a broad range of firms and/or industries.

Several reasons underlay the Bell System's involvement in the process of methodological definition. First, the firm became deeply interested in the creation of insightful means for assessing its underlying economic processes because as a natural monopoly it lacked competitive pricing signals that could be used to inform capital budgeting decisions.[4] Founded in 1875, the firm exploited its ownership of the Alexander Bell patents to enjoy a monopoly in the telecommunications markets until 1894 when the rights began to expire (Garnet 1985). A period of intense competition followed, but over the next two decades the firm was effectively able to re-establish its monopoly in many of the nation's most lucrative urban centers. The Bell System's dominance became so strong that the administration of President Woodrow Wilson intervened in 1913 to force the company under the "Kingsbury Commitment" to either cease growth through acquisition or face anti-trust litigation.[5]

The resurrection of monopoly power, however, created a serious deficit of information needed by management in determining resource allocation; Bell no longer had access to the pricing signals sent by market competition. In the absence of market pricing information, the firm needed to explore alternate means of assessing performance, of measuring costs and anticipated revenue gains (losses) associated with different options. This gave increased incentive for Bell managers to experiment with measurement innovations - including depreciation – as a better way of understanding

[4] This became especially important in the decade after World War I, when the firm tapped the capital markets four times to finance the strong growth of telephone service and the costs of system automation (Stehman 1967).

[5] As part of the Kingsbury Commitment, Bell was required to spin off the Western Union Telegraph Company which it had acquired in 1911 (Garnet 1985).

their cost structure. Since the Bell System as a whole had extensive experience with collecting and applying statistical information (Miranti 2002), management turned to the quantitative tools already successfully employed elsewhere in the firm. In the case of depreciation, management, as my dissertation will explain, adapted some of the probabilistic constructs used in the development of its actuarially based pension liability estimates (Chandar and Miranti 2007).

Measurement definition also became an important element in shaping the nature of its dialogue with the host of state and federal regulatory bodies who relied heavily on both accounting and statistical information to assess firm performance; these groups had authority over rate-setting, a power which could essentially determine firm profitability. In addition to the ICC, by 1915, 40 states had formed regulatory agencies to monitor the activities of natural monopolies in transportation, communications, and power generation (Symkay 1955). The critical standards of performance were the efficiency and economy of the telephone service provided to the public. Economy in this context meant the reasonableness of the cost of service to the public, a question which was amenable to accounting analysis. Efficiency, on the other hand, related to the quality of telephone service and was measured in terms of physical parameters such as clarity or transmission or the speed of call completion.

Capital costs constituted about half of the total pool of annual expenses that the firm sought regulatory approval to recapture through its allowable rate base. Depreciation charges alone could represent 25% of operating expenses (Krug 1935). The sophisticated use of probability theory in the determination of a significant portion of such costs provided AT&T with an important advantage in the public advocacy over the fairness of

telephone rates. Few regulatory boards had the capacity to challenge the telephone company's novel statistical methodologies, methodologies that had the great advantage of being grounded firmly within the rules of mathematical science. Moreover, this knowledge advantage also helped to insulate the firm against the unwanted encroachment of regulatory officials, thus helping to preserve the autonomy of corporate management. The regulators' expertise was primarily in legal and accounting matters, and the use of statistics was a recent development. The familiarity of Bell management with this subject gave them the opportunity to act as the leader in its relationship with regulatory authorities.

Importantly, the use of an innovative statistical methodology gave Bell management the opportunity to handle depreciation in a way that dampened expense volatility; in other words, it gave Bell management the ability to smooth earnings[6]. Accounting experts have long recognized that management can reduce earnings volatility through manipulation of depreciation expense (Hepworth 1953). The reduction of earnings volatility built confidence among external investors by implying lower levels of financial risk.

Moreover, as a regulated industry, Bell needed to defend its rate structure before governmental review boards. Beginning with the railroad industry[7], regulating agencies had spent much time and effort reviewing the financial statements of utilities as part of reviewing rates. The determination of what constituted an operating expense versus a

[6] The smoothing of expenses occurred through adoption of straight-line depreciation that tended to anticipate and lessen the expense impact of early retirements. Management adjustment of the depreciation expense was retained because management had flexibility in choosing time periods used to determine hazard rates and, ultimately, asset life spans. This topic will be explored in detail in a later chapter.

[7] In addition to the question of reasonable rates, railroad regulators also had to contend with the problem of financial statements which recognized too little depreciation, allowing management to "borrow from the property" and report sham earnings (Adams 1908). The omission of depreciation expense was a primarily a problem of railroad accounting.

capital extension was critical, and regulators were wary of utilities trying to classify capital expenditures as expenses in order to justify higher rates. The timing of operating expenses was also critical. The Bell system had been adamant in its contention that depreciation was an actual deterioration in a property's usefulness, and that this deterioration was in no way tied to the level of revenues collected as had long been contended by railroads (Marden 1957). By extension of this argument, then, depreciation expenses would be expected to be fairly constant, and volatile depreciation expense could be difficult to explain, making rate defenses more difficult. Smoother, more predictable expenses, and earnings, would make the Bell rates less susceptible to attacks on their reasonableness.

Depreciation studies were an important part of the Bell System's development of the effective capital budgeting[8] necessary to guide the firm as it invested heavily in new technologies over the 1920's. The firm's earlier experience with facilities' expansion had been problematic. During 1906-1907, the Bell System faced insolvency because of over-expansion; disaster was only avoided by the financial intervention of bankers led by J.P. Morgan (Garnet 1985). The subsequent regime of Theodore Vail emphasized standardization of financial and management practices to maintain strong control over the firm's disparate elements (Galambos 1992). In 1911, the use of the annual provisional estimate (a capital budget) was mandated for all operating subsidiaries; by 1922, the

[8] The growth of the firm's fixed assets can be seen in the following chart. (Data from Moody's.)

Year	Total Plant Size (in millions)	3 yr average growth rate	Long Lines Plant (in millions)	3 yr average growth rate
1916	$946,298		$53,458	
1919	1,215,944	8.7%	82,179	15.5%
1922	1,729,220	12.5%	108,757	9.9%
1925	2,524,906	13.5%	154,431	12.4%
1928	3,275,687	9.1%	262,233	19.3%
1931	4,195,749	8.7%	459,633	21.1%

provisional estimate took the form of a five year forecast, five years being the estimated duration of a business cycle. Prominent in these analyses was the change in the depreciation reserves; after service revenue, depreciation reserves usually represented the largest source of funds for building plants.

A moral dimension was also associated with depreciation measurement – how should the economic burden for maintaining a telecommunications system be shared? Depreciation was a material item in determining the cost of service, but as a joint cost it was difficult to apportion its use among service recipients: business versus consumer callers; long-distance versus local; party lines versus private lines or pay phones or private branch exchanges (PBX). And, all of these customers demanded assurance that they were actually being charged for operating expenses not for capital expansion.

These moral questions arose amid a confluence of factors influencing the managerial accounting choices made by one of the largest firms of the early 20th century: organizational learning, seen at Bell through the spread of sophisticated statistical tools from technology applied to operations; the use of this specialized knowledge to mediate the relationship between industry and regulator; rationalizing firm operations through the scientific management movement's application of scientific tools to operational issues, here, depreciation expense determination; and, the usefulness of statistical methodology in both accurately describing reality and in income smoothing - all played a role.

Questions pertaining to the proper measurement of depreciation became increasingly vital as US industry became more capital intensive during the 1920s.[9] With the increased recognition of depreciation's materiality, the methodological options for the

[9] In the first edition of the AIA's *Accountant's Index*, a bibliography that sought to identify the entire range of technical accounting writing through 1920, nearly 22 percent of its 1,565 pages dealt with depreciation, depletion and obsolescence.

treatment of depreciation were debated among accounting and industry professionals, allowing the Bell System to choose, or even develop, arguments that could promote desired ends. Many of the Bell arguments were tailored with regulatory bodies in mind. Nearly a century later, is it possible to describe these interactions and how they influenced the choice of managerial accounting methodologies? By answering this question, my research will provide a picture of how objectivity and advocacy underlay industrial, professional, and governmental interactions at a formative stage in a modernizing America (Wiebe 1967).

The format of the following sections in this chapter place in sharper perspective the relationship between my approaches to the analysis of the informational challenges facing the Bell System of the 1920s and the findings of four broad schools of interpretation with respect to the role of specialized knowledge in business management and industry regulation. I preface this analysis with a brief discussion of several salient aspects of the transition to modernity of American society that began with the harnessing of steam and electric power at the end of the 19th century. My narrative then considers the principal conclusions about the moral bases of this important pattern of change as advanced by scholars associated with the intellectual traditions of 1) Progressive History, 2) Organizational Synthesis, 3) Capture Theory, and 4) Accounting Theory: Traditional and Critical Perspectives. The literature review precedes the discussion of my hypotheses development and an outline of my methodological approach which are further developed in Chapter 2. My intent is to analyze the forces involved in the negotiations between industry, the accounting profession, and government in determining depreciation policy. I argue that an organizational learning process initiated the Bell System's approach to

depreciation accounting, and that the knowledge gained by the firm was also employed in an effort to maintain the firm's autonomy, an autonomy threatened by governmental regulators and, potentially, by outside professionals (the accounting profession)[10]. In the final section I review potential contributions and implications of this research.

2. Modernization

i) The Social and Economic Landscape

In the context of my investigation, modernization describes U.S. society's transition in the half-century following the Civil War from a primarily rural, parochial and agricultural society to one increasingly urban, inter-connected, and industrial. Modernization meant profound changes in both the physical and social landscapes. The advent of steam railroads greatly increased transportation efficiency, making possible the concentration of large populations in rising urban centers and the concomitant rise of large-scale manufacturing enterprises. Access to a continental market enabled leading firms to achieve economies of scale operationally by increasing their throughput of standardized products in a high fixed cost manufacturing environment. Many firms also achieved significant economies of scope through additions to their product lines and the extension of their geographic markets, through both in-house research endeavors and acquisitions.

The leaders of these firms were part of an expanded class of society's elite. Prior to industrialization, the elite had consisted of lawyers, doctors, and the clergy. By the late 1800's, an educated class had arisen who no longer held a direct and simple sense of causation. Instead of easy explanations, these men and women became aware of a much

[10] Professional accountants advocated depreciation accounting for all utilities (Bristline 1921; Calvert 1908), but they did not necessarily advocate use of mortality tables and sophisticated statistical tools.

more interconnected world with many factors involved in the creation of any phenomenon (Haskell 2000). To deal with such confusion, society's leaders increasingly turned to science and specialized inquiry. The resulting increase in the knowledge base decreased any one individual's ability to comprehend the world. Instead of attempting to understand the world as a whole, the aim became to learn about one area in depth, that is, specialization, and thus specialization became the mark of a scientific expert. In ante-bellum New England, the dilettante and the amateur scientist had been men of distinction. By the turn of the century, these men were disdained as mere dabblers with no expertise; knowledge belonged to the experts (Haskell).

This change was true not just for the traditional fields of science, but it also applied to the new social sciences. Within the social sciences, scientists divided into distinct specialties: economist, historian, sociologist, public policy experts, educator, or social worker (Ross 1991). For the social scientist, knowledge was theoretical research supplemented by empirical observation. The acquisition of this knowledge required employment of new analytical tools, most prominently quantification as a means of investigation and analysis (Beniger 1986).

Accountants' use of statistics fit a pattern of social sciences borrowing tools from the "hard" sciences. The founders of the first school of professional accountancy in the US at New York University in 1900 conceived of accounting as a science akin to physics. Others viewed accounting as a way to impose order over the disturbing flux of commerce and the economy. For one, "scientific accountancy", as opposed to mere bookkeeping, represented "…the conning tower of the ship of business" (Haskins 1901). Accounting

was a quantitative science dedicated to understanding business: the nature of costs, revenues, and income.

The picture thus far shows knowledge defined as a way of identifying cause and effect within specific fields. To determine causation required the use of technical, domain specific information, frequently quantifiable, and it was determined by experts in specialized fields, increasingly the professions. Concurrently, knowledge became more institutionalized. These changes were accompanied by a shift in the application of knowledge. America had a strong tradition of practical application of knowledge; the rapid spread of technologically advanced manufacturing and communication attest to this. However, as knowledge became more a product of specialized study, a sense of the primacy of "pure" science over the applied gained a foothold. The progress of this split is obvious in the social sciences. A spirit of volunteerism informed the first social scientists; many of the original leaders in social science were also reformers (Ross 1991). But, as social science evolved, the science was emphasized, and the reform element downplayed, without entirely disappearing. Instead, advocacy in social reform was shielded behind a screen of scientific knowledge. The emphasis of science in the social sciences legitimized the use of scientific tools to deal with social issues. In this sense, statistics emerged as both a science in and of itself and as a tool to be employed by social scientists. The use of statistics had a halo effect which increased the apparent scientific objectivity of accounting; in other words, statistics increased the legitimacy of accounting.

Another, less obvious, use of knowledge was to confer authority to its possessor. As part of specialization of knowledge, specific sub-cultures with their own norms and terminology emerged (Furner 1975). The technical knowledge became understandable

only to those within the professions, further restricting those qualified to opine in a given subject area. The emergence of specialists meant reliance on their expertise; regulating agencies became dependent upon the regulated industry as a source of knowledge. Academics quickly recognized this; in a 1933 article reviewing the operation of the ICC, Herring postulated that the more control the governmental agency expected to wield, the more active cooperation was required by the regulated industry (Herring 1933).

The dependencies between industry and regulator disclosed inherent tensions. Industries needed to use the skills of a specialized professional class; government also relied upon this class' expertise to understand the industries, and sometimes sought to employ the expert knowledge in socially "optimal" ways. And, though professionals received legitimacy when governmental agencies relied upon them, the professions did not want to entirely surrender direction to the regulators.

ii) Business Management and Quantification

An improvement in intellectual capacities of US workers as a result of the broadening of access to secondary and university education had implications for the nature of industrial enterprise.[11] The research of Paul David and Moses Abramovitz has revealed that the nation moved from capital intensive to knowledge intensive in the 20th century (Abramovitz 1993; Abramovitz and David 1973). Incremental gains in industrial productivity increasingly were the product of higher investment in human capital. A better-educated workforce facilitated a movement toward knowledge-driven corporate growth, and improved literacy and numeracy of the work force allowed businesses to employ intellectually challenging tools to create high value goods and services. By the

[11] In 1870, only 2% of 17 year olds graduated from high school; this rose to 6.3% in 1900, 16.3% in 1920, and 49% in 1940 (BiCentennial Census Statistics 1976).

end of the century, firms such as Standard Oil Company, DuPont, General Electric and Westinghouse Electric had formed scientific laboratories to discover new products and processes (Kevles 1979). During the same era, the scientific management movement also began to promote more rational and systematic approaches to business organization and operation. The drive toward improved knowledge of technology and management was further reinforced by the expansion of collegiate education at this time in business, engineering and science.

Earlier in the century, the accounting profession began as a branch of the legal profession in Scotland specializing in the provision of computational services (Walker 1988). These legal sub-specialists originally focused on bankruptcy cases, gaining in independent status as they expanded their jurisdiction into the auditing of financial statements and then cost accounting (Abbott 1988; Previts and Merino 1998). The emergence of national industries brought the need for expanded capital; to convince investors to provide this capital, accurate financial information was needed, and financial accounting experts could supply this need. Within industry, managers also needed a way to evaluate a firm's performance, hence, the development of a role for managerial accounting; but in contrast to the legal perspective underlying financial accounting, the managerial accountant relied on the tools and expertise of the engineer.

Though management practice became more reliant on quantitative information which could convey vital data about enterprise performance, the use of statistics was at first overlooked. Although statistics and probability theory had developed an increasing range of applications since the 18th century, these topics initially did not have as much of impact on business or accounting. However, scholars in many fields (Gustav Fechner and

Herman Ebbinghaus in psychology; Francis Galton in biology; James Maxwell in thermodynamics) steadily discovered the utility of this second body of quantitative methodologies to address the problems of uncertainty that was associated with complex phenomena (Stigler 1986). In Europe, statisticians played a pioneering role in the development of a increasing range of vital statistics to assist government in the formulation of public policies, and American social scientists extended the use of statistics to guide an interventionist state (Furner 1975).The interest of social scientists in statistics encompassed economists,[12] and it was through the use of statistics by both engineers and economists that accountants began to gain familiarity with the subject.

The principal source of quantitative information used to guide business management was accounting. Initially the community of professional accountants was poorly organized in the US[13]. Practitioners prepared for their careers by attending proprietary bookkeeping academies and through rote learning from bookkeeping primers. Although some local bookkeeper associations sponsored educational events for their members, these organizations functioned more like medieval guilds by providing insurance to members and acting informally as employment clearing houses. This pattern began to change in the 1880s. The ICC under the direction of its chief statistician Henry Carter Adams, the first recipient of a doctorate in economics from Johns Hopkins University, helped to form the American Association of Railway Accountants, a body which advised the federal agency about the acceptable accounting reports and methodologies for its annual compendium *Statistics of Railways of the United States* (Miranti 1989). That same year the first public accounting body, the American

[12] At Cambridge University, Francis Edgeworth addressed economic problems in probabilistic terms as early as 1887, when he published *Metretike: or, The Method of Measuring Probability and Utility* (Stigler).
[13] Information on the evolution of accounting in this paragraph is obtained from Miranti, 1990.

Association of Public Accountants was formed in New York and modeled after the traditions of the highly prestigious Institute of Chartered Accountants in England and Wales. Opportunities for receiving collegiate education in accounting soon emerged with the formation of the Wharton School at the University of Pennsylvania (Sass 1982), the School of Commerce, Finance and Accounts at New York University (1900) and Harvard Business School (1908). By 1916, specialized associations for both cost accountants and collegiate accounting educators had been formed.

During the first two decades of the 20th century, state regulatory boards which had been formed to monitor local natural monopolies began requiring the submission of standardized financial statements. Progressive reformers working through the auspices of such entities as the National Municipal League (Schiesl 1977) also directed efforts towards standardizing municipal accounting as a means for improving the transparency of public finance and, thus, serving as a palliative against local political corruption. In 1913, AT&T worked with the ICC to design a standardized prescribed set of accounts for telephone companies.

The managerial accountants who worked to create these standardized reports learned about their businesses, whether railroads, telephone, or gasworks, from firm engineers. The influence of industrial engineers in shaping the quantitative approaches that permeated managerial accounting in the late 19th and early 20th century has been well-documented (Epstein 1973; Biggs 1995; Miller and O'Leary 1987; Johnson and Kaplan 1987). Industrial engineers, like those in all of the growing professions, envisioned their field of expertise as having a scientific base. As doctors used research to discover the causes and cures of disease, as lawyers broke down case law into component

parts similarly to a chemist analyzing compounds (Kissam 1986), industrial engineers employed scientific management techniques to rationalize the flow of production and rationalize business. And, again borrowing from engineering, accountants became enamored of statistics.[14]

Accountants were learning to employ statistical tools to describe their businesses at the same time they attempted to answer calls to standardize accounting. A common set of measurement rules helped to reduce the risk associated with the asymmetric distribution of firm knowledge that managements enjoy over external stakeholders. In addition to heightening transparency, accounting standardization also made possible the formation of useful comparisons between companies operating in the same industry. Such data also provided the knowledge foundations for the analysis of the financial performance of companies over time.[15] In the Bell System, the development of insightful statistical tools progressed along with and complemented the creation of standardized reports.

Unlike the contemporary era, the standardization of practice was not centered in the private sector in a single, authoritative body such as the Financial Accounting Standards Board. Instead, as part of their oversight mandates, state and federal regulatory agencies prescribed rigorous rules that were frequently challenged both in the courts and in administrative hearings. The ICC, working in conjunction with members of the Association of American Railroad Accounting Officers, began mandating the filing of

[14] Accountants were not alone in their attraction to statistics. The social service professions saw in statistics a method of aggregating behavior and discovering the rules of social action (Ross 1991).
[15] The contributions of Albert Fink of the Louisville and Nashville exemplify this phenomenon. Trained as an engineer in Germany, Fink pioneered the development of financial reporting for US railroads. He invented new metrics for assessing operations, such as the ton-mile measure, that provided the basis of financial statement analysis useful for both management and external stakeholders (Heier 2000).

statements that employed uniform reporting formats and accounting methods in 1888 (Chapman 1908) . The Supreme Court, however, in the *Smyth v. Ames* case (1898) ruled that the agency did not have the authority to require uniform methods. In 1906, Congress restored these powers under the *Hepburn Act* and was further extended to encompass the financial reporting for interstate telephone and telegraph companies, express companies and pipeline enterprises under the *Mann-Elkins Act of 1910* (Sharfman 1931).

The government's ability to mandate accounting rules had been settled by 1920, but details concerning specific practices were unresolved. As in the 19th century, resolution of such issues frequently required advocacy before oversight boards or the courts. One such issue was the question of how depreciation should be handled. The railroads, as we shall see in this study, pushed for retirement accounting while the telephone industry advocated using straight-line accruals based on cost. Railroads claimed that because depreciation accounting required an estimate of assets' useful lives, which could not be known in advance, it required knowing the impossible. For their part, the telephone industry believed that though the life of an individual asset was unpredictable, the lives of groups of assets in aggregate were subject to accurate prediction. As part of their investigation into assessing the lives of their fixed assets, the Bell companies relied upon statistics.

iii) Industry, Regulation, and the Problem of Depreciation

Depreciation accounting was a product of industrialization. The issue of depreciation – what it meant, its relationship to valuation and how to account for it – only really began to appear with the railroad industry. Prior to the appearance of railroads and factories, mercantile enterprises were able to treat depreciation in a manner similar to inventory, by

periodically revaluing fixed assets to ascertain whether they had appreciated or depreciated in value (Littleton 1981). When railroad accounting began, neither accountants nor industry had standard ways to view depreciation. Railroad management wrestled with depreciation's impact on profitability, and questions about depreciation soon became political as railroad rates were a public policy issue.

By the late 19th century, accountants had come to recognize the importance of accounting for depreciation as an operating expense in order to get an accurate picture of profitability. Prior to the 19th century's tremendous growth in industry, depreciation had never been considered in determining a firm's profitability. Profitability, and an associated understanding of what constituted income and investment, changed as large, capital intensive firms emerged. The failure of many railroad lines (and later, of independent telephone companies) was seen to result from ignoring or underestimating depreciation (Marden 1957; Young 1914).

Depreciation became a concern of the ICC because depreciation expense was an integral factor in assessing the reasonableness of rates. Determination of rate reasonableness had been an essential part of the ICC's mandate since its formation (Sharfman)[16]. There was no attention paid to whether a scientific basis for rate regulation could or should exist, and the vague definition of a just and reasonable rate necessitated a search for clarification. The commission's first attempts at assessing rate reasonableness involved determining the value of service, which was essentially a market based

[16] Before the ICC's creation, rate regulation was the purview of state regulatory agencies. State bodies continued to play an important role in rate regulation even after the ICC came into existence, and some (Symkay) have framed the regulatory debates as primarily contests between state and federal authorities, as opposed to between government and business. Many of the issues concerning rates, depreciation, and the depreciable base were actually debated and resolved at the state level; the ICC used such decisions as precedents in its own decision-making capacity. Today, these investigations would also entail substantial contributions by the accounting profession; however, at the inception of rate regulation, the accounting profession itself was only becoming established.

valuation. It was also a tautology – the value of a service was the amount the shipper was willing to pay – and as such was ineffectual in assessing the reasonableness of rates. A variation of the value of service method centered on the value of competition; the ICC ruled that differential rates were fair if they served in the interests of increasing competition – that is, the consideration switched from the value of service to the value of increased competition to the national economy as a whole (Hammond 1911). Since the nation was composed of regions, however, benefiting the national economy devolved into making subjective decisions which favored one region or port over others. When it became clear that the value of service methods were unworkable, the commission settled on a fair rate of return on assets as the proper way to evaluate rate reasonableness. This immediately brought forth new questions: What constituted a fair return on investment? How should the actual investment be measured? What expenses needed to be subtracted in calculating profit?

By 1920, a fair return had been determined to mean a rate of about six percent (VanSant 1921; Rorem 1928). If six percent was acceptable, the next question was how to arrive at an income number. Most of the revenue was derived from rates paid by customers. The more expenses were subtracted from the revenues, the less the income. For the utilities, then, increasing the operating expenses was desirable. Though shippers argued that depreciation was a method of artificially increasing expenses to force higher rates, in the end regulators accepted that depreciation was an operating expense. The debate then moved on to determining how depreciation should be calculated; though I will explore this in detail later in this paper, for now it suffices to say that the ICC

recognized depreciation based on historical costs (plus improvements) less salvage value, applied in a straight line manner over the life of the asset.

Discussion of the investment return was also contentious. Investment could be calculated as the amount actually contributed by the stockholders, but fears of watered stock dictated against this approach. Using the asset base was problematic because there were various ways of valuing the assets; alternatives included historical cost, historical cost less depreciation, historical cost adjusted for inflation (or deflation), and replacement cost. No final definition of utility investment was agreed upon; in practice, some regulators allowed replacement cost while others required an asset's historical cost.[17]

The question of what constituted a "fair return" was political, not scientific, if by scientific we mean objective and fact based. Rate setting was (and is) a public bargaining process (Galambos and Pratt 1988). Certainly, if the facts under consideration were inaccurate any decision would be suspect, but unscientific outcomes also resulted from the participants subjective definitions of the terms of analysis. For example, since the time of Fink, a 19th century railroad superintendent, industry has argued that presence of high fixed costs creates cost behavior that would be difficult for regulators to understand, hence regulate (Heier 2000).

iv) Summary

A substantial portion of this introduction has been devoted to laying out the contextual landscape of the early 20th century, when Bell management settled upon a depreciation methodology and defended it before the ICC. This background contributes to our

[17] In general, today's investor will be indifferent to which investment base is used to calculate the return because regulators using current values for the investment allow for a lower return that regulators allow when historical cost is used for the investment (Deloitte & Touche LLP 2007).

understanding of the way accounting and bureaucracy interacted. It suggests that a combination of factors were involved in the development of costing methodology. This was a society in search of efficiency and scientific "truth", a society which relied upon expert knowledge for answering specialized problems. The specialists' knowledge certification was conferred by peers, with most basing their claims for the legitimacy of their knowledge upon a scientific basis. Dependencies and tensions existed among the actors involved: regulators depended on industries and the professions as both a source of knowledge and a reason to exist; industry required professionals, and the professions' reputations were enhanced by governmental recognition.

Industry wished to avoid governmental interference but at the same time recognized the need for government support. Industrial leaders acknowledged a centralized government's necessary coordinating role in increasingly national business enterprises, but more than this, they intuited that governmental authority could be used to help meet their business needs. Added to this for Bell was the desire to manage earnings volatility, to smooth earnings in a way that reassured both investors and regulators; this would facilitate management's pursuit of their business objectives without outside interference, interference from outsiders who did not really understand the business. An effective way to do this was to make an already difficult to comprehend subject – depreciation accounting – even more impenetrable.

3. Literature Review: The Moral Dimensions of Quantitative Knowledge & Business Governance

How then have historians evaluated the moral dimensions of the evolution of business and governmental organizations and their connections to specialized knowledge? Have

these developments contributed to raising society's overall levels of material abundance? What values have they helped to perpetuate or introduce in American society? Have these interactions helped to promote social justice? As we shall see in the following four sections scholars have rendered different judgments with respect to these questions.

i) Progressive History

The Progressive historians—Frederic Jackson Turner, Charles Beard, Vernon Louis Parrington—generally held a positive outlook about the role of knowledge in promoting social equity and material abundance. On the most basic level they perceived broad access to educationally opportunity as a critical precondition to the preservation of cherished democratic values and institutions inherited from the Revolution. In their view, democracy benefited from the participation of an enlightened electorate whose outlook had been shaped through formal instruction in both the moral and physical sciences. Additionally, they generally believed that the accumulation of useful knowledge played a vital role in raising incomes, living standards and the quality of life. They applauded the great inventions and advances in science that had transformed the American socioeconomic scene since the 19th century.

The Progressives sought to establish order – social, political, economic - and yet maintain a spirit of American democratic "exceptionalism". The Progressives made a religion of efficiency, and sought to employ science to achieve this in all spheres. To Teddy Roosevelt, governmental regulation was a scientific tool that could be used to bring order to a disordered market (Skowronek 1982). Contrary to popular belief which portrays Progressive politics as anti-business, Progressive and business leaders could work together toward the same goal of rationalization and increased efficiency (Kolko

1963). Many business leaders viewed capitalist and social reform efforts as complementary, though the sole purpose of the firm might not be limited to profit maximization. For example, the ICC's Adams believed the purpose of the firm was to achieve maximize social utility of a resource (Miranti 1989). To Adams and his ilk, capitalism had to operate as efficiently and rationally as possible in order to maximize social utility. This emphasis on efficiency also resonated with social reformers, and thus they applied quantitative tools to social problems. This period's emphasis on efficiency is obvious in arguments of the Bell System as it defined and defended its depreciation methodology.

To the Progressive the chief danger lay in the concentration of wealth and power in the hands of the rising business elite. The Progressives feared that great wealth would, if unchecked, transform American democracy to a corrupt plutocracy. They were distressed by the concentrated wealth and sheer size of emerging corporations. In their view, the democratic values on which their nation had been founded were products of the egalitarian, agricultural society that contemporary forces of modernization had done so much to dislodge. Progressives felt the solution lay in the development of a liberal state that would promote the commonweal and constrain the power of the new business oligarchy. In the 19th century the government's principal agencies included legislatures and the courts. The reformers, however, pushed for the extension of executive power at the federal and state levels both to preserve cherished institutions that made America a unique nation and to control powerful forces of change (Skowronek).

The Progressives generally viewed accounting as a highly effective tool in regulating Big Business. Such data became central in hearings before both state and

federal regulatory boards about the equity of rate structures. This information provided substance in the debates over whether particular public service franchise holders were adequately satisfying mandates for economy and efficiency. This disclosure also provided a high degree of public transparency about the affairs of economic units which wielded strong market power. The determination of the fairness of the rate base and the allowable returns to service providers through the analysis of accounting and statistical detail became central mechanisms in government's efforts to achieve social justice in the allocation of the economic goods produced by the great natural monopolies in transportation, communications and power generation.

Historians of political science in a similar vein have emphasized the role of quantitative specialization in the growth of the state beginning during the Progressive era. The emerging social science professionals gained legitimacy as government relied upon their knowledge; as these professional grew, they looked for more opportunities to provide government service and so cement their elite status (Ross 1991). These specialists used statistics to effectively deal with the collective behavior of a diverse population and to find ways to improve order and efficiency (Porter 1986). Indeed, to govern well the state needed to understand the laws underlying human behavior, information that could only be gained through statistics. Accounting allied with statistics was employed by a highly trained professional class in the creation of a new national administrative state at the end of the 1800's (Skowronek). Indeed, the view of government regulation as a scientific way to restore order to the markets was an essential element of the Progressive movement.

ii) Capture Theory

Capture theorists such as Marver Bernstein (1955) and Gabriel Kolko (1963) reject the Progressive contention that governmental regulation has proven effective in protecting the public interest. In their view, oversight bodies eventually become dominated by the powerful business interests that they seek to control. The reform movements of the early 20th century, to paraphrase the title of Kolko's critique, embody a triumph of conservatism rather than the liberal, democratic order that Progressive reformers had pursued. To the capture theorists, the acceptance of the ascendancy of Big Business was made more palatable through programs of employee largesse that they termed, "corporate liberalism." Through pension and health benefits, paid vacations, and other valuable perquisites, business was able to counter worker alienation from the structure and operation of the economic order.

Under a capture regime, the specialized quantitative knowledge central to the regulatory process assumed a different role than the one envisioned by Progressives. It would not function as the lens for placing into sharp focus the economic conditions that regulators had to evaluate. Instead, such information became a mere stage prop in an elaborate regulatory theater. The implication of this interpretation for accountants and statisticians suggested that they no longer were vigilant professionals dedicated to the search for truth and justice. Instead of serving the public good, they served only to further the interests of the ruling elite.

A more free-market interpretation of capture theory was proposed by Stigler (1971), who describes regulation as demanded by industry to protect its own interest. Instead of serving a protective, conservative, role, he viewed regulation as a means of

actively furthering an industry's self-interest (through, for example, direct subsidies or practices limiting competition). Whichever version of capture theory is espoused, however, both predict that the regulatory agencies will be captured by the very industries they were putatively established to monitor and direct.

The classic counterpoint to capture theory and regulatory agencies was the public interest theory of regulation (Posner 1974), a view which postulated that regulatory agencies only existed to better the publics' interests. Criticized as being naïve and simplistic, a more sophisticated view also recognized regulatory agencies as proxies for the public, without classifying this action as altruistic. As expressed by John Kenneth Galbraith (1980), the rise of regulatory agencies was part of a formation of countervailing powers which naturally arise in oligopolistic markets. Oligopolies give rise to economic surpluses which are enjoyed by corporate owners. In Galbraith's analysis, the regulatory agencies arise as part of an attempt by the utility customers to gain a share of this economic surplus through collective action.

By recognizing that regulatory agencies arose as part of the complex structure of the capitalist marketplace, Galbraith characterizes the agencies as part of a rational response to economic environmental changes. In this, he anticipates some of the arguments developed by writers of organizational synthesis.

iii) Organizational Synthesis

Organizational Synthesis was a term coined by Louis Galambos (1970) to represent a growing body of academic literature which challenged several of the major assumptions embraced by Progressives about the significance of large entities, particularly in business, in US history. This new school of interpretation argued that the most significant

development that transformed American society beginning during the latter half of the 19th century was the appearance and dominant role played by large-scale organizations in virtually all aspects of national life.

This shifting perspective first emerged in business history where Alfred D. Chandler, Jr. advanced a new interpretation that characterized business leaders as essentially economic rationalists confronted with the problem of developing new business strategies and business organizations to accommodate a fast-changing economic scene. For Chandler (1977) the development of large scale businesses followed by specialization and the rise of professionals came about so that society could reap the benefits of technology. At the Bell companies, science was the tool of economic rationalization. Statistics was an important aide to expanding technological knowledge, but statistics was used throughout the firm, even aiding in the management of human resources and physical assets.

A second commentator, Robert Wiebe, reinforced many of Chandler's themes. For Wiebe, the railroads connected the local with the national. They created both national production and consumer markets. What were once "islands of communities" (Wiebe 1967) were now localities linked together, first by rail, then by telegraph and telephone. Americans' parochial views were expanded, but the expanded world view brought complexities. To help comprehend this expanded world, Americans increasingly turned to the guidance of experts and specialists. Specialization also transformed the American economy. As America's first national industry, railroads represented the advance guard of increasingly large corporate enterprises which were replacing the once predominate family run firms. Running these large enterprises meant adopting new business practices,

including accounting; it also meant the development of a managerial class and hierarchical management levels.

The management class was part of a newly emerging elite. Beyond changing the structures of business, the technological changes brought by the railroads accelerated widespread changes in general U.S. society (Chandler 1962). Technology demanded specialized skills, giving impetus to the specialization of knowledge in America. This led to a change in leadership structure. The pre-existing ranks of the elite were challenged by new groups: the new professions, academics certified by institutions of higher education, and a new group of wealthy industrialists. The specialization of knowledge also exaggerated differences in education and wealth between the classes, threatening a previous sense of democratic equality (a fear that would play a role in the formation of populist reform movements such as the Grangers).

The changes in America did not appear at once, but over time. Wiebe emphasizes that changes in the degree of connectedness caused a disorientating shift in perspective from the local to the national. He feels that this increased the individual's perception of an uncertain environment and a resulting need to restore order. Institutional development was part of this reordering. Without as much emphasis on the individual's disorientation, Galambos (1982) believes that the organizational shift from small, informal organizations to formal, bureaucratic and nationally based organizations represented the most important change in American society at this time.

Louis Galambos felt that both scientific and professional knowledge impacted the interaction between public and private entities. As a description of this interaction, Galambos defined a new type of polity that he called "triocracy". Under triocracy, federal

agencies and business and professional groups compete for authority to govern important aspects of national life. The lines of demarcation separating the scope of control between these competing groups are fluid and sensitive to the force of public opinion. Under normal circumstances the high level knowledge of private business and professional groups provides a strong rationale for their autonomy in governing affairs in their fields of expertise, and the general populace defers to the superior knowledge of well-known expert groups. In the public's eye, experts seem effective in controlling some important social or economic function. In periods of crisis and breakdown, however, when private groups prove ineffective in executing their social responsibilities, the public turns to their representatives in Congress for relief. It is at this juncture that the peoples' representatives authorize federal regulatory bodies to intervene and encroach on the autonomy of private groups in order to restore order and tranquility. Thus, in the triocratic context outcomes are not predetermined. Knowledge functions as a vital factor in mediating the relationship between government and private groups. The persuasiveness of knowledge-based advocacy, however, depends heavily on its perceived effectiveness of each group.

The specialized knowledge of business and the professions helps assure their autonomy from government regulation. The superior insight of private groups derives from their long-term application of knowledge in practice. Private groups also may enjoy important advantages in the debates with regulators because of successful development of innovative ways of applying their knowledge from enterprise-specific research and development. The novel extensions of the ways that knowledge may be applied in

practice, thus, may help to constrain the interventionist urges of government bodies disadvantaged by their lack of proper understanding of what constitutes best practice.

The knowledge gap between industry and government was explored by Thomas McCraw who evaluated regulation in his Pulitzer prize-winning, *Prophets of Regulation*. McCraw (1984) was highly critical of efforts to control market competition through the activities of federal oversight agencies. He argued that the effectiveness of regulation of capital-intensive industries was largely doomed to failure because of the prominence of attorneys in determining these issues and the limited input from trained economists. In his view, daunting problems associated with an inability of regulators to allocate joint costs of operation doomed their efforts to formulate economically meaningful policies. For McCraw, governmental intervention frequently resulted in higher social costs from an inevitable misallocation of economic resources. McCraw further contended that the best examples of regulation were those associated with consumer protection rather than market competition. High in this latter category was the Securities and Exchange Commission (SEC) that was charged under the Securities Acts of 1933 and 1934 to protect the public interest by assuring probity and competency among the many professional groups that the financial markets relied upon for efficient function. McCraw's appraisal of the "sunshine commission" approach taken by Charles Adams when he led the Massachusetts Board of Railroad Commissioners was also positive. McCraw felt that Adams' approach yielded better results than the heavy-handed results from broad powers delegated to ill-defined agencies.

Institutionalist business historians have also explored the connection between knowledge and organizations, and their work illuminates the depreciation studies

undertaken at Bell. North (1991) has described institutional structures as arising and developing to facilitate increasingly complicated economic transactions. Eventually, these institutions assume an independent life, and the institutional forms will determine the way the organization handles challenges. In this sense, the Bell System's use of probability theory in depreciation studies was not only an intelligent application of knowledge from elsewhere in the firm, but the knowledge transfer was required by Bell's institutional mode of learning. At Bell, statistical tools reduced uncertainty and assisted in the making of informed decisions. Probability studies validated positions taken by management, because they used a language to transmit knowledge that was understood throughout the firm, whether in R&D, manufacturing, or accounting.[18] And, the interactions between Bell and its regulators fit an institutional pattern common to the history of Western capitalism: private industry relied on the state's usage of coercive power to facilitate economic growth while attempting to limit the state's confiscatory reach.

iv) Accounting History: Traditional and Critical Perspectives

The traditional school presents accounting history in a fairly linear fashion. These accounting researchers treat accounting solely as a method of recording economic transactions. The line of accounting evolution is direct and clear: changes in the economy lead to new transactions that need to be recorded, and accounting adapts to capture these changing needs (though Littleton (1981) did stress that advances in accounting in turn affected the development of business). Accounting history can thus be seen as a record of

[18] Interestingly, North (1991) specifically mentions the use of actuarial tools to transform uncertainty into risk as part of the institutional practices that facilitated the growth of capitalism. Without such transformations, uncertainty could prevent economic transactions from proceeding. Bell's use of statistics, then, carries on a long Western tradition of institutionally quantifying uncertainty.

changing economic transactions. (For managerial accounting, the best known researchers in this area are Johnson and Kaplan, whose 1987 book, *Relevance Lost,* recounted the growth of managerial accounting as a business tool during the industrialization of the late 19th and early 20th centuries.) The traditional school of accounting history is in general agreement with the view of business history advanced by Chandler, who saw business changes as rational responses to changes in the technological environment.

Chandler gives a prominent role to accounting in the rationalization process; he saw understanding the economics of a business through accounting as a necessary precondition to achieving economic efficiencies. Though Littleton's classic work on accounting history discusses the interaction between a changing business environment and accounting, the idea that accounting evolution reflects economic rationalization has been largely ignored by accounting historians. Previts and Merino (1998), for example, emphasize accounting's development solely in relationship to an evolving profession of public accountancy, not as a part of an evolution of business management. The accounting theoretician Brief has described the importance of correctly calculating depreciation to separate capital gains from income (Brief and Owen 1968; Brief 1968, 1965), hence as a key determinant in avoiding misallocation of resources in the nineteenth century (Brief 1965). But, he does not discuss accountant's depreciation methodology as an important contribution to the development of business management[19]. Littleton attributes changing business conditions (from mercantilism to factory production) as the impetus behind the development of depreciation accounting, but he spends no time discussing methodology. The contribution of managerial accounting to

[19] Brief does find Ladelle's theoretical writing on depreciation to be potentially useful in business management decisions, but he says Ladelle's work was ignored until the mid 20th century (Brief 1967).

business management is explicitly made by Johnson and Kaplan (1987), but again, they do not emphasize the role of depreciation studies per se. The Bell Systems' early application of statistical methodology to depreciation studies would appear to be an anomaly.

The critical school of accounting has a very different interpretation of history. Rather than viewing accounting as an attempt to scientifically measure some objective truth, critical accounting scholars view accounting as a tool employed to control the distribution of society's surplus, a way to preserve (or advance) the interests of one segment of society at the expense of others (Lehman 1992; Tinker 1988). Often following a perspective advanced by the French philosopher, Michel Foucault[20], they investigate accounting as a cultural artifact. These historians see accounting developments not as objective recordings of changes in economic events, but as selective, subjective tools of societal control. Miller and O'Leary (1987) explicitly link the development of managerial accounting with the attempt to create a governable, directable working class, the type of worker needed by the leaders of an industrializing, capitalist society.

In a more general manner, Loft (1986) describes management accounting as "intimately bound up with the operation of …a power/knowledge relationship….which can be used to discipline individuals." The mere choice of objects covered by accounting, she asserts, directs attention towards certain issues while excluding many others. This sentiment is in line with that of Tinker (2005) who questions the objectivity of accounting research by reminding readers that the observer is embedded in the observed. In even

[20] I have primarily derived my knowledge of Foucault's work by authors who mention him as an influence, such as Loft (1986). See Tinker (2005) for a good review of critical accounting and the influence of Foucault, and an excellent overview of the philosopher's views on history and historical methodology written by the author can be found at http://foucault.info/foucault/biography.html (Foucault 1984)

stronger terms, Watts and Zimmerman (1995) describe accounting theories as rationalizations useful for advancing the interests of one party over another; groups argue for positions that supposedly benefit the public interest, but in fact are self-serving, and the process of determining an accounting policy is actually a political process and not a scientific fact-finding process. In a similar vein, Tinker (1991) argues that accounting choices are never simple questions about how to faithfully represent economic transactions because the economic and political realms can not be separated; accounting choices always reflect political ideology.

These researchers extend themes developed by the social science historian Mary Furner (1975), who noted that control of subject matter and its presentation allows the presenter to successfully advocate for a particular social viewpoint. Her line of research complements the work of general business historians who have studied the generation and control of knowledge, individuals such as Clark (1969) writing on business regulation, or Abbott on the development of professions (1988). Again and again, these researchers stress that knowledge is not objective, but that both the content and the medium of conveyance reflect the interests of those responsible for creating the knowledge. In the view of these scholars, understanding the subject matter presented is impossible without examining the context of knowledge presentation. Within accounting, critical researchers assert that all accounting choices are historically contingent and can not be understood without understanding the social circumstances of the time the choice is made (Tinker 2005). In relation to the depreciation choices of AT&T and the firm's relationships with regulators, then, critical accounting history suggests a series of questions: who benefits from the methodologies employed?; who is excluded from the

discussion because of these choices?; whose own choices will be limited by the decisions reached by the Bell system and its regulators?

4. Research in Depreciation Accounting

i) Contemporary Empirical Research

The volume of scholarly activity devoted to managerial accounting research is dwarfed by financial accounting research, both empirical and theoretical. This reflects a bias that equates accounting's importance with financial reporting information in general, especially SEC reporting requirements. In managerial accounting, research can also be empirical or analytical, and historical research, a subset of empirical research, is not a crowded field. In order to properly appreciate my study, the state of scholarly research in my particular area of interest – depreciation – and my research methodology – historical – must be understood.

Experts from accounting and economics (Hayes), the government (Adams), and the railroads (Wymond) weighed in on the debate about what depreciation really meant and how it should be reflected in financial statements. As other regulated industries arose, they also contributed to the debates on the valuation and expensing issues associated with depreciation. Any statement purporting to speak for the accounting profession was strikingly absent from these debates.[21]

[21] Individual accountants and regional accounting associations did venture into the depreciation debates, as will be discussed later in this study. But, no authoritative statement on depreciation was issued by a professional accounting organization was issued until 1941, with the issuance of Statement on Auditing Procedures No. 4: *Clients Written Representations Regarding Investments, Liabilities, and Other Matters.*

Some academic accounting research on depreciation[22] was undertaken in the mid 20th century, work that explored the measurement issues associated with using probability principles to determine asset life *(e.g.: Kimball 1943, 1945, 1947; Ijiri and Kaplan 1969, 1970)*. Kimball pointed out the difficulties associated with constantly revising life tables, and asserted that in practice mortality tables were little used. In contrast, Ijiri and Kaplan advocated the use of life tables in depreciation calculations to accurately calculate depreciation expense; they found that conventional depreciation policy only approximated the more accurate probability methods when the assets have a long service life and the mean and median values are approximately equal. These researchers, then, focused on measurement issues, but not the implications of choosing a probability based depreciation approach, and recent academic research on depreciation has primarily been confined to discussion of tax issues. My research, then, is a revisit to and reanalysis of the methodological and analytical debates that primarily occurred early in the 20th century.

ii) Depreciation Methodology at Bell

Standardized depreciation methods for the telephone industry did not exist when the industry came under ICC jurisdiction. The ICC prescribed classes of assets for railroads, but had yet to do so for the telephone industry. Beginning with a simple rule to set aside 10% of fixed assets as a depreciation charge, Bell gradually developed more accurate depreciation methodologies (Crunden and Belcher 1929). Bell management mandated a formal depreciation policy for all associated firms between 1908-1910 (Marden 1957); given that legislation for federal regulation of the industry passed in 1912, these

[22] Some academics actively published research on depreciation methodology during the 1930's; articles by Edwin Kurtz and Gabriel Preinreich can be found in journals such as *Econometrica* and the *Journal of the American Statistical Association*. These researchers were also aware of, and favorably impressed by, the depreciation work at AT&T (Glover 1931). The work of these academics is reviewed later in this study.

depreciation rules were almost certainly developed by Bell management in anticipation of eventual regulatory review.

Bell divided its fixed assets into four different categories differentiated by the methodology employed to estimate useful life (Marden 1957). For two of the four groups, Bell used actuarial methods to estimate useful life, depreciation expense, and the depreciation reserve; together, these two groups accounted for approximately 50% of Bell's assets. To estimate both an asset's useful life and its salvage value, Bell accountants relied on engineering information. Careful attention was paid to accurately estimating useful life, because without accurate estimation Bell management believed they could be forced to realize depreciation expense only when assets were retired. Management objected to this depreciation treatment as contrary to accounting principals (it did not accurately match the using up of an asset with the service provided) and also for practical purposes (realizing depreciation only at retirement would result in wildly swinging depreciation expenses, making business planning difficult) (Bracelen 1926). Since delaying depreciation expense until retirement was unacceptable, a way was needed to estimate useful life.

Bell engineers borrowed tools from actuarial science because a simple review of mortality history did not provide sufficient information to accurately predict annual depreciation; within a given period of time, experience showed widely different average lives for comparable assets. Experience disclosed four broad reasons for depreciation: standard wear and tear, sudden weather related destruction, technical obsolescence, and equipment inadequacy due to market growth (Crunden and Belcher 1929). By use of the

Gompertz-Makeham [23]formula, Bell engineers were able to predict the risk of removal from service for a group of assets at each stage of the assets' lives. The formula described a constantly decreasing retirement rate.

Actuarial statistics had long used by insurance companies in calculating human mortality; at Bell, engineering records were used to calculate hazard rates which were translated into average service lives for particular types of assets. This service life was used to apply depreciation on a straight-line basis. The depreciation expense, then, for any type asset, would be predictable, not an uncertain expense varying with the vagaries of weather or uneven pace of technological advances.

5. Hypotheses Development and Methodology

My area of investigation involves the years when our current industrialized society was evolving. The great scientific and technological advances of the 19th century led to immense societal changes, among them new industrial forms, new social arrangements, new political institutions and functions. Not only did these changes require new organizational forms, but they also necessitated new manners of acquiring, transmitting, and employing knowledge. Accounting in this time evolved institutionally, professionally, and academically. Investigating the evolution of accounting during industrialization, then, can give insight into the way American society accommodated itself to a modern world. In order to investigate how these changes occurred, I investigate a specific accounting issue and develop a case study of the way this issue was framed, debated, and ultimately resolved to illuminate the relationships between new knowledge, industry, regulatory agencies, and the professions.

[23] The Gompertz-Makeham function is discussed in Chapter 3.

i) Choice of Industry and Time Frame

The primary regulatory agency I investigate is the Interstate Commerce Committee, ICC, the first U.S. federal regulatory agency. As the first agency of its kind, the ICC broke new ground by developing relationships and processes that would be adapted by later agencies. The resulting institutional and procedural forms resulted directly from negotiations between government, business, and other interested parties; there was no simple adoption of a pre-existing format. Following in the direction of Miranti's (1989) investigation of the ICC's formative years of regulating the railroads, I wish to examine the interaction between expert knowledge, regulatory reform and economic development through the play of one specific topic – the question of depreciation methodology.

In contrast to most other research with the ICC, I concentrate on the agency's involvement with the telephone industry rather than the transportation industry. There are practical reasons for this selection. The telephone industry, unlike the railroads, was dominated by one large corporation, the Bell System. When dealing with the ICC, the position of the telephone industry as a whole was clearly articulated by the Bell System[24]; access to supporting documents for the telephone industry's positions, then, was centralized, and surviving archival materials are also centrally located. In contrast, the various railroad firms were not always in agreement in their cases before the ICC, and the supporting documentation relating to their arguments are widely dispersed.

The age of the telephone industry relative to the railroad industry is also an important consideration. Railroad management needed to understand its own profitability structure

[24] Of course, Bell competitors, particularly the independent providers, sometimes took different positions from Bell, and the independents resented what they saw as Bell's attempt to impose its own philosophy and methods on the industry as a whole. However, from the ICC's perspective, the Bell system did represent the telephone industry; this is clearly seen by the simple repackaging of the Bell system of accounts when the ICC issued its Uniform System of Telephone Accounts in 1913 (Marden).

before it could relay this information to outsiders. Basic managerial accounting concepts were being devised by the railroads throughout the mid to late 1800's, but a common terminology and knowledge base was not yet in place at the time of the ICC's formation. Railroad regulatory issues therefore can be obscured by definitional debates. Indeed, railroad accounting debates were the arena where many issues concerning the standardization of accounting rules and conventions were resolved. By the time the ICC took over regulation of the telephone and telegraph industry, managerial accounting had advanced, and a large number of definitional terms had been agreed upon. [25]

ii) Significance of Depreciation Issues

The early 1900's was the time of many advances in managerial accounting. The question can be asked, why focus on depreciation issues? To begin, for utilities defining depreciation had important managerial, financial, and social implications. Issues of social equity and economic efficiency led to government interest and eventually governmental regulation. Regulation's impact on firm management extended beyond the obvious problem of how to deal with government oversight; regulation also reduced the pricing information which a firm received from market competition. To counter this lack, the firm needed to explore alternate means of assessing profitability, hence costs, including depreciation. The mathematical skills which allowed Bell engineers to make technical advancements in sound transmission were employed in ways of understanding costs that required estimation of future events, such as prediction of pension costs (Chandar and Miranti 2007) as well as depreciation expenses. In this sense, the application of

[25] This is not to imply that clarity of terminology had removed all instances of dual meanings and dissolved misunderstanding. Indeed, it is the contention of the author that dual definitions of depreciation and value continued, leading to unintentional difficulties in lay comprehension of the issues involved and providing the opportunity for industry to intentionally obfuscate its aims before regulators and the public.

probability theory to depreciation problems was a natural progression of Bell's institutional mode of learning.

The specialized nature of the Bell System's fixed assets meant that any depreciation work developed elsewhere might not meet the firm's specific informational needs. Beyond being the leader in the developer of telecommunications technology, then, the firm broke new ground in recording events relating to these assets. The direction the methodology developed would be guided by management's intentions; their intentions would not be obscured behind a claim that they were following standard industry practice, because they were the originators of the practices.

iii) Advocacy, Objectivity and the Application of Knowledge

I intend to extend the existing body of historical knowledge by investigating accounting's use as both a science and as a means of control. As a science, accounting presented itself as possessing esoteric knowledge inaccessible to the layman; as a scientific tool, the managerial accountants of AT&T employed statistics. But, the reasons for adopting this methodology were not only scientific; they were also strategic. The economic concerns of the firm were never discarded in the search for truth. The depreciation methodology provided management an opportunity to smooth earnings, reassuring investors and regulators alike by making earnings appear predictable; its adoption also shielded Bell management from unwanted regulatory interference as well. Unlike some previous accounting historians[26], I begin my investigation agnostic as to whether scientism or political aims ultimately determined the way accounting was employed. In a dynamic

[26] In this I follow Arnold (1998), who notes that postmodernism can go too far, stretching to fit political/sociological reasons for accounting choices when logical, material (production) explanations make more sense.

environment such as the rapidly industrializing U.S., each stakeholder in a controversy brought their own agenda to the debate, and each was influenced in turn by the debates themselves. I do believe, however, that both objective (scientific) and political factors must be understood in order to make sense of the accounting decisions which were reached; by the end of this paper, I intend to take a stand on what were the prime factors involved in the depreciation choices that were made.

At the Bell System, engineers in the school of scientific management employed statistical tools to perform accounting analyses. Several researchers have investigated the debt owed by accounting to scientific management (Epstein 1973; Johnson and Kaplan 1987; Loft 1986). My work extends the work of these researchers in that it further explores the involvement of engineering and scientific management in managerial accounting. Rather than simply emphasizing the technical connections between scientific management and cost accounting, however, I focus on *why* accounting borrowed from these fields and *how* accountants and industry used the knowledge they acquired.

6. Implications and Contributions

> *"The utility of accounting history, its potential in relation to current theoretical and practical concerns, is that through elucidating the resolution of past incongruities of accounting with its environment, it could facilitate the more effective resolution of such issues in the present."*(Miller and O'Leary 1987)

Explorations of the factors involved in the depreciation negotiations by the Bell System in the early 20th century can help illuminate present-day accounting debates. Today, accountants, regulators, and businesses debate various issues, ranging from the desirability of standardizing accounting presentations to the benefits of presenting "fair value" (market-based) balance sheets. Accounting researchers have offered various

theoretical explanations for why a specific accounting methodology might be chosen: agency theory suggests management may choose methodologies that allow them to profit at shareholder expense; critical accounting theory suggests issues of power and control inform methodological choices; rational economic theorists believe the choice of methodologies is determined by management's weighing the costs of any method versus the potential increases in profit from better information. An advantage of historical research is that the researcher can review empirical data to see which theory best explains reality. Armed with this information, one can hope to better understand the factors involved in current accounting controversies and make predictions about their eventual resolution; this also permits current preparers of accounting information to make informed choices about how, if so desired, to change expected outcomes.

The contention surrounding fair-value accounting is one current example. Typically, the banking industry is portrayed as opponents of fair-value disclosure, and regulators are seen as proponents of disclosure working to provide investors with better information. Arguments both for and against disclosure are seen as primarily suspect and therefore self-serving. For example, regulatory writings stressing practical considerations that must be addressed before adopting fair value accounting[27] can be characterized as being too conservative, perhaps because of industry pressures or simply an effort to turn back a natural progression of globalization and international economic integration (Barlev and Haddad 2003), despite academic investigations that fail to document significant market relevance of fair value disclosure information (Bhat 2008). Examination of the depreciation debates, however, suggests that both path dependent learning and a desire to maintain corporate autonomy might be strong factors underlying

[27] See for example, Bies (2005)

the banking industry's opposition to fair value rules. The depreciation debates also expose the key role played by unclear terminology; using the same terms for both valuation and profitability calculations prolonged the confusion surrounding depreciation choices, and unclear terminology also confounds today's fair value debates.

Understanding the extent institutions will go to maintain autonomy is a topic touched on by my research, and it has significance for all facets of industry regulation. The autonomy of an institution is threatened by regulatory authority. Regulators serve to prevent abuses of public, and, less obviously, provide a valuable review of institutional practices. This oversight from an external source can be invaluable, and its loss detrimental. It has been speculated that the Challenger Space Shuttle disaster in part occurred because NASA's autonomy prevented effective regulatory oversight (Vaughan 1990). As discussed in my dissertation, the capture theory of regulation suggests that attempts by industry to control their environment leads to intentional co-opting of the regulators, when perhaps even more problematic are the non-intentional symbiotic dependencies that render both industry and regulator less effective.

Of course, the capture theory is not the only lens which will be employed in this study. The sociological perspective on power relationships – both attempts to maintain a status quo and attempts to challenge it – will also be explored. This study documents a relationship between regulators and regulated which closely follows patterns predicted by Galbraith: an organic, dialectical interplay between the firm and government. Changes in these relationships may be initiated by exogenous events, as postulated by Galambos and Pratt, or they may be entirely endogenous. Certainly the time period covered,

encompassing the greatest economic crisis of the twentieth century, is well suited to investigate this issue.

This case study can also be used as empirical support for, or evidence against, theories advanced by other researchers on the evolution of managerial accounting. In a famous work by Johnson and Kaplan, the authors describe a golden age of managerial accounting, a period when managerial accounting's focus was on supplying information useful to running a business (Johnson and Kaplan 1987)[28]. This began in the latter half of the 19th century, when the emergence of large scale production led to a separation of management and ownership. Coordinating the activities of such large enterprises plus overseeing managerial performance required new information. New information tools were developed by managers and accountants working with production professionals, and included performance and efficiency measures such as the operating ratio, inventory turnover, and gross margin; later, accountants employed scientific management techniques to develop standard costing information that could be used in pricing decisions; finally, the need to coordinate diverse activities within vertical organizations brought up questions of asset allocation, resulting in the idea of ROI. According to Johnson and Kaplan, by 1925 virtually all managerial accounting tools that later generations of management accountants would employ had been developed. As innovations in organizations and manufacturing continued, however, managerial accounting tools did not similarly progress. They find that with minor exceptions, such as the ICC's use of statistical models to estimate long-term costs, accountants produced

[28] The British researchers Edwards and Newell (1991) argue that costing information was in development much earlier than postulated by Johnson and Kaplan. For example, Edwards and Newell find sophisticated managerial costing information was produced by the British mining industry in the early part of the 19th century.

costing information that met financial reporting needs but which could not supply the opportunity cost information necessary to direct the firm. They would not expect to see a firm in the 1920's and 1930's employing sophisticated statistical measures in managing their fixed assets, and yet this is exactly what occurred at the Bell System. Perhaps the Bell System was an outlier, or, it may be that other firms operated in similar fashion, but that the evidence is hidden within corporate archives.

Finally, evidence of income smoothing on the part of the Bell System, and recognition of its occurrence by regulators, would be an important contribution to the accounting literature on income smoothing. Buckmaster (1992) contends that the reason so many identify Hepworth's 1953 paper as the first in accounting to discuss the theory of income smoothing lies in the fact that earlier accounting articles dealt with the topic without using the term income smoothing. If the work of Johnson and Kaplan would lead researchers to expect the absence of statistical applications in management accounting, then, Buckmaster's thesis would predict that discussion of income smoothing should be found in early debates about managerial accounting methodologies. My exploration of the depreciation debates helps answer whether industry and regulators of the time expressly recognized the income smoothing potential inherent in depreciation methodology.

In summation, this study examines the factors underlying the evolution of a depreciation methodology based on probability science at AT&T. Understanding the methodology chosen, its development, and the alternatives which were rejected will help identify those factors which shaped an important managerial accounting choice.

Chapter 2 – Research Propositions and Methodology

7. Research Propositions

In this section, I discuss the elemental questions which inform my dissertation and the methods used to explore these questions. Historical research is dissimilar from more common accounting research methods. The researcher does not approach a problem with a set of hypotheses to be tested; rather, the researcher investigates a particular situation in detail guided by a series of propositions (McWatters 1995). In historical research, the researcher's propositions guide investigation of both published and unpublished sources to try and understand the context and actions of the actors. The research style is qualitative, though quantitative means can be used as part of the investigation.[29]

The choice of research subject relies in part upon the availability of source material, but the researcher should also focus on a subject that can in be meaningfully representative of some demographic, for instance, a firm leading in a new technology, or a firm of regional significance. If truly representative, the investigation's findings then have real explanatory power. In this dissertation, the focus is a case study of AT&T, a firm which meets the test of representativeness on several levels. AT&T represented an industry; the Bell companies, as holders of the original Graham Bell patents and later through work at Bell Labs, were the technological leaders in a new industry, an industry that was an important part of the transformation of American business and society, and they remained the U.S.'s largest telecommunications firm (until the 1980's breakup).

[29] In some ways, historical research resembles "grounded theory" research, where the data and theory interact to develop a theoretical description of the situation being investigated. For a discussion of grounded theory, see Glaser and Straus (1967).

AT&T also comprised a significant portion of the U.S. economy; by the late 1930's, at over $5 billion in assets, the firm represented the largest accumulation of capital to that time in the U.S. (Danielian 1939). As the dominant firm in the second federally regulated industry, telecommunications, AT&T helped define the relationship between regulators and regulated and established patterns (e.g., depreciation methodology, public relations activity) that would be followed by later regulated industries. Thus, understanding what underlay decisions made and actions taken by Bell management can shed light on the motivations behind managerial actions in general.

In this dissertation, I wish to understand the reasons behind the choice of depreciation methodology at AT&T. I attempt to understand these choices through investigation of the depreciation arguments presented by the Bell System before federal and state regulatory bodies in the 1920's and 1930's. The propositions which guide my investigation follow.

Proposition 1: The Bell System was involved in an evolutionary process of learning, and the tools used by the firm to understand its business evolved over time.

The telephone industry was less than 50 years old in 1913, when AT&T helped develop the uniform standard accounts for telephone companies. The firm was still learning about its business at this time – types of information, formats for presentation, and even definitions were constantly being revised. The evolutionary process can be followed through analysis of firm documents over this time frame. In fact, historical research is ideally suited to investigate policies, methods, and procedures that developed over time.

Proposition 2:AT&T viewed statistics as capable of providing essential operating information about firm performance.

Reliance upon statistical information required searching for trends within a large quantity of data. The users, then, looked for averages as providing better information than individual data points. This led firm management to see smoothing as accurately describing past performance as well as predicting the future, but smoothing of income would also be in the firm's economic self-interest. It may be difficult to differentiate between motivations for such smoothing.

Proposition 3: AT&T was influenced in its interactions with federal regulatory bodies (first the ICC and later the FCC) by the experience of the railroad industry with federal regulation.

The railroads were the first industry to experience federal regulation. AT&T officials observed the history of federal involvement in the railroad industry and saw potential threats to both the telephone industry as a whole and AT&T specifically. AT&T officials were concerned about legislative actions such as the recapture clause of the 1920's Transportation Act, whereby railroad profits in excess of 6% became part of a government fund[30]. They were dismayed by what appeared to be rate setting procedures that irreparably injured an industry, and they saw that even an ICC whose membership included knowledgeable professionals favorably disposed to the industry could not guarantee intelligent administration of regulations in the face of partisan political pressures (Martin 1971). To protect their industry and firm, Bell management wanted to actively shape the course of federal regulation.

Proposition 4: AT&T was influenced in its development of depreciation methodology by its firm history and culture.

[30] The act required that half of the profits over 6% be directed towards a fund that would be used to support failing rails. The remaining half of excess profits would be invested by firm management, and it would be available as a source of funds to pay future dividends when earnings fell below 6%.

AT&T was a firm built on technological innovation. The technology involved sophisticated science and mathematics, and management's familiarity with and approval of mathematical approaches created an environment that was institutionally predisposed to attacking problems with statistical tools. This environment encouraged engineers to search for the best methods they could find to reduce uncertainty. Probability theory was not proposed by accountants as methodology useful to estimate asset lives; probability theory was a tool adapted to depreciation studies because AT&T engineers felt it would produce the best information. The initial selection of this methodology resulted from the belief that it provided the best information, not because it produced results that were easy to manipulate or otherwise advantageous to management. The firm was drawn to the use of probability theory because of the methodology's internal legitimacy; the firm also recognized its external legitimacy, which leads to my fifth proposition, namely, *Proposition 5: AT&T's choice of depreciation methodology reflected societal trends of the time.*

The late 19th and early 20th centuries were defined by several societal trends. One marker of the age was scientism. This was expressed by searching for the scientific underpinnings of the social sciences, including economics and applied business fields. Accounting and management science, developing business sciences, gained legitimacy through the use of scientific tools. Both fields were heavily influenced by scientific management; accounting also borrowed from statistics.

In the public policy realm, scientific tools were beginning to be applied to the problems associated with a rapidly urbanizing and industrializing society; the Progressive political movement's platform was concerned with managing these changes through

applied scientific knowledge. The Progressives recognized tensions in the changing American landscape: between the demands of capitalism versus democratic equity, between the rural and the increasingly urban, between small scale business and national enterprises. The Progressive politicians sought legislation that would enable governmental involvement in industry, and the emerging management class was aware of this. Managerial accounting choices would be made with awareness that their actions would receive government scrutiny, scrutiny that could precede interference in businesses' daily operations and long-term planning. Since Progressive politicians were enamored of science, scientific support for expense estimation was an important weapon in Bell management's ability to defend its depreciation expenses, and ultimately its rate structure.

Scientific legitimacy, however, was not the sole factor determining Bell's depreciation methodology. Its choices were informed by the firm's economic self-interests, and external events also played an important role in the positions taken by the firm. In particular, AT&T's choice of depreciation policy was influenced by the national economic climate. Familiarity and appreciation of big business versus suspicion; times of great economic growth or depression – all impacted the relationship between the Bell System and its regulators, and influenced the direction the firm would take in developing its depreciation methodology. This leads directly to my next two propositions.

Proposition 6: The economic climate of the times was a critical determinant in the shape of the relationships between the Bell System and its regulators.

The mandates of regulatory authorities varied with the economy. The prosperous twenties encouraged an attitude of cooperation between business and government. The depression

of the thirties meant changes in the balance of power between business and government, and this change in reflected in the Bell System's ability to dictate the terms of the depreciation debates.

Proposition 7: The evolving nature of business – especially the rise of large publicly owned corporations and the emergence of public utilities – also played a part in the choice and application of depreciation methodology.

Two interrelated patterns are involved here. The first was society's changing perception of the purpose of the corporation and its function in a capitalist economy, the determination of what the roles were between the corporation and society. The second pattern involved the relationship between investors and the corporation they funded.

In the early years of the 19th century, the British and American public generally viewed corporations disparagingly. In Britain, this largely reflected the aftermath of the South Sea Market bubble, when the near collapse of the corporate securities market taught that financial investments were extremely risky; many believed that corporate offerings amounted to nothing more than attempts to fleece the public. This message also existed in the U.S., but in America, attempts at capital accumulation also contended with views on democratic equity; Jeffersonian and Jacksonian democrats favored the small farmer or businessmen over large scale businesses. In both the U.S. and Britain, significant legal and social barriers to the corporate form existed[31]. As the benefits from increased concentration of wealth were recognized, however, the legal barriers to such accumulations in the form of corporations dissolved, though lingering distrust and suspicion remained. And, when it came to railroads and utilities, corporations operating

[31] Until mid-century, formation of a corporation in most U.S. states required individual legislation to be passed on the application.

under a municipal franchise, the public felt that the businesses' pursuit of profit was not sacrosanct; since *Munn v Illinois* in 1876[32], Americans recognized the right of states to regulate rates, and hence limit the profits of utilities.

Railroads did nothing to defuse the public's mistrust of stock offerings, because these enterprises often issued watered stock, that is, stock whose value at issuance was below the book value of assets, with the difference between asset cost and capital contributed going into the pockets of stock promoters. In this environment, investors felt most comfortable when firms distributed all earnings as dividends. Neither investors nor the public recognized that retained earnings could be used to fund future expansion, expansion which was often necessary to a firm's survival. Any retention of "surplus" earnings was viewed as a corporation "robbing" its stock holders. Consistency in dividend payments was also required by stockholders who were leery of dividends (and income) that gyrated; in order to ensure a steady, economical source of funding, surprises were to be kept to a minimum. Smoothing of expenses could help manage investor qualms; it could also be useful in maintaining a constant rate level.

Finally, the relative brevity of American experience with both public corporations and utilities meant that a common terminology did not yet exist, and confusion in terminology led to conflicting expectations. In particular, at the turn of the century, accountants were arriving at a definition of conservatism that differed from that of public service regulators. Thus, both AT&T management and regulators could stress that they strived to achieve a conservative depreciation methodology and yet disagree on what this implied. *Proposition 8: In any decisions about depreciation methodology, the impact of a chosen methodology on AT&T's economic interests was always a factor.*

[32] 94 U.S. 113

Microeconomic theory posits that the firm always acts in a manner to maximize profits, either by maximizing revenue or minimizing expenses. For a regulated monopoly such as AT&T, this assumption is maintained, but with a difference. Utilities focus on obtaining the highest possible service rates. Rates were based on three factors: recovery of operating expenses, allowed profit, and the rate base. In brief, the firm maximized its profits by maximizing its allowable expenses and rate base. For AT&T, then, minimization of operating expenses was not an economic necessity because these expenses would be recovered by the firm; indeed, one of the major tasks of regulatory bodies was to ensure that the operation was efficient and cost-effective. In terms of depreciation, the shorter the asset life, the greater the annual depreciation; AT&T could be expected, then, to have a bias that would lead them to err on the short side when estimating lives. By the end of the 1930's, however, AT&T's preference for accelerated depreciation expenses and a high rate base became subject to a countervailing pressure[33] as regulators pushed the firm to subtract accumulated depreciation from historical cost when determining the rate base. The greater the annual depreciation, the higher the accumulated depreciation, and the lower the rate base upon which the firm will receive a return.

8. Methodology

I primarily investigate the AT&T depreciation debates through exploration of archival materials. As a supplement to this work, I also perform counter-factual history.

[33] "Countervailing pressure" in the sense coined by Galbraith (1952) to describe the interplay between producers and consumers in oligopolistic markets is specifically discussed in Chapter 4.

i) Archival Sources

The primary repository for written records of AT&T and associated companies (prior to the 1980 breakup) is the AT&T archives, maintained at a facility in Warren, NJ[34]. AT&T materials reviewed include: annual reports; internal documents relating to depreciation and presentations by AT&T employees before legal, accounting, and regulatory meetings; the legal brief for AT&T's presentation before the ICC, prepared by Nathaniel Guernsey, AT&T counsel; transcripts of ICC Docket 14,700 proceedings; initial findings of the ICC and AT&T's responses, and the final findings of the ICC. FCC related material included summaries of the 1939 proceedings and findings. These documents provide a rich source of firsthand information on what the participants, in particular Bell management, attempted to achieve through their choice of depreciation methods.

ii) Contemporary Accounting Knowledge

The choice of depreciation methodology was influenced by the state of managerial accounting knowledge, and in turn, AT&T's application of probability theory to depreciation influenced general accounting research in depreciation. Depreciation can not be studied in isolation; it was only one accounting concept that was being explored in the early years of the twentieth century. Development of the accounting concepts of cost, valuation, and depreciation were all interrelated and can be tracked by reading the writing of contemporary authors. I refer to this literature to trace developments in the understanding of these terms as well as to see the awareness of AT&T's methods and how it influenced thinking on depreciation.

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[34] The archives were founded in 1921, and have been continuously maintained since that time. It includes the AT&T Corporate Collection, the Western Electric Collection, and the Bell Telephone Laboratories Collection.

Cost determination, valuation, and depreciation were concepts of concern to all areas of accounting, but these issues had unique implications for public utilities. During the 1920's and 1930's, many authors wrote about the relationship between depreciation and rate making in relation to utilities, including academics (e.g., H.E. Riggs), engineers (e.g., AT&T's Hammond Hayes), or lawyers (e.g., Edwin C. Goddard). The use of terminology was not consistent across these writers, reflecting the evolving state of understanding in key accounting concepts. Views on the purposes of regulation, the responsibilities of corporations to the public and the state's responsibilities to private enterprise were also evolving and frequently in conflict. By referring to the work of contemporary authors, I am able to record the conflicting viewpoints as well as the eventual agreed upon positions.

State commissions were important players in the depreciation debates, and significant work was done by such commissions. In 1933, the Wisconsin Public Service Commission compiled an investigation, *Depreciation and its Relation to Public Utilities*. Now out of print, the summary report of legal and accounting problems found by the commission is available from several university collections. This report summarizes legal and methodological issues from around the country, including the work of the Bell Systems, and provides a useful third-party perspective on the interactions between the ICC and AT&T. Another useful source for material relating to the state commission reports comes from the Public Utility Reports (PUR), held at the Rutgers law library in Newark.

iii) Counterfactual History

Counterfactual history is not commonly employed as part of a case study, but in this dissertation it serves as a tool to test the possible results from using alternative options which AT&T confronted but did not adopt. Can any statements thus be made regarding the reasonableness of the firm's actual depreciation choices?

Counterfactual history is a form of "what-if" analysis. Paraphrasing Martin Bunzl (2004), counterfactual history is not unconstrained imagination but imagining grounded in historical evidence. I use the illustrative data supplied by AT&T in their presentations to regulatory bodies as source material for estimating asset lives. Through manipulation of the same data, I can estimate asset life-spans, depreciation expense, and the rate base. The manipulations I introduce reflect plausible, not just possible, differences in assumptions, and are suggested by the archival evidence itself. For example, different lives will result if estimates are made from a band of data 3 years wide versus 5 years; as disclosed by the FCC investigations in the late 1930's, both 3 and 5 year bands were used by entities within the Bell system. The decision to include or exclude storm damage when estimating useful life also leads to different conclusions about life spans.

The results of these tests are used to see if whether they support or contradict statements found in the archival evidence. In this sense, then, counterfactual history is a type of comparative history, where the plausibility of historical assertions is tested by comparison to experimental results. (Both Excel and the statistical package R were used to perform survival analysis and related calculations.) For example, the FCC contended that AT&T's calculations of estimated lives were inaccurate and self-serving. Counterfactual history can support the FCC's contentions by exposing how easily

changed assumptions could result in different estimates of life. The fact that the estimates were manipulatable does not necessarily mean that manipulation occurred, but it does mean that strategic manipulation was possible and that the reasons behind such manipulation should be explored.

Chapter 3: 1913 – 1934

9. Introduction to the ICC Years

In this chapter, I investigate the use of probability theory in depreciation methodology during the initial period of federal regulatory control of the telephone industry, from 1913 through 1934. My investigation begins with a discussion of the socioeconomic environment. I then examine the state of contemporary knowledge about probability theory and its application to depreciation, including AT&T's statements on these topics; I also directly examine depreciation data from AT&T. The chapter ends with a discussion of the reasons that underlay AT&T's choice of probability theory to manage its' depreciation issues.

The years when the Bell System wrestled with devising ways to measure depreciation were generally prosperous times in America. The government's involvement in business affairs was minimal, allowing the Bell System the freedom to develop its knowledge and methodology without externally imposed direction. Additionally, any regulators or government observers attempting to follow developments at AT&T would have been experts in law and accounting, not science or statistics; they would need the firm to interpret the knowledge it was developing.

i) The Socioeconomic Background to Measurement Innovation

The accounting measurement questions faced by utilities and their governmental regulators emerged during a time of accommodation and cooperation between government and business. Prior to World War I, Progressive Era politicians and

government officials had been active in attempting to curtail the power of giant economic enterprises. For example, Progressive Era lawyer and later Supreme Court Justice Louis Brandeis thought the very bigness of business was enough to threaten democracy (McCraw 1984). It was during this era that AT&T president, Theodore Vail, embraced limited regulatory control of the telephone industry, in part to forestall breakup of the Bell System (Danielan).

The picture changed in the 1920's. During WWI, industries deemed essential to successful prosecution of the war effort were put under direct federal control, including the railroad and telephone industries. Their contributions to the war effort resulted in favorable public opinion and a lessening of the automatic suspicion that industrial size alone had engendered. This favorable opinion partly reflected a new conception of big business; instead of automatically fearing these corporations because of their size, people saw these firms as new frontiers, places where opportunities for individual success existed. The large corporation was seen as a new avenue for achieving wealth, status and prestige (Wiebe).

Though there was some discussion of continued federalization of the phone system[35], the railroads and telephone firms were returned to private control in 1919. Over the decade of the "roaring twenties", big business remained unfettered. Such government intervention as did occur (e.g., the commerce department's initiative in waterfront development or the labor department's attempts to meet unemployment crises

[35] The Postmaster-General, for example, was a strong proponent of the government ownership of the telephone system, and he attempted unsuccessfully to align public opinion with this viewpoint. See, for example, his article in the 1918 *The American Review of Reviews* (Burleson 1918).

through construction projects (Hawley 1974) reflected actions aimed at promoting social benefits through economic growth, a trend noted by many (Galambos and Pratt 1988; Alchon 1985).

Alchon explored the idea of an "associative" state, a concept first theorized by Ellis Hawley (1974). Hawley contended that a new form of control emerged during the time that Herbert Hoover served as Secretary of Commerce. Hoover served as Secretary of Commerce. Hoover believed that a major goal of the federal government was to advance the benefits of capitalism to all Americans through working in close cooperation with representative business organizations.[36] Governmental agencies such as the the Bureau of Labor, Bureau of Markets, and the Bureau of Foreign and Domestic Commerce were made into central organizations for the gathering and dissemination of essential information to related industrial associations. The government agencies were enjoined to expand American commercial opportunities at home and abroad, but they were also perceived to be transitory; when sufficient aid had been supplied to American industry, the industrial associations could continue the work on their own, without continued government support.

Galambos and Pratt (1988) term this partnership between government and industry the corporate commonwealth. In their analysis, the associative state operated successfully during the prosperous 1920's. Because of this success, little pressure existed to change the relative power between government and industry. For the utilities, this meant that the firms were free to forge ahead in developing tools to better understand their businesses and applying them as they saw fit.

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[36] During the 1920's, the number of U.S. trade associations increased from approximately 700 to over 2,000 (Hawley 1974)

Cost measurement became increasingly important to AT&T in this time of rapid growth and technological development. Operationally, the firm needed detailed cost analyses to compensate for the lack of information from external markets and competition[37]. At the most basic level, simple decisions such as whether to repair or replace equipment could not be made without knowledge of fixed assets' useful lives. In terms of rate defense, the firm needed to know the cost of service provided in order for it to be recovered. The formation of the statistical department within the accounting department in 1921 reflected these circumstances (Miranti 2002).

A fast growing utility, AT&T also needed to manage its measurement issues to satisfy the imperatives of the financial markets. The firm aggressively pursued a wider distribution of securities as a means to increase its financing, forming a separate Securities Corporation for this purpose (Stehman). From 1920-1930, the parent firm and subsidiary enterprises regularly raised funds in the capital markets. The following table illustrates the firm's tremendous growth.

Growth of the Bell System: 1915 - 1930[38]					
Year	**Par Value of American Co Stock**	**Total Assets**	**Total Revenues**	**Miles of Wire**	**No. of Employees**
1915	380,477,100	1,057,907,703	239,909,649	18,505,545	156,294
1920	442, 825,400	1,634,249,533	458,140,556	25,377,404	231,316
1930	1,795,651,200	5,000,195,801	1,151,965,344	76,248,265	324,343

Table 1

To attract investors, the firm needed to minimize investors' perception of the risk associated with the firm's securities, and one way this could be accomplished was by minimizing expense variability. As depreciation expense could represent about half of the

[37] Although the 1913 Kingsbury Agreement divested Western Union Telegraph from the Bell System, the firm effectively operated as a monopoly in the largest markets in the country until the 1980's divestitures.
[38] Statistics taken from FCC information as reported in *A.T.&T.: The Story of Industrial Conquest* (Danielian 1939), except for par value information, which was taken directly from the summary of the FCC 1936 investigations (Special Investigation Docket No. 1, Report on AT&T Financial History 1937)

firm's fixed annual costs, depreciation methodologies which enhanced expense predictability thus served an important financing role.

Steady, predictable cost patterns also aided management planning and control. With a large number of subsidiary operating entities, AT&T management needed to ensure standardization of accounting throughout its growing system and to end the different depreciation practices followed by various Bell companies[39]. The trend towards cost smoothing was further encouraged by the statistics division's development of business cycle predictions to help in capital asset budgeting that accompanied the expansion of the telephone system.

Standardization in regulation was also an important goal for the Bell System. Though the ICC was the federal regulator of the telephone industry, the industry was also overseen by state regulatory commissions; requirements, enforcement, and rulings varied greatly among the states.[40] Moreover, these regulatory agencies did not just oversee the telephone industry. The ICC's primary concerns were the railroads; at the state level, public utility commissions usually oversaw the rails (street and steam), telephone, gas, electric, and water services. This presented problems in defining acceptable practice. AT&T selected asset accounting policies that its management thought was highly appropriate to meet the firm's needs. These practices, particularly with respect to depreciation, came in sharp conflict with the approaches championed by railroads.

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[39] The first accounting circular in 1894 stated that a standard 10% of fixed assets should be annually reserved for depreciation (DuBois 1913). As late as 1920, some Bell subsidiaries appeared to continue using this method.

[40] Up until the 1930's, judicial intervention in the regulatory process essentially made the federal judiciary, not the ICC, the final arbiter of differing opinions on depreciation. In the 1930's, the Supreme Court began to refuse to hear cases involving questions of justice or equity or fact in regards to the rulings of regulatory agencies; only cases centering upon whether constitutional strictures had been breached were reviewed by the Court. This change moved final decisions on matters of fact, such as depreciation, to the ICC.

10. Probability Science and Depreciation

Depreciation accounting developed as enterprises owning large fixed assets became part of the industrial scene, and railroads grappled with depreciation issues almost immediately[41]. Railroads favored maintenance accounting, arguing that depreciation only occurred when property did not receive adequate repairs and upkeep. Properly maintained assets would retain their value, with no depreciation expense. (Conveniently for the railroads, assets that maintained their value continued as part of the rate base indefinitely.) The maintenance view of depreciation held that the capital investment in fixed assets never dissipated, and so the costs of the assets never ran through the income statement.

Railmen eventually conceded the appropriateness of some provision for future replacements. The replacement reserve would consist of reserves set aside out of current profits in anticipation of a future date when service demands would require the provision of bigger and better assets. Replacement reserves were not mandatory, but were based on prudent management. Firms felt that when regulators required the establishment of depreciation reserves, the government unjustly relieved management of their decision-making prerogatives (Blauvelt 1908; Young 1914; Riggs 1922).

The replacement reserves served to fund future asset purchases, not to recover the cost of existing fixed assets. Under this accounting scheme, depreciation occurred only when the asset left service, hence the name retirement accounting. Creating reserves in anticipation of retirement would lower the expense recognized when retirement occurred, but the largest part of the depreciation expense would still fall in one accounting period.

[41] Mason records numerous references to depreciation issues in early railroad reports, beginning with an 1833 Baltimore & Ohio Railroad annual report (1933).

Retirement accounting became the preferred method of depreciation accounting for railroads and most utilities, except for the telephone industry[42].

Some utilities took the position that depreciation did occur, but that its progress could only be determined by physical inspection of property (Riggs 1922). Depreciation expense recognition therefore required property appraisal. This system of depreciation calculation had serious practical flaws. As with retirement accounting, depreciation based on appraisals resulted in wide fluctuations in the annual depreciation expense. Furthermore, its implementation required huge, ongoing efforts of appraisal; and, as no external market for these fixed assets existed, different appraisers could return vastly different valuations. Because of these difficulties, physical appraisal to determine annual depreciation expense was not widely used, though appraisals were used when calculating the value of the rate base.

AT&T's opposition to retirement accounting, however, demands further investigation. Would not retirement accounting have generated a higher annual return for the firm than depreciation accounting?[43] Were there benefits to raising capital if one depreciation method was chosen over the other?

Retirement accounting allowed initial lower expenses than under depreciation accounting. Delay of expenses allowed a firm to report higher income and thus pay

[42] Retirement accounting is not strictly speaking depreciation accounting, because it does not accrue for the ongoing using up of an asset. In the depreciation debates, retirement accounting was treated as a substitute for accrual depreciation accounting, and it is discussed in this sense in this paper.

[43] The courts recognized that including costs previously recovered in the rate base (e.g.., through depreciation) was unfair to the customers by 1910, though this principle was inconsistently applied in rulings (Whitten 1919). The effect of depreciation methodology upon the rate base, however, was not initially emphasized by AT&T because they used fair value, without subtracting theoretical depreciation, as the rate base. The implications of this divergence are discussed in Chapter 4.

higher dividends[44], at least initially, making it easier to attract capital. Thus, it would seem that early on a firm would prefer retirement accounting, or at least the ability to avoid mandated depreciation expense. Eventually, once a firm had reached a stable size, annual retirements would roughly equal the annual depreciation accrual, making a firm economically indifferent to retirement or depreciation accounting. But, for a growing firm, like AT&T, the retirement method of depreciation actually resulted in a higher annual recovery of costs (through higher rates) because annual retirements could actually exceed the annual depreciation accrual (Preinreich 1938). So why would a firm wish to go beyond retirement accounting?

Retirement accounting did have problems – principally, lack of predictability and increased expenses gyrations[45] resulting in volatility that could increase the cost of capital. The alternative, depreciation accounting, had two important factors in its favor: it provided a predictable pattern of expenses[46], reducing the perception of income volatility and associated risk; and, it helped promote equity in payment for services rendered.

The equity argument against retirement accounting in favor of depreciation accounting involves two issues of equity. The first issue concerns who should pay for utility services, how to fairly match the expense of services with service users. Utilities set customer rates prospectively. To recover expenses, the utility needed to accurately

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[44] The various Bell entities were sensitive to the impact depreciation accounting could make on their dividend policy. The archives record numerous examples of subsidiary firms requesting that they be allowed to diverge from firmwide depreciation policy because of its impact on their dividends. For example, in 1913, the president of the Michigan State Telephone Company stated in correspondence to AT&T's comptroller that depreciation rates needed to be decreased in order to maintain its dividend (Sunny 1913). Similar requests from the Mountain States Telephone Company were made in 1919 (Kingsbury 1919). Both requests were denied.

[45] Alternatively, retirement accounting could result in reduced income volatility if the timing of retirements was matched to business conditions – that is, retirements increased in years of high revenue and decreased in years of poor revenue (Sivakumar and Waymire 2003).

[46] Even opponents of depreciation accounting recognized its income stabilizing benefits. For example, Riggs (1922) states that "the sole reason for the adoption of any allowance method is that the ratio between earnings and operating expenses may be held fairly uniform year after year" (p.69).

anticipate its expenses. By its very nature, however, retirement accounting said nothing about future expenses, and instead postponed expense recovery. Retirement expenses could only be recovered through rate increases instated after retirement occurred. This meant that the customers benefiting from an asset's service would not necessarily pay for its cost; future customers paid for the cost of prior service.

The second issue of equity concerns the rate of return paid on assets providing service. Customers' payments flow to the investors who contributed the capital for purchases of fixed assets. As the asset deteriorates, the investors recover their investment through repayment of the annual depreciation expense. New asset purchases are funded either from new infusions of investment capital or from retained earnings. Retained earnings represent the cumulative sum of profits earned by the utility over the years. But, if the rates charged exceeded expenses plus a reasonable profit, the retained earnings would constitute overpayments by customers, that is, unreasonable profits. Use of these excess earnings to purchase additional equipment effectively meant that customers, not investors, contributed the capital to purchase new assets. Going forward, as customer rates cover the depreciation expenses associated with these new assets, investors receive payment on an investment they did not make (Hayes 1913; Adams 1918). Therefore, an accounting methodology such as depreciation accounting which matched actual costs and benefits was also a more equitable method of sharing utility costs among customers than retirement accounting.

The accounting literature during this time showed the profession moving towards an understanding of depreciation that equated it with capital recovery (Hotelling 1925). To the accounting profession, depreciation showed the using up of invested capital over

time; it was not the economist's definition of depreciation as a physical loss in the value of an asset[47], and AT&T adopted the accounting definition of depreciation. Depreciation accounting, unlike maintenance or retirement accounting, dealt with allocating investment over the useful life of the asset.

In depreciation accounting, the two central questions involved the proper determination of the asset's cost and lifespan. For some utilities, and especially for railroads, poor record keeping made the determination of cost problematic. But, the Bell companies kept well maintained records of asset cost and installation, allowing for accurate determination of original cost. A much bigger problem for the Bell System, and for industry in general, was the determination of asset life spans.

Opinions on how to handle the question of determining asset life spans varied greatly. As noted earlier, railroads often described their assets as essentially immortal; even if assets would eventually leave service, railroad management stated that it was impossible to predict asset life with any certainty (Riggs 1922). Accountants were not much help; Kurtz (1930) believed that most accountants merely selected as an average life span the age when the largest number of assets were retired, that is, the mode.

The accounting profession ignored the practical problems associated with the matching of asset life and capital recovery when dealing with large industrial plants[48]. While accounting texts usually discussed depreciation in terms of individual assets, utility plants were often composed of units that aged as part of a composite unit – the life span

[47] Though confusion between the accounting and economic definitions of depreciation could still be found in the period's accounting journals. For example, a 1922 author in *The Cost Accountant* called depreciation a substitute for revaluation (Winder 1922).

[48] One of the better texts of the time "Cost Accounting for Control" (Sanders 1934) does mention that problems can arise when plants are composite units; the author also briefly mentions that life tables can be used to estimate lives, but there is no substantive discussion of these subjects.

of individual units was nearly irrelevant when assessing the life of the plant in total. Other times the assets consisted of large numbers of homogenous items with greatly varying life spans. Furthermore, while accountants sometimes discussed the complications in depreciation resulting from changing prices, they did not mention the role of plant expansion in depreciation, a situation experienced by many utilities. And, almost always, accounting texts simply assumed that the life-span[49] of an asset was a known quantity, yet life estimation was one of the biggest unknowns faced by utilities. The Bell companies needed to move beyond the simple depreciation analyses provided by professional accountants, and probability science, already being investigated as a tool for managing pension benefits, was chosen as a tool that could enhance management's understanding of fixed asset costs.

AT&T could have simply professed to possess the expert judgment necessary to predict asset lives with certainty. Or, they could have used simple calculations based on the mode of retirements, claiming that the mode provided an accurate estimate of asset life span. Indeed, use of the mode would have resulted in depreciable lives even shorter than those eventually estimated through use of probability theory[50]. Why did AT&T go to the trouble and expense of developing probability theory to predict asset lives? There are several reasons, including accuracy, equity, predictability, and autonomy. An initial belief in the power of science to reduce uncertainty merged with a desire to maintain control over the estimation process while reducing the influence of outside oversight. At

[49] Texts sometimes distinguished between useful, or productive, life and maximum life, but the sole guidance to determining these was to refer to actual experience and judgment.

[50] Per review of life table information calculated by Kurtz (1937), the average ratio of mean life to modal life for equipment used by the telephone industry was 1.131, meaning that reliance on the mode rather than the mean generally resulted in underestimations of life by roughly 10%

the same time, management wanted to ensure that the chosen methodology would advance the firm's economic interests.

Probabilistic knowledge attempts to reach beyond a knowledge barrier; it reduces, but does not eliminate uncertainty. Though employing sophisticated mathematical techniques, probability does not deliver answers to problems with mathematical precision. Instead, probability provides a range, a distribution of likely results. This is an important goal, because it allows the scientist (or engineer, or businessman) to estimate risks and thus plan. AT&T management agreed that life estimation involved a large amount of judgment, but they felt that with probability theory they could estimate life expectancy with a high degree of accuracy. This faith in the power of probability science to reduce uncertainty came naturally to a firm that had depended upon the successful application of scientific tools to develop its technology.

The particular needs of their businesses shaped the Bell companies' approach to depreciation. In situations where the initial installation records were incomplete, they developed the turnover method[51] to estimate average lives; they developed the composite life method of depreciation (basically, a weighted average) for situations where plants consisted of individual items of different life-spans. Another difficult depreciation problem occurred when determining depreciation for numerous homogenous items which were installed and retired on a continual basis; this was the problem addressed by probability science.

[51] The turnover method is another actuarial methodology. Each year, the accountant counts the number of assets in service, the number retired, and the number added. Either the number of retirements or additions per year is summed to reach the number of assets in service. The number of summations required is the average life (Marden 1957).

The accounting profession could not provide help in the problem of determining the life spans of assets like telephone poles, cables, and wires. Deficiencies in the accountant's approach to depreciation extended beyond the problem of life determination, because accountants treated asset retirements before useful life had been reached as unusual events to be expensed, creating expense volatility.

For an asset with a known life-span, standard depreciation allowed the cost of service to be reasonably allocated over the asset's lifespan because early retirements and associated losses were not expected to occur. This methodology failed when asset lives showed variation, when most assets did not retire at approximately the same time, when, rather, a significant number of assets retired before reaching the average life-span. Under the contemporary accounting treatment of depreciation, early retirements were recognized as losses in the year of retirement, reflecting the unexpected and unpredictable nature of such retirements. Thus, standard accounting's treatment of early retirements obviated the smoothing benefits of depreciation accruals since early retirements were treated as losses without the benefit of accruals even if the early losses were anticipated. But, for many assets, Bell engineers anticipated the dispersed nature of retirements as the natural, expected pattern of retirement, or, depreciation. To handle this situation, AT&T began with standard depreciation accounting and adapted it.

AT&T's depreciation methodology met the stated purpose of depreciation accounting because it matched service received with recovery of the capital invested to deliver the service. Equity for service was also promoted under this system, because the chance timing of retirements would not dictate the expenses recovered in rates. The smoothing of expense recovery also promoted equity in the return to investors. Their

methodology removed the expense fluctuations associated with depreciation accounting when a dispersed pattern of retirements existed. AT&T called their methodology straight-line depreciation accounting.[52] Today, the methodology they developed is better known as group depreciation.

ii) Straight-Line Depreciation at the Bell System (Group Depreciation)

The straight-line method of depreciation as used by the Bell System applied a constant depreciation percentage to a group of assets; depreciation expense was recognized over the total life of the group of assets, with no losses recognized on early retirements. This methodology was recognized by Preinreich to be the "true" straight-line method (1939) as opposed to what he calls the "accountant's straight-line method, " where losses were recognized on assets retired before reaching average life. Though both methods resulted in the recovery of the original cost of the assets, the "true" straight-line method resulted in smoother and more predictable expenses than the accountant's method.[53]

The following example compares traditional and AT&T straight-line depreciation for a group of 10 assets; the average life has been accurately estimated to be 8 years and the maximum life-span 20 years. The depreciation rate of 12.5% (1/8) is applied on the assets remaining in service (column d), and this is the annual expense recognized by the Bell methodology. The accountant's straight line method also recognizes losses on retirement (column e) for a total expense combining annual depreciation and retirements, (column f). Both methods of depreciation show expenses fluctuating with the timing of

[52] It should be noted once again that different users assign the same terms different meanings. To accountants, straight-line accounting involved taking losses for early retirements; AT&T's straight-line accounting expressly avoided the recognition of losses for early retirements. It is doubtful whether the ICC and other regulatory bodies recognized this distinction.

[53] The main difficulty with AT&T's straight-line accounting was its reliance upon an accurate estimate of life distribution; errors of either average or maximum life will cumulatively distort the book value of assets, hence the rate base. These problems are discussed in chapter 4.

retirements, but the fluctuations are far less under the methodology adopted by Bell (column d) than when using the accountant's straight-line method (column f).

Annual Expense – Bell Depreciation Method vs. Accountant's Straight-Line					
Year of Service (a)	**Average Assets in Service (b)**	**Retirements at cost (c)**	**Depreciation Expense (assets in service x rate) (d)**	**Loss on Retirement (retirement book values) (e)**	**Standard Method Straight-line Expense (f) = (d)+(e)**
0-1	100,000	0	12,500	0	12,500
1-2	95,000	10,000	11,875	8,125	20,000
2-3	85,000	10,000	10,625	6,875	17,500
3-4	75,000	10,000	9,375	5,625	15,000
4-5	65,000	10,000	8,125	4,375	12,500
5-6	55,000	10,000	6,875	3,125	10,000
6-7	45,000	10,000	5,625	1,875	7,500
7-8	35,000	10,000	4,375	625	5,000
8-9	30,000	0	3,750		
9-10	30,000	0	3,750		
10-11	25,000	10,000	3,125		
11-12	20,000	0	2,500		
12-13	20,000	0	2,500		
13-14	20,000	0	2,500		
14-15	20,000	0	2,500		
15-16	20,000	0	2,500		
16-17	20,000	0	2,500		
17-18	20,000	0	2,500		
18-19	15,000	10,000	1,875		
19-20	5,000	10,000	625		
Total			100,000		100,000
Bell's annual depreciation expense = column d; accountant's straight-line annual expense = column f.					

Table 2

The Bell straight-line methodology shows depreciation expenses as a decreasing function of time; annual expense using the accountant's straight-line method fluctuated with the timing of retirements. From this example, the second major difference between straight-line depreciation as used at Bell versus the standard treatment also becomes obvious – differences in the total time needed to recover depreciation expense. In the above example, three assets remain in service in year 9, one is still in service in the 20th

year (the maximum useful life), but full depreciation occurs by the end of the 8th year (the average life). The Bell methodology spreads the assets' cost over their estimated useful life-span; when the accountant's straight-line method uses average life without consideration of the useful life costs will be spread over a shorter period[54].

Average life equaled the useful life only when no early retirements occurred. Indeed, from the above example is also easy to answer why AT&T could not simply substitute the mode for the average life in depreciation studies: the mode did not reasonably approximate useful life for assets with a large variation in retirements. Recall that since the utility's expenses were subject to regulatory review, any depreciation methodology chosen by AT&T needed to be defensible. Depreciation schedules which routinely showed fully depreciated assets remaining in operation had a high likelihood of being rejected by regulators.

In situations where asset retirements are dispersed and the traditional straight-line depreciation approach is applied, depreciation accruals will only be accurate if estimated useful life is used instead of average life in determining the depreciation rate. This ensures that expenses are taken over the lifespan of the group as a whole, but problems remain – the retirements still resulted in expense fluctuations. (In the case of an expanding firm, depreciation expense would increase, but the increase would be smooth.) AT&T management saw that recognizing retirement expense at the time of retirements would result in expenses that "would be highly irregular" (Crunden and Belcher 1929) – and they wished to avoid this. To avoid the irregular impact of retirements on expenses

[54] The traditional straight-line depreciation methodology would be improved by substituting useful life for average life, but problems of expense fluctuations due to retirements remain.

required AT&T to not only reject retirement accounting, but also traditional straight-line depreciation.

The smoothing feature of AT&T's straight-line methodology versus traditional straight-line depreciation can easily be seen by calculating depreciation expense using the two methodologies, and this will be undertaken in the next section. Before doing this, however, I must first examine the data and practical statistical tools which underlay AT&T's calculation of average life.

iii) Survival Analysis and Life Estimation

In trying to discover the most informative depreciation methodology, AT&T management needed answers to specific life-span problems exposed by AT&T's practical experience. Though the accounting literature of the time discussed the distinction between average life and effective life, this equated to recognition that an asset's actual productive life was not always the same as its potential useful life. Though accountants seemed to have recognized that obsolescence was a depreciation issue, they did not venture into a discussion on the consequences of uneven wear and tear or accidents on life-span. Without recognizing that a dispersed pattern of retirements best represented average asset experience, the accountant was also unable to recognize the problems associated with the application of straight-line depreciation: when asset retirements occurred over time, the ordinary straight-line method of depreciation would not evenly distribute the costs of service over asset life.

The telephone business was less than half a century old in 1913, when the ICC's uniform accounting for telephone companies was first instated, requiring straight line depreciation. The ICC's definition of straight-line depreciation merely called for

distribution of the costs of the assets as evenly as possible over the life of the asset (Uniform System of Accounts for Telephone Companies 1913); the accounting procedures did not cover issues of life determination, nor how retirements should be handled. As the pioneering firm in telephone communications, AT&T could not rely upon prior industry experience when predicting asset lives. What AT&T did have however, were extensive, detailed records of assets' costs, placement dates, and annual retirements. Treated as frequency tables, this data became the basic building blocks in estimating asset lives, used to create mortality tables following practices well established in the insurance industry. Just as collecting extensive data on human mortality allowed actuaries to make predictions about the average life spans of similar individuals, data could be collected and used to make predictions about mechanical failure.

AT&T felt strongly that the "most satisfactory means of determining average lives which eliminates all of the objections inherent in other methods is the actuarial procedure developed by the American Company…... As employed in the Laboratories, these permit the prognostication of the probable rate of retirements, to the complete exhaustion of the plant in service at the time of the study."(AT&T 1937)[55] A pioneer in developing these tools, AT&T was not the first firm, however, to recognize possible parallels between the actuarial estimation of human life and asset lives.

In a survey of the use of mortality tables for estimating asset lives, Kurtz (1930) documents early examples of data collection for creation of mortality tables. He found sixteen examples of statistical compilations of mortality experience between 1903 and

[55] The other methods referred to would include retirement accounting and other methods of calculating annual depreciation – whether based on income, asset values, or sole reliance upon managerial judgment. All of these methods had been used to calculate depreciation expense by various Bell companies, and it was important for the firm to standardize practices across entities.

1918, with most of the studies created between 1916 and 1917[56]. The studies involved the experience of waterworks pumps and boilers, wooden poles, incandescent lamps, cast iron wheels, cable (aerial, underground, and submarine), railroad rolling stock, pumping stations, railway cross ties, steam locomotives, grain binders, railroad cars (box, ore, and stock), and automobiles.

Of particular interest in the studies collected by Kurtz was a 1905 German governmental study of the life experience of telegraph poles. This study, using over 50 years of data from the Prussian and North-German telegraph system, represented the first instance Kurtz found of mortality tables being used to predict asset lives. Foreshadowing work later done at the Bell System, the German study separated poles into groups based on treatments applied to them; the study's author was thus able to make predictions of the impact of various treatments on asset lives.

All of these studies involved assets where a large number of homogenous units entered service, retired, and were replaced over time. It was impossible to predict when any individual asset would retire, but by applying probability theory to the experience of large numbers of individuals, patterns of retirement could be discerned. The information on placements and retirements was gathered in life tables; today, this process is the basis of the science of survival analysis.

Survival analysis begins with the creation of mortality curves. The process of creating mortality curves requires knowledge of the number of units placed in service and retired each year. The number of units in active service in any one year included new

[56] The earliest data collection, a 1903 study of 22 years of annual additions and retirements of waterworks pumps and boilers, did not actually produce mortality curves, though all of the data necessary to produce them was collected. Kurtz's survey of sixteen studies includes the 1916 research on cable life by Sergius P. Grace, for NYT, which the FCC recognized as the earliest publicly available example of mortality analysis in determining asset life span (FCC, p. 142)

installations as well as those installed in prior years and not yet retired. Over a given year, units of all ages would retire. The assets in service during any one year were those exposed to the risk of retirement, or subject to hazard. The hazard rate calculation reflected the percentage of assets in service for the year that actually retired. The assets that did not retire were survivors, and the resulting survivor curve showed the percentage of assets remaining in service over the asset's theoretical maximum lifespan, beginning with 100% assets surviving at initial placement and reaching 0% when the maximum life was achieved and all assets retired.

From the available records, it appears that New York Telephone (NYT) (Kurtz 1930) was one of the first Bell entities to collect mortality data. The work was begun by engineers who wished to know how long assets could be relied upon to deliver service. For engineers, mortality information was essential in planning the provision of service to existing customers as well as for expansions. These studies were established to seek the objective truth about asset lives, to determine how long assets could be expected to supply useful service given a variety of conditions including differences in location, treatment, and service growth. This information, then, was not originally collected to meet regulatory requirements, though it was adapted for use in support of Bell's positions before regulatory bodies, both state and federal.

11. Depreciation Arguments before the ICC

The ICC, the federal regulatory agency responsible for overseeing Bell's depreciation practices, created a Depreciation Section as part of the 1920's Transportation Act. Presentations before this section were the latest in a long series of industrial attempts to educate governmental authorities about informational advances by industry and to

increase the government's understanding of the economic impact of technology.[57] Two separate hearings were established, with Docket 15,100 presenting the depreciation arguments of the railroads, gas, and electric industries. These industries pressed three main themes in Docket 15,100: 1.most physical depreciation could be prevented by maintenance; 2. any depreciation of assets that did result in retirement was unpredictable; 3. that while retirement reserves might smooth the expense impact of replacements, the calculation of these reserves was a matter of judgment and not subject to mathematical calculation (Marden 1957).

In Docket 14,700, the ICC heard the depreciation arguments of the telephone industry. In these hearings AT&T presented its depreciation theory and methodologies and attempted to convince the regulatory commissioners that Bell practices should become the industry standard, if not the standard for all utilities. Expert testimony from firm engineers and management was presented along with testimony from experts in mathematics and statistics. AT&T's testimony also included extensive statistical evidence in tables, charts, and graphs[58].

The statistical evidence presented was drawn from the actual records of unnamed Bell operating firms. Typewritten spreadsheets contained the mortality experience for four types of assets: Chart 9, listed the additions and retirements of aerial cables from 1902 through 1926; Chart 10, listed underground cable added and retired from 1895 through 1926 (reproduced in Exhibit I); Chart 11, enumerated the additions of toll poles from 1910 through 1926 and the retirements over the same time frame of poles placed in

[57] As early as the 1870's, before formation of the ICC, Fink presented testimony before Congress on railroad accounting concepts, including depreciation (Heier 2000).
[58] The following information comes from the transcript of Docket 14700 (Testimony of Witnesses for Bell System Companies; Docket No. 14,700: Depreciation Charges of Telephone Companies 1928).

service between 1895 and 1926; and Chart 12, dealt with the additions of P.B.X.'s (private branch exchanges) from 1910 through 1926 as well as retirements over the same period for exchanges placed in service between 1903 and 1926. (The information was presented in constant dollars, without specifying the base year.)

In terms of survival analysis, the exhibits detailed the experience of cohorts of assets. A cohort is a group of assets entering into service in the same year. Thus, for 1895, Chart 10 showed that the cohort's initial size was 37,260 cables, with no cables retired that year but with 1,513 retired during 1896, the second year of service. Each column of the spreadsheet showed one year's life of the cohort, and successive columns to the right showed the size of the cohort at the beginning of the year and the retirements for the year. Every row introduced a new cohort. Immediately following presentation of the charts were survivor curves derived from the tables.

As the exhibits were designed to support AT&T's contention that they had the tools necessary to scientifically analyze historical experience and accurately predict future mortality, the format of the exhibits had to be carefully chosen. Evidence that emphasized the random or haphazard nature of retirements would make AT&T's case more difficult to argue. Intentional downplaying of any evidence that highlighted random fluctuations appears to partly explain the graphic material included or excluded in ATT's presentation.

The first statistics calculated from the mortality tables are hazard rates, the rates which show the annual rate of retirement. It is from the hazard rates that the survivor curves and average lives are developed[59]. Despite the importance of the hazard rates in

[59] The annual hazard rate, *h(t)*. is the probability of failure over the next period, conditional on the individual surviving to the beginning of the period. It can be simply calculated as: number experiencing

the estimation of asset lives, however, no visual plotting of the hazard rates was included in the ICC presentation. Among the voluminous materials included as exhibits, this absence seems surprising, but the exclusion was likely because annual retirements are not predictable – they can vary greatly from year to year – and thus, the plotting of hazard rates does not produce a smooth curve indicative of predictability. Indeed, plotting the hazard rates of the retirement history from the four charts[60] shows that the rates appear to vary widely.[61] For example, though the hazard rates for cables (charts 9 & 10) averaged less than 10% a year, in one year the retirements of aerial cables (chart 9) exceeded 50%.

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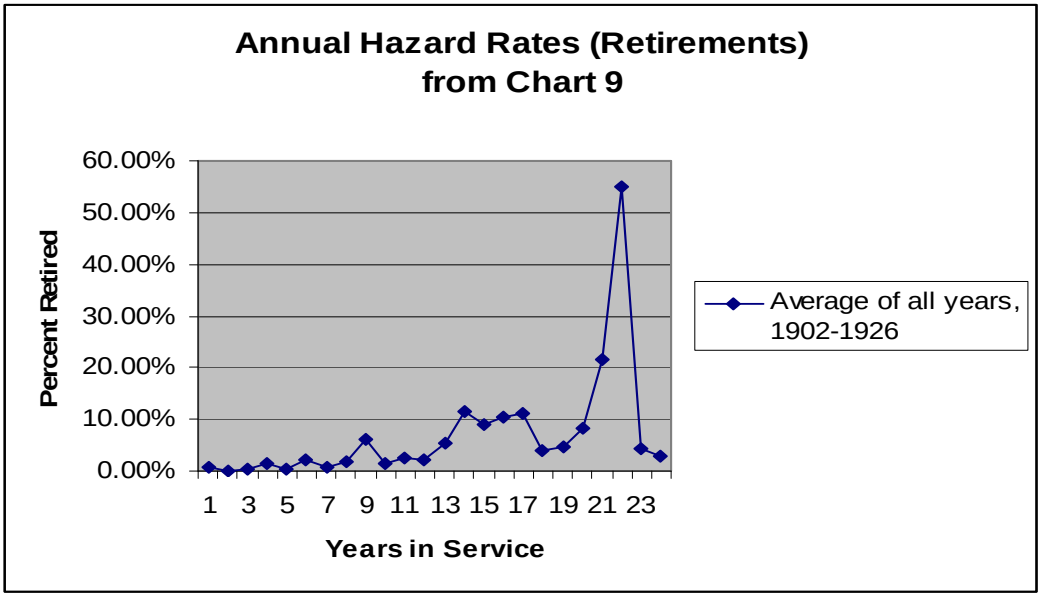
failure in a period/ number exposed to the risk of failure. The survivor function is $S(t)=Pr(T>t)$, the probability of surviving beyond time *t.* The relationship between the hazard rate and survivor function is seen by recognizing that $S(t+1) = S(t)*(1-h(t+1))$.

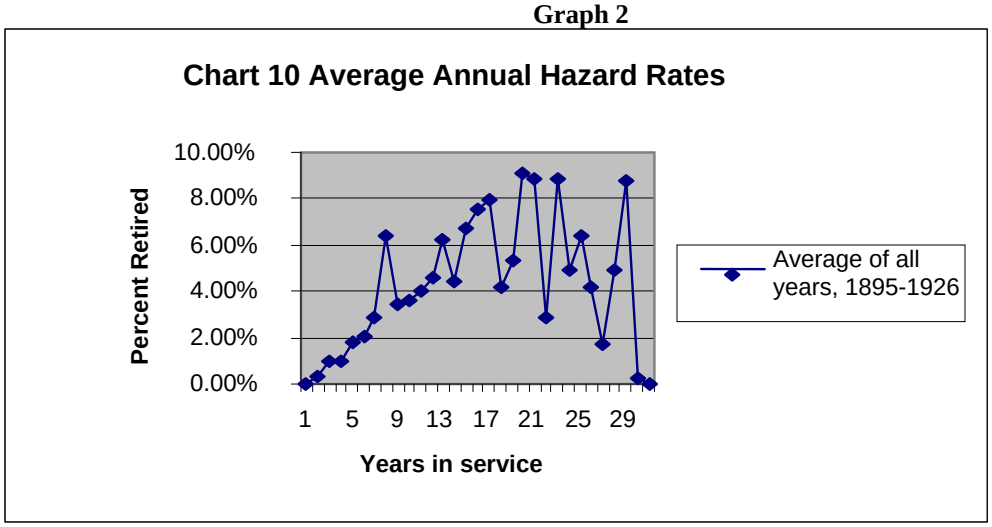
[60]The plots of hazard and survival rates shown here were created in Excel. Information from charts 9, 10, 11, & 12 was manually input into Excel in order to perform survival analysis.

[61] The plots presented here are of hazard rates for all years; single year, 3 year averages, and 5 year averages show similar variation when plotted.

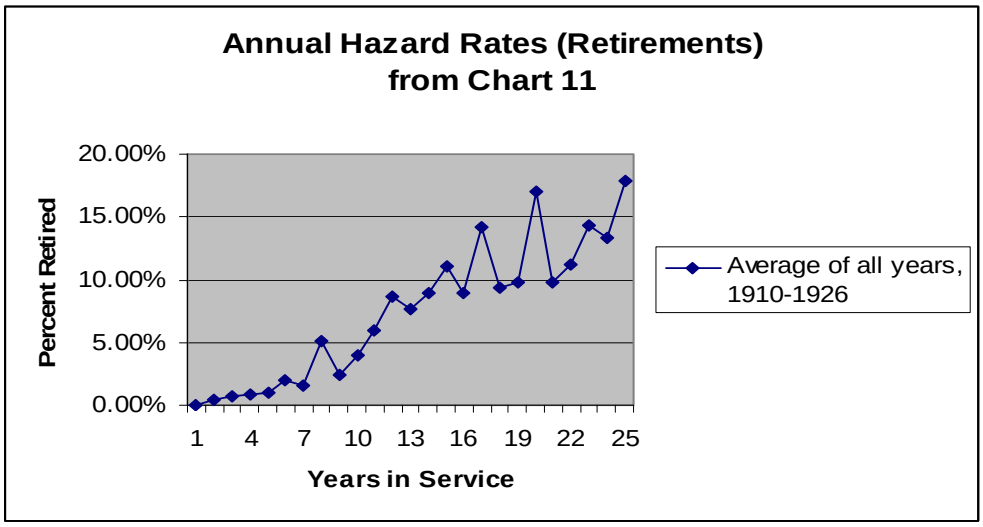
Graph 1



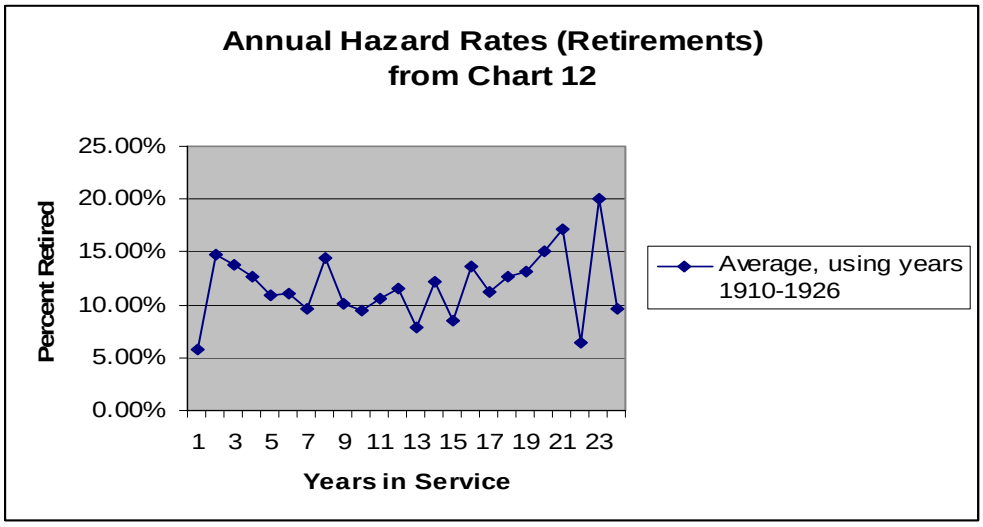
Graph 2



Graph 3



Graph 4



In contrast to the curves of hazard rates, the survivor curves were smooth, a detail firm experts made sure to emphasize. *"…In general, each of these four life tables shows a smooth and fairly well defined trend."* (Prof. James W. Glover, mathematician: ICC Docket No. 14,700).

In contrast to the curves of hazard rates, the survivor curves were smooth, a detail firm experts made sure to emphasize.

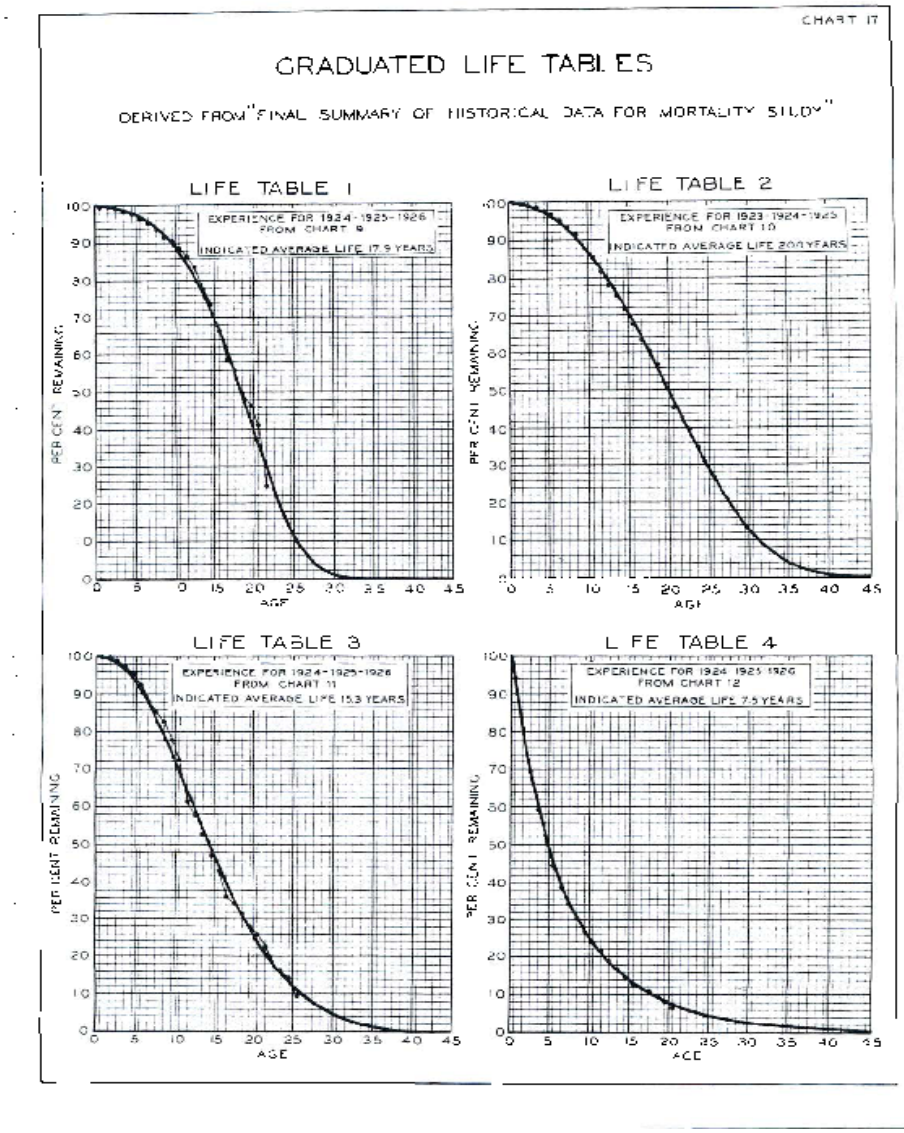


Figure 1

Chart 17, from exhibits presented to the ICC in Docket 14,700

The survivor curves were important because they underlay the estimation of asset lives. Assuming that conditions from the past were predicted to continue into the future, the mean value from the curves became the estimated asset life, and its reciprocal the annual depreciation rate. Examination of the life tables and the resulting survivor curves can therefore shed led light on motives behind AT&T's use of probability theory. The firm's selection of methodology which reduced expense fluctuations has already been

posited to have been a strategic choice. But, there were other methodological decisions to be made. In general, the shortest recovery period was advantageous to the firm. Evidence that the firm attempted to artificially shorten lives may indicate that strategic economic motivations underlay their methodological choices. On the other hand, the firm's declining opportunities which existed to calculate short life spans indicates that strategic motivations did not dictate all methodological choices. The rest of this chapter examines the firm's methodological choices in this light.

i) Reducing the Impact of Retirements on Annual Expenses

AT&T's straight-line depreciation differed from traditional straight-line accounting in the treatment of retirements. To see how great the impact could be on annual depreciation expense, I took the life table data for underground cables (Chart 10), and then calculated the annual depreciation expense. For the AT&T methodology, I used an average life span of twenty years[62]; for the traditional straight-line depreciation method I used a life-span of thirty years[63]. Using AT&T's methodology, the annual depreciation expense is 5% of the cost of assets in service. For the traditional method, the expense included the depreciation (3.33%) of the assets in service plus the undepreciated cost of retired assets. As can be seen by the following chart, over the years 1896 through 1926, the depreciation expense for underground cables increased as the size of the asset base increased, but the expenses fluctuated much more using the traditional straight-line method compared to AT&T's straight-line method.

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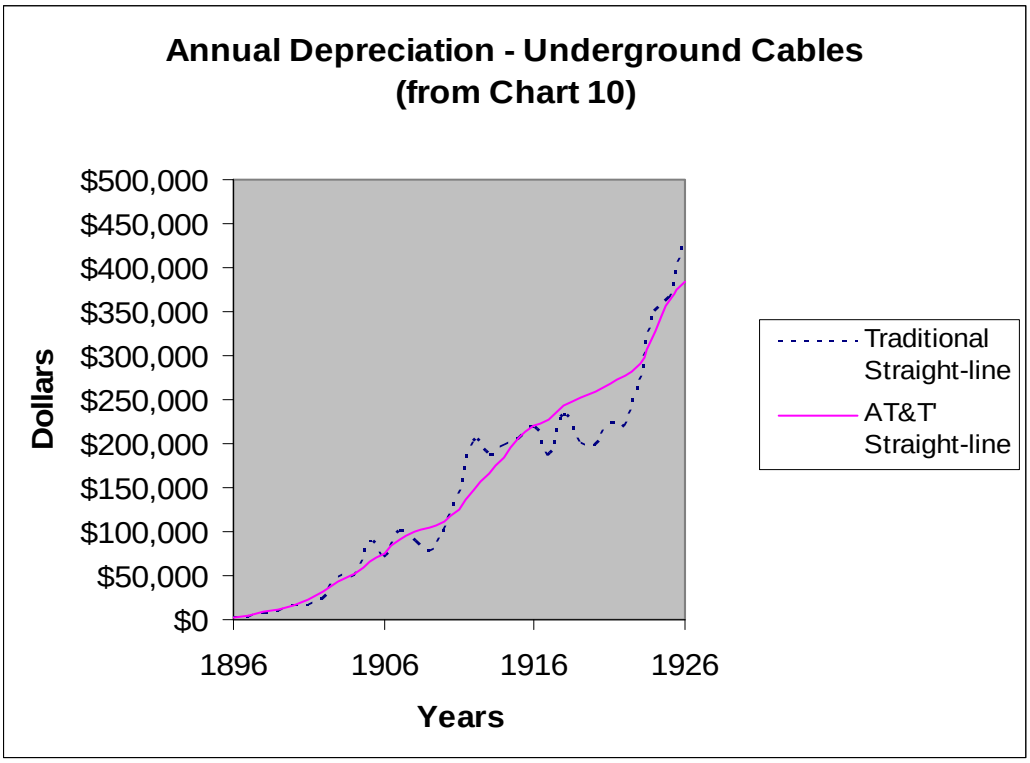
[62] Twenty years life was given by AT&T in testimony before the ICC; this compares to 19.4 years which I calculated when creating the survivor curves.

[63] Recall that when using the traditional straight-line depreciation method, the expected useful life and not the average life must be used. From examination of the data, it appeared that after thirty years experience the expected useful life of the cables was still undetermined (18% of the original 1896 cohort was still in use in 1926). I selected thirty years as reasonable because it was 150% of the average life.



Graph 5

It is clear that in order to avoid expense fluctuations, AT&T not only had to reject retirement accounting, but the firm needed to move beyond the accountant's practice of straight-line depreciation.

ii) Inclusion of Storms

In both testimony before the ICC and other written documents[64], AT&T repeatedly defined depreciation to include destruction from storms. The firm's adamancy on this point is interesting, because the inclusion of storms in the firm's definition of depreciation appears to have changed over time. I believe that the firm's insistence that storms and other casualties be considered in estimating asset lives is an example of the firm strategically selecting the data used in life estimation for its own benefit.

[64] For example, numerous articles on storm damage populated the various house organs: *Western Electric News*, *Bell Telephone Quarterly*, and *Long Lines.*

In terms of advocacy, expanding the universe of “predictable” events enhanced the firm’s contention that it could manage uncertainty with science. Consideration of storms when determining the probable lives of assets implied that severe weather catastrophes were certain to occur, hence not wholly unpredictable. Including storms when determining life-spans had practical implications, too, because it resulted in shorter average life-spans. Inclusion of storms as expected events also allowed their financial impact to be spread over a number of years, reducing expense fluctuations.

Originally, AT&T stated that catastrophic storms were not determinants of depreciable life. In an internal document (Strachan 1907) prepared with an eye on eventual regulatory oversight of telephones, the author clearly states that storm losses are currently treated as extra-ordinary. But, Bell management also seemed to believe the firm should anticipate losses from even extraordinary events. In the 1910 Bell System annual report, firm management may be referring to storms when it says it is the policy of the Bell companies to provide against all possible contingencies, based on past experience, not future expectations. The report says that even where there is a small probability that any such causes will occur again, it is for the benefit of the public and the corporation to have ample reserves.

Anticipation of retirements from a variety of causes led to the establishment of different reserve accounts: a depreciation reserve; a self-insurance account used to accumulate reserves for unexpected problems, like fires; and a reserve for extra-ordinary repairs. The differences between these accounts seems to have been the likelihood of occurrence – with depreciation certain, fires unlikely events which the firm would self-insure against, and storms infrequent but probable events which required a separate a

reserve. By 1912, the difference between the reserves for unexpected events and extra-ordinary events has disappeared. The Bell System's accounting now listed an account Reserve for Extraordinary Repairs (1912, p.28), which was to capture expenses related to storms. "This account may be credited (account 436, Extraordinary Repairs being charged) provision for future extraordinary repairs such as experience indicates are likely to occur at uncertain intervals, as, for instance, damages from sleet storms and fires."

At the Bell System's 1921 accounting conference, attention shifted from the distinction between ordinary and extra-ordinary causes of physical depreciation to the differences between physical and functional causes of depreciation. The firm was attempting to arrive at a definition of depreciable events that could be anticipated, and reserved against, versus those that could not be anticipated. The latter losses, proposed the firm's controller, should be charged to maintenance – that is, expensed entirely in the year in which they occurred (VanSant 1921). Obsolescence, as well as storms, became events to be anticipated, their impact considered when estimating asset lives.[65]

The distinction between reserving for extra-ordinary events and ordinary depreciation was not maintained by Bell. In their brief on depreciation before the ICC, the Bell System argued that ice storms and other unpredictable weather casualties should be considered when attempting to assess the useful life of an asset because "such items have always been considered when determining depreciation" (Bracelen 1926). Bell management insisted that estimation of asset lives required consideration of storm catastrophes, publicly stating this view at a professional accounting conference on depreciation: "The great enemy of the outdoor plant proved to be the sleet

[65] See, for example, the testimony of Jewett before the NY Public Utilities Commission, where he declares technical obsolescence to be inherent to the telephone industry.

storm."(Crunden and Belcher 1929). Investigating the potential impact of storm damage on depreciable lives, then, can illuminate the motivations behind such a dramatic change, from treating storms as extra-ordinary events to their inclusion as necessary variables when estimating depreciable lives.

My investigation begins with imagining the impact of a catastrophic storm on assets in service. Simply put, a severe storm could wipe out an entire asset class in an affected region. Firm engineers repeatedly spoke of the potential disasters that could result from severe weather; two storms (in 1881 and 1887) even merited inclusion as important events in a history of the firm's first fifty years, side by side with such significant items as the introduction of the first multiple switchboard (1884) and the development of the coin telephone (1890) (Hayes 1977).

Without loss accruals, the most immediate effect of storms on firm expenses would be to increase expense volatility. The effect was similar to the problems associated with use of retirement accounting: without establishment of reserve accruals in advance, the timing of storms would dictate when expenses would enter the income statement, which would, as the firm noted, be a "most unsettling and unsettling financial factor" (Crunden 1922). The problem of expense fluctuation could be mitigated at least in part by the establishment of reserves.

Combining the losses from catastrophic events and ordinary depreciation also decreased estimated asset life spans. A severe storm increased the hazard rates for all cohorts in service - from assets recently placed in service to those which had already existed for a long time. With an increase in the hazard rates, the corresponding survivor curves shifted downwards, reflecting a shorter life.

I began by examining the exhibits in the ICC presentations, searching for evidence of catastrophic storm damage. Theoretically, the hazard (retirement) rate for affected assets could reach 100%, but (not surprisingly)[66] I did not expect to find such extreme retirement experience in the material presented in the regulatory examples. In reviewing the AT&T examples I found no evidence of early 100% retirements in a single calendar year[67]. Indeed, calendar year (as opposed to life year) hazard rates within the asset groups did not show great variation.

Retirement Experience of Assets			
Asset Type (Chart #)	**Lowest Annual Retirements (Year)**	**Highest Annual Retirements (Year)**	**Average Annual Retirements**
Aerial Cables (Chart 9)	0% (1902)	6.3% (1914)	2.6%
Underground cables (Chart 10)	0% (1896, 1897)	4.6% (1912)	1.8%
Poles (Chart 11)	2.3% (1913)	10.8% (1926)	6.1%
PBX's (Chart 12)	3.5% (1911)	16.1% (1921)	10.9%

Table 3

Since evidence of catastrophic storms was not found in the examples, I introduced manipulations to simulate such an event. I began my what-if analysis with information about the mortality experience of underground cables from chart 10 (since this was the example with the largest number of cohorts, 31). I compared the actual retirement experience during 1926 to hypothetical retirements that could result from a severe storm.

[66] Inclusion of an example of extreme mortality experience would entail explanations, and the firm wished to control all explanations.

[67] 100% retirement rates did occur when cohorts finally retired, but none of these retirements were "early". The 100% retirements only occurred when cohorts had achieved significant age; for example, the 1895 and 1896 cohorts from chart 11 were entirely removed from service after 31 and 28 years of service, respectively. For chart 10, however, there were no 100% retirements, meaning that in 1926 some assets remained in service for all cohorts.

As individual hazard rates by cohort could be quite high[68], I replaced the actual retirements with retirements ranging from 10% to 50% of the cohorts in service. The rate applied was based on the actual retirements experienced by each cohort in 1926; thus, the cohorts with the lowest retirement experience received a retirement amount of 10% of the outstanding assets, 20% was applied to the cohorts with slightly higher actual retirements, and so on. For example, of the 1900 cohort, $16,903 worth of poles remained in service at the beginning of 1926; the actual retirements for the year amounted to $1,387. This actual retirement rate of 8.2%[69] was one of the highest cohort retirement rates for year 1926; therefore, I used a rate of 50% as a catastrophic retirement rate, resulting in a retirement amount of $8,452.

The following chart lists the cohorts by year, the assets in service at the beginning of 1926, the actual retirement experienced, and the hypothetical retirement amount.

Table 4

1926 Retirements, Actual vs. Hypothetical (using Chart 10 data)

Cohort Year	Amount in Service	Actual Retirement Experience	Hypothetical Catastrophic Retirement Rate	Hypothetical Catastrophic Retirement
1896	$7,066	$0	10%	$707
1897	6,181	0	10%	618
1898	6,471	0	10%	647
1899	11,156	0	10%	1,116
1900	16,903	6,225	50%	8,452
1901	42,044	7,850	50%	21,022
1902	75,845	3,807	40%	30,336
1903	103,049	20,726	50%	51,525
1904	90,990	4,352	40%	36,396
1905	136,786	2,325	30%	41,034
1906	127,057	20,873	50%	63,529
1907	204,521	8,669	40%	81,808

[68] For example, underground cables from the 1896 cohort experienced a hazard rate of 33% in 1913; there was a 24% hazard rate for the 1920 PBX cohort in 1921; a 75% hazard rate was experienced by underground cables of the 1902 cohort in 1923.

[69] $1,387/16,903

1908	110,598	2,864	30%	33,177
1909	33,284	258	20%	6,656
1910	100,151	2,269	30%	30,045
1911	258,968	5,550	30%	77,988
1912	491,123	21,224	40%	196,448
1913	362,782	3,081	20%	72,556
1914	406,691	13,358	40%	162,676
1915	504,532	15,818	40%	201,740
1916	342,550	707	20%	68,510
1917	191,907	11,656	50%	95,954
1918	376,876	7,505	30%	113,061
1919	244,797	675	20%	48,958
1920	159,469	642	20%	31,892
1921	248,334	2,235	20%	49,668
1922	257,443	6,467	30%	77,232
1923	524,625	679	10%	52,462
1924	844,590	3,095	20%	168,918
1925	987,471	2,845	20%	197,494
1926	562,231	0	10%	56,223
Total		$175, 755		$2,078,878[70]

After creating a year depicting drastic storm losses, I used the resulting data to create two new survival curves, the first using only one year's experience and the second using three years experience. The differences in estimated lives between the actual and manipulated data are significant; the catastrophic storm curve has shorter life-span, thus a higher depreciation rate. Though the impact of the catastrophe on the survivor curve is greater if only a single year's experience is used in its creation compared to curves created from several years' experience (where the impact of a catastrophe is diminished),[71] even the

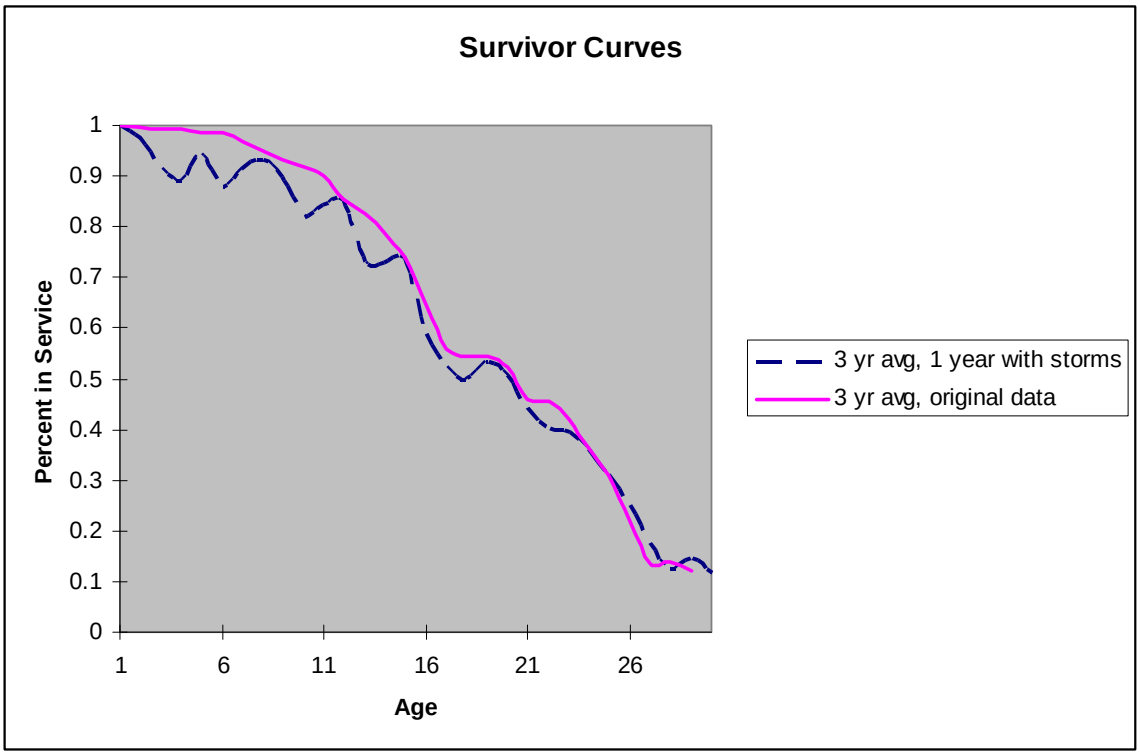
[70] This more than ten-fold increase in depreciation expense is not unreasonable. In 1926, storm damage was calculated at more than $7,500,000 across Long Lines and various regional Bell companies (Crunden 1932).

[71] It is important at this point to remember the difference between life year hazard rates and calendar year hazard rates. A hazard rate shows the rate of retirement. A calendar year hazard rate shows the rate of retirements in one year based on the total assets in service for that year, regardless of their age. A life year hazard rate shows the retirements that occur by age – ie., the retirements for assets one year old, the retirements for assets two years old, etc. Only when one year's experience is used to calculate the survivor curve will the average of the life year hazard rates and the annual hazard rate for the calendar year be equal.

impact on a 3 year band is significant - using the 3 year band's experience the mean life drops from 19.3 yeas to 18.4 years. .

Table 5
Expected Asset Life,
Actual Life vs. Hypothetical

	Average Life, actual experience	**Average Life, with disaster**
1926, median	17.5 years	14.8 years
1926, mean	19.4 years	14.5
3 yr band, median	21 years	17.5 years
3 yr band, mean	19.3 years	18.4



Life Expectancies,
Actual experience vs. hypothetical

Graph 6

As expected, the increased numbers of retirements due to the storm results in a lowered survivor curve. There are several additional comments to make about this test. In the example presented above, I estimated different degrees of loss occurring for different cohorts. It is certainly plausible to envision a catastrophic event which would uniformly

affect all cohorts. For example, the hypothetical 1926 storm could have damaged half of all assets in service (which would have meant retirements equaling $3,918,250 for the year 1926). The effect of such a catastrophe on estimated lives would have been extreme, returning mean lives of 10.2 or 16.9 years, depending on whether one or three years of data were used. The larger the disaster included in the sample years, the greater its impact on shortening estimated life spans.

Besides generating a shorter average life, the inclusion of storm losses generates a much less smooth survivor curve than the original survivor curve[72]. Bell management would not wish to draw attention to this fact – they wished to emphasize predictability, not volatility. (Again, this is a likely reason that management ensured the examples presented did not incur large losses from catastrophic events). However, even when large swings in the size of retirements produced a less than smooth curve, there was a way to handle this problem: instead of showing actual data points and a curve with gyrations, the firm could "mathematically fit smooth curves to the data" (Prof. James Glover, mathematician, witness for AT&T in Docket 14,700). To do this, the firm employed the Gompertz-Makeham formula.

iii) The Gompertz-Makeham Formula

Bell management selected the Gompetz-Makeham formula because they felt it fit the mortality experience presented in the life history tables[73]. AT&T used the Gompertz-Makeham formula to smooth out curves. The formula was also employed to predict the

[72] It appears that the new curve is less smooth than the curve without the catastrophic events – how, then, does this support my contention that the inclusion of storms led to less expense volatility? The survivor curve comparison in this case is deceiving; both curves would be smoothed to yield a mean age and depreciation rate.

[73] Discussed at length by AT&T witness, D.R.Belcher before the ICC, beginning p. 75.

total life span when the historical data did not encompass final cohort retirements, that is, when the maximum lifespan was not indicated by the historical data.

The Gompertz-Makeham formula is $L_X = K \bullet S^X \bullet G^{C^X}$, where L_X is the percent of assets in service during any year, *x*, and *K* is the total population. The formula says that retirement is subject to an accidental rate of decay, S^X, as well as a death rate that is time dependent, represented by G^{C^X}, an exponential decay function.[74]

By selecting a function, engineers were saying that the lives of the assets followed a certain distribution, that their survival pattern could be described by a parametric distribution. Citing similarities with human mortality patterns, the firm's experts selected the Gompertz-Makeham function, a staple of the insurance industry. Some conclusions about the choice of this function can be made. First, the Gompertz-Makeham function assumes that the hazard rate decreases monotonically with time – that is, the hazard rate generally decreases over time. But, the graphs of the hazard rates made with the data do not seem to operate in this manner – the annual retirements appear neither to increase nor decrease over time[75]. Second, as stated by the firm's own witnesses, application of the Gompertz-Makeham formula to estimate asset lives depended on the existence of stable ratios – that the retirement experience of the past would carry forward into the future. In an industry which experienced rapid technological obsolescence, this statement begs for more support, but this was not forthcoming. It is also possible that the formula's

[74] The variables were computed based on actual life table data, and the formulas involved in the derivation are included in Exhibit II.

[75] Some recent examinations of equipment failure suggest that a Weibull curve might be a more appropriate model. See, for example, the discussion by Gavrilov and Gavrilova at http://longevity-science.org/Paris-2006.ppt.

computational complexity made its use attractive to the firm, because it intimidated regulators[76].

Demonstrating that objective measurement supported life estimations was central to AT&T's control of the regulatory process; this control was enhanced when the regulators were forced to rely upon the company and its experts. Instead of demanding that the firm convince the regulators of the reasonableness of firm positions, regulators were dependent upon the firm for decoding any evidence presented, and the extent of the ICC's understanding of the firm's depreciation methodology was determined by the firm. The following exchange on the Gompertz-Makeham formula (Exhibit II) clearly shows the firm in control:

Commissioner Bell[77]: Is this the simplest presentation?

Prof Glover (AT&T witness): Yes – it is fairly straightforward

Commissioner Bell– Makes the theory of relativity look simple

The Bell System's presentation of a science of depreciation estimation did not go uncontested. Detractors of depreciation accounting existed both within industry and among the public; they were vocal in attacking the possibility of a "science" of depreciation. The use of mortality tables to predict asset life-spans was attacked by Riggs (1922), who pointed out that the asset life-tables were not actually life-tables at all, but the experience of a limited number of cases. He also pointed out that in applying the table estimates to asset types, accountants overlooked the differing characteristics of maintenance and use that affected property life. But, Riggs was unusual in that he at least

[76] The comprehensive Wisconsin Public Services Commission report on depreciation issues did not include a detailed discussion of the Gompertz-Makeham formula, citing the formula's complexity.
[77] Bell was the railroad industry representative at Docket 14,700.

had an understanding of what he criticized; most critics lacked credibility because they misunderstood the very concept of depreciation accounting.

To some businessmen, there remained a belief that depreciation accounting in general was nothing less than confiscation of private property by municipal authorities, and they suggested that the government attempted to obscure this agenda behind the screen of science. Speaking of municipal appraisers of utility properties, one author said, "Like a priest of some mystic cult, he signifies the exclusiveness of his special learning by the liberal use of a new and terrifying terminology. He displays weird mathematical diagrams, covered with wriggling, portentous lines like a robed sooth-sayer who surrounds himself in his darkened chambers with the mummery of outlandish alembics and astronomical charts." (Webster 1920)

The public also suspected that depreciation accounting was an attempt at unlawful taking, but with customers the victim. A series of NY Times articles following NYT rate cases frequently equated depreciation accounting with the creation of "secret reserves" stolen from the public[78]. All in all, sources outside of Docket 14,700 indicate a widespread lack of understanding of depreciation accounting in general, and a fear of its mathematical derivations in particular. This fear and ignorance provided an effective barrier to external control of AT&T's depreciation methodologies, allowing AT&T to determine its depreciation policies without regulatory input. In the 1930's however, this situation began to change.

[78] See, for example, a 1924 article entitled "Say Phone Fund Belongs to Public".

12. Significance of ICC Presentations

In AT&T's initial years of regulatory supervision, the firm enjoyed a generally positive reputation with the government and public. Industry and government continued to see science as a way of extending the benefits of democratic capitalism throughout American society. AT&T led in the development of practical scientific applications, both technically and for informational purposes.

AT&T's exploration of the use of actuarial tools in understanding depreciation provided important benefits to the firm. The information from mortality studies provided highly accurate estimates of asset lives, necessary for operational decisions. Use of actuarial principles led the firm to create a customized methodology of depreciation accounting; the methodology was employed across subsidiaries to enhance centralized control. AT&T's straight-line depreciation provided a way of smoothing expenses, which was important in gaining investor confidence and access to funds. However, the smoothing was not just an attempt to manage investor expectations. Smoothing was the expected result when analyzing raw data with statistical tools. The smoothing allowed management to discern patterns of average behavior. By averaging, distortions from any unusual years would be minimized, and the actual cost behaviors become more apparent.

The smoothing also promoted a better matching of actual costs and benefits, an important consideration when questions of rate setting and customer equity were involved. In this sense, the choice of depreciation policy had important social implications; the tools of probability science could help answer questions about what constituted rate equity. But, as the leader in the development of this knowledge, AT&T

also controlled access to it, forcing government officials to rely upon the firm's translation of the knowledge into common terminology.

Though the temper of the times did not support government control of industry, government oversight was becoming expected. AT&T managed to hold off even potential intervention by presenting their methodology in mathematical terms that regulators found intimidating. In this sense, the experience of the ICC and AT&T presents partial evidence in support of Kolko's capture theory in that the regulator was controlled by the regulated. But, the regulating agency, the ICC, did not exist solely to further AT&T's agenda. The interests of the railroad industry meant that the ICC was confronted with conflicting views of depreciation. In order to gain ICC support for their chosen methodology, AT&T needed to convince the regulators of both the objective validity of their methods and of the benefits that would accrue to society overall by use of Bell's methodology over the methods proposed by the railroads.

Both the regulator and telephone industry felt that by furthering the interests of the Bell System they were also benefiting greater American society. The use of science as a wall between firm practices and regulatory involvement, however, hints that Bell management felt that they might need to "manage" the regulators; firm management knew that they could not automatically expect governmental support for all firm aims.

During the 1920's, the potential for regulatory interference was not ignored by the Bell System, but the firm gained valuable time without such interference because a relatively stable economic climate contributed to the existence of a stable power relationship between business and government. This period of relative quiet allowed the Bell System to study and innovate: what factors caused depreciation, how should

depreciation be tracked, how should it be recorded in the accounting records – the firm had the opportunity to investigate and answer these and similar questions. They defended their practices as both scientific and equitable, but their arguments were rarely contested by external agents.

In their discussion of the corporate commonwealth, Galambos and Pratt note that without crises, economic or otherwise, public pressure for change is muted. Until the Great Depression, the status quo was acceptable to most Americans, allowing the Bell System the freedom to develop depreciation methodologies on their own, allowing their use to become routine within the firm. (External observers also had the opportunity to learn about, and ruminate on, the firm's depreciation procedures.) Practices which originally relied upon scientific legitimacy for acceptance now had the legitimacy of standard, accepted practice. The firm would need to rely upon this legitimacy when the power relationships were adjusted as a result of the Great Depression.

Chapter 4: 1934 – 1941

13. Introduction

By the 1920's, the Bell System had developed a depreciation methodology that suited its business needs and presented this methodology to industry regulators. The firm emphasized the scientific underpinnings of their approach, and maintained sole control over the direction of their depreciation practices. The times were such that science and technology were highly regarded, and growing businesses were seen as contributing to the betterment of American lives. These sentiments did not survive the Great Depression.

The administration of Franklin D. Roosevelt (D) inaugurated an era of greater governmental intervention in the economy. The early Roosevelt years have been described as the First New Deal (Morley), a time when government attempted recovery through aiding business. This aid mainly took the form of limiting competition and stabilizing prices. By the mid-1930's, this policy was succeeded by the Second New Deal, which aimed at increasing aggregate demand, as advocated by the writing of John M. Keynes (Galbraith). Increased demand was stimulated by direct support of the consumer. This was the time when Social Security came into being, when the Wagner Act gave labor more opportunity to organize. What was best for big business was not necessarily equated with what was best for America. Politicians still believed that planning was essential in directing the economy, but this planning needed to be directed by the technocrats, not by businessmen supported by technocrats.

In an environment less favorably disposed to both science and businesses, regulatory agencies demanded more of a say in the operations of public utilities. Government

wanted to ensure the utilities provided more than economic efficiency; they required social equity. It is the impact of these environmental changes as it relates to the Bell System's depreciation practices that will be examined in this chapter. In general, the straight-line methodologies developed by the firm continued in operation, now relying on "standard practice" for their support rather than scientific demonstrations. Related issues unresolved in the 1920's were resolved in the 1930's, sometimes to the advantage of the firm, and sometimes not.

i) Historical Context

The 1920's cooperation between the federal government and businesses expressed the belief that American capitalism could bring tremendous material advances to society. The greatest threat to this cooperative effort came with the Great Depression; it resulted in a rearrangement of the relationship between business and government. As the depression continued, voluntary cooperation between industry and government proved insufficient to ensure continued economic growth and prosperity in the face of severe economic structural flaws and imbalances (Alchon 1985). Whereas in the 1920's the aim of government was to serve business, by the end of the 1930's the vision had shifted to one of business serving government. The pro-business Republican administrations of the 1920's were not immediately replaced by a Democratic administration that was antagonistic towards industry, but an interventionist one that was not adverse to limiting corporate power and prerogatives in order to benefit American society overall. Instead of government and business as coequal in directing American society, industry's proper role would be subservient to governmental policy (Leuchtenberg 1995). As a regulated industry, AT&T was directly affected by this shift in outlook.

At the beginning of the Roosevelt administration, emphasis was on governmental support of businesses as a means of fixing the nation's economy. In many cases, industrial and governmental officials viewed competition as the root cause of business depression; efforts were aimed at ending "destructive" competition. One effort in this vein was the National Recovery Administration's (NRA) support of price fixing, a strategy favored by (and favorable to) large industries as a means of ending a depressive business cycle (Hawley 1969). As the Depression dragged on, however, criticism of the direction of recovery efforts grew, and momentum built for a change in policy. The demise of the NRA in 1935 came as the first New Deal faded, overtaken by an emerging second New Deal. It was at exactly this time that the FCC was organized.

The second phase of Roosevelt's attempt to resuscitate the economy focused on stimulating consumption. These New Dealers were suspicious of the size of big business, a return to the suspicions retained by some earlier Progressives. These politicos did not see large size as evidence of greater efficiency or productivity but proof of unfair privileges. They saw the associative state as a way for monopolists to hide behind a façade of promoting national interest (Hawley 1974), and they believed that monopoly power was a major factor contributing to the economic crisis of the 1930's (Hawley 1969). The Bell System's profits continued profitability during the Great Depression, anomalous to that of the economy overall, made them vulnerable to such criticism[79].

[79] Though AT&T's revenues decreased due to the recession, their profitability remained high. The consolidated results for the Bell System (excluding Western Electric) showed operating revenues and profits as follows (in millions):

Year	Operating Revenues	Operating Income	Op Inc as % Op Revs

Two new federal agencies directly impacted AT&T: the Securities and Exchange Commission (SEC) and the Federal Communications Commission (FCC), both begun in 1934. The SEC subjected all public companies, including AT&T, to new financial reporting requirements and oversight, but the agency had no impact on the firm's operations. In contrast, the FCC had the potential to impact operational decisions, a power also inherent with the ICC but never seriously exercised. [80]

From the ICC's initial involvement with telephone accounting, the professed aim of the agency had been to prescribe classes of property subject to depreciation and the depreciation rates to be used (Sharfman 1931). But, the ICC never succeeded in this, instead allowing the phone companies to determine the classes and rates themselves[81], though significant regulatory action occurred at the state level[82]. State level decisions, when appealed to the federal courts, effected some changes in depreciation policy, but it was an inefficient method of implementing national policy.

1927	$894	$206	23.04%
1928	$975	$228	23.38%
1929	$1,071	$247	23.06%
1930	$1,104	$236	21.38%
1931	$1,076	$237	22.03%
1932	$956	$192	20.08%
1933	$854	$166	19.44%
1934	$870	$175	20.11%
1935	$919	$183	19.91%
1936	$995	$219	22.01%
1937	$1,051	$207	19.70%
1938	$1,053	$191	18.14%
1939	$1,107	$217	19.60%
1940	$1,174	$221	18.82%
1941	$1,299	$229	17.63%

Information from Moody's Public Utilities Series Reports.

[80] Interestingly, in an on-line firm history of the Bell System written by former Bell employees, the role of the ICC in relation to the telephone industry was deemed "advisory". See http://www.porticus.org/bell/

[81] The final ICC report on depreciation was issued in 1931, but a stay on implementation of its findings was immediately introduced.

[82] It is likely that activists found the states more receptive to reform activity than the federal agency. For a discussion, see Schiesl, 1977.

This situation changed when the FCC took over supervision of the telephone industry. From its inception, the FCC announced that it planned on removing these depreciation decisions from corporate discretion, and establishing uniform property classes and associated depreciation rates became a goal of the FCC investigations which began in 1934.

The changed direction in federal oversight towards AT&T was matched by a new judicial atmosphere. Court decisions during the 1930's convey two impressions: that the Court had acquired a more sophisticated understanding of the issues involved, and that the Court was less willing to second-guess commissions. This judicial stance on balance favored the regulatory commissions over the utilities, though, as will be discussed in more depth later in this chapter, the Bell System retained some ability to circumvent commission limits on profits.

Though AT&T would have been encouraged by the 1933 demise of the "excess" profits clause of the 1920's Transportation Act (Ruggles 1938), concerns would have been revived by the 1936 Revenue Act which enacted taxes on excess profits and excess undistributed earnings across industries. Another piece of potentially dangerous legislation was the 1938 Public Utility Holding Company Act which forced the holding companies of power producers to register with the SEC; the Act also authorized the FTC to break up holding companies if to do so would increase efficiency (Hawley 1969; Parrish 1994).

These actions represented popular attacks against concentrated economic power; as both the largest utility and largest corporation in the U.S., AT&T would have recognized its vulnerability to such populist sentiments. Because of this, AT&T

encouraged a positive public image for the firm, whether from internal or external sources. For example, the firm gained positive exposure in the public discussions that led to enactment of the Holding Company Act. An important voice advocating for this legislation was Bonbright, an economics professor and public utilities expert. He railed against abuses of the holding company organizational form in public utilities, abuses that effectively led to watered stock and excessive rates. But, he specifically held up AT&T as an example of the proper use of a holding company, a firm employing the structure for administrative efficiency and not to enrich a small group of investors (Bonbright and Means 1932).

All of this reflects awareness by firm management of the possible rise of countervailing power, a concept developed by John Kenneth Galbraith (1980). He described a situation where oligopolistic buyers, by creating surplus profit, created rewards for the formation of oppositional power, in this case an alliance of buyers who could force the sharing of this surplus. Extending his analysis to the FCC and AT&T, the agency can be seen as acting as a proxy for customers of the telephone system. The continued profitability and expansion of AT&T created the incentives for consumers to demand governmental action on their part, not because of any abuses by the firm, but because of its success and profitability.

American society's changed view toward science also affected the Bell System. Practical application of science became the standard of merit, and this standard applied to the field of statistics. Data collection and the information derived from it were deemed useless unless they led to the development of practical applications (Hawley 1969). Thus, the prestige of science was insufficient to justify Bell System's methodological decisions.

Though scientific justification still carried weight, it became more important to ask whether or not business practices were good for society. During the Second New Deal, the government technocrats concentrated on applying information, often statistical in nature, to achieve social goals, most importantly employment goals.

14. Contemporary Authors

In the years under ICC oversight, the relationship of probability science to depreciation was explored and developed by the Bell companies. During the ICC depreciation investigations, the Bell System provided its own experts to explain its methodologies, and as the Bell System was the innovator in this methodology, outsiders relied on Bell expertise. The distribution of this knowledge changed in the 1930's, evinced as experts in public utilities and the mathematics of probability science began publishing their findings. These authors might reference AT&T's work in depreciation, but for the most part they did not rely upon AT&T to provide explanations or implications of various depreciation options.

During this period, important contributions to depreciation knowledge were produced by regulatory bodies[83]. In1933, the Wisconsin Public Services Commission published *Depreciation: A Review of Legal and Accounting Problems*. This work surveyed depreciation practices and policies throughout the United States.[84] Two years later, in 1935, the Iowa Utilities Board published a study which investigated the depreciation experience of industrial assets. The Iowa study determined that the

[83] Writing in a 1939 article on public utility regulation, the authors noted, "In the past five years there has been unusual activity on the part of state legislatures and regulatory authorities in this field" (Wilson and Rose 1939).

[84] This report was generally favorable to the Bell System's depreciation work. In reviewing depreciation accounting practices the report said, "the only method legitimately called depreciation accounting is that based on "service-life" methods…..the universal practice among the Bell telephone companies."

depreciation experience of all such assets could be characterized by one of 18 mortality curves, and the Board developed a series of survival tables which came to be known as the Iowa curves (Winfrey 1935). The Iowa curves became the basis of life estimations for firms which did not have sufficient statistical abilities to collect and analyze the life experience of their own assets[85].

A distinctly critical attitude towards utilities' economic practices began to appear in academic literature, both in legal and accounting papers. This was a distinct change from earlier writings on the subject. For example, in 1918, when William Raymond, an engineering professor, wrote a book reviewing utility problems he cast a "greedy public" as the source of many of these problems. In the 1920's, legal writers, though aware that utilities could manage the regulatory process to their own advantage, felt that the utilities were not taking "unfair" advantage of the public (Goddard 1927; Frederick 1929[86]). During the 1930's, these same authors become more protective of the public's welfare when it conflicted with that of investors. For example, by the 1930's, Goddard stated that investors in utilities could not expect high or speculative returns (1935).

Bauer (1937, 1924, 1927, 1930) was a researcher who attempted to synchronize economic and legal perspectives of utilities. He started by writing of the distinctive economic and social characteristics of public utilities; he then distinguished between the concepts of capital and income as applied to the public utility industries as opposed to ordinary private business.[87] Bauer emphasized that the underlying principles of purely

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[85] Edwin Kurtz, whose work on estimating asset lives was discussed in Chapter 3, was also involved in the Iowa project.

[86] Goddard was a professor of law at the University of Michigan; Frederick was a professor at the University of Pennsylvania.

[87] Bauer asks the reader to imagine any commercial enterprise where income can be predicted purely based on the investment amount. Such a situation does not exist in purely commercial business, but it is precisely the situation of public utilities.

private enterprise were solely related to profit, while governmentally controlled economic activity was guided by both private and public policy principles. He thus tried to turn attention to the rate base, a concept whose definition remained unsettled until the end of the 1930's.

Bauer was not an isolated example of academic writers examining depreciation problems associated with public utilities. In 1933 came the first publication of a case book examining problems in public utilities, part of the "Harvard Problem Books" series. The updated 1938 edition included the prominent Illinois Bell Telephone case, where the commission addressed the issue of observed versus theoretical accumulated depreciation.[88] And, academicians realized that not all of the problems associated with rate setting could be attributed to the utilities alone; the accounting profession itself was indicted as contributing to the difficulties in understanding depreciation. These were discussed in a 1936 essay by Hatfield, where he discussed the inconsistencies and contradictions with which accounting textbooks of the time treated depreciation: confusing the fact of depreciation with its recording in the accounts; confusing the meaning of the recording of consumption with establishment of a reserve[89].

The accounting profession did not reach definitional agreement on key concepts quickly. It was not until 1931[90], after 6 years of work, that the AIA's Committee on the Definition of Earned Surplus arrived at agreement presentation for the earned surplus (retained earnings) (Kohler 1931). Without even a definition of the earned surplus, how could regulators or the public be expected to understand the role of depreciation

[88] Lindheimer v Illinois Bell, 292 U.S. 151 (1934).
[89] Hatfield also interestingly argues that precision of terminology is a necessary perquisite for accounting to be deemed a scientific endeavor.
[90] Shortly thereafter renamed Retained Earnings (Littleton 1932).

reserves?[91] As to depreciation accounting, the first pronouncement on the subject did not appear until 1941[92].

Beyond discussing the calculation of depreciation expense, commentators on public utilities also investigated the role of related concepts, such as accumulated depreciation, depreciation reserves, and the rate base. They recognized that no uniform understanding of these concepts existed, much less uniform procedures for handling them. Without agreed upon definitions and procedures, no method of equitably establishing rates was possible.

i) The Rate Base

The rate base is the denominator in the rate of return equation; the larger the base, the more revenue the utility would receive. For years, the question of what constituted the rate base remained unresolved. The famous Smyth v. Ames (1898) decision merely stated that the firm was entitled to a reasonable return based upon the fair value of the property, without defining fair value. Instead, the court listed, without prioritizing, items to consider when assessing fair value: original and replacement construction cost, amounts expended in improvements, the potential future earnings of the property, and the value of the firm's capital.

This unclear definition led to different valuations of the rate base. In the 1923 Southwestern Bell case, the courts held that reproduction cost less depreciation should be used to determine the rate base. Two years later, a NY court delivered an even more

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[91] The confusion about treatment of these reserves was even greater when they were treated not as contra-asset accounts but as a separate liability category or special surplus in the equity section of the balance sheet. At this time, AT&T presented accumulated depreciation under liabilities.

[92] Statement on Auditing Procedures No. 4: *Clients Written Representations Regarding Investments, Liabilities, and Other Matters* discussed the necessity to include depreciation reserves in the financial statements.

favorable ruling for the Bell System by declaring that the rate base should be equal to the invested capital plus accrued depreciation[93]. Also favorable to Bell was the 1926 Indianapolis Water Co. case[94]; here, the court stated that the sum of annual depreciation expense need not equal the accumulated depreciation considered in arriving at the rate base, tacitly approving use of "observed" depreciation in rate base calculations.

Reliance upon fickle judicial opinion, however, was not a strong a base to build legitimacy. While AT&T could claim that its depreciation methodology was based on science, no such claims could be used to support its definition of the rate base. Instead, the firm relied on the vagueness of the term "fair value" to define a rate-base that was as large as possible. In general, the firm tried to define the rate base as the reproduction cost of its equipment. This value would be determined by physical appraisal of property. Because the reproduction value determined was for "used", not new, property, the next question involved how to measure the amount of accumulated depreciation. For this, the firm distinguished between "observed" and "theoretical" depreciation. Observed depreciation was actual depreciation, the deterioration physically observable in a property. Theoretical depreciation was not actual depreciation, but the sum of past depreciation incurred by an asset. Following this reasoning, the historical balance of theoretical depreciation found in accumulated depreciation bore no relationship to the true value of property and should not be considered in the rate base. Indeed, AT&T defined accumulated depreciation as simply an accounting artifact created by

[93]This case, Board of Public Utility Commissioners et al, Appellants v. NYT,271 U.S. 23, appears to be an anomaly, because the majority of the rate base cases still revolved around the issue of whether cost or reproduction should be used for the rate base, and how to calculate accumulated depreciation.
[94] McCardle v Indianapolis Water Co., 272 U.S. 400 (1926)

depreciation accounting with no connection to a real decrease in value (Guernsey 1923, 1927).

This was a difficult argument to make to an audience that understood depreciation accounting. The regulators of the 1920's had enough difficulty understanding the calculation of the annual depreciation expense; that its calculation could have implications for the rate base would be overlooked. The audience of the 1930's, however, recognized the contradictions inherent in AT&T's arguments.

Goddard (1935) gave a good summary of inconsistent contemporary manners of dealing with depreciation. He discussed cases where cost was used to calculate annual depreciation but ignored in favor of present value estimates when determining the rate base; in other cases, differences existed about whether the rate base (based either on historical cost or present value) should be a gross number or net of accumulated depreciation. In relation to accumulated depreciation, he listed cases where the amount was calculated based on observed depreciation and others where it equaled the sum of the depreciation charges for the property still in service[95].

The use of inconsistent valuation bases for determining the rate base and the annual depreciation expense was recognized as ultimately benefiting the utility at the public's expense, allowing the utilities to "have their cake and eat it too" (Haun 1939), because it simultaneously allowed the utility to claim the largest expense number and largest rate base. Moreover, Haun felt that courts did not recognize the problems which arose because of such inconsistencies. The courts deficiencies in technical matters had long been recognized in some quarters; it was a major reason behind Adams' advocating

[95] A further elaboration of this last controversy involved the question of whether accumulated depreciation reserves should be looked at for firm property in the aggregate, or whether it needed to be calculated and maintained separately for each individual property.

for formation of the ICC in the 1870's (Miranti 1989). But, this problem would soon diminish.

In the 1930's, the judiciary's grasp of the technical issues involved in depreciation issues became less relevant because courts stopped attempting to re-investigate the facts of technical cases brought against the regulatory agencies. In an important 1936 case (St. Joseph Stockyards v. U.S.[96]), the court ruled that the judiciary could not substitute its own discretion for that of the federal regulatory body. The court was moving towards a stance where judicial review of commission findings would be limited to constitutional questions and not expand into inquiries into the fairness of rates. The court recognized that the agency involved, not the judiciary, possessed the knowledge needed to arbitrate on the fairness of rates. These rulings helped establish the precedent whereby courts refused to interfere in agency rulings unless constitutional issues were at stake.[97]

By the end of the 1930's, the controversy over the rate-base had largely ended[98]. A review of trends in public utility regulation written in this year would say that the Supreme Court favored use of historical cost, and "prudent investment" or its equivalent seemed destined to become the accepted definition of the rate base by the states (Wilson

[96] 298 U.S.38, 81 (1936)

[97] Regulatory agencies also emphasized that the vague definition of fair value led to wasted money because of the huge effort expended in determining fair value, while much less effort was expended to determine cost (Flewellen 1960). The utilities themselves would have recognized that fair value estimation involved high costs, not only of the value process itself, but in terms of the costly litigation involved when rate cases devolved into battles over valuation. Moreover, reliance on cost basis, for the firms, would reduce the costs associated with uncertainty.

[98] In 1936, AT&T v US (299U.S. 232) was decided in favor of the FCC; it required that the rate base be calculated as cost less accumulated depreciation. The last, and definitive, case on this matter was the 1944 Hope Case (Federal Power Commission v Hope Natural Gas, 320 U.S. 591); the ruling stated that the rate base was the "actual legitimate cost" of the property, with no consideration of "reproduction cost new" or "trended original cost", basically an inflation indexed cost.

and Rose 1939)[99]. Prudent investment, a term first coined by Justice Brandeis, essentially equaled the cost of capital that reasonable businessmen would commit to a project. In effect, prudent investment equaled the historical cost of assets, while allowing agencies to deduct any excessive costs resulting from unreasonable expenditures.

By focusing on the rate base, regulators were clearly showing that utilities needed to concern themselves with questions of equity as well as efficiency. As Bauer (1937) argued, because the purposes behind private enterprise and utilities differed, their measurement criteria must also diverge. In private firms, the capital is the present value of future net cash flows based on revenues; in utilities, it is the amount invested that will yield a set interest rate – in other words, the capital of a private firm is based on anticipated earnings, but in utilities, the capital must be determined before the determination of a revenue stream. Since this revenue was generated by public fees, the public effectively guaranteed a safe return to private investors; in return for this guarantee, the public was entitled to set a limit on the return.

15. Archival Evidence

During the 1930's, Bell's position on rate setting necessarily evolved, and the changes are well documented. While in the 1920's firm spokesmen contended that any limits on firm profits equaled confiscation (Guernsey 1928), by the 1930's the firm agreed to reasonable limits on profits. This shift reflected the force of accepted practices – for years, the firm had acceptance of reasonable limits meant that the firm agreed that the state's limiting firm profits did not constitute the confiscation of property, but it also

[99] The movement by courts to acceptance of the cost basis brought calculation of depreciation expense for regulatory and income tax purposes in line, since income tax always recognized cost basis (Flewellen 1960).

signified the firm's ability to accurately read and respond to public opinion. In the 1930's, a firm dependent on public goodwill was well advised to be content with "reasonable" profits.

Beyond merely adapting to the public opinion, the Bell System actively sought to mold it. AT&T was adept at using publicity to manage its image. Acceptance of a role for governmental regulation of the telephone industry was publicly trumpeted as early as 1907, in comments made by firm president Theodore Vail, part of an effort to forestall a forced divesture of the firm or governmental takeover (Danielan).

> "Any revenue produced over and above such requirements [maintenance of equipment and fair return to investors] and the proper reserve to provide for contingencies could be used for the benefit of the public…" (p. 16)" ...there is no serious objection to such control (governmental oversight), provided it is intelligent, considerate, thorough, and just…" (P. 18)
>
> *AT&T, 1907Annual Report*

Again and again in its public statements, AT&T emphasized the social benefits brought to America courtesy of the Bell System. The breadth and efficiency of service were continually touted, but so too was the widespread ownership of the firm's stock, emphasizing that the fair returns received by AT&T were ultimately going to average American citizens.[100] The employees of the firm were also enlisted in public relations campaigns. In 1934[101], the firm began issuance of Public Interest Bulletins, which gave the company line on specific issues of the day. The firm recognized a need to maintain a balance between economic profitability and public approval (Clark 2000). This led

[100] For example, the 1930 annual report stated "The number of stockholders of the Company at the end of 1930 was 567,694. The average shares held by a stockholder is 32, with no single individual holding as much as one per cent of the total…."

[101] The first of these bulletins, issued in July of 1934, was entitled Public Relations Bulletin No1. By the time of the second bulletin, in November of the same year, the name had changed to Public Information Bulletin No. 2.

management to accept some limits on profit seeking, and the firm relished publicity that highlighted their restraint.

Definitional matters were not easily influenced by such publicity efforts. AT&T contended that the value of the rate base should be equal to asset fair value, determined by current replacement values. The firm also held that any reductions from the rate base attributable to depreciation should be based on actual depreciation experience determined by observation. In taking this stand, the Bell System relied on an amendment to the 1920 Transportation Act (section 19a) which required physical valuation of railroad properties. But, this position was in striking contrast to the firm's position on depreciation expense. During the depreciation hearings before the ICC, AT&T had convinced the Commission that its position on depreciation was correct, not the railroad position. The railroads had held that it was impossible to determine depreciation before retirement, that unobservable depreciation was non-existent. AT&T had convincingly argued that depreciation constantly occurred, whether or not it was observable to the naked eye. Now, the Bell System appeared to be selectively adhering to depreciation accounting or ignoring it, depending on what benefited the firm. The firm's stance towards depreciation appears to be a striking example of subjective bias in applying knowledge. The firm attempted to focus attention in one area and away from others (Loft 1986) – it demanded recognition of an ongoing but undetectable process, depreciation, for some purposes but not for others.

The state commissions realized that the inconsistent treatment of depreciation in the rate base and annual expense led to tremendous difficulty and confusion in establishing rates (Ruggles). Though the courts generally lagged the commissions in grasping the

importance of using divergent depreciation definitions, some courts did recognize the inconsistent nature of AT&T's depreciation arguments. One federal court decision stated:

> When it built up its reserve, it claimed the reserve as its actual depreciation. It cannot now take an inconsistent position about depreciation ….The plaintiff was right about depreciation when it created its reserves, and it is wrong in its position now, in its claims for a lesser sum as actual depreciation in this effort to establish fair value.
>
> *NY Telephone Co. v. Prendergast* 36(F) 1929

The FCC's investigation into depreciation practices in the telephone industry, begun in 1938, used NYT for its source documents; interestingly, however, the FCC report did not discuss calculation of the rate base, per se, though the issue of the depreciation reserve was discussed. The FCC report, presented in 1939, challenged several aspects of the firm's depreciation procedures. Rate base disputes appear repeatedly in court cases, clear evidence that the firm and regulators held contradictory positions on the rate base. Why then, do these disagreements not figure prominently in the ICC or FCC depreciation investigations?

The answer to this question is simply that no agreement had yet been reached on the definition of the rate base. To begin, a distinction existed between depreciation reserves and accumulated depreciation. The ICC recognized the former as a component of valuation and the latter as part of the calculation of annual expense recovery, and in the commission's opinion the two should be equivalent, but they did nothing to enforce this equivalency (FCC, p. xii). As long as the distinction between such reserves and accumulated depreciation was recognized, the door was opened to allowing reserves to be subjectively determined.

Though the definition of the rate base was unsettled, conceptually, it was a much easier subject to grasp than the practice of depreciation. All parties agreed that the rate

base represented physical capital; though the valuation of that capital was disputed, its existence was never in doubt. Depreciation, however, was a very different concept, occurring without necessarily any physical evidence of its occurrence. AT&T, therefore, needed to convince regulators of the existence of the invisible. Thus, the firm needed to spend much time and effort educating the regulators. Added to this, was the ignorance of and attendant apprehension towards the statistical tools the firm employed to measure the invisible. The firm did not need to have regulators understand the mathematics underlying their choice of depreciation methodologies, but the firm needed them to accept the legitimacy of these methods – hence, the extensive expert testimony presented to the ICC.

The FCC makes clear that it is not intimidated by the mathematics of survival analysis; further, the FCC denies the unassailably "scientific" nature of the Bell System methodology, saying, "Although the American Telephone and Telegraph Company attempts to conceal the fact behind an overwhelming mass of figures, service life determination is still mainly based upon judgment." (FCC, p. 188) But, in the main the FCC's analysis of Bell's use of life tables to derive depreciation rates focused on tweaking the methodology, not questioning the underlying appropriateness of statistical tools. Survival analysis and associated tools of probability science were accepted as a reasonable way to estimate asset lives, and AT&T's use of straight-line depreciation, a use which was unique to the firm, was also accepted.

16. Direct Examination of Life Table Histories

In Chapter 3, the question was raised of why a firm would choose depreciation accounting over retirement accounting, and my analysis showed the firm benefitting from

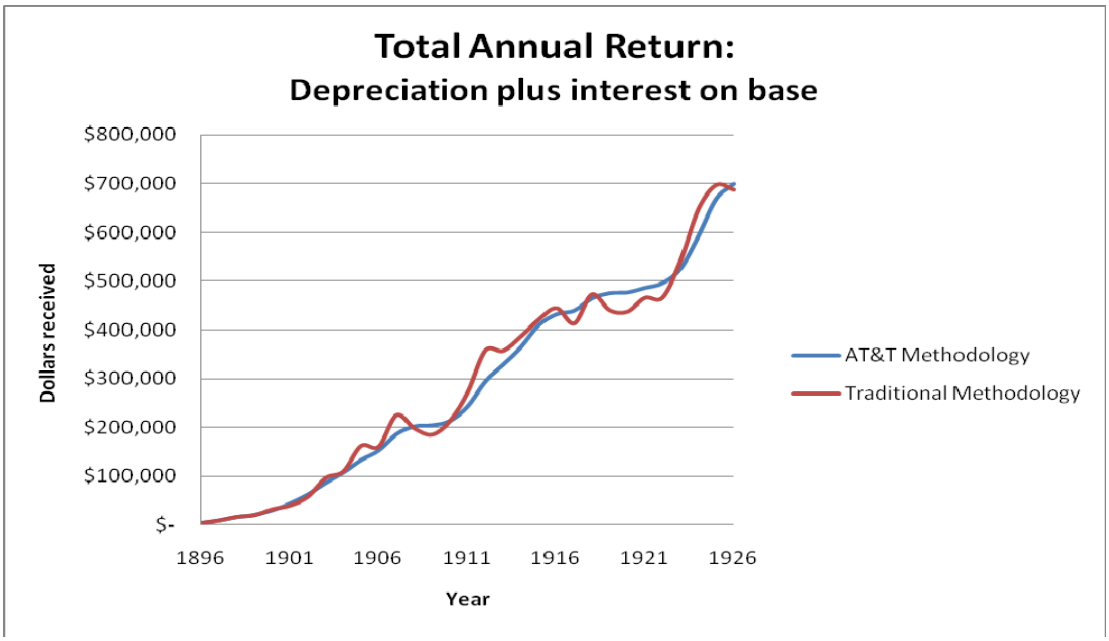
the smoothing effects of depreciation accounting. The accounting researcher Preinreich investigated this same question in the 1930's, and his work showed that the use of depreciation accounting resulted in higher total recovery for a utility than the use of retirement accounting when the utility's rate of expansion exceeded 6% annually. This was because the increased size of the rate base (through new assets) exceeded the annual depreciation accruals (1938). Though my review of the ICC exhibit data reveals annual growth rates averaging over 20% annually for three of the four exhibits[102], AT&T did not need to rely on the beneficial rate base aspects of depreciation accounting throughout much of the 1920's and 1930's, because the firm relied upon valuations, not accounting records, to supply a number for the rate base. It was not until the 1930's, when the FCC had won its battle to require the Bell System to use historical cost less accumulated depreciation, that the rate base distinction between retirement accounting and depreciation accounting became important. And, when the choice of retirement versus depreciation accounting did affect the rate base, as long as the firm continued to expand at a rate greater than 6%, its recovery would be maximized by using straight-line depreciation. What is unclear, however, is whether there was a difference in the rate base depending on the use of traditional straight-line depreciation or the true straight-line method, that is, group depreciation. Did the return vary based on whether traditional straight-line or group depreciation was adopted?

To investigate this further, I returned to the evidence submitted before the ICC. The first issue was comparing the rate base calculated using both depreciation methods. Using chart 10 (underground cables), I calculated the rate base at the beginning of 1927

[102] Aerial cables: 26%, underground cables 10: 21%, wooden poles 11: 4%, PBX 12:26%, though most growth rates had slowed to less than 10% in the latter years. 1926 expansion rates were 7% for aerial cables, 9, 8% for underground cables, 10, .3% for poles, and 25% for PBX.

for all asset using cohorts. When group depreciation is used, the value of the rate base at 1927 is $5,094, 260; using traditional straight-line depreciation, the rate base is $5,325,090[103]. Does this small difference lead to large differences in the total return?

The total return for the firm equals annual depreciation plus interest paid on the value of the rate base. I compare the annual total returns for 1895 through 1926, using both the traditional straight-line and group depreciation methods[104]. The annual return is estimated at 6% of the rate base in both cases. A comparison of the returns received produces the following plot.



Graph 7

Similar returns are received regardless of whether traditional or group depreciation was used. The biggest difference appears to be that AT&T's methodology, the group

[103] The cost value of assets in service at this date amounted to $7,668,746. Assuming a 10% reduction for observed depreciation, this would yield a fair value of $6,901,871; this much higher number would obviously be AT&T's first choice as a depreciation base.

[104] The annual depreciation expense for group depreciation is calculated at a rate of .04545 (the reciprocal of the average life of 22 years), while the traditional straight-line rate is equal to .0333 (the reciprocal of an estimated useful life of 30 years).

depreciation method, yields a smoother, more consistent return than when using the traditional methodology. This difference reflects the impact of retirements, which causes both the annual depreciation expense and the size of the rate base, hence the interest, to fluctuate. The group methodology provides a more consistent and predictable total return without any loss in return.

Beyond the benefit gained from expense predictability, is there evidence that the firm manipulated the use of this data to their economic advantage? Certainly the FCC thought there was. In their review of depreciation practices at Bell, the FCC examined contemporary operating data from NY Telephone (NYT) and also reviewed the example exhibits presented by AT&T in its testimony before the ICC. The FCC took issue with some of the methods used in determining lives. (Importantly, this was a difference on details, not opposition to the overall theory of depreciation that the firm had developed.)

In terms of life estimation, federal regulators found errors in AT&T's application of the Gompertz-Makeham formula to project lives. These problems included: differences in human life experience and equipment mortality (specifically, lack of high infant mortality for equipment) resulting in a misspecification of the functional form of the survivor function; problems with sample selection[105]; lack of terminal values in many of the Bell experience tables[106]; and treating heterogeneous items as homogeneous.

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[105] The use of sampling to estimate plant lives appears to be an example of institutional knowledge developed in one section of the firm being adopted elsewhere. Walter Shewhart, the founder of statistical quality control, worked with Harold S. Dodge and Harry Romig to develop sampling tools for quantifying variation and quality at Bell Laboratories. W.E. Deming, an important communicator of statistical quality control concepts to business, was familiar with the work being done at AT&T. For an overview of Deming's thoughts on business applications of sampling and statistics, see his 1944 article in *The Accounting Review*.

[106] Lack of terminal values is another reason that application of the gompertz-makeham formula was problematic: human life tables always contain terminal values.

The question of selection bias is difficult to prove or disprove, but not difficult to guard against. Continuous audits of the samples used by Bell to determine asset lives, as the FCC did of NYT test data, could determine the representativeness of the samples. The FCC did uncover presumptive evidence that the firm may have been aware of errors in their sampling process. The FCC cites internal NYT documents that showed NYT to find samples taken at the sub-account level to be more effective than those at the group level, as required by Bell System policy (FCC, p. 158). This use of separate sampling for sub-groups of asset categories was advocated by the FCC to be applied throughout the firm.

Evaluating the validity of the FCC's contention that AT&T did not differentiate among causes of depreciation sufficiently in depreciation studies is more problematic. Certainly the firm appeared to be interested in such studies; for example, a 1931 Bell paper (Jones 1931) on differences between tree species and pole circumference and strength (and by extension, total pole lives). If the FCC was correct in contending that similar information was ignored in determining depreciation rates, this is very suggestive. Since the firm realized the importance of differences in performance characteristics for operational decision-making, its exclusion from depreciation studies meant that the firm either did not believe the information to be relevant, or that it did realize its importance, but purposely excluded it. Lumping together different classes of assets in depreciation studies creates a composite depreciation rate that is less accurate than that obtained by creating sub-accounts and estimating lives for these, exactly the contention of the FCC. The effect would be similar to the inclusion of storms and other catastrophic events in the definition of retirement – by expanding the causes of retirement, a grosser and shorter estimate of average lifespan is returned.

To overcome these problems, the FCC advocated changes. They wanted to see asset groups more narrowly defined, and further distinguished by causes of depreciation (e.g., accidents versus service inadequacy versus weather related). The FCC wanted to see forecast period shortened, requiring frequent re-estimates of lives and recalculation of depreciation rates. They called for regular reviews of life estimates from sample data with actual experience of the broad class of equipment these samples purported to represent. And, they advocated replacing the use of the Gompertz-Makeham formula to smooth curves and estimate lives with use of the "osculatory survival rate"[107] method of life estimation, developed and employed at NYT (FCC, p.270). Through this method, the firm would no longer rely on projections based on a formula, but would instead rely more heavily on actual experience.

A second area of dispute concerned the choice of life bands used to estimate lives. Though the general depreciation methodology was standardized for all Bell System firms, some local adaptations were made by the individual regional firms; one of these differences was NYT's use of five years of experience in survival analysis instead of the three years' experience that was standard time for most Bell System firms (as indicated by the testimony before the ICC). The FCC investigation suggested that the use of five years worth of data was more reliable than three, and they advocated its adoption throughout the Bell System.

The choice of bands is important, because different experience samples can yield different lives. In general, predictions based upon only one year's experience should be suspect because any one year may be unusual. But, is the difference between using a five

[107] The osculatory survival life method was basically an ongoing weighted average. The FCC proposed some modifications to the method as developed by NYT, but its basic operations remained unchanged.

and three year band meaningful? To investigate the possible significance in depreciation rates using either three or five year bands, I returned to the example exhibits supplied by AT&T. Data from the four example charts are shown below, each with a survivor function calculated using all year data, a three year band, and a five year band. The average (mean) lives per each band is listed in the table below.

Table 6

Asset Category	**Average Life – Using All Years**	**Average Life – Three Year Band**	**Average Life – Five Year Band**
Aerial cable (Chart 9)	12.1 years	15.4 years	15.9 years
Underground cable (Chart 10)	16.4 years	20 years	20 years
Wooden poles (Chart 11)	16.5 years	16.5 years	16.1 years
P.B.X.s (Chart 12)	10.2 years	5.1 years	5 years

Comparing the survival curves derived from either three, five, or total years of experience, AT&T does not appear to have merely selected the rate that yields the lowest average life, hence the highest depreciation. For two of the four examples presented, underground and aerial cables, the average life calculated using all available experience delivers a significantly shorter life span than when using either three or five years worth of data; for the wooden poles, there is virtually identical lives whatever time frame is examined. Only for the P.B.X's does use of the three and five year bands result in shorter lives than use of the full mortality data.

As in all four samples the life span obtained whether using three or five year bands of data are virtually identical, the FCC's contention that use of five years' data would provide significantly more accurate information on life estimation is not supported. However, this examination does raise another issue – why would the Bell System not choose to include all years' experience when estimating average life?

It is reasonable to assume that improvements in both the products themselves (as well in maintenance) will increase over time. This would indicate that more reliance should be placed on the most recent experience, and it implies that earlier cohorts of assets placed in service can be expected to have shorter lives than more recent cohorts. And, indeed this appears to be the case; use of the entire mortality experience produces shorter lives than when only three (or five) years is used. Since the more recent bands produce more reliable estimates of asset mortality than can be achieved by using the total asset history, AT&T appears to be choosing bands based on what will provide the best information to predict future lives even if the depreciable lives that result are longer, hence less favorable to the firm.

Both practical and scientific reasons can explain AT&T's choice. Their decision is purely self-serving from the standpoint that the firm needed to have accurate information to manage their business, but it does not appear that the firm selected bands in order to enhance firm profits by increasing expenses and therefore allowable rates. This can, however, have been a strategic choice in the sense that the firm needed to have defensible positions. As discussed in Chapter 3, AT&T knew their choices would be subject to regulatory review, and evidence of wild divergence between predicted and actual lives would decrease the firm's credibility. The firm needed to maintain a balance. They aimed to estimate lives on the short end of possible, "conservatively", but not too short to appear unreasonable.

The FCC's review found repeated instances of underestimation of life. For example, the FCC noted the following discrepancies between their estimates and those of NYT:

Table 7

Underground cable	FCC Life	NYT Life
NYC	2.6	1.4
Rest of NY	2.5	1.3

(FCC, xxviii)

It appears that underestimation of life was much more common than overestimation. The FCC review found that, "It has unquestionably been the objective of the Bell Companies to make depreciation charges and depreciation reserves as high as could reasonably be done. Margins of safety have been added generally to figures derived from company experience and most doubtful points have been resolved in favor of the higher depreciation rate." (FCC, p.4)

Maintaining the ability to establish conservative rates, even if later revised, was an important strategy for the firm, much more important than controlling the definition of accumulated depreciation (and its impact on the rate base). The relative importance of the annual depreciation calculation as opposed to accumulated depreciation exists because the annual depreciation amount is immediately recoverable through rates. To receive the same amount in allowed return as expense recovered, the rate base must be several times the size of the annual expense. For example, if the utility was authorized to receive a 5% rate of return, the firm would be indifferent between $1,000 in depreciation expense or a $20,000 rate base – each would return $1,000 to the firm.

Besides, the firm had found that unique aspects of the public utility field could lead to a depreciation expense recovery that was could be very advantageous to the firm. In particular, the issue of intergenerational equity could be profitably exploited by the firm. Conservative initial life estimations, combined with the total life methodology, benefitted the firm economically.

17. Intergenerational Equity and Total Life Methodology

Intergenerational-equity, conceptually similar to the accountant's matching principle, is a desired goal in public finance decisions. Robinson (1998) defines intergenerational equity as the golden rule of fiscal policy, saying:

> "… taxpayers in each time period should as a group contribute to public expenditures from which they derive benefits in accordance with their share of the benefits generated by those expenditures. In doing so, they may be regarded as 'paying their way', without either subsidising, or being subsidised by, taxpayers in another time period."

This concept has important implications for rate setting. It implies that the rates paid by customers reflect the value of the benefit they derive from the services. Incorrect estimation of expenses, then, results in customers being either over or under-charged. These over (under) charges are not to be considered when prospectively determining upcoming rates. In terms of depreciation, if lives are estimated "conservatively", the annual depreciation rates may be too high. If life-spans are later revised, the revision will result in lower depreciation rates going forward, with no reduction in current rates to reflect overpayments by earlier customers. This happened because the firm employed total life depreciation in order to determine the annual depreciation expense.

Total life methodology treats revisions in life estimations in an unusual manner. The focus of the total life methodology is the proper matching of period expenses and benefits, not with recovering the cost of capital represented by an asset. Usually, revisions in depreciable lives result in the calculation of remaining service life; new depreciation rates are calculated based on the entire remaining life, and these rates are applied to the net-book (remaining) value of assets. In the total life method, the depreciable base is always the original cost (less salvage value). The practical result of

this methodology is that over an asset's useful life the firm was nearly guaranteed to recover more than the cost of the assets[108]

An example shows this clearly. Assume the firm has an asset costing $10,000, with no estimated salvage value. An initial estimate of 10 years life yields an annual depreciation rate of 10%. After 5 years, the remaining useful life was reviewed and determined to be10 years, for a total useful life of 15 years. Standard accounting treatment would be to spread the undepreciated cost over the remaining life of the asset; total life depreciation, however, used the original cost times the new depreciation rate to get the annual expense.

Table 8

Year In Service	Book Value, Beg of Year	Beg of Yr, Estimated Lifespan (Remaining Service Life Method)	Current Year Depreciation - Remaining Service Life Method	Total Depreciation Recovered - Remaining Service Life Method	Current Year Depreciation - Total Life Method	Total Depreciation Recovered - Total Life Method
1	10,000	10 (10)	1,000	1,000	1,000	1,000
2	9,000	10 (10)	1,000	2,000	1,000	2,000
3	8,000	10 (10)	1,000	3,000	1,000	3,000
4	7,000	10 (10)	1,000	4,000	1,000	4,000
5	6,000	10 (10)	1,000	5,000	1,000	5,000
6	5,000	15 (10)	500	5,500	667	5,667
7	4,500	15 (10)	500	6,000	667	6,333
8	4,000	15 (10)	500	6,500	667	7,000
9	3,500	15 (10)	500	7,000	667	7,667
10	3,000	15 (10)	500	7,500	667	8,333
11	2,500	15 (10)	500	8,000	667	9,000
12	2,000	15 (10)	500	8,500	667	9,667
13	1,500	15 (10)	500	9,000	667	10,333
14	1,000	15 (10)	500	9,500	667	11,000
15	500	15 (10)	500	10,000	667	11,667

[108] In a 1978 dissertation, Bailey discusses use of the total life method of depreciation with AT&T depreciation accountants who indicated that over-recovery of depreciation expense was routine.

In defending the use of total life depreciation[109], the firm stated that some estimations would prove too short while others would be too long; AT&T implied that these errors would average out (AT&T 1937; Bailey 1979). Of course, the over-recovery of expenses meant the accumulated depreciation grew to an amount greater than the asset's historical cost and a correspondingly low rate base. But, because of the relationship between the annual expense and rate base, for many years the firm would benefit as the excess depreciation expense recovered would more than compensate for the decreased rate of return from the smaller asset base.

No mention of the total life depreciation method is found in the ICC presentations; the first mention appears in the FCC investigations. The ICC investigations emphasized understanding depreciation and how it reflected the recovery of an asset over its life. These concerns were addressed by AT&T's presentation of realms of scientific testimony. The FCC investigations shifted the emphasis to a concern for customer equity; because its focus was on the implications of particular practices, the FCC disapproved of the use of total-life depreciation. Recognizing the potential for over-recovery of costs, the FCC argued for the remaining service value method of cost allocation.

Ironically, the argument that total-life depreciation was unfair to the public was met by the firm's position that intergenerational equity was violated by use of the remaining-value method. The remaining life method averaged out the depreciation expense over the life of the asset; this resulted in a mismatch between the cost of service and the fares paid. Since each rate period was to stand by itself, customers should neither benefit from nor be charged for past errors in expense estimation. The firm's earlier arguments favoring group depreciation accounting over traditional straight-line

[109] The total life methodology remained in use at AT&T until 1980.

depreciation or retirement accounting also stressed that their preferred method provided greater customer equity[110]. These earlier arguments had the ring of truth; the present equity arguments in favor of the total-life methodology sound more like rationalizations for a system that was beneficial to the firm.

18. Resolution

The Bell System came under FCC jurisdiction in 1934. During the preceding two decades, the firm had developed, articulated, and defended a sophisticated depreciation methodology which combined probability science with accounting. Now, forces outside the firm were attempting to impact its depreciation policy; the firm's preferred methods of rate base valuation, life estimation, and the total-life methodology were all challenged.

The FCC investigated depreciation from the standpoint of determining what was in the public's best interest, not with the agenda to promote the health of an industry. From the FCC's perspective, "conservative" estimation of lives resulted in excessive depreciation charges; to thwart excessively conservative estimations, the agency proposed frequent comparisons of actual lives with estimates[111], replacing the Gompertz-Makeham formula with the "osculatory survival rate" method and increasing the classification of assets. And, recognizing that the total-life methodology resulted in the firm more than recovering their costs and overcharging the public, the FCC advocated a switch to the remaining service life methodology. There is no evidence that any of these

[110] See Chapter 3.

[111] By requiring frequent checks on the accuracy of life estimates, the FCC was actually handling the issue with leniency. In Docket 14,700, the ICC had actually stated that a bias against conservative life estimates should be undertaken to ensure that depreciation charges are not front-loaded.

changes occurred. And, overall, the FCC[112] did not dispute the validity of probability estimation of lives and use of straight-line depreciation. AT&T's methodology, specifically the use of survival tables to estimate life, and use of group depreciation, had become the accepted standard.

The suggested changes were part of the finding presented to Congress in the FCC's 1939 report. Action on the report was postponed in 1940, and escalation of the war in Europe, followed by the U.S. entry in 1941, made the postponement of indefinite duration. Even under regulatory control of a new and activist agency, AT&T's depreciation methodology and calculation of the annual expense continued in the pattern established by the firm. Eventually, beginning in 1949, the FCC began to prescribe depreciation rates for the individual Bell companies (Marden), but, again, the underlying methodology was not changed. Instead, the FCC began a process of informal three way meetings, bringing together the operating companies, the FCC, and state commissioners to agree upon depreciation rates as part of rate setting negotiations (Phillips 1988). This had the effect of reducing the publicity surrounding depreciation issues, as well as ending judicial involvement.

The storyline for the rate base played out differently. A more comprehensible subject for outsiders than the detailed workings of depreciation methodology, the rate base issue had been debated by regulators and the utilities for years, both in and out of court. The Bell System was not the innovator in this area, just one of the many interested parties that contended in defining the rate base. With no settled definition, AT&T could

[112] This paper deals with AT&T's application of actuarial science to depreciation, thus only FCC findings related to this methodology are discussed. The FCC did, however, criticize AT&T's other depreciation methodologies including the turnover method and the composite life method.

not claim that its definition of the rate base had the authority of standard industry practice.

In defining the rate base, AT&T did not prevail. AT&T's preferred definition of the rate base was logically inconsistent with its calculation of depreciation as an annual expense, but the fact that the firm lost out in defining the rate base was also environmental. Society's reverence for all things scientific had diminished, as had an unalloyed belief that what was good for American business was good for American society.

19. Significance of the Depreciation Debates

The resolution of the depreciation debates partially support predictions of the capture theory. By moving to informal procedures, the firm and its regulatory agencies were working together, potentially increasing their dependencies and reducing the regulatory agencies' abilities to regulate. However, the scenario perhaps better fulfills Galbraith's predictions about the development of countervailing power. In this analysis, public antagonism is not the barometer of regulatory effectiveness; instead, we need to look at the reasons for the development of an oppositional force and its effectiveness. The ICC, in this analysis, did not meet the criteria of an effective counterweight to the telephone industry, but this was not its primary purpose. The ICC's focus was on the railroads industry, and the telecommunications industry was peripheral. During the 1920's, the most effective regulators of telephones were the state agencies, agencies which represented collections of customers, but not at a national level. As AT&T grew and prospered, the potential benefit for customers from joint action grew, and the result was a strong federal agency that acted as a proxy for the consumer. In terms of depreciation, the

FCC recognized that its mandate differed from that of the ICC, stating that the ICC had never sought to substantiate depreciation rates. “From 1913 to 1933, the telephone companies were at liberty to interpret the provisions of the Uniform System of Accounts relating to depreciation accounting in their own way.” (FCC, p.23) It was this laissez faire attitude that was replaced by the FCC as it exercised power on behalf of the paying public.

In the courts, the firm had been able to challenge depreciation rulings on a state by state basis. Even if rulings were unfavorable in one state, they might be favorable in another. By changing the venue for settling rate disputes from the courts to informal negotiations, the agency gained leverage with the firm in rate setting. Again, leverage for the agencies translated to benefits for customers.

The timing of this change is important, coming as it does at the beginning of the Second New Deal. Galambos and Pratt predicted that it is precisely at times of economic crisis that the public will demand changes in the power relationships between governmental agencies and industry. Legislative activity mediates these changed relationships. Thus, the crisis of the Great Depression gave impetus for the coalescence of consumer power in the formation of the FCC.

The history of AT&T’s use of probability science to create a depreciation methodology is thus an example of how government and industry interacted as two parts of a dialectical process. The Bell System was part of a technology that was reordering American society. [113] The firm was on the cutting edge of telecommunications science, but it also was creating the necessary knowledge to administer a national communications system. Recognizing a need to understand its assets, the firm turned to probability

[113] Transcontinental telephone service was introduced by AT&T in 1915 (Galambos and Pratt, 1988).

science; as the firm successfully expanded its operations, the methodology was rolled out throughout the firm to increase standardization.

At the same time that the firm was developing this methodology, governmental agencies were operating as a countervailing power for the American public. The utilities, including telecommunications, promised expanded horizons and greater opportunities for growth to the American people, but the essential nature of the services also left the public vulnerable to exploitation by the holders of these resources. The methods used by the government to maintain a level of control over industry (in general) were threat of anti-trust prosecution and the use of federal agencies to monitor practices, but in the 1910's and 1920's the basic premise was that "tweaking" the system sufficed to ensure that everyone's good was achieved. The crisis of the Depression changed the equation, eventually leading to the formation of activist agencies intent on directly aiding the consumer, not indirectly through industry.

In Chapter 2, seven propositions were listed as guiding my research, and upon conclusion of this research I can estimate the degree to which they have been confirmed. The significance of the model established by the railroad industry appears minimal. The experience of the Bell System under regulators was influenced by the experience of the railroads with the ICC, but in terms of depreciation methodology, the primary role of the railroads was negative – the Bell System found the retirement accounting advocated by the railroad industry unacceptable. Similarly, though a respect for science and scientific tools permeated AT&T, the adoption of statistical tools was not an inevitable result of institutional learning. Rather, the absence of any tools (by other firms or accounting

professionals) required the firm to search and develop their own methods to measure and allocate the using up of fixed assets.

The most interesting findings relate to the process of firm learning. I expected the role of institutional learning to be expressed primarily through a predisposition to attack problems with tools used elsewhere in the firm. And yes, the application of statistics throughout the firm made its adoption as a method of measuring depreciation easier. But, the engineers who used probability science to understand the life span of the firm's fixed assets did not simply take methods developed elsewhere and apply these tools in a new area. Instead, a process of learning from the data occurred. AT&T engineers used probability science to understand the average lifespan of homogenous assets, recognizing that the average provided more information than the raw data. This meant that they found smoothed results descriptive of past activity and predictive of the future. It is important to recognize, then, that the firm used smoothing in an effort to provide insight, not merely as an effort at obfuscation. Two purposes could and were accomplished by the same means. The fact that the firm received economic benefits from the smoothing feature of the group depreciation (as less volatility reduced the cost of capital) does not negate the fact that smoothing also provided useful information.

The special nature of public utilities also meant that equity could be better achieved with smoothed rather than raw data. It did not appear equitable to charge customers more in one period (from expense recovery) due to a higher level of retirements than in another period. For the firm, too, a reasonable rate of return would be

better ensured by setting rates that were based on more than one year's activity, a year that may or may not be abnormal[114].

The economic and social context also influenced the interactions between regulators and the firm as it developed its depreciation methodology. In the 1920's, a collaborative relationship between government and industry combined with a general respect for science, making for easy acceptance of the firm's methodology by the ICC. The crisis of the Great Depression, however, changed this relationship. The new federal regulator, the FCC, was not content to accept AT&T's methodology on faith, and the FCC reviewed whether application of the methodology was detrimental to the public. To a limited extent, the FCC was successful in forcing change, notably in requiring the rate base to be calculated as cost less accumulated depreciation. But, the concept of using probability theory to measure the depreciation of physical assets was not attacked, and they were unable to end the use of total life methodology.

This research illuminates the evolution of learning intertwined with the evolution of the relationship between a regulated industry and its regulator. The role of the accounting profession in this process was insignificant. Throughout the time the firm was developing its methodology, few accounting researchers touched upon this area. Later accounting researchers in this area, Preinreich in the 1930's, Kimball in the 1940's, Zannetos or Ijiri and Kaplan in the 1960's, evaluated the methodological merits of group depreciation which relied on statistical tools to estimate lives, but they ignored the equity questions implicit in AT&T's use of total life methodology.[115] The little that has been

[114] Some academic observers of the time also noted that public utilities' rates should be set using averaged trends. See Nash, 1930.

[115] Articles from both Zannetos (1962) and Ijiri and Kaplan (1969) discussed the fact that AT&T's application of a single rate to the sum total of assets in service provided less accurate matching of expenses

written on this subject has been done by researchers in the field of public utility regulation.[116]

The FCC did not shy away from questioning equity implications of AT&T's methodology. They did not succeed in making changes to the calculation of the annual depreciation expense. The Bell System had developed this methodology, advanced scientific arguments for its soundness, and by the time the FCC came into the picture, the methodology had achieved self-sustaining legitimacy as accepted practice. Over the same time period, however, the Bell System had argued that the value of the rate base was not connected to the issue of depreciation. The firm's success in maintaining the distinction between annual depreciation and observed depreciation actually boomeranged in later years, when the inconsistencies in the arguments for recognizing theoretical versus observed depreciation were understood. This allowed the agency's position on the rate base, as historical cost less accumulated depreciation to prevail. As critical accounting theory maintains, the firm attempted to draw attention to depreciation in one circumstance and not another according to its own benefits; in this instance, the countervailing power of the regulators prevented this subjective application.

It is likely that the inconsistency in the firm's definition of depreciation – recognizing it for the annual expense but not for the rate base – originally reflected the incomplete state of knowledge on depreciation within the firm. Without fully understanding these inconsistencies, the firm stressed the scientific basis of its

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than if a different rate was applied to each cohort based on its age. Kimball's contribution was primarily recognition that the turnover method was inadequate in calculating average life for firms whose plant were expanding.

[116] A 1983 article by John Ferguson, for example, examined differences between using average life depreciation and equal life group depreciation in which he specifically discusses the problem of balancing intergenerational equity with capital recovery.

methodology in order to establish their legitimacy. Science, therefore, was called upon as an advocate for the firm. When the logic behind the scientific arguments was extended to the rate base, it was recognized to be disadvantageous to the firm. The firm resisted acceptance of a definition of the rate base that was logically consistent with its treatment of depreciation expense for as long as possible. This ended when the economic crisis forced a change in the relationship between government and industry.

The acquisition of knowledge, advocacy, and accommodation to changes in environment all affected the firm's use of probability theory for depreciation purposes. As a process that evolved over time, the historical approach is uniquely qualified to capture these interactions. This research then, contributes to our knowledge by identifying the themes which influenced a technology leader in its development of an important managerial accounting policy, depreciation. It also sheds light on the dynamic relations between industry and government and the role played by accounting in mediating this relationship.

References

Abbott, A. 1988. *The System of Professions*. Chicago: The University of Chicago Press.

Abramovitz, M. 1993. The Search for the Sources of Growth: Areas of Ignorance, Old and New. *The Journal of Economic History* 53 (2).

Abramovitz, M., and P. A. David. 1973. Reinterpreting Economic Growth: Parables and Realities. *The American Economic Review* 63 (2).

Adams, H. C. 1908. Railway Accounting in Its Relation to the Twentieth Section of the Act to Regulate Commerce. *The Journal of Accountancy* 6 (6).

Adams, C. F. 1918. *American Railway Accounting*. New York: Henry Holt and Company.

Alchon, G. 1985. *The Invisible Hand of Planning: Capitalism, Social Science, and the State in the 1920's*. Princeton, NJ: Princeton University Press.

Arnold, P. J. 1998. The Limits of Postmodernism in Accounting History: The Decatur Experience. *Accounting, Organizations & Society* 23 (7).

AT&T. 1907 Annual Report.
———. 1910 Annual Report.
———. 1912. Accounting Circular 6A.
———. 1930 Annual Report.
———. Statistical Department. 1937. The Determination of Depreciation Rates.

Bailey, T. 1979. The Effects of Regulation on AT&T Depreciation Policy, 1884-1968. Economics, Massachusetts Institute of Technology, Cambridge.

Barlev, B., and J. R. Haddad. 2003. Fair Value Accounting and the Management of the Firm. *Critical Perspectives on Accounting* 14.

Bauer, J. 1924. Recent Decisions by the Supreme Court of the United States on Valuation and Rate Making. *The American Economic Review* 14 (2).
———. 1927. Interstate Commerce Commission Adopts Actual Investment at Cost Basis. *National Municipal Review* July.
———. 1930. Depreciation and Public Utility Valuation. *The Accounting Review* 5 (2).
———. 1937. The Concepts of Capital and Income in the Regulation of Public Utilities. *The Accounting Review* 12 (1).

Beniger, J. R. 1986. *The Control Revolution: Technological and Economic Origins of the Information Society*. Cambridge, Ma: Harvard University Press.

Bernstein, M. H. 1955. *Regulating Business by Independent Commission*. Princeton: Princeton University Press.

Bhat, G. 2008. Risk Relevance of Fair Value Gains and Losses, and the Impact of Disclosure and Corporate Governance, Accounting, University of Toronto.

BiCentennial Census Statistics. 1976. edited by U. S. D. o. t. Census.

Bies, S. S. 2005. Fair Value Accounting. *Federal Reserve Bulletin* Winter.

Biggs, L. 1995. The Engineered Factory. *Technology and Culture* 36 (2).

Blauvelt, M. P. 1908. Railroad Accounting Under Government Supervision. *The Journal of Accountancy* 6 (2).

Bonbright, J.C., and Means, G.C. 1932. *The Holding Company; Its Public Significance and its Regulation.* New York: McGraw Hill.

Bracelen, C. M. 1926. Docket No. 14,700 before the Interstate Commerce Commision: Depreciation Charges of Telephone Companies: Brief on Behalf of Bell System Companies.

Brief, R. P. 1965. Nineteenth Century Accounting Error. *Journal of Accounting Research* 3 (1).
———. 1967. A Late Nineteenth Century Contribution to the Theory of Depreciation. *Journal of Accounting Research* 5 (1).
———. 1968. Depreciation Theory and Capital Gains. *Journal of Accounting Research* 6 (1).

Brief, R. P., and J. Owen. 1968. Depreciation and Capital Gains: A "New" Approach. *The Accounting Review* 43 (2).

Bristline, E. D. 1921. Cost Accounting for Public Utilities. *National Association of Cost Accountants' Official Publications* 2 (9).

Buckmaster, D. 1992. Income Smoothing in Accounting and Business Literature Prior to 1954. *The Accounting Historians Journal* 19 (2).

Bunzl, M. 2004. Counterfactual History: A User's Guide. *The American Historical Review* 109 (3).

Burleson, A. S. 1918. Telegraph and Telephone in Government Hands. *The American Review of Reviews*

Calvert, J. F. 1908. Depreciation in Railway Accounting. *The Journal of Accountancy* 6 (4).

Chandar, N., and P. J. Miranti, Jr. 2007. The development of actuarial-based pension accounting at the Bell System, 1914-40. *Accounting History* 12 (2).

Chandler, A. D. 1962. *Strategy and Structure: Chapters in the History of the Industrial Enterprise*. Cambridge, Ma: The M.I.T. Press.
———. 1977. *The Visible Hand: The Managerial Revolution in American Business.* Cambridge: Belknap Press.

Chapman, S. 1908. American Methods of Railway Accounting. *Journal of the Royal Statistical Society* 71 (4).

Clark, C.E. 2000.Differences Between Public Relations and Corporate Social Responsibility: An Analysis. *Public Policy Review.* 26 (3)

Clark, J. M. 1969. *Social Control of Business*. New York: Augustus M. Kelley Publishers.

Crunden, A. B. 1932. Sleet Storms. *Bell Telephone Quarterly*, 14-22.

Crunden, A. B., and D. R. Belcher. 1929. The Straight-Line Depreciation Accounting Practice of Telephone Companies in the United States. Paper read at International Congress on Accounting, at New York.

Danielian, N. R. 1939. *AT&T: The Story of Industrial Conquest*. New York: The Vanguard Press.

Deloitte & Touche LLP, E. R. P. 2007. Regulatory Primer on Capital Recovery in the Regulated Utilities Industry.

Deming, W.E. 1944. A View of the Statistical Method. *The Accounting Review* 19 (3).

DuBois, C. G. 1913. A Brief History of Telephone Accounting. In *Lecture to Amos Tuck School of Business at Dartmouth College*. Hanover, NH.

Edwards, J. R., and E. Newell. 1991. The Development of Industrial Cost and Management Accounting Before 1850: A Survey of the Evidence. *Business History* 33 (1).

Engineering and Operations in the Bell System. 1984. Edited by R. F. Rey. Murray Hill, NJ: AT&T Bell Laboratories.

Epstein, M. J. 1973. The Effect of Scientific Management on the Development of the Standard Cost System, Accounting and Quantitative Methods University of Oregon.

1937. Federal Communications Commission. *Special Investigation Docket No. 1. Report on American Telephone and Telegraph Company Depreciation Accounting and Engineering Methods.* May 25, 1937.
———. *Special Investigation Docket No. 1. Report on American Telephone and Telegraph Company Financial History.* May 25, 1937.

Ferguson, S. 1943. *Depreciation Accounting as Applied to Public Utilities*. Hartford, Ct: The Case, Lockwood, & Brainard Co.

Ferguson, J. 1983. The Methodology and Mythology of Equal Life Group Depreciation. *Public Utilities Fortnightly* 111(1).

Flewellen, J., W.C. 1960. Concept of Depreciation Accounting Held by the United States Supreme Court. *The Accounting Review* 35 (3).

Foucault, M. 1984.

Frederick, J. H. 1929. Federal Regulation of Railroad Securities. *Journal of Political Economy* 37 (2).

Furner, M. O. 1975. *Advocacy & Objectivity; A Crisis in the Professionalization of American Social Science, 1865-1905*. Lexington: The University Press of Kentucky.

Galambos, L. 1970. The Emerging Organizational Synthesis in Modern American History. *Business History Review* 44 (3).
———. 1982. *America at middle age: a new history of the United States in the twentieth century*. New York: The Free Press.
———. 1992. Theodore N. Vail and the Role of Innovation in the Modern Bell System. *Business History Review* 66 (1).

Galambos, L., and J. Pratt. 1988. *The Rise of the Corporate Commonwealth*. New York: Basic Books, Inc.

Galbraith, J. K. 1980. *American Capitalism: The Concept of Countervailing Power*. M.E. Sharpe, Inc., White Plains.

Garnet, R. W. 1985. *The Telephone Enterprise: The Evolution of the Bell System's Horizontal Structure, 1876-1909*. Baltimore: The John Hopkins University Press.

Glaser, B.G. and Straus, A.L. 1967. *The Discovery of Grounded Theory*. Chicago. Adline.

Glover, J. W. 1931. Review of Edwin Kurtz's Life Expectancy of Physical Property. *Journal of the American Statistical Association* 26 (175).

Goddard, E. C. 1927. The Problem of Valuation. *Harvard Law Review* 41.
———. 1935. The Interest of Public Utility Ratepayers in Depreciation. *Harvard Law Review* 48 (5).

Guernsey, N.T. 1923. Some Matters Relating to Depreciation. *Bell Telephone Quarterly,* April 1923.
———.1927 The Rule As To Depreciation in Determining Value. *Tennessee Law Review* 5(4).
———.1928. Regulation and Management. *Iowa Law Review* 13(2).

Hammond, M. B. 1911. Railway Rate Theories of the Interstate Commerce Commission. *The Quarterly Journal of Economics* 25 (3).

Haskell, T. L. 2000. *The Emergence of Professional Social Science; The American Social Science Association and the Nineteenth-Century Crisis of Authority*. Baltimore: The John Hopkins University Press.

Haskins, C. W. 1901. The Place of the Science of Accounts in Collegiate Commercial Education. *Publications of the American Economic Association, 3rd Series* 2 (1).

Hatfield, H. R. 1936. What They Say about Depreciation. *The Accounting Review* 11 (1).

Haun, R. D. 1939. Inconsistencies in Public Utilities Depreciation *Michigan Law Review* 38 (1).

Hawley, E. W. 1974. Herbert Hoover, the Commerce Secretariat, and the Vision of an "Associative State," 1921-1928. *The Journal of American History* 61 (1):116-140.
———.1969. *The New Deal and the Problem of Monopoly* Princeton, NJ: Princeton University Press.

Hayes, H. V. 1913. *Public Utilities, Their Cost New and Depreciation*. New York: D. Van Nostrand Company.

Hayes, T. 1977. *"Family Album: A visual presentation in observance of the 100th anniversary of telephone service in New York City"*: AT&T.

Heier, J. R. 2000. The foundations of modern cost management: the life and work of Albert Fink. *Accounting, Business & Financial History* 10 (2).

Hepworth, S. R. 1953. Smoothing Periodic Income. *The Accounting Review* 28 (1).

Herring, E. P. 1933. Special Interests and the Interstate Commerce Commission, I. *The American Political Science Review* 27 (5).

Hotelling, H. 1925. A General Mathematical Theory of Depreciation. *Journal of the American Statistical Association* 20 (151).

Ijiri, Y., and R. S. Kaplan. 1969. Probabilistic Depreciation and Its Implications for Group Depreciation. *The Accounting Review* 44 (4).
1970. Sequential Models in Probabilistic Depreciation. *Journal of Accounting Research* 8 (1).

Interstate Commerce Commission. 1913.*Uniform System of Accounts for Telephone Companies.*
———.1928. *Testimony of Witnesses for Bell System Companies; Docket No. 14,700: Depreciation Charges of Telephone Companies*. March 19, 20, and 21, 1928.

Johnson, H. T., and R. S. Kaplan. 1987. *Relevance Lost; The Rise and Fall of Management Accounting.* Boston: Harvard Business School Press.

Jones, R. L. 1931. New Standard Specifications for Wood Poles. *Bell System Technical Journal*:514-524.

Kevles, D. 1979. The Physics, Mathematics, and Chemistry Communities: A Comparative Analysis. In *The Organization of Knowledge in Modern America, 1860-1920,* edited by A. Oleson and J. Voss. Baltimore: Johns Hopkins University Press.

Kimball, B. F. 1943. General Theory of Plant Account Subject to Constant Mortality Law of Retirements. *Econometrica* 11 (1).
———. 1945. Mortality Characteristics of Physical Property Based upon Location Life Table and Re-Use Ratios. *Econometrica* 13 (3).
———. 1947. A System of Life Tables for Physical Property Based on the Truncated Normal Distribution. *Econometrica* 15 (4).

Kingsbury, N. C. 1919. September 15, 1919 letter to Benjamin S. Read. Denver.

Kissam, P. C. 1986. The Decline of Law School Professionalism. *University of Pennsylvania Law Review*.

Kohler, E. L. 1931. The Concept of Earned Surplus. *The Accounting Review* 6 (3).

Kolko, G. 1963. *The Triumph of Conservatism*. New York: The Free Press.

Krug, J. A. 1935. Utility Depreciation Practices under Commission Scrutiny. *The Journal of Land & Public Utility Economics* 11 (3).

Kurtz, E. B. 1930. *Life Expectancy of Physical Property Based on Mortality Laws*. New York: The Ronald Press Company.
———. 1937. *The Science of Valuation and Depreciation*. New York: The Ronald Press Company.

Lehman, C. R. 1992. *Accounting's Changing Role in Social Conflict*. New York: Markus Wiener Publishing, Inc. .

Leuchtenberg, W. E. 1995. *The FDR Years: On Roosevelt and his Legacy*. New York: Columbia University Press.

Littleton, A. C. 1981. *Accounting Evolution to 1900*. Edited by G. J. Previts. University, Ala: University of Alabama Press.
———.Littleton, A203.. C. 1932. Capital and Surplus. *The Accounting Review* 7 (4).

Loft, A. 1986. Towards a Critical Understanding of Accounting: The Case of Cost Accounting in the U.K., 1914-1925. *Accounting, Organizations & Society* 11 (2):137-169.

Martin, A. 1971. *Enterprise Denied: Origins of the Decline of American Railroads, 1897-1917*. New York: Columbia University Press.

Marden, J. R. 1957. *Depreciation: History and Concepts in the Bell System*: American Telephone and Telegraph Company.

Mason, P. 1933. Illustrations of the Early Treatment of Depreciation. *The Accounting Review* 8 (3).

McCraw, T. K. 1984. *Prophets of Regulation: Charles Francis Adams, Louis D. Brandeis, James M. Landis, Alfred E. Kahn*. Cambridge: The Belknap Press of Harvard University Press.

McWatters, C. S. 1995. Accounting Change and the Emergence of Management Accounting. In *Studies in Accounting History*, edited by A. Tsuji and P. Garner. Westport Greenwood Press.

Miller, P., and T. O'Leary. 1987. Accounting and the Construction of the Governable Person. *Accounting, Organizations & Society* 12 (3).

Miranti, P. J., Jr. 1989. The Mind's Eye of Reform: The ICC's Bureau of Statistics and Accounts and a Vision of Regulation, 1887-1940. *Business History Review* 63 (3).
———. 1990. *Accountancy Comes of Age: The Development of an American Profession, 1886-1940*. Chapel Hill: The University of North Carolina Press.
———. 2002. Corporate Learning and Traffic Management at the Bell System, 1900-1929: Probability Theory and the Evolution of Organizational Capabilities. *Business History Review* 76 (Winter).

Moody's Public Utility Series. 1920-1942. New York: Moody's Investor Services.

Morley, Raymond. 1966. *The First New Deal*. New York: Harcourt, Brace & World, Inc.

Nash, L. R. 1930. Depreciation Accounting Methods for Public Utilities. *The Accounting Review* 5 (2).

North, D. C. 1991. Institutions. *Journal of Economic Perspectives* 5 (1).

NYT. July 23, 1934. *Public Relations Bulletin No. 1*
———.November 22, 1934. *Information Bulletin No. 2*

Parrish, M.1994. *Anxious Decades, 1921-1940.* New York. W.W. Norton & Co.

Phillips, C. 1988. *The Regulation of Public Utilities: Theory and Practice.* Vienna, Va: Public Utilities Reports, Inc.

Porter, T. 1986. *The Rise of Statistical Thinking: 1820 - 1900*. Princeton: Princeton University Press.

Posner, R.A. 1974. Theories of Economic Regulation. *The Bell Journal of Economics and Management* 5 (2).

Preinreich, G. 1938. The Principles of Public Utility Depreciation. *The Accounting Review* June.
———. 1939. The Practice of Depreciation. *Econometrica* July.

Previts, G. J., and B. D. Merino. 1998. *A History of Accountancy in the United States: The Cultural Significance of Accounting*. Columbus: Ohio State University Press.

1934. Public Services Commission. *Minutes, December 5, 1934*.

Public Services Commission of Wisconsin. 1933. *Depreciation: A Review of Legal and Accounting Problems.* Madison: Public Service Commission of Wisconsin.

Raymond, W.G. 1918. *What is Fair: A Study of Some Problems of Public Utility Regulation.* New York: John Wiley & Sons.

Riggs, H. E. 1922. *Depreciation of Public Utility Properties*. New York: McGraw-Hill.

Robinson, M. 1998. Measuring Compliance with the Golden Rule. *Fiscal Studies* 19 (4).

Rorem, C. R. 1928. Social Control Through Accounts. *The Accounting Review* 3 (3).

Ross, D. 1991. *The Origins of American Social Science*. Cambridge: Cambridge University Press.

Ruggles, C. O. 1938. *Problems in Public Utility Economics and Management*. New York: McGraw-Hill.

Sanders, T. H. 1934. *Cost Accounting for Control*. New York: McGraw-Hill.

Say Phone Fund Belongs to Public. 1924. *New York Times*, November 13, 1924.

Sass, S. 1982. *The Pragmatic Imagination: A History of the Wharton School, 1881-1981*. Philadelphia: University of Pennsylvania Press.

Schiesl, M. J. 1977. *The Politics of Effeciency: Municipal Administration and Reform in America, 1880-1920*. Berkeley and Los Angeles: University of California Press.

Sharfman, I. L. 1931. *The Interstate Commerce Commission: A Study in Administrative Law and Procedure, Part I*. New York: The Commonwealth Fund.

Sivakumar, K., and G. Waymire. 2003. Enforceable Accounting Rules and Income Measurement by Early 20th Century Railroads. *Journal of Accounting Research* 41 (2).

Skowronek, S. 1982. *Building a New American State: The Expansion of National Administrative Capacities, 1877 - 1920*. Cambridge: Cambridge University Press.

Special Investigation Docket No. 1, Report on AT&T Financial History. 1937. Edited by FCC.

Stehman, J. W. 1967. *The Financial History of the American Telephone and Telegraph Company*. New York: Augustus M. Kelley.

Stigler, G. J. 1971. The Theory of Economic Regulation. *The Bell Journal of Economics and Management Science* 2 (1).

Stigler, S. M. 1986. *The History of Statistics*. Cambridge: Harvard University Press.

Strachan. 1907. Accounting for Telephone Companies under Supervision of Commissions.

Sunny, B. E. 1913. November 20, 1913 letter to C.G. Dubois. Chicago.

Symkay, E. W. 1955. The National Association of Railroad and Utility Commissioners as the Originators and Promoters of Public Policy for the Public Utilities, Business, University of Wisconsin, Milwaukee.

Tinker, T. 1988. Panglossian accounting theories: The science of apologising in style. *Accounting, Organizations & Society* 13 (2).
———. 1991. The Accountant as Partisan. *Accounting, Organizations & Society* 16 (3).
———. 2005. The withering of criticism. *Accounting, Auditing & Accountability Journal* 18 (1).

Uniform System of Accounts for Telephone Companies. 1913. Prepared by I.C.C.

VanSant, J. W. 1921. Discussion of Depreciation Accounting. Paper read at General Accounting Conference.

Vaughan, D. 1990. Autonomy, interdependence, and social control: NASA and the Space Shuttle Challenger. *Administrative Science Quarterly* 35 (2).

Walker, S. P. 1988.*The Society of Accountants in Edinburgh, 1854-1914.* New York: Garland Pub.

Watts, R., and G. Zimmerman. 1995. The Demand for and Supply of Accounting Theories: The Market for Excuses. In *Policing Accounting Knowledge: The Market for Excuses*, edited by T. Tinker and T. Puxty. Princeton: Markus Wiener Publishers.

Webster, G. N. 1920. *Theoretical depreciation: a menace to the public and the investor*. New York.

Whitten, R. H. 1919. *Valuation of Public Service Corporations*. New York: The Banks Law Publishing Co.

Wiebe, R. H. 1967. *The Search for Order, 1877-1920*. Edited by D. H. Donald. New York: Hill and Wang.

Wilson, G. L., and J. R. Rose. 1939. Some Recent Trends in Public Utility Regulation. *The American Economic Review* 29 (4).

Winder, A. 1922. Depreciation of Plant. *The Cost Accountant* 1 (8).

Winfrey, R. 1935. Statistical Analyses of Industrial Retirements. *Iowa State College Engineering Experiment Bulletin* 125.

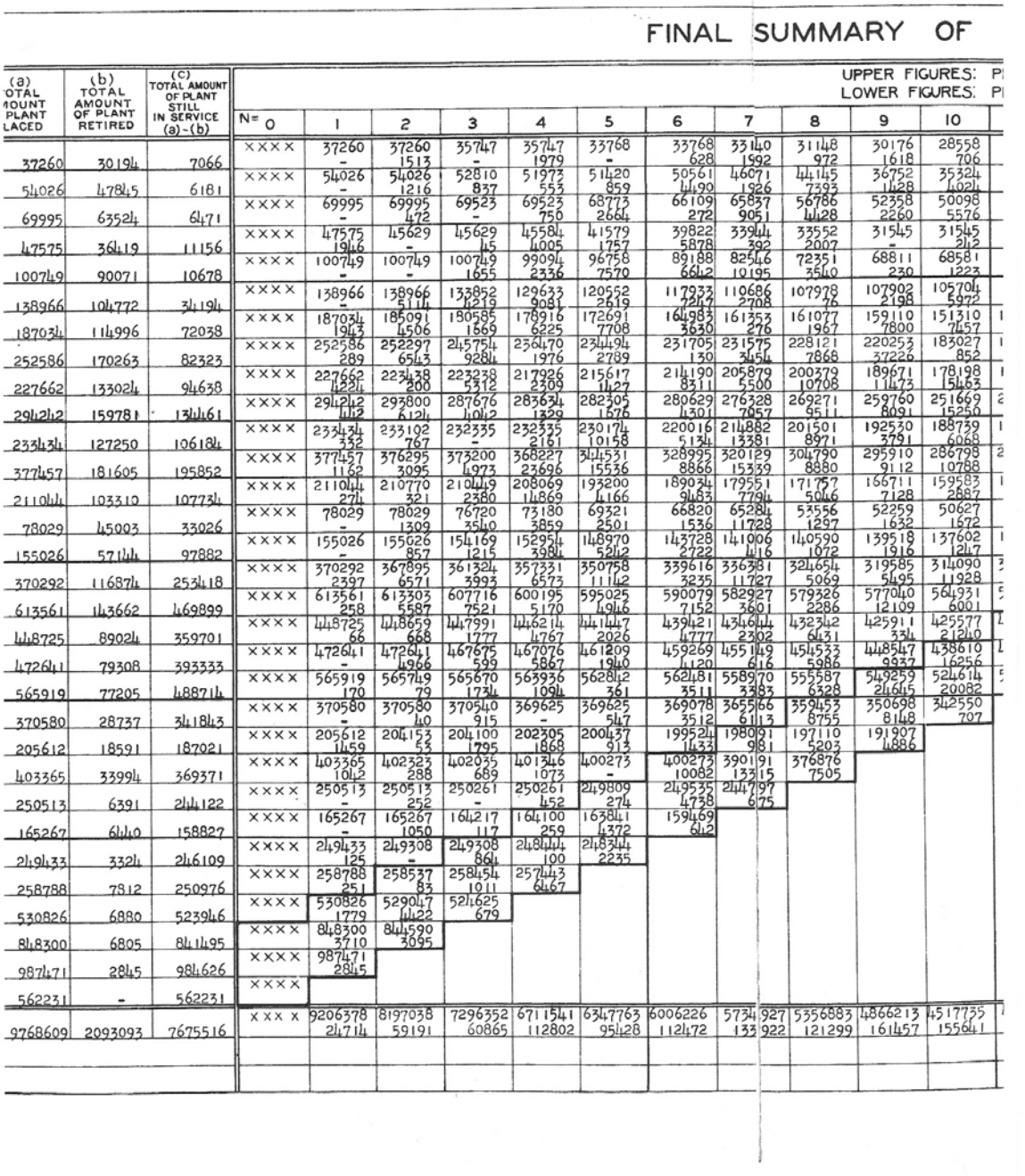
Young, A. A. 1914. Depreciation and Rate Control. *The Quarterly Journal of Economics* 28 (4).

Zannetos, Z. 1962. Statistical Attributes of Group Depreciation. *The Accounting Review* 37(4)

Zeff, S. A. 1991. *American Accounting Association, Its First Fifty Years: 1916-1966.* New York: Prentice-Hall.

Exhibit I

Life Table for underground cables



FINAL SUMMARY OF

UPPER FIGURES:
LOWER FIGURES:

(a) TOTAL AMOUNT PLANT LACED	(b) TOTAL AMOUNT OF PLANT RETIRED	(c) TOTAL AMOUNT OF PLANT STILL IN SERVICE (a)-(b)	N= 0	1	2	3	4	5	6	7	8	9	10
37260	30194	7066	XXXX	37260	37260	35747	35747	33768	33768	33140	31148	30176	28558
				-	1513	-	1979	-	628	1592	972	1618	706
54026	47845	6181	XXXX	54026	54026	52810	51973	51420	50561	46071	44145	36752	35324
				-	1216	837	553	859	4490	1926	7393	1428	4024
69995	63524	6471	XXXX	69995	69995	69523	69523	68773	66109	65837	56786	52358	50098
				-	472	-	750	2664	272	9051	4428	2260	5576
47575	36419	11156	XXXX	47575	45629	45629	45584	41579	39822	33944	33552	31545	31545
				1946	-	45	4005	1757	5878	392	2007	-	242
100749	90071	10678	XXXX	100749	100749	100749	99094	96758	89188	82546	72351	68811	68581
				-	-	1655	2336	7570	6642	10195	3540	230	1223
138966	104772	34194	XXXX	138966	138966	133852	129633	120552	117933	110686	107978	107902	105704
				-	5114	4219	9081	2619	7247	2708	76	2198	5973
187034	114996	72038	XXXX	187034	185091	180585	178916	172691	164983	161353	161077	159110	151310
				1943	4506	1569	6225	7708	3630	276	1967	7800	7457
252586	170263	82323	XXXX	252586	252297	245754	236470	234494	231705	231575	228121	220253	183027
				289	6543	9284	1976	2789	130	3454	7868	37226	852
227662	133024	94638	XXXX	227662	223438	223238	217926	215617	214190	205879	200379	189671	178198
				4224	200	5312	2309	1427	8311	5500	10708	11473	15463
294242	159781	134461	XXXX	294242	293800	287676	283634	282305	280629	276328	269271	259760	251669
				442	6124	4062	1329	1676	4301	7057	9511	8091	15250
233434	127250	106184	XXXX	233434	233102	232335	232335	230174	220016	214882	201501	192530	188739
				332	767	-	2161	10158	5134	13381	8971	3791	6068
377457	181605	195852	XXXX	377457	376295	373200	368227	344531	328995	320129	304790	295910	286798
				1162	3095	4973	23696	15536	8866	15339	8880	9112	10788
211044	103310	107734	XXXX	211044	210770	210449	208069	193200	189034	179551	171757	166711	159583
				274	321	2380	14869	4166	9483	7794	5046	7128	2887
78029	45003	33026	XXXX	78029	78029	76720	73180	69321	66820	65284	53556	52259	50627
				-	1309	3540	3859	2501	1536	11728	1297	1632	1672
155026	57144	97882	XXXX	155026	155026	154169	152954	148970	143728	141006	140590	139518	137602
				-	857	1215	3984	5242	2722	4116	1072	1916	1247
370292	116874	253418	XXXX	370292	367895	361324	357331	350758	339616	336381	324654	319585	314090
				2397	6571	3993	6573	11142	3235	11727	5069	5495	11928
613561	143662	469899	XXXX	613561	613303	607716	600195	595025	590079	582927	579326	577040	564931
				258	5587	7521	5170	4946	7152	3601	2286	12109	6001
448725	89024	359701	XXXX	448725	448659	447991	446214	441447	439421	434644	432342	425911	425577
				66	668	1777	4767	2026	4777	2302	6431	334	21240
472641	79308	393333	XXXX	472641	472641	467675	467076	461209	459269	455149	454533	448547	438610
				-	4966	599	5867	1940	4120	616	5986	9937	16256
565919	77205	488714	XXXX	565919	565749	565670	563936	562842	562481	558970	555587	549259	524614
				170	79	1734	1094	361	3511	3383	6328	24645	20082
370580	28737	341843	XXXX	370580	370580	370540	369625	369625	369078	365566	359453	350698	342550
				-	40	915	-	547	3512	6113	8755	8148	707
205612	18591	187021	XXXX	205612	204153	204100	202305	200437	199524	198091	197110	191907	
				1459	53	1795	1868	913	1433	981	5203	4886	
403365	33994	369371	XXXX	403365	402323	402035	401346	400273	400273	390191	376876		
				1042	288	689	1073	-	10082	13315	7505		
250513	6391	244122	XXXX	250513	250513	250261	250261	249809	249535	244797			
				-	252	-	452	274	4738	6775			
165267	6440	158827	XXXX	165267	165267	164217	164100	163841	159469				
				-	1050	117	259	4372	642				
249433	3324	246109	XXXX	249433	249308	249308	248444	248344					
				125	-	864	100	2235					
258788	7812	250976	XXXX	258788	258537	258454	257443						
				251	83	1911	6467						
530826	6880	523946	XXXX	530826	529047	521625							
				1779	1422	679							
848300	6805	841495	XXXX	848300	844590								
				3710	3095								
987471	2845	984626	XXXX	987471									
				2845									
562231	-	562231	XXXX										
9768609	2093093	7675516	XXX X	9206378	8197038	7296352	6711541	6347763	6006226	5734927	5356883	4866213	4517735
				247114	59191	60865	112802	95428	112472	133922	121299	161457	155641

(continued next page)

SUMMARY OF HISTORICAL DATA FOR MORTALITY STUDY

UPPER FIGURES: PLANT REMAINING IN SERVICE AT BEGINNING OF NTH CALENDAR YEAR AFTER YEAR
LOWER FIGURES: PLANT RETIRED DURING NTH CALENDAR YEAR AFTER YEAR OF PLACING

	8	9	10	11	12	13	14	15	16	17	18	19	20	21
40	31148	30176	28558	27852	27326	25911	25804	25455	25251	22666	20520	13265	10060	10060
92	972	1618	706	526	1415	107	348	204	2585	2146	7255	3205	-	-
71	44145	36752	35324	31300	30894	29768	29579	28940	20111	16105	15388	15388	10208	9991
26	7393	1428	1424	406	1126	189	639	8829	4006	717	-	5180	217	-
37	56786	52358	50098	44522	42718	34888	32026	26060	19629	13242	11894	11833	11833	8451
51	4428	2260	5576	1804	7830	2862	5966	6431	6387	1348	61	-	3382	541
44	33552	31545	31545	31303	28974	26080	23023	17972	17132	16541	16428	16428	14428	12241
92	2007	-	242	2329	2894	3057	5051	840	591	113	-	2000	2187	340
46	72351	68811	68581	67358	64989	57540	45214	38118	34736	32210	31452	31173	29696	28784
95	3540	230	1223	2369	7449	12326	7096	3382	2526	758	279	1477	910	906
86	107978	107902	105704	99732	88139	75457	73298	70284	64802	63400	56160	53768	53100	52185
08	76	2198	5972	11593	12682	2159	3014	5482	1402	7240	2392	668	915	105
53	161077	159110	151310	143853	135624	129152	118163	107175	105018	97777	96204	94936	93112	90077
76	1967	7800	7457	8229	6472	10989	10988	2157	7241	1573	1268	1824	3035	3711
75	228121	220253	183027	182175	176250	165841	162087	160141	154698	152002	149033	140183	139742	131480
54	7868	37226	852	5925	10409	3754	1946	5443	2696	2969	8850	441	8262	12519
79	200379	189671	178198	162735	151144	144630	144423	129065	127424	125820	125667	123572	118859	104064
00	10708	11473	15463	8591	9514	207	15358	1641	1604	153	2095	4713	14795	5074
28	269271	259760	251669	236419	226280	219957	213118	204721	200734	194903	188950	179352	149319	136786
57	9511	8091	15250	10139	6323	6839	8397	3987	5831	5953	9598	30033	12533	2325
82	201501	192530	188739	182671	178097	158465	157697	156132	154184	144111	142742	134813	127057	
81	8971	3791	6068	4574	19632	768	1565	1948	10073	1369	7929	7756	20873	
29	304790	295910	286798	276010	265337	262416	261781	259451	252447	232752	219343	204521		
39	8880	9112	10788	10673	2921	635	2339	7004	19695	13409	14822	8669		
51	171757	166711	159583	156696	152656	151429	149446	146581	130566	117748	110598			
94	5046	7128	2887	4040	1227	1983	2865	16015	12818	7150	2861			
84	53556	52259	50627	48955	42496	40304	39187	36387	34691	33284				
28	1297	1632	1672	6459	2192	1117	2800	1696	1407	258				
06	140590	139518	137602	136355	130277	128609	121472	115962	100151					
16	1072	1916	1247	6078	1668	7137	5510	15811	2269					
81	324654	319585	314090	302162	298877	290478	274699	258968						
27	5069	5495	11928	3285	8399	15779	15731	5550						
27	579326	577040	564931	558930	544352	511684	491123							
01	2286	12109	6001	14578	32668	20561	21224							
44	432342	425911	425577	404337	377155	362782								
02	6431	334	21240	27182	14373	3081								
49	454533	448547	438610	422354	406691									
16	5986	9937	16256	15663	13358									
70	555587	549259	524614	504532										
83	6328	24645	20082	15818										
66	359453	350698	342550											
13	8755	8148	707											
91	197110	191907												
81	5203	4886												
91	376876													
15	7505													
97														
75														
927	5356883	4866213	4517755	4020251	3371276	2815391	2362140	1781412	1441574	1262561	1184379	1019232	757414	584121
922	121299	161457	155641	160261	162552	93550	110829	86420	81131	45156	57413	65966	67109	25521

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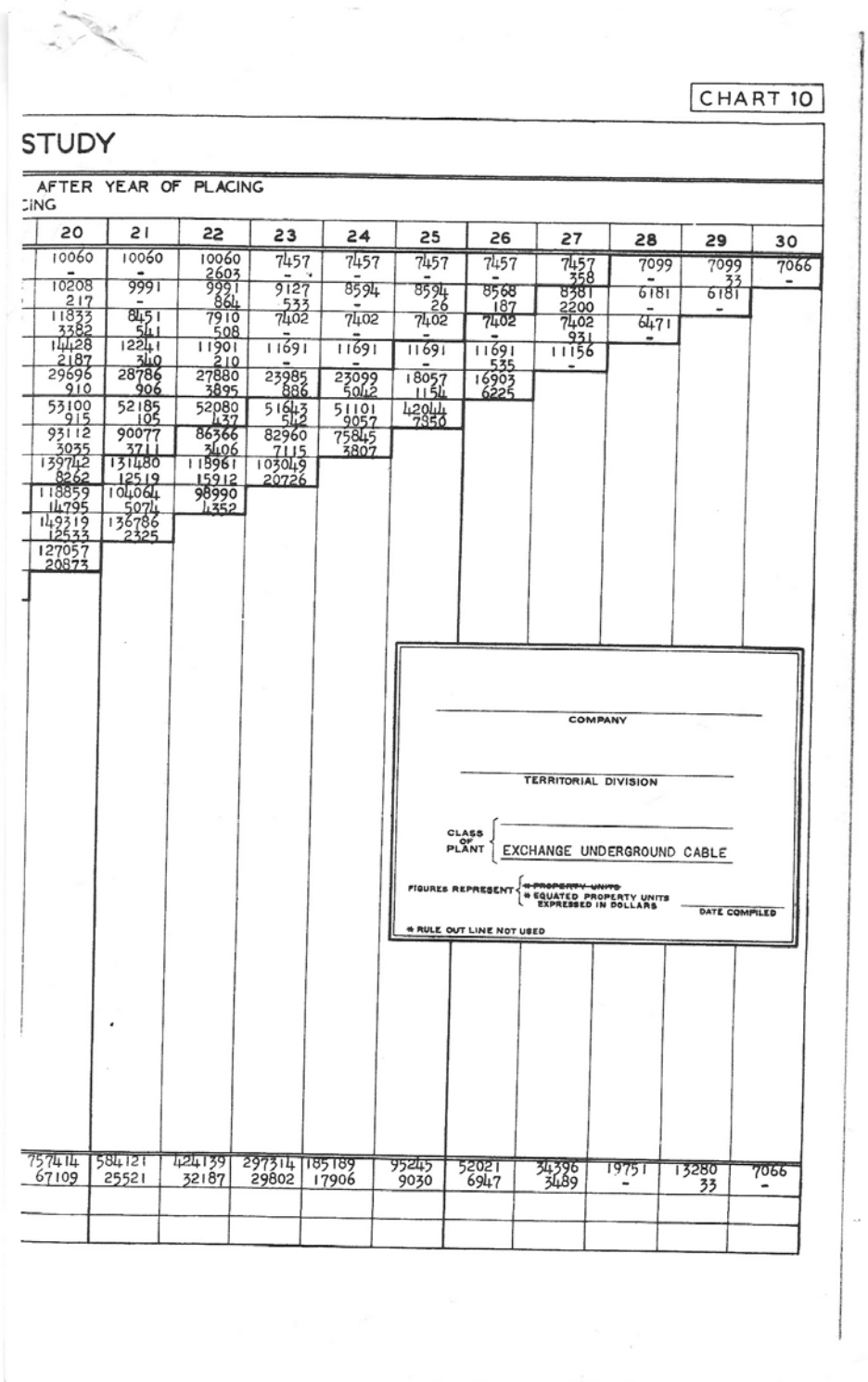

CHART 10

STUDY

AFTER YEAR OF PLACING

CING

20	21	22	23	24	25	26	27	28	29	30
10060 –	10060 –	10060 2603	7457 –	7457 –	7457 –	7457 –	7457 358	7099 –	7099 33	7066 –
10208 217	9991 –	9991 864	9127 533	8594 –	8594 26	8568 187	8381 2200	6181 –	6181 –	
11833 3382	8451 541	7910 508	7402 –	7402 –	7402 –	7402 –	7402 931	6471 –		
14428 2187	12241 340	11901 210	11691 –	11691 –	11691 –	11691 535	11156 –			
29696 910	28786 906	27880 3895	23985 886	23099 5042	18057 1154	16903 6225				
53100 915	52185 105	52080 437	51643 542	51101 9057	42044 7350					
93112 3035	90077 3711	86366 3406	82960 7115	75845 3807						
139742 8262	131480 12519	118961 15912	103049 20726							
118859 14795	104064 5074	98990 4352								
149319 12533	136786 2325									
127057 20873										
757414 67109	584121 25521	424139 32187	297314 29802	185189 17906	95245 9030	52021 6947	34396 3489	19751 –	13280 33	7066 –

COMPANY

TERRITORIAL DIVISION

CLASS OF PLANT: EXCHANGE UNDERGROUND CABLE

FIGURES REPRESENT: ~~* PROPERTY UNITS~~ * EQUATED PROPERTY UNITS EXPRESSED IN DOLLARS

DATE COMPILED

* RULE OUT LINE NOT USED

from ICC Docket 14,700

VITA

Deirdre M. Collier

1960 Born February 4, in New York, New York

1978 Graduated from Ridge High School, Basking Ridge, New Jersey.

1978-1982 Attended College of William & Mary, Williamsburg, Va.

1982 B.A, College of William & Mary; Majors: History (cum laude) and Philosophy.

1982-84 Employed by Time Inc., New York City, as assistant business manager.

1985-86 Attended Columbia University School of Business, New York City.

1986 MBA, Columbia University; concentrations in accounting and finance.

1986-88 Employed by Arthur Andersen, New York City, as auditor.

1987 Certified Public Accountant, New York State.

1988-1997 Employed at Goldman, Sachs, New York City, as vice-president in the controllers department.

1997-2005 Employed at College of Staten Island, New York, as adjunct lecturer in accounting.

2005-2009 Graduate work at Rutgers University School of Management, Newark, New Jersey.

2005-2009 Teaching assistantship, Accounting Department.

2008 AAA/Deloitte/Michael Cook Doctoral Consortium Fellow, Lake Tahoe, California.

2009 Ph.D. in Management.

Exhibit II

Derivation of Gompertz-Makeham Formula

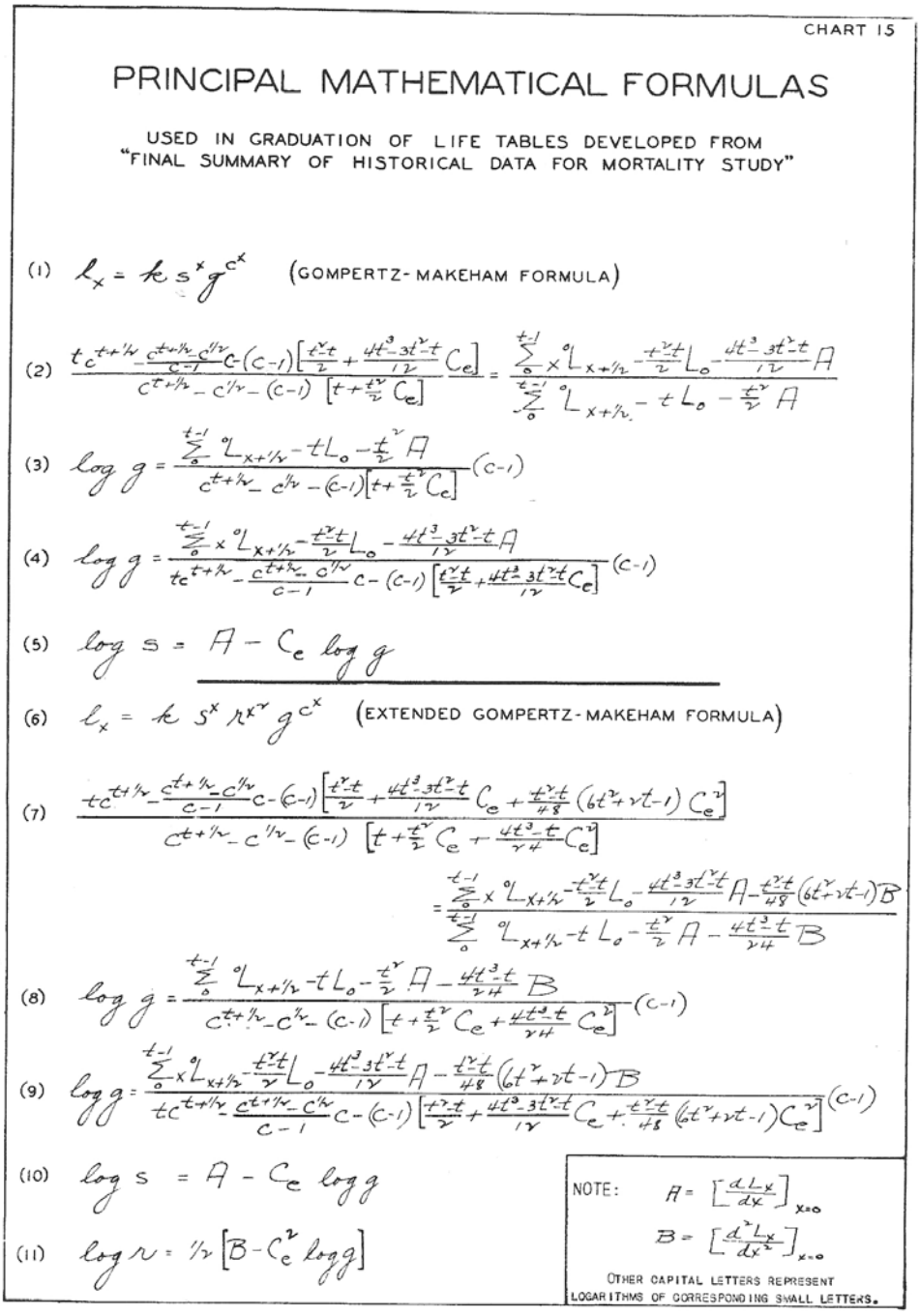

CHART 15

PRINCIPAL MATHEMATICAL FORMULAS

USED IN GRADUATION OF LIFE TABLES DEVELOPED FROM "FINAL SUMMARY OF HISTORICAL DATA FOR MORTALITY STUDY"

(1) $l_x = k\, s^x g^{c^x}$ (GOMPERTZ-MAKEHAM FORMULA)

(2) $$\frac{t c^{t+1/2} - \frac{c^{t+1/2} - c^{1/2}}{c-1} c - (c-1)\left[\frac{t^2-t}{2} + \frac{4t^3-3t^2-t}{12} C_e\right]}{c^{t+1/2} - c^{1/2} - (c-1)\left[t + \frac{t^2}{2} C_e\right]} = \frac{\sum_0^{t-1} {}^0L_{x+1/2} - \frac{t^2-t}{2} L_0 - \frac{4t^3-3t^2-t}{12} A}{\sum_0^{t-1} {}^0L_{x+1/2} - t L_0 - \frac{t^2}{2} A}$$

(3) $$\log g = \frac{\sum_0^{t-1} {}^0L_{x+1/2} - t L_0 - \frac{t^2}{2} A}{c^{t+1/2} - c^{1/2} - (c-1)\left[t + \frac{t^2}{2} C_e\right]} (c-1)$$

(4) $$\log g = \frac{\sum_0^{t-1} x\, {}^0L_{x+1/2} - \frac{t^2-t}{2} L_0 - \frac{4t^3-3t^2-t}{12} A}{t c^{t+1/2} - \frac{c^{t+1/2} - c^{1/2}}{c-1} c - (c-1)\left[\frac{t^2-t}{2} + \frac{4t^3-3t^2-t}{12} C_e\right]} (c-1)$$

(5) $\log s = A - C_e \log g$

(6) $l_x = k\, s^x x^{x^2} g^{c^x}$ (EXTENDED GOMPERTZ-MAKEHAM FORMULA)

(7) $$\frac{t c^{t+1/2} - \frac{c^{t+1/2} - c^{1/2}}{c-1} c - (c-1)\left[\frac{t^2-t}{2} + \frac{4t^3-3t^2-t}{12} C_e + \frac{t^2-t}{48}(6t^2+2t-1) C_e^2\right]}{c^{t+1/2} - c^{1/2} - (c-1)\left[t + \frac{t^2}{2} C_e + \frac{4t^3-t}{24} C_e^2\right]}$$

$$= \frac{\sum_0^{t-1} x\, {}^0L_{x+1/2} - \frac{t^2-t}{2} L_0 - \frac{4t^3-3t^2-t}{12} A - \frac{t^2-t}{48}(6t^2+2t-1) B}{\sum_0^{t-1} {}^0L_{x+1/2} - t L_0 - \frac{t^2}{2} A - \frac{4t^3-t}{24} B}$$

(8) $$\log g = \frac{\sum_0^{t-1} {}^0L_{x+1/2} - t L_0 - \frac{t^2}{2} A - \frac{4t^3-t}{24} B}{c^{t+1/2} - c^{1/2} - (c-1)\left[t + \frac{t^2}{2} C_e + \frac{4t^3-t}{24} C_e^2\right]} (c-1)$$

(9) $$\log g = \frac{\sum_0^{t-1} x\, {}^0L_{x+1/2} - \frac{t^2-t}{2} L_0 - \frac{4t^3-3t^2-t}{12} A - \frac{t^2-t}{48}(6t^2+2t-1) B}{t c^{t+1/2} - \frac{c^{t+1/2} - c^{1/2}}{c-1} c - (c-1)\left[\frac{t^2-t}{2} + \frac{4t^3-3t^2-t}{12} C_e + \frac{t^2-t}{48}(6t^2+2t-1) C_e^2\right]} (c-1)$$

(10) $\log s = A - C_e \log g$

(11) $\log x = 1/2\left[B - C_e^2 \log g\right]$

NOTE: $A = \left[\frac{d L_x}{dx}\right]_{x=0}$

$B = \left[\frac{d^2 L_x}{dx^2}\right]_{x=0}$

OTHER CAPITAL LETTERS REPRESENT LOGARITHMS OF CORRESPONDING SMALL LETTERS.

from ICC Docket 14,700