For the Record: The Embodiment of Organizational Memory, 1850-1920

JoAnne Yates
Massachusetts Institute of Technology

One of a firm's key organizational capabilities is an active organizational memory that allows it to store and retrieve knowledge of facts, processes, or experiences. A review of the recent literature on organizational memory shows that there are widely varying views of its nature, locus, and influence [21]. The concept of an organizational--as opposed to individual--memory is viewed by some as purely metaphorical, by others as the aggregation of individual memories, and by yet others as an independent capability of the organization itself. Scholars also have suggested various repositories of organizational memory, including the minds of individuals; organizational culture, processes, structures, and roles; and the paper or computer files of individuals and organizations. Finally, scholars see organizational memory as both a useful capability necessary to allow an organization to learn from the past and as a drag that ties an organization to the past, thus preventing it from innovating.

This paper provides a historical study of the evolution of one significant repository of organizational memory, the written record, during a key period of change in business enterprises. Organizational memory in American firms changed radically in the late nineteenth and early twentieth centuries, driven by the growth of firms and major changes in the nature of management, culminating with the emergence of the systematic management philosophy. A major tenet of that philosophy was that rational management of firms required a reasonably complete and permanent embodiment of organizational memory independent of specific individuals. Under the influence of this philosophy and its precursors, managers established systems of written communication in part as repositories for corporate memory intended to facilitate the systematic use of the past to serve the present. This paper uses both published literature and archival materials from two manufacturing firms to trace the evolution of the internal communication system as an embodiment of organizational memory.[1]

---

[1]An earlier version of this paper was presented at the 1988 meeting of the Economic and Business History Society. The paper draws heavily on material presented in a different context in [24].

BUSINESS AND ECONOMIC HISTORY, Second Series, Volume Nineteen, 1990.
 ISSN 0849-6825.

Precursors of Systematic Management

In the early nineteenth century, organizational memory in American firms consisted of the memories of individuals, simple routines, and very limited records. Most firms were managed by their owners, who carried much of the knowledge of business methods and past successes and failures in their own heads. These owner/managers were often aided by skilled artisans, who in turn carried most of the knowledge of technical methods in their heads and hands. Both owners and skilled employees applied their knowledge through simple standard procedures and through oral orders. This knowledge could be passed on only by prolonged apprenticeship, either technical or managerial.

Written records consisted primarily of simple accounts of financial transactions and long-distance correspondence. While these records constituted a more permanent form of organizational memory than the inherently transient individual memory, they were limited in their extent and usefulness for shaping the future. For the most part, the journals and ledgers simply recorded the firm's external transactions. Such accounts allowed a firm to determine overall profits, but they revealed little about the firm's management of costs or operations. Most correspondence concerned specific transactions, primarily with external parties. Correspondence with partners and employees took place only when required by distance. It was unsystematic and not easily accessible for later reference.

The small textile factories that appeared in New England beginning in the early nineteenth century instituted some preliminary advances in preserving an organizational memory of internal activities. These factories combined several production processes in a single location, with each process run by a foreman, who in turn reported to the owner or to an "agent" who managed the factory for absent owner(s) [10, 15, 20]. The owners found that they needed new mechanisms for controlling production processes. Some of them developed primitive cost accounts for recording previously documented internal transactions and computing cost per unit of output [10, 20]. These accounts preserved an organizational memory of operations useful in assessing current performance against past performance, foreshadowing much that was to come.

Nevertheless, other aspects of factory life, such as individual jobs and organizational procedures, went undocumented. Some factories had printed lists of rules, made up by the owners or factory managers and posted throughout the factory. These rules did not really serve as an active repository of knowledge about the workers' jobs, however, for Daniel Nelson notes that with minor exceptions, "the shop rules were largely what the foreman made them" [15, pp. 3-4]. It remained for another industry--railroads--to make innovations in this aspect of organizational memory.

The railroads faced the need to maintain an active organizational memory independent of individuals. The need was precipitated by issues of safety and efficiency in a geographically dispersed and dangerous business [24]. The earliest railroads had only a single track, so as soon as more than one engine was running on a line, the danger of collision was high. Moreover, the essential dispersion of the business precluded centralized

personal supervision of all employees. From the beginning, timetables and basic rules for coordinating traffic and conducting business were printed for employees. Collisions such as those suffered in 1841 by the Western Railroad in Massachusetts reinforced the importance of depending on this documentation rather than on individual judgment [19]. The desire for efficiency drove innovations in upward reporting. As Alfred D. Chandler has shown, the New York and Erie Railroad's Daniel McCallum made major innovations in operational reporting and cost accounting beginning in the 1850s [2]. Railroad advances in this area, like those already realized in textile factories, created a written organizational memory of operations and outcomes to serve as the basis for controlling large firms.

By the late nineteenth century, the need to document organizational memory of rules, procedures, operations, and outcomes had been established in a few pockets of the economy--such as textile factories and railroads--but neither the concept nor the organizational capability was very widespread.

Systematic Management: Transcending Individual Memory

Widespread documentation of organizational memory in American firms awaited the emergence of the systematic management movement in the 1880s. Manufacturing firms grew in the late nineteenth century but initially this growth was not accompanied by significant changes in management methods. The firms still were run by the ad hoc methods of the past, resulting in confusion and disorder. While the hierarchy had grown both vertically and horizontally, coordination had broken down [11, 12]. Production itself generally was controlled by foremen or job contractors who operated autonomously on most matters [15]. Middle and upper managers had virtually no tools for controlling what occurred on the production floor. Moreover, they lacked methods for coordinating their own actions to make efficient the horizontal flow of materials through the production process. The profits expected from expansion often failed to materialize.

In response to these problems, managers began a "search for order and integration" that Joseph Litterer has called systematic management [11, 12, 13]. In the 1870s a literature on management theory and technique began to appear. Litterer has described the systematic management movement as an attempt to "put 'method' into the management of firms to avoid confusion and waste, to promote co-ordination and to re-establish effective control by top management" [11, p. 370]. These "systematizers" shared the belief that method or system needed to replace "the old slipshod way of our forefathers" [12, p. 473] in order to achieve efficiency and profitability.

The broad and somewhat amorphous movement that emerged from this literature over the next several decades, of which the better known scientific management of Frederick W. Taylor was a part, was grounded in a few basic principles. One of these was "a continuing attempt to transcend dependence upon the skills, memory, or capacity of any single individual" [9, p. 64]. As long as knowledge of shop floor and administrative processes

and outcomes was diffused among many individuals, the comprehensive overview necessary to achieve efficient coordination was impossible. Moreover, the loss of an individual meant the loss of important company knowledge. Organizational memory needed to be able to bridge time as well as space.

Thus the knowledge and skills of individuals from the lowliest worker to the head of the firm needed to exist independently of that individual. Concerning the lowest level of the hierarchy, Frederick Taylor noted that this required "The deliberate gathering in on the part of those on management's side of all the great mass of traditional knowledge, which in the past has been in the heads of the workmen, and in the physical skill and knack of the workman, which he has acquired through years of experience" [17, p. 265]. Most of the systematizers of the 1880s and 1890s were more concerned with capturing the knowledge of foremen, supervisors, and managers. H. L. Arnold, for example, noted that as the hierarchy grew, each manager became "the depository of a mass of unrecorded information not possessed" by those at higher levels, and the firm became "every day more and more an assemblage of independent powers," protecting their knowledge from others and failing to achieve efficient coordination [12, p. 472]. Alexander Hamilton Church was concerned with the highest level of the hierarchy: "How many concerns languish when the care of their founder is withdrawn and why? Simply because he cannot transfer the multitudinous details of organization from his memory to that of a successor" [12, p. 471].

Systematizers such as Henry Metcalfe argued that the solution to these problems lay in recording knowledge:

> Now, administration without records is like music without notes--by ear. Good as far as it goes--which is but a little way--it bequethes nothing to the future. Except in the very rudest industries, carried on as if from hand to mouth, all recognize that the present must prepare for the demands of the future, and hence records, more or less elaborate, are kept [14, p. 440].

Records and reports documented both procedures and outcomes. They recorded and transmitted existing knowledge as well as provided data on the basis of which further analysis could be made. As Church stated, "Under rational management the accumulation of experience and its systematic use and application, form the first fighting line" [13, p. 223].

The desire to transcend the vulnerability of individual skills and memory by establishing a more enduring embodiment of organizational memory was an important factor in the explosion of internal communication within firms over the next few decades. Policies and procedures were documented and disseminated via downward communication, and operating information was documented and drawn up the hierarchy via records and reports. Developments in filing systems and other repositories improved the firm's capacity for accessible storage of this form of organizational memory.

Documenting Policies and Procedures

Communicating policies, procedures, and orders in writing made them available for future reference [26]. One systematizer noted,

> As to the form that an order should take, the only satisfactory form is the written order . . . . If the request is in writing neither [the sender nor the recipient] is obliged to depend on his memory. The written order removes all chance of dispute as to its conditions, neither can there be a question of the authority of an order which bears the signature of the head of a department . . . . Another great advantage of the written order is that the head of a department may keep copies and follow-up each order to see that it is properly executed [7, pp. 19-20].

The written order, whether to an individual or to the whole company, became an embodiment of organizational memory independent of the individuals involved, available for whatever future needs might arise.

Documenting rules seemed unnecessary to an executive of the Scovill Manufacturing Company, a small fabricator of brass products, as late as 1887:

> We have never had any shop rules printed. There is a general understanding that ten hours constitute a day's work and that the hands are expected to do a day's work if they get a day's pay. Each department is under the direction of a foreman, in whom we trust and who sees that the hands are industrious and attend to their business. If they do not do it, he sends them off and gets others . . . . We do not think printed rules amount to anything unless there is somebody around constantly to enforce them and if such a person is around printed forms can be dispensed with [1, p. 205].

Only when the systematic management philosophy found its way into the company's management in the early twentieth century did this policy change. By 1905 a member of a new generation of management at the company, J. H. Goss, presented a series of recommendations for overcoming inefficiencies by systematizing a particular function in the company.[2] In this report, one of his recommendations was to record policies and issue written regulations so that "there could be no chance for misunderstanding due to changes of one sort or another." From then on, an ever increasing flow of written orders, policies, and procedures was issued from various levels of management.

---

[2]J. H. Goss, "Report Made to the General Manager on Timekeeping in the Departments," 22 February 1905, in "Notices, 1905-1907," Case 34, Scovill II, Baker Library, Harvard Business School. (Hereafter Scovill II/34, 2/22/1905. Further references to documents in this collection are indicated parenthetically.)

Driven by safety concerns, Du Pont had a posted rule against matches in its explosives plant, but it documented no other rules and policies before Du Pont reorganized in 1902.[3] Even communication with its many agents throughout the country was handled via individual letters dealing with specific cases [e.g., Du Pont 500/I/I/B/#307-310]. Only agency contracts were standardized and printed in a form intended to be relatively permanent. The documentation of rules and procedures began earlier at the Repauno Chemical Company, founded in 1880 by a member of the du Pont family who broke off from the main firm and established the separate but partially Du Pont-owned firm [3, 23]. By at least 1895, Lammot du Pont and the other executives at Repauno, early systematizers [5, 22], issued circular letters to agents, both standardizing procedures and documenting them for future reference [Du Pont 500/II/2/#991, 2/20/1895].

After Du Pont was reorganized in 1902 [3], it absorbed Repauno Chemical Company and built its High Explosives Operating Department (HEOD) around it. Thus HEOD inherited a tradition of documenting policies and procedures via bulletins and circular letters. The department used such communications heavily in systematizing activities at the many plants that Du Pont bought up in the wake of the reorganization. Moreover, developments in the format and storage of these circulars reinforced their role in documenting policies for future reference. Beginning in 1906 and 1907, HEOD headquarters numbered each circular consecutively and also indicated a subject-based file number under which it was to be stored [Du Pont 500/II/2/#550-551, 553-554]. Within a few years, methods of filing the circulars at each of the plants were mandated as well, "in order that we may be sure that all plants have a complete and permanent file of circular letters" [Du Pont 500/II/2/#550, 7/8/1910]. Even the methods of indexing that file were prescribed, to "allow easy and quick reference to any particular letter that is desired." In the Du Pont of the early twentieth century an accessible and relatively permanent organizational memory was considered an important organizational capability.

However complete the storage system for circular letters, such individual communications on different topics were, by nature, fragmentary. Eventually manufacturing firms supplemented them with a more comprehensive embodiment of organizational memory: manuals that brought together all of the rules and procedures for a firm or department. These manuals were generally, as one systematizer noted, "planned to be permanent and to be in such complete form that a new man in the department, after reading the instructions would have a thorough understanding of the duties and responsibilities of it" [18]. Furthermore, by compiling all of the rules and procedures in a single place, the manual

---

[3]The match rule may be found in Accession 504, Series A, Box #20, Hagley Museum and Library, Wilmington, Delaware. (Hereafter Du Pont 504/A/#20. Further references to documents from Du Pont materials will be indicated parenthetically. Materials from Hagley's Longwood Manuscripts are designated Du Pont LMss.)

made it easier for managers to analyze and update them. These manuals could be in bound or loose-leaf form [e.g., 6]. The former seemed more permanent, but had to be replaced periodically. The latter, which were considered more modern, created a more dynamic organizational memory that could be updated as needed.

In Du Pont's HEOD, which had the benefit of a long history of circular letters within Repauno, a loose-leaf manual called HOW appeared as early as 1907 [Du Pont LMss 10/A/418/#13]. Scovill only issued its first manuals for workers and foremen in 1918 [Scovill II/34]. While the bound employees' manuals covered all company workers, the looseleaf foremen's manuals were made and updated as needed for a given department. Manuals took the embodiment of organizational memory a step further than circular letters by attempting comprehensive documentation of policies and procedures. Their form emphasized either their permanence (bound) or their modernity (loose-leaf).

Documenting Operating Information

Reports recorded operating results for future reference [24]. One of the principal tenets of systematic management was the need for each level of management to monitor, analyze, and compare the performance at lower levels with the ultimate aim of achieving greater efficiency. Routine reporting systems were established to pull various types of information up the hierarchy for use in managerial decision making. Operating information once known only by foremen, if at all, was now recorded and reported to higher levels. As Alexander Hamilton Church put it, "The object of the commercial, or, as it might also be termed, the administrative organization scheme, should be to collect knowledge of what is going forward, not merely qualitatively, but quantitatively: It should also provide the means of regulating as well as the means of recording" [13, p. 213]. Clearly this scheme required that data be collected and preserved in consistent form for later analysis and comparison.

Before the early twentieth century, records and reports at Scovill were limited and almost exclusively financial. At the same time that circular letters began to document policies and procedures, records and reports began to proliferate. Beginning in 1907 J. H. Goss instituted various records and tabular reports on costs [Scovill II/333]. At the end of each year a summary was compiled for each cost category, with the comparable data for the previous year provided in the adjacent column for comparison. Such comparisons could only be made when the figures were recorded and stored in organizational memory for retrieval when needed. Building an organizational memory of operating data allowed types of analysis never before possible.

By the end of World War I, records and reports were widespread in the firm; in 1919 over 200 reports were routinely sent to the general superintendent's office [Scovill II/34]. The reporting system had grown to such an extent that in 1918 a Statistics Office was created to rationalize it. In statistician E. H. Davis's initial report on his office's goals, he described the process by which records were made at the production level, transcribed

in more permanent form, then summarized into reports, eventually building "a sort of numerical history" [Scovill II/34, 8/13/1918]. "The problem of the present day is," he stated, the need "for a more reliable and comprehensive application of this traditional process." As a first stage in rationalizing the process, "the statistical office will become a clearing house of reference as to what current records actually exist, and where they are available." His ultimate goal was to make the office the actual "depository of carbon copies of many such reports or records, as they are made; and thus a general body of statistical data covering the entire plant will be accumulated." Only after establishing the firm's statistical memory could Davis begin to develop more sophisticated statistical capabilities.

The development of reporting at Du Pont was less gradual than that at Scovill. Repauno was well ahead of Du Pont before its 1902 change in management, and Du Pont adopted many of its methods at that point. For example, while most Du Pont sales agents had no reporting requirements beyond their quarterly accounts, Repauno sales agents were required to submit monthly credit reports and almost daily trade reports [Du Pont 500/II/2/#989/A8]. In the post-1902 Du Pont, the sales department adopted and elaborated on Repauno's reporting system. Within a decade the department had organized a sales record division concerned exclusively with maintaining a card reference system with "all information concerning the smallest unit (customer) in one place for Quick reference--and Follow-up of trade and salesmen" [Du Pont 500/II/3/#127]. This system was essentially a card data base of sales information--a constantly updated, readily accessible organizational memory.

Systems for collecting and monitoring manufacturing data were also imported from Repauno and expanded. By 1907 HEOD headquarters demanded yearly, monthly, weekly, and even daily reports from each plant. These reports, a representative of headquarters explained to plant superintendents at a 1914 meeting, were both "for the Superintendent's guidance" in running the plant, and "for the Main Office records" [Du Pont 500/II/2/#585/mtg. #36]. In the latter function, they served as the basis for the many comparisons headquarters made of the various dynamite plants [e.g., Du Pont 500/II/2/#577/ mtg. #33]. The superintendents often complained about the number of reports demanded of them, no doubt both because time was required to make out such reports and because the organizational memory these reports created enabled headquarters to evaluate their performance more specifically. Their resentment was expressed, for example, in the following satiric item in a humorous newsletter created for one superintendents' meeting:

> The Chemical Division [of HEOD] is just about to distribute new forms known as the Hourly Operating Reports. Every plant operation is covered from the Nitration Process to tool sharpening and belt lacing. Each form contains about 600 spaces to be filled in and the reports are to be forwarded to the Wilmington Office hourly by special messenger, where they will be carefully filed for the benefit of Posterity [8].

Far from serving just posterity, however these reports helped headquarters analyze and compare performance both between plants and over time.

In Scovill, Du Pont, and many other systematized companies of the early twentieth century, records and reports had evolved as a mechanism for transcending the individual memory as well as for regaining control over the production process. Their contribution to organizational memory was increasingly in numerical form, allowing new kinds of analysis and progressive improvements on the basis of this analysis.

Making Organizational Memory Accessible

In the recording of both policies and operational data, storage of the documents played an important role in their functionality. Only if they were accessible could they fulfill their purpose. Nineteenth century systems of storage, including bound books, pigeonholes, and letter boxes, were old and inconvenient. They separated outgoing from incoming items and were organized in different ways. These old systems came under great pressure both from increased external correspondence and from the evolution of internal documentation. Around the turn of the century they gave way to the vertical files we still use today [24, 25]. As one filing textbook explained, "It will already have become evident that it is impossible to sever the problem of finding a good practicable filing system from the whole problem of business organization" [4, p. 14]. Filing documents accessibly was critical to maintaining an efficient organizational memory.

Filing systems were adopted in the early twentieth century in both Scovill and Du Pont. An exchange between Scovill's New York store and its headquarters that took place at the end of 1913, just before vertical filing was adopted, illustrated the problems with the old systems: "Replying to yours of the 24th regarding terms to Jos. L. Porter & Co., we are sorry that our record for 1908 is quite as inaccessible as yours seem to be, and, unless you consider the matter of enough importance, you will let the matter pass" [Scovill I/558, 12/26/1913]. One day later headquarters announced that on the first day of 1914 the company would institute its new system of vertical filing [Scovill I/558, 12/27/1913]. The new files were organized by subject, rather than by chronology or source, making the firm's records and correspondence a much more functional organizational memory.

Again, Du Pont followed Repauno's lead. Repauno had adopted vertical filing by 1901, before the 1902 reorganization that brought it into Du Pont [Du Pont 500/II/2/#986]. We have already seen the importance that the HEOD placed on accessible filing of circular letters and bulletins at the various plants and of statistical records and reports in the Statistics Office. With the enormous number of records and reports being created there, in HEOD headquarters, in the sales department, and elsewhere in the firm, space and long-term storage soon became a concern. By at least 1907 Du Pont had established a records center called the Hall of Records to serve as "a storage place for books, records and valuable papers which have ceased to be of active use but which, for good reasons, it is desirable to keep" [Du Pont LMss 10/418/#5, 5/11/1922]. Thus while some

outdated records were disposed of, others were stored to provide a more permanent corporate memory.

Embodying Organizational Memory

During the late nineteenth and early twentieth centuries, managers concerned with systematizing their firms came to recognize the importance of establishing an organizational memory independent of the individuals involved. Transactions with the external world had long been documented for later reference; driven by growth and the spread of systematic management, firms now documented internal knowledge just as scrupulously. The impulse towards relatively permanent documentation of policies and procedures and of operating data transformed internal record-keeping and communication. The files became an important repository for the firm's knowledge about itself. The nature (and consequently uses) as well as the amount of recorded knowledge changed.

Recording policies and procedures allowed them to be analyzed as a whole and changed as needed for better efficiency and control. Scholars such as David Noble have seen this process as an aggressive attempt by managers to oppress the working class: "As managers in industry, engineers now undertook to expropriate and systematize the intelligence of production, to place it in the hands and handbooks of management, and to use it to reorganize the production process for maximum output and profit" [17, p. 260]. Yet this conversion of individual knowledge into firm knowledge was not limited to the workers; it occurred in the managerial ranks as well. Even with its potential for abuse, this capability was an important one in converting small family businesses dependent on the founder into ongoing enterprises in which actions were systematically coordinated for efficiency. Now the firm could continue even as individuals came and went.

Documenting operational information in records and reports created a data base of information susceptible to analysis. Using such data, managers could help identify more and less efficient processes and individuals. Decisions could now be based on statistics rather than intuition. This abstraction of reality also had its potential for abuse, since numbers could conceal non-quantifiable concerns. Nevertheless, the recorded information gave each level of management a tool for understanding and controlling what went on at lower levels. It helped reintegrate the firm vertically, as systematizers desired. It was an organizational capability basic to the large firm as it has evolved in this century.

References

1. Philip W. Bishop, unpublished manuscript history of Scovill (c. 1952), in Scovill Archives, Baker Library, Harvard Business School, Cambridge, MA.
2. Alfred D. Chandler, Jr., *The Visible Hand: The Managerial Revolution in American Business* (Cambridge, MA, 1977).
3. _____ and Stephen Salsbury, *Pierre S. du Pont and the Making of the Modern Corporation* (New York, 1971).

4. Edward A. Cope, *Filing Systems: Their Principles and Their Application to Modern Office Requirements* (London and New York, [1913]).
5. Ernest Dale and Charles Meloy, "Hamilton MacFarland Barksdale and the Du Pont Contributions to Systematic Management," *Business History Review*, 36 (Summer 1962), 131-144.
6. Lee Galloway, *Organization and Management*, Vol. II, *Modern Business* (New York, 1914).
7. James B. Griffith, ed., *Systematizing*, 2 vols. (Detroit, 1905), 19-20.
8. "The H.E.O.D. Knocker," January 28, 1909, a newsletter in the Hagley Museum and Library imprints collection, Wilmington, DE.
9. Marian Jelinek, "Toward Systematic Management: Alexander Hamilton Church," *Business History Review*, 54 (Spring 1980), 63-79.
10. H. Thomas Johnson and Robert S. Kaplan, *Relevance Lost: The Rise and Fall of Management Accounting* (Boston, 1987).
11. Joseph Litterer, "Systematic Management: Design for Organizational Recoupling in American Manufacturing Firms," *Business History Review*, 37 (Winter 1963), 369-91.
12. _____, "Systematic Management: The Search for Order and Integration," *Business History Review*, 35 (Winter 1961), 461-76.
13. _____, "Alexander Hamilton Church and the Development of Modern Management," *Business History Review* 35, (Summer 1961), 211-25.
14. Henry Metcalfe, "The Shop-Order System of Accounts," *Transactions of the American Society of Mechanical Engineers*, 7 (May 1886 meeting), 440-46.
15. Daniel Nelson, *Managers and Workers: Origins of the New Factory System in the United States, 1880-1920* (Madison, WI, 1978).
16. _____, "Scientific Management, Systematic Management, and Labor, 1880-1915," *Business History Review*, 48 (Winter 1974), 479-500.
17. David F. Noble, *America by Design: Science, Technology, and the Rise of Corporate Capitalism* (New York, 1977).
18. H.A. Russell, "Keeping Track of Work in Process," *Iron Age*, 98 (July 6, 1916), 8.
19. Stephen Salsbury, *The State, the Investor, and the Railroad: Boston & Albany, 1825-1867* (Cambridge, MA 1967).
20. Barbara M. Tucker, "The Merchant, the Manufacturer, and the Factory Manager: The Case of Samuel Slater," *Business History Review*, 55 (Autumn 1981), 297-313.
21. James P. Walsh and Gerardo Rivera Ungson, "Organizational Memory: Structure, Functions, and Applications," unpublished working paper, Amos Tuck School of Business Administration, 1990.
22. Norman B. Wilkinson, "In Anticipation of Frederick W. Taylor: A Study of Work by Lammot du Pont, 1872," *Technology and Culture*, 6 (Spring 1965), 208-221.
23. _____, *Lammot du Pont and the American Explosives Industry, 1850-1884* (Charlottesville, VA, 1984).
24. JoAnne Yates, *Control through Communication: The Rise of System in American Management* (Baltimore, 1989).
25. _____, "From Press Book and Pigeonhole to Vertical Filing: Revolution in Storage and Access Systems for Correspondence," *Journal of Business Communication*, 19 (Summer 1982), 5-26.