Standardization of Information for Planning and Control: Graphical Representation of Management Accounting Information at AT&T during the 1920s

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Abstract

This study draws on archival resources and focuses on the standardization of graphical representations of managerial accounting information at AT&T in the United States during the 1920’s. The goal of this specialized form of organizational learning was partially to eliminate internal informational asymmetries that increased risk perceptions in management processes. In addition, the standardization of information presentation also strengthened top management’s capabilities to coordinate and control business activities in an enterprise of great scale and scope. The new methodologies also helped to shape the corporate culture by establishing norms with respect to the accumulation, analysis and application of firm-specific economic information.

Keywords: AT&T, Bell System, standardization, graphical representation, managerial accounting, organizational learning
1. **Introduction**

   After experiencing a near brush with bankruptcy in 1906-07 because of overbuilding, the giant American Telephone & Telegraph Company endeavored to tighten control over its fast-growing system consisting of 24 regional operating affiliates and Western Electric, a captive manufacturing subsidiary, by standardizing management practice and network technology. A bankers’ committee lead by the House of Morgan recruited Theodore N. Vail, a director and former executive, to preside over the corporate revival. Vail confronted a difficult challenge that derived from the decision taken in 1877 to run the company on license-franchise basis. Although this facilitated capital acquisition, it weakened central management’s ability to supervise the activities of affiliated enterprises in pursuing its two-pronged strategy involving the development of service in traffic-dense urban centers and the establishment of a continental, long-distance network.

   Several impediments slowed Vail’s drive to surmount a legacy of weak management. First, the firm began to experience competition in its local markets after the expiration of Alexander Graham Bell’s patents in 1893-94. Second it took many years for the parent to buy back sufficient stock in its affiliates to reassert strong influence. Third, significant internal informational asymmetries occluded top management’s clear vision of activity in important business segments. Fourth, unevenness in administrative practice and system technology also impaired the economical and efficient operation of the network at a time when both federal and state regulatory bodies began to extend their authority over the activities of the telephone company.
Like the approaches followed by Frederic Winslow Taylor and other scientific management proponents, Vail’s sought to promote corporate revival by standardizing the organization of work and the deployment of technology. The scope of the standardization initiative pervaded a wide range of company activities. It affected decisions relating to plant design, the selection of manufacturing plant, equipment and process. It defined uniform approaches for the distribution and installation of apparatus. It led to the establishment of mandatory routines and procedures for such operational activities as plant maintenance, traffic management and construction. It also infused business office activity through the specification of forms design, billing and collection procedures, and the acceptability of particular types of office equipment. Even health and safety practices became transformed through the scrutiny of the firm’s systematizers. This initiative afforded several advantages which enhanced the ability of top management to plan, monitor and assess operations.

In our study we focus on one aspect of the standardization process, namely the design of charts and graphs for depicting virtually every aspect of enterprise activity. The firm’s managers and engineers made extensive use of such media to provide visual representation to various numeric series. We examine how graphical representations of accounting and statistical information were developed as tools of managerial accounting in order to strengthen business management and control at AT&T during the 1920s. The firm devised graphical summarizations which aided management’s understanding of complex economic processes. The visual depiction of numeric series aided comprehension by communicating clearly such phenomenological attributes as the
direction, rate and magnitude of change, periodic patterns, points of inflexion, and gauges of relative magnitudes.

The standardization of graphs helped to promote operational efficiency in several ways. First, the employment of standard methods saved time and money as it reduced uncertainty and confusion by specifying a limited range of decision options. Second, standardized graphs diminished costly internal information asymmetries by creating unambiguous reports about operational performance that were well understood by all managerial echelons. Third, standard graphical formats reduced the number of acceptable alternatives and, thus, helped to lower data summary and analysis costs. Fourth, efficient forms design improved cognition through the simplification of complex business dynamics. Fifth, it strengthened management by helping to ensure that all levels of management had access to best practices and technologies. Sixth, standardization promoted efficiency and helped to define firm culture by specifying norms and accepted practices for guiding group action in resolving recurrent operational problems.

Scholarship dealing with managerial accounting history has focused on the nexus between knowledge and organization. Alfred D. Chandler in *The Visible Hand* explained how the development of the nation’s first big business—the railroads—would have been impossible without the early cost accounting standardization promoted by Albert Fink and others (Chandler, 1977). H. Thomas Johnson and Robert Kaplan in *Relevance Lost*, stressed how the problem of joint cost allocation and the difficulties of acquiring economically relevant information impeded managerial decision making at large, complex business organizations (Johnson and Kaplan, 1987). Margaret Levenstein in *Accounting for Growth* demonstrated how the information provided by the cost
accounting system at Dow Chemical Company changed as the firm made the transition to research-driven growth (Levinstein, 1998). Similarly, management accounting researchers have examined the development of cost constructs and their role in improving business decision processes (Boyns et al., 2004; Chatfield, 1974; Garner, 1954; Johnson, 1972; Kaplan, 1984; Johnson and Kaplan, 1987; MacDonald and Richardson, 2002; Previts and Merino, 1998; Fleischmann and Tyson, 1996, 1998; Solomons, 1968). Our study contributes to the latter body of literature by examining graphical artifacts developed and used within AT&T, as important early innovators of managerial accounting.

The modern use of graphs as a tool of communications with external users has been investigated by Vivien Beattie and Michael Jones (1994, 2000, 2002), who examine whether managements’ use of discretion in the selection of graphical forms is guided by attempts to manage external perceptions of economic performance. In focusing on the role of graphic representations as a way to control external information dissemination, these researchers assume the existence of numerous formats from which management will make their selections. In contrast, our study examines the role of graphs in internal communication and the compilation of a firm’s stock of knowledge.

Graphical representations can be classified as a genre of organizational communication produced by a firm’s internal reporting systems (Yates, 1989; Yates and Orlikowski, 1992). Each genre addressed a recurrent business situation by employing a communication style consistent in both form and substance, and genres can develop within either a particular firm or across an industry. At AT&T in the 1920’s, then, we
have a case study in the creation, standardization, and dispersion of a particular
communication genre: the transmission of operational business information graphically.

Scholars who have studied organizational learning patterns have long recognized
that institutional artifacts such as graphs and charts frequently incorporate learning from
past experience. Both Douglas North and James Beniger in their separate theoretical
studies describe iterative patterns whereby economic entities acquire knowledge about
the business environment and incorporate the new understanding into formal procedures
and practices to guide future action (Beniger, 1986; North, 1994). In explaining
comparative firm performance in high-tech industries, Alfred D. Chandler focused on the
effective ordering of internal learning capacities as a prerequisite for exploiting first
mover advantages from new scientific knowledge (Chandler, 1992). In the field of
management research, Robert M. Grant believes that successful knowledge integration
within the firm requires the development of common modes of interaction—rules,
routines, sequencing—all of which depend on the use of a common language and other
modes of inter-group expression (Grant, 1996). The high degree of common language
absorption, thus, facilitates the smooth transmission of information and knowledge
through complex organizational settings. Another management researcher, Michael
Dennis, conceived of statistics and accounting information as heuristic devices employed
by firms as a way of internally leveraging their substantial investment in knowledge
(Dennis, 1987). In this same vein, John Burns and Michael Scapens (2000), who focus
narrowly on the evolution of managerial accounting, see the process of innovation as
being bounded by the influence of “rules” (formal guidelines), ”routines” (actual
practices) and “institutions” (underlying assumptions about inter-group dynamics).
Innovation researchers would classify Burns’ and Scapens’ investigations into the genesis of new managerial accounting practices as studies of administrative innovations. Innovation can occur in either the design of a product or its delivery. Innovation can be radical or groundbreaking, overturning existing industry standards; or incremental, reflecting adaptations and developments that improve an earlier innovation or move it into a different arena. Though innovation is commonly thought of as being related to technology, it can also refer to changes and improvements in administrative or managerial practices. To succeed in a new industry or with a new product, firms may need to adapt their organizational practices, but by their very nature, administrative innovations usually lag technological innovations (Damanpour and Evan, 1984). As a firm constantly pushing technological barriers, AT&T’s challenge of managing businesses where proven measurement standards did not exist, which forced the firm to innovate administratively.

All of the researchers referenced above, whether focusing on managerial accounting innovation or general learning patterns of successful businesses, study the recursive interaction between firm culture, knowledge, and the tools used to codify, standardize, and transmit this knowledge. Our study, then, utilizes the development and diffusion of graphical tools by the accounting department as a lens to explore the role of knowledge institutionalization as a factor in the successful evolution of modern industrial organizations.

We explore the creation of standardized charts and graphs at AT&T, the artifacts of managerial accounting innovation which contributed to the creation of the firm’s knowledge base and common culture, in the following sections. In Section 2, we discuss
key features of its historical context that propelled AT&T’s push to standardize graphical applications in the 1920s. Section 3 describes the evolution of graphing techniques in general and provides evidence on AT&T’s efforts to standardize practices relating to graphing and visual representation of data in the 1920s as contained in its Statistical Bulletins. Section 4 concludes by discussing how our evidence relates to and amplifies our theoretical foundations.

2. **Impetus to Standardize Visual Reporting Techniques at AT&T**

   Founded in 1875, AT&T exploited its ownership of the Alexander Bell patents to enjoy a monopoly in the telecommunications markets until 1894 when the rights expired (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. In 1907, Bell had just over half (50.3%) of the national telephone market of 6.1 million phones. ii As the telephone market expanded, Bell was intent on increasing its share of the market by expanding the firm’s physical facilities and through acquisitions. The costs associated with this strategy were huge; the total telephone plant on the books in 1907 amounted to $503 million and grew to $742 million in 5 years, representing an annualized growth rate exceeding 8%. This growth rate was superseded by an over 10% annual increase in Bell’s customers: Bell’s market share of the nine million phones in service was 55.8% by 1912.

   The Bell System’s dominance became so apparent that the administration of President Woodrow Wilson intervened in 1913 to force the company under the “Kingsbury Commitment” to sell its interest in Western Union in an effort to boost competition (Danielian, 1939). Though the commitment further called for Bell to either
cease growth through acquisition or face anti-trust litigation, in actuality growth continued. By 1920, Bell phones totaling nearly 8.3 million, represented 61.5% of the market. If connecting and subscribing phones are included, the Bell System served 94% of the market. This growth strategy succeeded because the firm balanced the operating companies’ ability to respond flexibly to local needs while still coordinating national interconnections. Table 1 illustrates the rapid growth of the firm.

[Insert Table 1 about here]

Much of this growth occurred under the leadership of Theodore N. Vail who began his tenure as AT&T’s president in 1907. Under his “universal service” plan, Vail sought to broaden public access to telephone service that previously had been limited to the most wealthy individuals and companies. To reduce costs to achieve his goal, the telephone executive tightened controls over the firm’s widespread and loosely monitored operations by mandating greater standardization of system technology and management practice. The development of uniform management accounting reporting regimes proved difficult in a loosely knit holding company structure that had allowed a high degree of administrative autonomy among its many decentralized subsidiary units. Part of the problem stemmed from the early decision to build the company through exclusive regional franchises and later through corporate acquisitions from an aggressive program of horizontal expansion.

From Vail’s perspective, it was vital for effective planning and control that the information set available to management at the center of the firm mirrored that used in peripheral operations. Such consistency in information was critical in pursuing its two-prong strategy of growth originally propounded in the 1880s. First, the firm focused on
developing economies of scale operations by concentrating on building local service in fast-growing and traffic-dense cities. Second, it sought to exploit economies of scope by linking urban centers together through a nationwide, long-distance telephone network.

Standardization of reporting formats also responded to the new demands of both state and federal agencies which began to encroach on corporate prerogatives during the early decades of the 20th century. Although such oversight had initially centered in urban utility commissions such as the one that monitored telephone growth in Chicago, this began to change with the rapid rise of state regulatory boards in the period 1906-1915. In 1915, there were 45 state commissions in operation. These agencies exercised authority over rate setting in their jurisdictions and other critical corporate policies. Moreover, they increasingly demanded that telephone companies present evidence of economical (reasonable cost) and efficient (rapid system response and good transmission quality) service to justify the continuance of their valuable public franchises. On the national level, the Bell System first came under federal authority in the form of the Interstate Commerce Commission (ICC). The ICC required the Bell System to file uniform financial and statistical reports (reports whose design the firm helped to define).

From the beginning of his tenure, Vail had anticipated and welcomed federal regulation, stating “…there is no serious objection to such control, provided that it is intelligent, considerate, thorough, and just…” (AT&T, 1907 p. 18). Vail’s embrace of regulatory oversight was in part an attempt to forestall a breakup of the Bell System, but it also reflected operational realities (Danielian, 1939). Regulation implied both the need for and the rationale supporting standardization, a process that could help weave together an integrated national system from a sprawling enterprise.
Strong, centralized administrative controls were needed to bring order to Bell’s far-flung components. The System’s toll lines reached over 70,000 locations throughout the continental U.S., and in 1913, there were 8,133,017 stations, of which roughly a third were operated by independent or associated firms and not by the Bell System directly (AT&T, 1913). Regulation, though representing external interference in the firm’s affairs, was useful to Vail because it provided added force to management’s standardization efforts. The regulators’ value system favored a large-scale telephone network over local alternatives, a position that aligned regulators’ interests with those of Bell management’s and against parochial regional concerns. Moreover, standardization could help protect the overall system from suffering because of weakness in any one section (Liparito, 1989).

3. **Standardization of Graphical Reporting at AT&T in the 1920s**

The drive to standardize graphical representations was closely aligned with efforts to improve the application of managerial accounting at the Bell System. Although such depictions had long been used for engineering and business purposes, the firm had not established rules about acceptable forms and designs. This doubtless reflected the lack of consensus among world experts concerning best practices. In 1855, for example, the International Congress of Statistics, which attracted such experts as Adolphe Quetelet of Belgium’s National Observatory, Ernst Engel of the Prussian State Statistical Bureau, Alfred Marshall and Francis Y. Edgeworth of Cambridge University and Willard C. Brinton of the American Society of Mechanical Engineers, could not reach agreement about standardization. Although a unified theory did not emerge, the conclave increased the sensitivity of the problem for both statisticians and business leaders.
Interest in graphing took stronger hold in the Bell System’s corporate accounting department with the formation of a specialized statistics division in 1909 under the leadership of Malcolm Churchill Rorty. Although the scope of graphical analysis increased during Rorty’s tenure (lasting until 1917), the firm did not initially adopt formal methodological policies. This, however, changed with the 1920 reorganization of the statistics division by its new director (and eventual firm president), Walter Sherman Gifford. A gifted financial analyst and system designer, Gifford was well prepared for the task of statistical reorganization because of experience gained during World War I as chief statistician for the War Industries Board. His goal was to improve the quality and comprehensibility of vital information and to reduce transaction costs by increasing the efficiency of graph preparation through standard practices. Gifford increased the division’s reporting responsibilities and expanded the staff to over 100 professionals.

AT&T relied upon firm-wide conferences, which had begun in the 1880’s, as a means for standardizing practices. Originally informal exchanges between the statisticians and the consumers of their information from operating departments, the conferences evolved into platforms for Bell management to lay out standard routines and procedures that the operating subsidiaries were compelled to adopt (Liparito, 1989). In 1921, at the General Accounting Conference (GAC) the parent company specified both the types of requisite information and reporting formats (Belcher, 1921; Crunden, 1921).

Other corporate media also supported graphic standardization. The statistical department provided guidance about its new practices through articles in its technical bulletin. The *Bell System Technical Journal* published articles such as “A Method of Graphical Analysis” (Bateman 1922), or “Some Applications of Statistical Methods to
the Analysis of Physical and Engineering Data” (Shewhart, 1924). More general periodicals including *Long Lines* and the *Bell Telephone Quarterly* produced basic pieces such as “Making Facts and Figures Talk Plain English” (Grimes, 1924) which introduced graphing concepts and techniques to a lay audience.

Besides enhancing the development of a standardized firm language and knowledge base, the repetition of common topics in firm publications shows how important standardization was in the creation of a shared culture throughout the Bell System. The smallest details of operations were managed. At the 1929 Southeastern Bell Conference, for example, plans were distributed showing standard arrangements for office furniture. Bell management recognized that in such a large firm, geographically dispersed and with many different divisions, separate cultures (with associated practices and measurement norms) could arise. If this happened, conflicts of interest could develop which would cripple the firm. Dissimilar reporting practices would create internal informational asymmetries and perceptions of uncertainty that could undermine the effectiveness of central management’s efforts to coordinate and control the many interdependent elements of the giant enterprise. Standardized reporting tools, the creation of common institutions and a shared sense of identity across the firm militated against this.

In the standardization drive Statistical Bulletin No. 11 (AT&T, 1928) served as a primer in promoting graphical regularization and more effective design. One general rubric involved the need to achieve simplicity and visual appeal to enhance comprehensibility. While recognizing the value of single data series such as for the depiction of seasonal fluctuations, the bulletin stressed the desirability of showing several
related curves on the same grid to build up a chart’s informational richness and reveal correlations and other data relationships. Some of the rules seemed very narrow such as the requirement that a zero value always appear on the horizontal axis of a graph. For the most part, however, design advice pertained to more general issues. This was apparent in the definition of the broad classes of generic graphs acceptable for corporate purposes.

Statistical Bulletin No. 11 provided an overall framework of acceptable graphic methods. It illustrated the applications and interrelationships among various types of possible diagrammatic representations. Exhibit 1 identifies the three major categories of graphs and their interrelationships: (I) time-trend charts; (II) frequency charts and (III) bar charts.

In the remainder of this section we discuss these three main categories and their variants. We show how these graphical techniques were applied in several areas of managerial accounting as gleaned from presentations and papers at various internal conferences conducted by the firm in the 1920s, including the General Accounting Conferences, the Plant and Engineering Conferences, Traffic Conferences, Personnel Conferences, State Managers’ Conferences, and regional conferences such as the Southern Bell Telephone and Telegraph Company Plant Conferences. We then discuss standardization with respect to the physical construction of various graphs as disseminated through Statistical Bulletin No. 5.

[Insert Exhibit 1 about here]

3.a. Time Trend Charts

The extensively used time-trend charts were favored heavily in depicting comparisons such as between planned and actual performance in financial budgets (called
“provisional estimates” in the Bell System). A second time-trend variant involved depictions of the impact that one time series exerted on another closely related activity such as changes in new plants per station against total plant investment per station. A third category involved contrasts between current and previous performance for a given series such as number of toll calls per day contrasted by the use of a device such as a “superimposed curve” to reveal past patterns.

The push to employ time trend analyses in the 1920s paralleled major advances in statistical approaches to forecasting, budgeting and production planning (Chandar and Miranti, 2009). These analyses used to assess enterprise performance made heavy use of budget-actual comparisons. Exhibit 2 captures such comparative information for the both the number of stations and net station gains for the operating companies (Gherardi, 1929).

[Insert Exhibit 2 about here]

Time trend analysis also encouraged the use of data smoothing techniques to eliminate random or seasonal fluctuations that might mask important long-term trends (AT&T, 1921, Chandar and Miranti, 2009). Smoothing became critical in constraining the adverse effects of statistical noise or unusual fluctuations due to extraordinary items that could impede visualization of central tendencies. At the General Traffic Conference in 1925, for instance, the smoothed trend in traffic expense at the operating companies was depicted as shown in Exhibit 3 (Allen, 1925).

[Insert Exhibit 3 about here]

One time-trend sub-category was the cumulative curve chart that portrayed successive cumulative totals in a given data item from a specific date. This smoothed out
unusual fluctuations and permitted a better picture of the general trend. Exhibit 4 illustrates the use of this approach in plotting the trend in cumulative net gain in company stations in 1928 against similar curves for the prior two years.

[Insert Exhibit 4 about here]

Problems of scale differences in time trends were addressed through the application of a Double-Vertical-Scale Chart. Two series with materially different scales like “Net Telephone Earnings” and “Average Plant in Service” could be plotted on the same grid with the separate gauges presented on the left (vertical scale) and the right (secondary scale). The design emphasized the proportionality of the two scales so that the unit intervals for the two scales bear a constant relationship to each other. The Bell statisticians recognized that the interpretation of the significance of the relationship between two such series depends on the scales used. Because of the danger of manipulation through scalar adjustment, the firm recommended against using these tables for drawing inferences. Instead, they were used primarily as an approximate means for making comparison.

Another dual scale variant was the Secondary-Scale Chart. This blended a small and large series on a single scale. The interrelationship between the two component elements were shown by using a common attribute such as dollars or as a percentages of a common base measure. Exhibit 5 relates “Net Telephone Earnings” with a band of curves depicting 3% to 8% of “Average Plant Assets in Service” to reflect the range of values of telephone earnings as a percentage of plant assets. So, “Net Telephone Earnings” could be read both in dollars and as a percentage of “Average Plant Assets in Service”.

Guidance was also provided about how to resolve problems of adjusting time scales to accommodate extended periods using graphs of standard dimensions. The portion of the time scale representing the current period was enlarged and set off separately from the projection whose scale was compressed. This created a noticeable break with the change reflected in the shape and slope of the curve for the projected period. The charts may also incorporate a *logarithmic scale* to convey change in rates rather than amounts.

*Surface Charts* were time-trend charts in which the space between a continuous series curve and the horizontal axis was shaded to form a two-dimensional surface. Bulletin 11 notes that, “this shading emphasizes the relation to the base line and creates a stronger impression of quantity than would the curve alone” (AT&T, 1928, page 9). The “bold relief” that the shading provides, made the graphic element stand out visually when used as an insert or in a compilation with other charts. A zero line was necessary in these cases to avoid communicating “an entirely false impression of the magnitude and relative change of the series” (AT&T, 1928, page 9).

In a *Strata Chart*, value layers were stacked on top of each other. Each layer was measured from the top of the layer immediately below. Exhibit 6 shows a *strata chart* that decomposed plant additions for the Bell Operating Companies and its component parts used in reviewing production performance at the Plant and Engineering Conference in 1929 (Burcher, 1926). *Strata Charts* could also be structured using a percentage scale. For instance, revenues could be broken down into its proportional components.
The use of *Strata Charts* however, had several limitations. These charts were considered appropriate only when the component series was relatively stable. Irregularities disproportionately narrowed the strata “as there is a natural tendency for the eye to measure the width of a band at right angles to its general movement at any particular point” (AT&T, 1928, page 9). Moreover, an irregularity in single series would be reflected in all the higher strata. Misinterpretation could also occur if each series was interpreted with reference to the zero line. The bulletin therefore recommended that layers should be ordered from the most stable series to the least (as in Exhibit 6), with the most important series being placed at the bottom of a presentation so that it can be read from the zero line.

[Insert Exhibit 6 about here]

*Column Charts* employed vertical bars or columns to place in sharp contrast changes in sequential values. In contrast to the surface chart, the *column chart* tracked discrete data points. A zero line was important in the design of these charts because “the eye seeks the zero line as the base of comparison much more surely in the case of columns than in the case of curves” (AT&T, 1928 page 12).

In general the column chart was less subject to misinterpretation because its component sections were directly proportional to their values. *Composite-Column Charts* yielded better results than *Strata Charts* in representing time series trends for components elements. In addition there were many variants to the column chart including the *Contiguous-Column Chart*, the *Grouped-Column Chart* the *Deviation-Column Chart* (measuring variances) and *Range Charts*, which depicted a range of values on a regular basis such as daily high and low prices. Exhibit 7 is a *Deviation-Column Chart* used to
present the annual revenue effects of rate changes for exchange, toll, and total for the years 1916-25 and the budgeted amounts for 1926 at the Plant and Engineering Conference in Shawnee (Wilson, 1926).

Bell statisticians also experimented with *Combined Forms* that blended graphing forms to increase comprehension. One such example would be a chart that overlays total physical property (bar chart) with funded debt (line chart). The combined chart should be rooted in the simple graphical forms and not deviate from “the fundamental principles of presentation” (AT&T, 1928, page 16). Suggested applications included comparing actual and budgeted expenses in which monthly and cumulative figures shown on the same grid are distinguished by the use of different graphic forms.

When superimposed graphic forms could be confusing, Bell statisticians resorted to parallel presentation of separate grids. As illustrated in Exhibit 8, Southern Bell provided parallel presentations relating to the number of its employees eligible to receive pensions and its pension outlays over time (Sharp, 1926). Exhibit 8 also incorporates superimposed charts to provide additional information about pensioner service and disability.

3.b. Frequency Charts

*Frequency Charts* represented the second major graph category. Unlike time-trend charts, the horizontal scale of frequency charts allowed for the depiction of the distribution of groups or class intervals within a population. Examples might include the
number of shares per shareholder or age intervals in years. The vertical scale, on the other hand, represented the relative frequency expressed either in terms of numbers or percentages. This might include, for example, the number of stockholders corresponding to the number of shares per holder category on the horizontal axis or the percent of employees falling within each age interval. While many data point arrays are continuous such as the summarization of employee age segments, a histogram or “staircase” configuration could be used for discrete representations. This method was not considered useful, however, for comparing two frequency distributions. Instead, the alternative preferred was the employment of a continuous curve formed by reducing the intervals that separate each composite class.

3.c. Comparative bar charts

*Comparative Bar Charts*, unlike time-trend or frequency charts, had only one numerical scale. The lengths of the bars were proportional to their comparative values. Horizontal columns were considered to be more effective than vertical because they facilitated the parallel depiction of supplemental information. Because of their single scales, bar graphs were unsuitable for time series analysis. Moreover, because the width of the bar lacked interpretive significance, Bell statisticians did not include any secondary information within these areas that might cause confusion. These charts were prized for their ability to summarize significant information and provide a comprehensive picture of operations of a large, complex business. The company used this graphical form, as seen in Exhibit 9, to depict the total number of operating problems experienced in the different
parts of the exchange plant in the nation’s thirty largest cities during the fourth quarter of 1925 (Burcher, 1926).

[Insert Exhibit 9 about here]

Graded Bar Charts were used to depict bars either in ascending or descending order. Exhibit 10 illustrates the use of these for comparing plant repair expense (Burcher, 1926). Its principal advantage derived from the fact that “the graded bar chart directs attention primarily to the top and bottom items of an arranged list and so meets an important requirement of business graphics by emphasizing outstanding situations” (AT&T, 1928, page 21). Such an arrangement also permitted, by distinctive shading, the setting off of medians and quartiles. Although frequently useful in contrasting data, Bell statisticians remained concerned about the statistical validity of such comparisons.

[Insert Exhibit 10 about here]

The bar chart also evolved into many hybrid forms. A Bar-and-Symbol Chart allowed insertion of supplemental information on a bar chart by using a symbol such as a dot or diamond. This facilitated the making of comparisons with prior years (as in Exhibit 10), or with forecasts. A Percentage-Line-Bar-Chart compared a list of items with a requirement or estimate. Data was related to a common base such as in the instance of contrasts between net station gains expressed as a percentage of a provisional estimate. A Composite-Bar Chart segmented the bars to show a limited number of component elements such as charts dividing employment between men and women. Grouped-Bar Charts permitted simultaneous comparison of multiple items. One such example best illustrated through a single scale design, might involve the inter-corporate comparison of estimated growth percentages in plant and stations. Two-Directional Bar
Charts, on the other hand, better served cases using elements derived from different scales or those in which favorable-unfavorable differences predominate. Exhibit 11 is a two directional chart for measuring revenues, expenses and net revenues used by Southern Bell (Southern Bell Telephone and Telegraph Company, 1929).

[Insert Exhibit 11 about here]

3.d. Graph Construction

Through internal documents such as Statistical Bulletin No. 5, the Bell System also specified in great detail the methods to be employed in constructing charts, choosing grids for chart preparation, standardizing titles, scales and captions, and selecting gummed tapes and other materials to plot curves and mark off areas (AT&T, 1922). Through the special properties of the five standard grids alternatives, chart makers had some degree of flexibility in planning document lay out. Bulletin 5 not only provided detailed descriptions of specific grids but also identified the ideal circumstances for their use. For instance, Grid No. 2 was considered appropriate “when it is desired to compare current figures with the corresponding figures for the previous year, and where seasonal variation is not as important as the trend of the curve…” (AT&T 1922, page 3).

The firm provided close guidance on standardizing titles, captions and scales used in chart construction. Sheets containing words that appeared most frequently in various parts of the chart were pre-prepared using plain block letters with different fonts “in order to insure the greatest legibility…” and “to give proper balance between the various parts of the chart” (AT&T, 1922, page 4). The six sheets of words were grouped as Title Words (Sheet A), Title Letters, to enable formation of words not contained in Sheet A (Sheet B), Vertical Scale Captions such as thousands of dollars or number of stations.
(Sheet C), Curve Labels, such as total toll revenues or provisional estimate (Sheet D), numerical Vertical Scales, printed in strips which could be cut and pasted flush with the edges of the grid (Sheet E), and Time Scales representing years or months that were pre-formatted for use with specific grids. When the standardized sheets could not be used, the firm turned to draftsmen who were required to use Payzant pens of a specific size. A No. 2 Payzant pen was mandated to create title words which should be 0.45” in height and a No. 5 Payzant pen for vertical scale captions with letters that are 0.3” in height.

Prepared materials for use in constructing curve charts and areas were also itemized. The use of gum tape in four widths – 3/32”, 1/8”, ¼” and 3/8” – was advocated, with the two narrower ones available for use in forming curves and the two wider ones for preparing column charts. It was suggested that dash lines could be formed by cutting the tape. Two cross-hatched surfaces were prepared for use in constructing area trend charts. A single cross-hatched surface could be used to form a third area when turned at right angles.

The firm also specified the steps for constructing a chart using prepared or standard materials (see Exhibit 12). These included: (1) selecting and preparing the grid appropriate for the planned presentation, (2) plotting the curve, (3) applying the curve using gummed tape, rulers or ribbon pens, and (4) applying titles, captions and making slides.

[Insert Exhibit 12 about here]

The assembling of charts from standardized materials was called the “cut and paste method” and was believed to be superior to type written or hand constructed presentations for several reasons. It helped reduce the cost of constructing these charts in
two ways: (1) by reducing preparation times and (2) by eliminating the need for skilled
draftsman. Additionally, their use increased the speed with which charts could be
produced. Furthermore, the charts obtained by this process would be uniform in
appearance due to standardized curves, titles, scale captions, and other attributes. Finally,
this process proved greater flexibility in introducing any revisions.

4. Conclusion

It is clear that graphical approaches at AT&T resulted in standardized visual
reporting formats that were used extensively to summarize, rationalize and communicate
complex economic phenomena. By creating and disseminating the modalities for the
standardization of graphical constructs as much as possible, the firm sought to create a
shared language and meaning that could be used in internal communication, management
control and firm planning. This approach was intended to result in increased
transparency and was seen as a significant step in reducing internal informational
asymmetry, which was a major challenge in the control and coordination of such a
decentralized and complex firm. Standardized graphical communication was a key to
institutional learning as well and expressed the path dependency of knowledge within the
organization.

North proposed that the mental models of employees would dictate how the firm
approached learning. The location of learning informs its direction, and the Bell System,
a firm founded on technological innovation, turned naturally to science and mathematics
in its attempts to solve administrative and operational problems. Mathematical tools were
used to provide insights into problems of control associated with the rapid growth of the
firm in the early part of the twentieth century. As the firm rolled out new methods of
measuring results and predicting future developments, management attempted to create stability by codifying and standardizing the new practices. The shared language of the firm was not solely scientific, however. Indeed, financial performance measures (as opposed to customer satisfaction, production throughput, or quality control) were the prime measures used by the firm to assess success. Thus, while organizers of firm-wide conferences spoke about the importance of bringing advances in knowledge from operating companies to the attention of the firm overall, these conferences and related literature primarily ensured dissemination of standardized methodologies and formats. Standardization saved time and money, but by employing uniform goals throughout the firm, AT&T also limited future conflicts about what the goals of the business should be. That the shared measures of success were primarily financial can be seen by the examples chosen by the statistics department in Statistical Bulletin 11; of the 35 chart examples presented, 13 related to revenues or earnings and 12 displayed relationships between balance sheet items. The message with respect to graphical tools was consistent – performance results were measured financially, and the standardized measurement and representation of these results was a priority.

The rapidly developing role of statistics in communicating operational results had import beyond the design of reports; it also influenced the composition of employees. In some cases, the standardized reports diminished the need to find employees with specific skill sets, as when the need for trained draughtsmen to create charts was diminished by the creation of a “standard” tool kit included as part of Statistical Bulletin 5. In terms of accounting personnel, it was recognized that use of statistical tools required personnel who if not experts in statistics would not be intimidated by its use. The analysis of the
firm’s operational information demanded that firm accountants expand their skills beyond familiarity with accrual accounting; to help manage a technically innovative firm, accountants would be required to innovate when evaluating costs and their relationship to revenue.

AT&T’s use of graphics and statistical tools occurred at the intersection of accounting and operations management, and thus represents another debt owed by accountants to the field of scientific management. We find, however, that the use of statistics and graphics by AT&T’s accountants reveals more than a simple combining of knowledge across disciplines. The use of graphical tools by the accounting department at AT&T provides insight into incremental innovation. The firm innovated incrementally to create new administrative tools, and the bulletins produced by the firm’s statistical department show the diffusion of an administrative innovation and the creation of a firm’s knowledge base.

AT&T’s development of graphical approaches to management accounting information speaks to its culture of innovation. As a firm, AT&T was responsible for truly radical and path-breaking innovations, but its success with breakthrough scientific innovations can obscure the fact that the firm also innovated administratively. The experience of the Bell System also suggests that the adoption of administrative innovations is synergistic, that is, administrative innovations are more likely to diffuse throughout an organization when more than one such innovation is being developed. Hence, it is not an accident that the use of graphics as a managerial accounting control device occurred at the same time as the firm was developing an actuarial-based pension system or pioneering innovative depreciation methods. The path dependency of
knowledge is also clear; in the Bell System, the mathematical skills which allowed Bell
engineers to make technical advances in sound transmission were respected throughout
the firm and became embedded in its culture; the same statistical tools were employed in
technical, operational, and administrative areas. The development of graphical
communication modalities at AT&T represented the firm’s scientific and mathematical
roots and shows how administrative innovation was used to consolidate the firm’s
learning base.
References


American Telephone and Telegraph Company (AT&T). 1929. State Managers Conference of Southeastern Bell Telephone & Company, New Orleans


Table 1

<table>
<thead>
<tr>
<th>Year</th>
<th>Total Assets</th>
<th>Total Revenues</th>
<th>Miles of Wire</th>
<th>No. of Employees (excludes Western Electric &amp; Bell Labs)</th>
<th>No. of AT&amp;T Stockholders</th>
</tr>
</thead>
<tbody>
<tr>
<td>1900</td>
<td>230,226</td>
<td>46,386</td>
<td>1,962</td>
<td>37,067</td>
<td>23,469&lt;sup&gt;iii&lt;/sup&gt;</td>
</tr>
<tr>
<td>1910</td>
<td>753,324</td>
<td>165,613</td>
<td>11,642</td>
<td>120,311</td>
<td>40,381</td>
</tr>
<tr>
<td>1920</td>
<td>1,634,250</td>
<td>458,141</td>
<td>25,377</td>
<td>231,316</td>
<td>139,448</td>
</tr>
<tr>
<td>1930</td>
<td>5,000,196</td>
<td>1,151,965</td>
<td>76,248</td>
<td>324,343</td>
<td>567,694</td>
</tr>
</tbody>
</table>

Information from AT&T annual reports; numbers in 000’s, except for employees & stockholders

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<sup>i</sup> During the time period covered by our study, American Telephone and Telegraph Company (AT&T) was a holding company that dominated US telecommunications. Its primary constituents included: AT&T, the parent, which also operated the firm’s long-distance business; Western Electric, a captive manufacturing arm; the Bell Telephone Laboratories (formed in 1925); and several state and regional operating companies that concentrated on providing local and toll service. The term ‘Bell System’ was commonly used to denote the operating businesses of AT&T, which included the long lines division controlled by the company headquarters and its network of regional operating subsidiaries.

<sup>ii</sup> All data in this and following paragraphs are taken from Garnet (1985).

<sup>iii</sup> The Mann-Elkins Act of 1910 extended the ICC’s authority to include telecommunications firms, pipelines, and express companies; prior to this, the commission had only regulated railroads (Stehman, 1925). In addition to the ICC, by 1915, 40 states had formed regulatory agencies to monitor the activities of natural monopolies in transportation, communication, and power generation (Symkay 1955).

<sup>iv</sup> The growing interest in this topic among US business leaders was reflected in the success of Brinton’s pioneering volume in 1914 entitled, *Graphic Methods for Presenting Fact* (Brinton, 1914).

<sup>v</sup> The conferences were also recognized as providing a valuable opportunity for individual operating companies to present new information (for example, best practices) to the firm as a whole.

<sup>vi</sup> The provisional estimates, or regional capital budgets, were five year forecasts that were first instituted in 1922. They were based on local market studies or commercial surveys, local switching station evaluations or basic plans, and district revenue analysis which determined the different mix of services or fundamental plans. These provisional estimates were the main informational linkages from the operating companies to the headquarters where they were used to develop a corporate-wide financial plan.

<sup>viii</sup> Number of shareholders at December 31, 1907, the earliest count of shareholders mentioned in annual report.