

A Framework for Understanding Information Ecosystems in Firms and Industries

James W. Cortada

Historians interested in the history of firms or industries deal with complex and varied communities that operate within these two collections of organizations. These communities can consist of sales and production within a firm, for example, or a collection of companies that collaborate and compete within an industry. Each plays a different role, some collaborative, others at cross-purposes. But all operate in an environment in which information is collected, analyzed and used, and influence their interactions within a firm and across an industry. Shared missions, understood objectives, and economic incentives are all communicated and understood through the acquisition and transmission of information. In short, information is the glue that binds organizations together.¹ Understanding the informational ecosystems of both firms and industries is thus essential for the historian. Without such an appreciation, one cannot understand what went on in these organizations, how people were motivated and influenced by events, or even on a mundane level, what individuals did on a day-to-day basis, and why. Because the study of the history of information in business remains underdeveloped, this paper defines concepts historians need to understand, discusses challenges faced in the study of business information, and suggests approaches for this type of research.

Business historians are beginning to study the role of information in businesses and industries, leading to various approaches. For example, Lisa Bud-Frierman emphasizes the importance of the “information infrastructure,”² while JoAnne Yates, who has studied the role of information both in companies and in one industry, is partial to the development of systematic managerial practices that promoted efficiency of operations at the firm level, with a particular emphasis on the role of communications within an enterprise. She is also sympathetic to the use of theoretical constructs.³ Students of industries and international organizations emphasize information flows across spaces, economies, and firms.⁴

In an earlier discussion about the shaping of information’s historiography, I suggested five questions relevant to the study of firms and their industries, and that address our interests in information ecosystems and infrastructures. Briefly, they are repeated, because they apply just as much to the history of firms and their industries:

1. What media and mediums were used to collect and store information in many different societies and times, or in different firms and industries?
2. By profession, job, or other human activity, what information was collected, used, and shared?
3. What were the patterns of adoption and the use of information over time?
4. How did the use of information affect the work and lives of specific individuals, and of groups? In our case, this question also applies to firms, associations, and whole industries.

5. What other historical discourses should be viewed as information history? This question can apply to the adoption of new technologies, traditional business, and economic histories as well.⁵

Definitions Central to the Study of Information in Business History

Key to a useful paradigm are the concepts of *information ecosystems*, *information infrastructures*, and *information flows*. Because the definition of what constitutes an *industry* is also subject to imprecise definition, it too needs clarification. All are related, yet have distinct meanings and purposes, so understanding how they “fit together” is essential in any construction of a framework of information history in a business arena. To make the discussion simple, I define the term *framework* as a loosely structured approach to the study of a subject, offering a path, possibly a map, for organizing the exploration of an idea or topic. It serves merely as a way to get to a sensible account of events, causes, and consequences. A framework has built into it assumptions about what might be discovered, and possibly hypotheses to be challenged or proved. The purpose of the framework is transitory, a temporary intellectual scaffolding to assist in the identification, in our case, of what to study in the way of information’s history in business.

For our purposes, the dominant, overarching concept to embrace is that of “information ecosystems.” Elsewhere, I have defined an information ecosystem as: “a collection of knowledge, experts and users much as academics think of a discipline (i.e., economics, history, or physics), but with the important difference that this body of knowledge and associated communities were far broader (larger too) than an academic discipline, the latter which would be more populated with academics and R&D practitioners in government and corporations.”⁶

Over time information ecosystems have become denser and larger. Density in business is characterized by more information, current knowledge of relevant technologies, and activities involving a greater variety of participants (industries, vendors, public agencies, schools, and universities). The use of foreign and domestic published sources of information grew as literacy and the quantity and variety of publications increased, along with expanded experience with international and local training. Learning experiences integrated across borders, such as what occurred in IBM R&D labs that were populated with many nationals, literally under one roof in a growing number of company campuses around the world, beginning in the 1930s.⁷

Embedded within information ecosystems is another notion, that of “information infrastructures.” Historians have expressed more interest in defining this term than information ecosystems, because it is often the physical manifestation of the ecosystems, consisting of the “things” that make the movement and use of information possible. These can include information and communications technologies. Included are networks, as in telephone lines, and today, the Internet. Not all infrastructures were electronic, as with telephony or laptops, but they can be paper-based too. Part of the infrastructure in business included reports, books, magazines, spread sheets, various paper documents from

the train ticket to some thick report prepared by a consulting company for a client. An information infrastructure could also include buildings, such as libraries, magazine editorial headquarters, printing plants, classrooms, the ubiquitous office, and organizational schemes. Whole institutions can also be part of an information infrastructure (also its ecosystem), such as a university, a school, training center, headquarters, library, or publisher. It is both a term and a concept.

One group of scholars defined the term as “a broad category referring to pervasive enabling resources in the networked form.”⁸ Keying off that definition, Megan Finn thinks in terms of analyzing these “pervasive enabling resources” that “help” people to do their work, but also acknowledges the physical feature of infrastructures, or “tubes and wires.”⁹ Others contributed to the definition by arguing that it included non-physical elements, such as organizations, information standards, and practices. Examples include time keeping (standardization) that make possible coordination of work over time and distances; practices in the way information is collected and used (best practices or the way things are done in a profession), role of institutions in formatting and delivering information as practiced by an organization. Finn reminds us that another historian, Paul Edwards, wants scholars to look at what appears at the bottom of an organization, things and activities that have “become standard, routine, transparent, invisible.”¹⁰

One can think of information as circulating within some organization and used by a defined set of individuals with which to do their work. These are people who communicate information back and forth with each other on a frequent basis and who depend on this shared information with which to conduct their activities. This ecosystem includes documents formatted in familiar ways about shared interests, other publications, knowledge, even value systems and worldviews, all bonded together as common experiences laden with information and knowledge too. One can begin research on the topic by describing its components, leaving to others to opine later on consequences. However, Karl E. Weick, a professor of organizational behavior and psychology, along with a growing coterie of like-minded scholars, have demonstrated over the past forty years that organizations have cultures and practices that influence how they learn. Their thinking has done much to lend itself to the study of information’s role in firms. Central to Weick’s assessment is that organizations make “sense” of their surroundings by understanding activities, circumstances, and placing these in a relevant context. Historians could borrow examples and approaches from this highly prolific scholar, because they are compatible with our discussion of information, although using the phrasing of other academic disciplines often not familiar to the historian.¹¹

Infrastructures have been likened to “information systems,” the subject of useful examination, as they existed in business enterprises.¹² In these instances, historians focus on the use of knowledge, monitoring of operations (managing), and strategies (the work of senior management). For historians of information in business, it has largely been about the production and use of information to control operations of a firm.¹³ Bud-Friedman has usefully thought of such infrastructures in two ways. “At the *micro*-level” it is about “the information structures of organizations and systems, primarily within firms,” although other types of organizations can fit here too, such as a government agency. But, she also thinks in

terms of the “*macro-level*,” which is about “the underlying foundation of information in society or the fixed information capital within an economy.”¹⁴ The macro-element is useful for the study of information at an industry level.

Since firms operate within industries, and industries are largely defined by the firms that they identify with, both micro- and macro-approaches to the study of information’s history are related, and indeed, co-dependent. But, let us be clear about what we mean by industries as the word is used quite loosely. For our purposes we shall use Walter Kiechel’s simple yet practical definition, drawn from an interview with an important American management consultant, Philip Evans:

“What’s an industry? A small number of largely similar organizations, internally collaborative, externally competitive, that connect to each other through the mechanism of a competitive market, and connect upstream to suppliers, downstream to customers.”¹⁵

Add in the various social and economic constructs of nations on top of industries, and the conversation about the use of information takes one directly to the globalization of the work of firms and industries that historians admit have been world-wide far longer and more intensely so than even twenty years ago.¹⁶

Another important informational term, used less by historians and more by economists and business managers, yet crucial to our understanding of information in business and economic settings, is the notion of *information flows*. If one thinks of information as if it were an object, a “thing,” we can ask, what does it do? Where does it go? Who does things with it? Why do its handlers do what they do?

Information flows is the movement of information from one spot to another for different purposes and consequences. For example, a salesman obtains an order for a computer (the order is a collection of facts, such as the size of the machine and when it is needed), which then is entered into the company’s order system, and the facts of the order are sent to a factory as one grouping of information, where it causes a production schedule to be created, while the same data goes to headquarters where it is tracked as a forecast of future business, and once installed, is converted into accounting and financial data accumulating with that of other sales to appear within quarterly and annual reports to stakeholders. Information flows is about the creation and movement of data (facts), with emphasis on action. It is about activity, not descriptions of the informational artifact itself.

These concepts about information can now be joined. Essential to our understanding of the role of information in businesses and industries is the notion of *co-location*. Since the creation of firms that had more than one room, or one building, or was located in multiple cities and countries, or situated in different industries, a piece of information could be located (physically deposited) in multiple places. Second is the idea that different people could be using the same information either the same way or in different ways at the same time. For example, Ford automobile salesmen could rely on the same information about the features of a particular model of a car in 1948 in their simultaneous attempts to sell that specific model to customers in five cities on, say, April 16 at 3 P.M. Yet another feature of co-location is the availability of the same information for use by different companies and people, such as information about the state of the economy, “best practices,” and the history of rivals.

There is a substantial body of literature on the symmetry and asymmetry of information in business that has drawn much attention by economists, but not yet by historians.¹⁷ Historians should acknowledge that access to the same information by contentious groups (e.g., one's competitors) and by those not in contending situations (e.g., the same information about a biological phenomenon used by the medical profession and pharmaceutical companies) also exist simultaneously. The histories of technology and the work of business management professors are rife with examples and solid historical research on this characteristic, but this has not yet been part of the study of information history.¹⁸ To summarize, table 1 provides our key definitions of informational constructs for a historians.

Table 1
Definitions of Information History Concepts

Information Framework: An approach to the study of a subject, offering a path, possibly a map, for organizing the exploration of an idea or topic.

Information Ecosystems: A collection of knowledge, experts and users much as academics think of a discipline, but with the important difference that this body of knowledge and associated communities are far broader than an academic discipline.

Information Infrastructures: Networks of physical items that make the movement and use of information possible, such as the Internet and laptop computers.

Information Flows: The movement of information from one spot to another for different purposes and consequences.

Challenges and Issues: Piecing It All Together

The study of the use of information within organizations, firms and industries remains relatively immature, despite the fact that there is now a growing literature on the subject.¹⁹ Three circumstances make the subject immature. The first is a lack of definitions agreed to by the majority of students of information on the terms used: information ecosystems, information infrastructures, and information itself. Second, how information is situated in people and organizations remains the domain of case studies and there are too few to discern patterns. Third, the identification of how information (data, facts, numbers, text, and so forth) moves about and is used by individuals and institutions, and by industries and societies, remains in its infancy.

In addition, there are no unifying theories to inform historians with which to inform research methodologies across multiple disciplines.²⁰ While historians are normally the least interested in conforming to an overarching theory of how information operates, other disciplines welcome theories as a way to develop "best practices" (in business), and to identify behaviors that can be empirically validated, all largely by statistical and mathematical means (economists), and through

repeated observation of behavior (sociologists and educators/trainers).²¹ Extant theories are largely discipline specific. Yet, they can serve as an assist to historians.

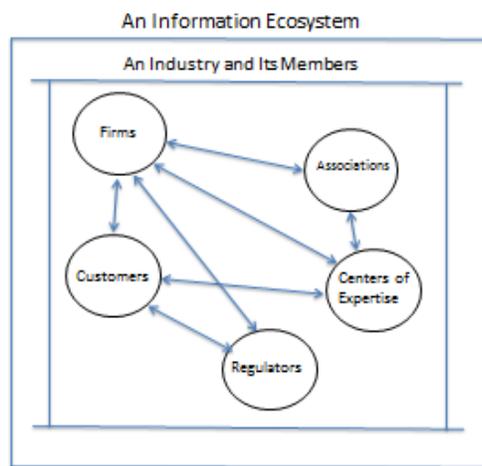
More humble than theory, and required to help get to widely believed paradigms, is the need for frameworks to help structure research agendas. That is something historians would subscribe to because frameworks fit neatly within methodologies and approaches in historiography, making it possible to raise open-ended questions that scholars can attempt to answer. Research agendas and ways to go about conducting such investigations (methodologies) are needed more now than some grand historiographical theory on the use of information, because the subfield of information history is so new. There has been a growing appetite for such approaches to the study of information's historical role, cutting across many aspects of society's activities: warfare, diplomacy, library science, computing, and literature.²² Historians have shown a growing interest in the role of information by exploring cases at the firm and institutional (e.g., university or government agency) level, and across some industries.²³ At firm and industry levels much discussion has centered on the role of accounting, financial, and inventory control data, and about the use of data processing equipment to more efficiently and quickly collect and move information, using everything from the telegraph and post offices to computers and the Internet.²⁴ With so much focus on the role of computing in the past half century, insufficient attention has been paid to the whole purpose of using that technology: to inform what Nobel Prize economist and early student of information Herbert Simon considered essential: "decision-making."²⁵ One needs to include a logical sequence to that focus: understanding results of actions taken.²⁶ In individual firms as within their industries, this became even more so beginning in the nineteenth century, with the establishment of large organizations, with industries creating their own self-identities and supporting organizations for sharing of information, and with the emergence of customers as self-identified cohorts (i.e., consumers).²⁷

Lest we forget, the central issue regarding our subject, in the words of economist/historian Bud-Frierman, is that "information is a resource that requires wise husbandry and an element of craft practice," because information is created by people and social groups, not just by massive uses of computing (although that may change with the introduction of "learning" computers).²⁸ The history of information is not dominated by the experience with computers; that technology is increasingly being situated into a broader texture of human activity, more as a handmaiden than as a leading actor, with growing emphasis on its use and consequential effects on human behavior.²⁹ Business and economic historians borrow methods used by their subjects in the performance of their work, such as the growing use of charts and graphics, while economic historians are facile in their reliance on statistics, calculus, and displaying information in logarithmic forms.³⁰

How do all the pieces of a framework for the study of information in firms and industries conceptually fit together? There exists a well-defined ecosystem comprised of firms supplying goods and services to each other (often called the supply chain), firms that sell to other firms and to individual customers, and firms that collaborate in the sale of their products and services to people and organizations (called business partners). Firms identify with each other as

members of an industry if they sell the same goods and services, compete, and also occasionally partner together. Industries provide a larger sense of identity, such as providing training and information relevant to its members through conventions, associations, educational standards, and publications (usually industry magazines and newspapers). Other participants in this information ecosystem include educational institutions (such as academic centers that specialize in the work of an industry, e.g., automotive at the University of Michigan, Kennedy School of Government at Harvard University), local, state, and national government regulators responsible for the activities occurring in specific industries (as in banking and financial industries), industry associations, and customers within other industries that interact with an industry (such as IT managers related to the computer industry). Figure 1 schematically illustrates these complex relationships.

Figure 1
Information Ecosystem



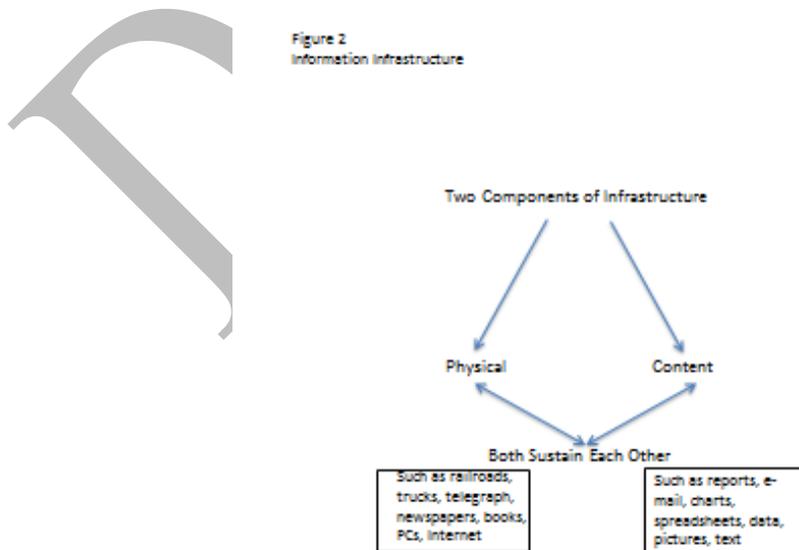
Note: An information ecosystem can include multiple industries

None of the participants operates in isolation; each is affected by the activities of others. Customers inform companies about their needs, which affect new product developments, while sellers introduce customers to new products, trends, and ways of using goods and services. All stay in constant motion, sharing, collecting, and communicating information about all aspects of each other's activities. In figure 1 the arrows between communities within the information ecosystem are suggestive of where information flows to and from on a more-or-less continuous basis. Seen this way, one can situate the work of individuals, departments, and whole enterprises within a broader framework of an information ecosystem. Many questions can be asked about the collection, use, and flow of information, some of which are described below.

A second element of our framework is the recognition that underpinning this information ecosystem is an information infrastructure. Key elements can be categorized as a physical infrastructure filled with content. The physical infrastructure can include railroads and trucks (transportation of content) buildings in which it was kept (such as books, newsletters, sales literature), and supporting players, such as a delivery service (e.g., UPS, Federal Express, postal systems).

Another can involve non-paper communications, such as telegraphy since the 1840s, telephony since the 1870s, PCs since the 1980s, the Internet since the 1990s and, of course, such paper-based physical elements as newspapers, books, and other corporate ephemera.³¹ One can quickly see a great deal of physical information infrastructure at the personal, institutional, and industry level. The first two are obvious as the examples just cited illustrate. But even at an industry level they exist, such as the central banks that serve as conduits for the movement of information about funds from one bank to another (e.g., U.S. Federal Reserve, which has been in service since 1913). Military communications systems linked to their suppliers and R&D communities comprise another example (e.g., early Internet users).³²

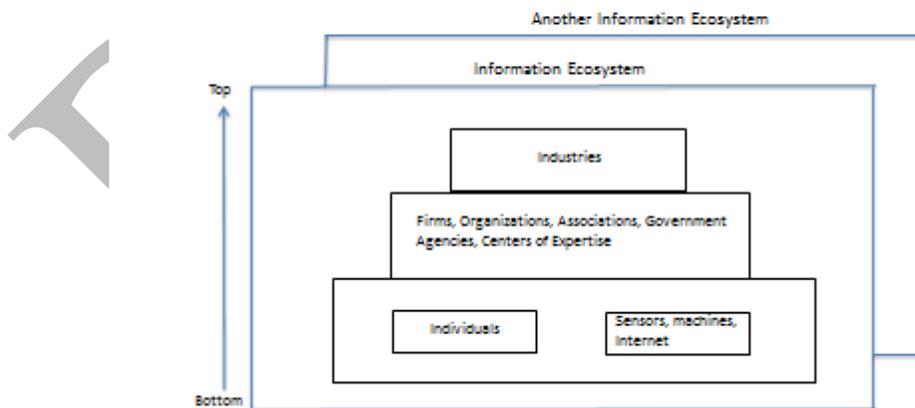
Figure 2 suggests the physical infrastructure that can exist within an information ecosystem. It also calls out that information flowing through this infrastructure parallels and is de facto part of that infrastructure, what media experts refer to as “content.” Scholars have written extensively about content flowing through the Internet, but historians know that content has moved through information ecosystems in many forms for centuries.³³ William Aspray has referred to this content and its outward manifestations as “the invisible infrastructures” of American life; his notion applies as well to any other nation’s activities too.³⁴ Both the physical infrastructure and content are needed to support one another. The physical is justified as the way to move information—content—from one point in the ecosystem to another with which to conduct business. The more physical infrastructure or content there is, the more dependent people and organizations are on information.³⁵ The diversity of both physical infrastructure and content suggests the variety, indeed complexity, and influence of the information ecosystem on human activities. Looked at this way, our framework makes it possible to begin identifying the role of information, and effects on human activities, most notably the work of individuals and the shape and actions of organizations.



To make the framework complete, we need to add the issue of professions, in other words, the role of individuals. While this essay concentrates on the activities of firms (and by implication non-profit organizations such as universities and governments) and their industries, if one assumes that much is interconnected—a basic assumption of the existence of information ecosystems—then the metaphorical atom, or lowest unit of measure, is the individual. Much work has been done to describe the work of individuals, engaging in discussions about their reliance on information, development of skills, and application of knowledge to their work, play, and politics. The evidence is quite rich for the United States.³⁶ In fact, more research about the role of information has been done within professions than about information in organizations, let alone in industries. Additionally, of course, there is now a vast literature about modern nations forming into an “information society,” operating in some “Information Age.”³⁷

Figure 3 conceptually places the individual within the framework so as not to lose them in our discussion. They personally create, use, and disseminate the vast majority of information. However, that is also not always the complete story. Sensors on an oil pipeline create and disseminate information about how much crude is flowing, its temperature, and its form. Video cameras in cities communicate traffic conditions over the Internet, further to officials, and even to citizens on digital billboards and through telephone “apps”. In fact, it is now believed that sensors and other computational devices generate more information (data) flowing through the Internet than humans.³⁸ While the history of that development has yet to unfold, its role as part of the information framework should, in time, become as important as that of people, and is why it is included in figure 3.

Figure 3
Hierarchy of Participants in an Information Ecosystem



The figure suggests a hierarchical nature to the relationships of people, organizations, and the flow of information. This is intentional, since extant historical evidence suggests that it is the activities of people within organizations that drives the creation and use of information, and that institutions larger than a company or university influence the work of people and organizations. One could

just as easily, however, conceptualize a framework that looks like concentric circles, but that would suggest that whatever is put in the middle of those circles is the dominant influence in the information ecosystem while the reality is different. In an information ecosystem multiple agents and circumstances are in constant motion, with some more influential at one moment than at another. So figure 3, although a static graphic, should be seen as representative of communities whose influence (e.g., size in the graphic) would expand and contract, depending on events at any given moment. For the historian, the figure is a reminder that whatever is being studied about the history of information must also be situated in a continuously dynamic set of circumstances, the latter comprising the information ecosystem. Failure to account for each of the components of that system either represents incomplete work by historians or gaps to be filled as new evidence becomes available. This figure alerts historians to map flows of information from, to, and among individuals, within organizations, and through industries and economies.

Elements of a Firm-Level Information Ecosystem

It is not enough to postulate that information is “everywhere” in an organization, even though this is undoubtedly true. The study of information and its role requires a more structured approach. Traditionally, business historians, consultants, and managers examining the activities of firms have found it essential to explore these within the confines of branch offices, regions, and divisions; in short, what was occurring within organizations, then possibly across organizations *within a firm*.³⁹ An alternative way to probe the affairs of a firm is to examine the role of individuals and professions (roles) within a firm, such as that of the president, chief financial officer, shop floor worker, secretary, and so forth, although the predisposition of historians is to study these within the functions of an enterprise, privileging studies of actions not organizations.⁴⁰ Normally, one examined expectations of an individual worker (or of a profession), what they did, results, and consequences of those actions.⁴¹ Since information was collected and used in support of work, it makes sense, then, when examining the role of information, even its forms, to explore the use of data used by employees within their job descriptions, performance plans, and operating work culture. This exercise complements the organizational/job-centric approach taken to study activities of enterprises. Management consultants, in particular, have learned that at a highly tactical level the merger of information, work, and organization constructs is often best understood by examining workflows, specifically processes. They have developed extensive methods for doing this, which historians might benefit from in their appropriation.⁴²

Essentially, this activity calls for identifying and documenting all the steps in a process, describing roles and consequences of all participants (including variations), paper/data trails they create (electronic and paper), and actual information collected and used (i.e., numbers, descriptions, facts). Often one extends the survey across the enterprise and even from one end of the “value chain” to the other. For example, the sale, or manufacture, of an engagement ring can begin with miners digging a diamond and gold out of mountains, processing of these

materials by other companies, then construction of rings by jewelers in yet other enterprises, shipment of these to stores, sales of these items, the activities of the young man to acquire and present the ring, and the insertion of the ring on a woman's finger. One can study what happens only in mining companies, or in jewelry manufacturing environments, or in retail outlets, for example, but in each instance records are kept and insights are acquired that lead to optimization of work, competitive pricing, and outcomes. Every form of work optimization involves collecting data, and no more so than since the 1870s, after which "scientific management" methods began to surface, ultimately made famous as Taylorism, still later as mass production, statistical quality control, newer iterations of Taylorism (such as process engineering), and outsourcing.⁴³ Each of these evolutions gives historians of information much to do. It also calls for identifying tight links between work activities and roles of departments and other organizational entities that normally existed. Thus, one can imagine studies of the information infrastructure of supply chains within a particular firm, or comparative studies of the same process (or supply chain) across an industry.⁴⁴

Each major function of an organization is a potential subject. Obvious candidates include accounting, finance, manufacturing, distribution, sales, product service, legal affairs, personnel management, training, public relations, advertising, and lobbying. These comprise the bulk of what a firm does and constitute their "value proposition," which is to say their rationale for existing. Some of these activities have become increasingly standardized worldwide over the course of the twentieth century, offering additional research opportunities for historians of information: how did this standardization happen, why, what exactly occurred, and what were the standardization activities?⁴⁵ Historians are increasingly examining the role of standards and systems in processes, science, and technology; that seems an important conversation for historians to participate in regarding information.⁴⁶

A related approach is to examine the work of individuals, or classes of workers. This is the preferred approach taken by sociologists, and increasingly by historians of professions.⁴⁷ From the perspective of a framework, one documents the activities (including information spun off) from classes of workers of individual ones, examining the dynamics of work/information. These dynamics change over time as well. For example, as products change, workers need to learn to work with new ones. A Ford Motor Company shop floor employee in the 1920s would have learned to work with wood and metal in highly repetitive Taylorist style, but by the 1950s, also with increasingly complex motors and electrical systems, and by the end of the 1980s, how to manage robotic devices, and analyze statistics of production results. Over time, what information they needed and how they used it, as well as the effects on their work, morale, income, and results for the corporation evolved.⁴⁸

One can envision studies of the role of salesmen, nurses, doctors, lawyers, paper-making shop floor employees, and home economists—indeed each has already been the subject of historical investigations.⁴⁹ However, a limitation of these kinds of studies is their insufficient or uneven discussion of four issues of interest to historians: what facts these professions had, training needed to master this information along with skills to apply the data, facts acquired in the course of their work and how that changed over time, and the effects on the workers

(physical, mental, income, career consequences). Models are emerging to suggest what issues to address, what research to conduct, and how to present the results.⁵⁰

A third approach, following explorations of processes and roles, is to study the role of information in how organizations are structured. There has been very little work done on this by historians.⁵¹ Information affects how and what one organizes. In the 1960s and 1970s, historian Alfred D. Chandler, Jr. famously discussed the structure of railroads of the nineteenth century as a response to the need of these transportation firms to control the flow of information about train schedules (to meet customer needs and to avoid train crashes), and monitor rolling stocks (i.e., where individual rail cars were and what they had in them).⁵² His work stimulated many other studies of railroads that inherently were about information and management of that data, resulting in a wealth of business literature and debate about “form (how an organization is structured) following function.”⁵³

A more recent trend concerns the effects of computers. This technology went from being large mainframes that could only be cost-justified if situated in central locations to serve many users and departments to smaller units utilizing less expensive devices, ultimately leading to wide use by individuals of personal computers by the early 1990s, work, delegation of authority, and physical dispersion of people evolved. Usage went from locating thousands of people in large, but few, buildings, to a model with many employees that are now geographically scattered.

In each of these evolving work environments historians can ask several questions:

- What data (facts) were needed to support the work of people, processes, and organizations?
- How was that information collected, analyzed, and stored?
- What information was tracked and how did that data affect subsequent actions, processes, and the work and nature of an organization?

In each instance, the “paper trail” is often the first place to begin probing for answers. Asking what data was recorded, who read it and was responsible for its accuracy, where did it go (information flows), and why it was saved. A second important tool to use when possible, is the exercise of oral history techniques to fill in the gaps between the documents (including publications) in order to understand more fully the use and consequences of having specific types of information. In short, it enhances our understanding of the feedback loop so essential in appreciating the role of information in human and institutional activities.⁵⁴

The effects of where information could be accessed are more obvious, because one can track its ephemera and material manifestations, most notably where computers functioned. Less obvious are the effects on work and individuals. Does remote access to information change the kind of data one needs and uses? What effects does that access and type of information have on work processes, work habits, attitudes of employees, security of corporate information, cost of collecting and diffusing it? These are central questions for researchers of information to ask.

In summary, any framework suggesting how to study information in a small or large enterprise should accommodate any of these three approaches: processes, roles, and organization. A sophisticated study of information history might include discussion of all three approaches, to provide a more realistic, holistic study of the role of information in a firm. We have yet to see such a publication, although a study of the U.S. National Science Foundation's massive research proposal system (FastLane) may provide an early model, albeit one drawn from the public sector.⁵⁵ Table 2 summarizes the key firm research concepts to keep in mind.

Table 2
Elements of a Firm-Level Information Ecosystem

Jobs, professions	Each using/generating specialized information
Process/work flows	Documented activities/measures of performance and results
Functions/departments/organization	Specialized missions, information

Key Questions to Answer for Each Element

- What data (facts) were needed to support the work of people, processes, and organizations?
- How was that information collected, analyzed, and stored?
- What information was tracked and how did that data affect subsequent actions, processes, and the work and nature of an organization?

Elements of an Industry-Level Information Ecosystem

Industries are constructs of the mind. They are less physically evident than a firm, where at least about the latter one can point to buildings filled with office and factory workers, publications, and, of course, to their products. Industries might have associations within them that have national headquarter buildings, industry-specific trade magazines and newsletters, and national conventions, to which thousands of people may annually gather at some large hotel for a few days, then disperse back into their firms. Industries are social constructs too, with which people who perceive that they share similar activities, or compete against each other, can identify. From a practical perspective, industries as communities help define the nature of work in a group of companies, identify and track their competitors and business partners of these, inform members about each other's activities and those occurring outside of the industry impinging on them, training people in new technologies, managerial practices, and work processes.⁵⁶

Two visible tangible manifestations of industries are information laden. The first consists of industry associations; most industries have one or few of these, much like a club in which members are either individuals or companies from the industry. The American Banking Association (ABA) is one of hundreds of such

examples; almost every bank in the United States is a member. A variant can be a cross-industry, profession-centered association similar in mission, such as the IEEE Computer Society for IT workers, or the Society for Human Resource Management for personnel professionals. There is even an association of associations to help managers of these non-profits organizations.⁵⁷ Associations hold annual conventions, where much networking (information exchanges) and training occur. They provide other tangible manifestations of their existence: newspapers, trade magazines, white papers, proceedings, books, video tapes, podcasts, and websites dedicated to their association and industry filled with information and news, all grist for the historian. Yet, historians have not studied extensively the collection and use of industry association information. A historian would be challenged to find historical analyses of training movies and videos, for example, yet a vast quantity of these were prepared by both firms and industries in the twentieth century.⁵⁸ Most industry trade magazines and newsletters also have yet to be studied, even collected by archives. Yet, many of these publications had large subscription rates, often running over 200,000 by the late 1900s, serving as rich sources of information.⁵⁹

As with firms, processes, and individuals, industries have their members, ways of doing things across firms and with and (within) associations, and social and professional makeup of its members. In short, industries have their distinctive cultures. There are many historical information questions that can be asked of industries, quite similar to what one would explore when studying firms:

- What data (facts) were needed to support the work of people, processes, and organizations within an industry, including its associations?
- How was that information collected, analyzed, and stored?
- What information was tracked and how did that data affect subsequent actions, processes, and the work and nature of an industry association and the industry at large?
- How did use of information vary within an industry by firms, and what were the effects on enterprises and their industries?
- How did information flow among firms within an industry, indeed also through their associations and important periodicals?
- What was the role and effects of standards, pressures to conform to certain operational and managerial practices, and in promotion of professionalization and credentialing of work?⁶⁰

Table 3 summarizes the key research issues for industries.

Table 3
 Elements of an Industry-Level Information Ecosystem

Organizations, associations, members	Who they are, their demographics
Role of members and their associations	Process documentation, results
Communications practices	What they discuss, report
Industry-wide events	Conference information

Key Questions to Answer for Each Element

- What facts were needed to support the work of people, processes, and organizations with an industry, including its associations?
 - How was that information collected, analyzed, and stored?
 - What information was tracked and how did that data affect subsequent actions, processes, and the work and nature of an industry association and the industry at large?
 - How did use of information vary within an industry by firms, and what were the effects on enterprises and their industries?
 - How did information flow among firms within an industry, also through their associations and important periodicals?
 - What role did standards play, and pressures to conform to certain operational and managerial practices in promoting professionalism and credentialing of work?
-

Similarities, Differences, and Co-dependencies Between Firm and Industry Information Ecosystems

Any attempt to define the total information ecosystem takes one back to the construct illustrated in figure 1. However, an information ecosystem is bigger and more complex than a simple diagram can express. Summarizing similarities and differences can help historians choose which information ecosystem to study, or at least to understand the contextual issues they face with either or both.

There are at least three obvious similarities between firms and industries. First, both companies and industries have firms, processes, and people that share practices, values, interests, and experiences within a company and across an industry. Historians can seek to identify what these are—they are glued together by information. Second, people organize their work, information, and interests into organizations, be it companies or associations. Third, their exchange of information is expanding to virtual associations, better known as chat rooms, websites, and social media communities. The concept is essentially the same: they are identifiable communities bound by shared information, interests, and activities. They tend to use the same specialized vocabulary. Phrases have meanings unique to them.

There also are differences. Firms are very precisely defined organizations with clear legal and operational boundaries within which specific pools of information flows, supported by infrastructures designed to function largely within those boundaries. An Apple Computer employee uses information only available to

them; the same happens within Zara, IBM, and tens of millions of other enterprises. Boundaries are normally marked and even reasonably obvious to a historian, providing a convenient control over the scope of his or her informational research. However, it can also be the case that a firm may be a part of more than one industry, such as with a securities firm that sells stocks and provides banking services, and is thus subject to two sets of regulators and participates in associations that focus on one or the other set of activities. Boundaries can be expanded to incorporate communities of suppliers, customers, competitors, and regulators, making the ecosystem's borders less precise, but their extension controllable by the scope of an historian's research agenda. Thus, for example, one could study the information ecosystem and infrastructure of an IBM salesman,⁶¹ or the information the company takes and sends out to a set (or to all) its customers. The data that flows back and forth and how they are used changes in both content and volume depend on context.

Second, industries are fuzzy at best because there are potentially so many participants. Yet, government economists in industrialized nations have long tracked very precisely what firms are in which industries.⁶² A historian would find those lists quite limiting because they leave out customers who sit in other industries.⁶³ There are informational exchanges within these loosely defined industries that historians will want to understand. Association economists and professors of economics and business management can be found who specialize in specific industries with this kind of data. They are essential allies for the historian of a firm's, or industry's, information ecosystem.

Compounding the problems of definitions and scope is the fact that industries are largely defined within the confines of a national or regional economy, such as the automotive industry in Japan or in the European Union. So, if an industry and its members operate in a globalized market, as the automotive industry does, one needs to consider participants from multiple countries that manufacture parts, assemble vehicles, and sell and support products around the world, all from a company that can be seen as originating from one country, but operates everywhere. Is Ford Motors an American firm, even though parts come from dozens of countries and sells its products in over 100 countries? Yet another imposition are international associations, each with its own definition, such as the United Nations (UN), International Monetary Fund (IMF), European Union, World Bank, and the Organization for Economic Cooperation and Development (OECD).

Third, industries have missions different from those of firms, hence much of their activities vary, too. Companies exist to make and sell goods and services to customers, generate profits, and offer returns to their stakeholders. Industries are not legal entities, rather communities of practice in support of its members and, thus, are not in the business of making a profit. An industry's associations are not profit centers either, yet they play supportive roles to firms, and comment in a positive way about the attributes and activities of its collective memberships. "Think tanks" are often associated with specific industries too.⁶⁴ So, their informational activities are different than those accumulating in an industry's ecosystem or within a firm. Historians need to be aware of that reality as they define their research agendas.

Implications for Future Historiography

So what is unique about the study of information's history as compared to any other subfield of historiography? The answer is not that protagonists of the story are people, organizations, or information's ephemera (such as the history of books or PCs). Rather, the hero of our tale, the center of our attention, is the information that people, organizations, and the ephemera used. There is a fine line between information and the other elements, one that historians of information are going to have to define, then demonstrate they can manage. The trick is not to fall back on the histories of organizations, information technologies (both paper and electronic), or to traditional sociological histories. This problem exists, for example, in histories of education where, for instance, the political activities of school boards and national debates about the value and forms of education dominate the historiographical discussion, and rarely curriculums, let alone what information is used in that industry and in the teaching profession.⁶⁵ Understand the role of information in other types of historiography, how information in a specific book affected human behavior, not how that book became a best seller, represented a new printing technology, or why and how it was banned from a public library.

As suggested at the start of this essay, information history can conveniently be seen as analogous to an object, with its own identity. Historians of software offer approaches for how to treat data as objects to be studied by observing how they are conducting research on software, and most specifically, databases.⁶⁶ Computer science's evolving role, and the study of information sciences by librarians and their scholars also suggest paths forward.

ADD A PARAGRAPH OR TWO SUMMARIZING INSIGHTS FROM THE PAPERS IN THIS SPECIAL ISSUE OF I&C. Essentially what authors of this issue of I&C uncover

¹ I have described the role of information in firms in more detail in James W.

Cortada, *Information and the Modern Corporation* (Cambridge, Mass.: MIT Press, 2011).

² Bud-Frierman, *Information Acumen*, 7.

³ Yates, *Control through Communication and Structuring the Information Age: Life Insurance and Technology in the Twentieth Century* (Baltimore, Md.: Johns Hopkins University Press, 2005).

⁴ Geoffrey Bowker and Susan Leigh Star, "Knowledge and Infrastructure in International Information Management: Problems of Classification and Coding," in Bud-Frierman, *Information Acumen*, 187-213.

⁵ James W. Cortada, "Shaping Information History as an Intellectual Discipline," *Information and Culture* 47, no. 2 (2012): 119-144.

⁶ James W. Cortada, "When Knowledge Transfer Goes Global: How People, Public Organizations, and Businesses Learned About Information Technology, 1945-1970," forthcoming.

⁷ Arthur L. Norbert and Jeffrey R. Yost, *IBM Rochester: A Half Century of Innovation* (Rochester, Minn.: IBM Corporation, 2006).

⁸ Geoffrey C. Bowker, Karen Baker, Florence Millerand, and David Ribes, "Toward Information Infrastructure Studies: Ways of Knowing in a Networked Environment," in *International Handbook of Internet Research*, ed. Jeremy Hunsinger, Lisbeth Klastrup, and Matthew Allen (Dordrecht: Springer Science+Business Media B.V., 2010): 98.

⁹ Quoted in Margot Finn, "Information Infrastructure and Description of the 1857 Fort Tejon Earthquake," *Information and Culture* 48, no. 2 (2013): 196-197," 196.

¹⁰ Paul N. Edwards, *A Vast Machine* (Cambridge, Mass.: MIT Press, 2010): 20; discussed by Finn, "Information Infrastructure and Description of the 1857 Fort Tejon Earthquake," 196-197.

¹¹ His major works have been collected into two volumes, Karl E. Weick, *Making Sense of the Organization* 2 vols. (Malden, Mass.: Blackwell Publishing, 2001 for volume one) (Hoboken, N.J.: John Wiley & Sons, 2009). Volume two is the more useful one for historians of information; but see also Karl E. Weick, *Sensemaking in Organizations* (Thousand Oaks, Cal.: SAGE Publications, 1995): 63-82, 184-185, and the extensive bibliography in *ibid.*, 198-217.

¹² H.T. Johnson, "Managing by Remote Control: Recent Management Accounting Practices in Historical Perspective," in Peter Temin (ed.), *Inside the Business Enterprise: Historical Perspectives on the Use of Information* (Chicago, Ill.: University of Chicago Press, 1991): 41-70; M. Levenstein, "The Use of Cost Measures: The Dow Chemical Company, 1890-1914," *Ibid.*, 71-116.

¹³ Alfred D. Chandler, Jr., *The Visible Hand: The Managerial Revolution in American Business* (Cambridge, Mass.: Harvard University Press, 1977); Yates, *Control through Communication*; James R. Beniger, *The Control Revolution: Technological and Economic Origins of the Information Society* (Cambridge, Mass.: Harvard University Press, 1986); Cortada, *The Digital Hand*, 3 vols. and *Information and the Modern Corporation*; Bud Frierman, *Information Acumen*, 7-25; Johnson, "Managing by

Remote Control: Recent Management Accounting Practices in Historical Perspective.”

¹⁴ Both quotes, Bud Frierman, *Information Acumen*, 7-8.

¹⁵ Walter Kiechel III, *The Lords of Strategy: The Secret Intellectual History of the New Corporate World* (Boston, Mass.: Harvard Business Press, 2010): 293.

¹⁶ Emily S. Rosenberg (ed.), *A World Connecting, 1870-1945* (Cambridge, Mass.: Harvard University Press, 2013); Alfred D. Chandler, Jr., *Scale and Scope: The Dynamics of Industrial Capitalism* (Cambridge, Mass.: Harvard University Press, 1990); John H. Dunning, “The Key Literature on IB [international business, ed. Note] Activities: 1960-2006,” in Alan M. Rugman (ed.), *The Oxford Handbook of International Business, 2nd ed.* (New York: Oxford University Press, 2009): 39-71.

Although not an historian, rather a business management professor, the work of Michael E. Porter is seminal to any understanding of late twentieth century business practices, and in particular for global issues see, *Competition in Global Industries* (Boston, Mass.: Harvard University Press, 1986), *The Competitive Advantage of Nations* (New York: The Free Press, 1990).

¹⁷ One of the first economists to examine the issue through many articles is Joseph E. Stiglitz, *Selected Works of Joseph E. Stiglitz*, vol. 1, *Information and Economic Analysis* (New York: Oxford University Press, 2009): 29-94, 481-648, and the large bibliography that follows in this volume. 649-688.

¹⁸ For an excellent collection of case studies, see Clayton Christensen, *The Innovator’s Dilemma* (Cambridge, Mass.: Harvard Business School Press, 1997).

¹⁹ For examples, see Bengt Carlsson and Paul Davidsson, "Surplus Values in Information Ecosystems," *International Journal of Information Technology & Decision Making* 1, no. 3 (2002): 559-571; Shazia Rafiullah Miller and James E. Rosenbaum, "Hiring in a Hobbesian World: Social Infrastructure and Employers' Use of Information," *Work and Occupations* 24, no. 4 (November 1997): 498-523; Jacky A. Swan and Sue Newell, "The Role of Professional Associations in Technology Diffusion," *Organization Studies* 16, no. 5 (1995): 847-874; Paul Attewell, "What Is Skill?," *Work and Occupations* 17, no. 4 (November 1990): 422-448; James M. Bishop, "Institutional and Operational Knowledge in Work," *Sociology of Work and Occupations* 6, no. 3 (August 1979): 328-352; Matthew S. Weber and Peter Monge, "The Flow of Digital News in a Network of Sources, Authorities, and Hubs," *Journal of Communication* 61 (2011): 1062-1081; Charles Williams and Will Mitchell, "Focusing Firm Evolution: The Impact of Information Infrastructure on Market Entry by U.S. Telecommunications Companies, 1984-1998," *Management Science* 50, no. 11 (November 2004): 1561-1575; James W. Cortada, *Information and the Modern Corporation* (Cambridge, Mass.: MIT Press, 2011); Ramesh Subramanian and Eddan Katz (eds.), *The Global Flow of Information: Legal, Social, and Cultural Perspectives* (New York: New York University Press, 2011). For a bibliography of history studies published on a regular basis, see *Library and Information History*.

²⁰ I discuss this issue more thoroughly in James W. Cortada, "Shaping Information History as an Intellectual Discipline," *Information and Culture* 47, no. 2 (2012): 119-144, which includes extensive bibliographic sources.

²¹ For a useful, if slightly dated, introduction to some of the issues, see Frank Blackler, "Knowledge, Knowledge Work and Organizations: An Overview and Interpretation," *Organization Studies* 16, no. 6 (1995): 1021-1046; Toni Weller, *Information History—An Introduction: Exploring an Emergent Field* (Oxford: Chandos Publishing, 2008).

²² The recent evolution of two library history journals to meet that need provides both evidence of growing interest, and that serve as central hubs for historiographical discussions, *Information and Culture: A Journal of History* and *Library and Information History*.

²³ For a collection of firm-level case studies, Lisa Bud-Frierman (ed.), *Information Acumen: The Understanding and Use of Knowledge in Modern Business* (London: Routledge, 1994) with essays by her, JoAnne Yates and Geoffrey Bowker defining the topic as well. For an early attempt to look at information and information technologies in several dozen American industries, James W. Cortada, *The Digital Hand*, 3 vols. (New York: Oxford University Press, 2004-2008).

²⁴ In particular, about accounting and finance, Trevor Boyns, "Accounting, Information, and Communications Systems," in Geoffrey Jones and Jonathan Zeitlin (eds.), *The Oxford Handbook of Business History* (New York: Oxford University Press, 2007): 447-469; K.W. Hoskin and R.H. Macve, "Knowing More as Knowing Less? Alternative Histories of Cost and Management Accounting in the U.S. and the U.K.," *Accounting Historians Journal* 27, no. 1 (2000): 91-149; M. Schweitzer, "The Significance of Production and Cost Theory for Costing Systems in the 19th and 20th Centuries," in *Accounting and History* (Madrid: AECA, 2000): 285-295; T. Tyson,

“The Impact of Advancements in Manufacturing and Information Technology on Management Accounting Systems,” in T.A. Lee, A. Bishop, and R.H. Parker (eds.), *Accounting History from the Renaissance to the Present* (London: Garland Publishing, 1996): 143-165; JoAnne Yates, *Control through Communication: The Rise of System in American Management* (Baltimore, Md.: Johns Hopkins University Press, 1989).

²⁵ Herbert A. Simon, *Models of Bounded Rationality*, vol. 1, *Economic Analysis and Public Policy* (Cambridge, Mass.: MIT Press, 1982): xvii.

²⁶ A point of emphasis made by Peter F. Drucker, one of the twentieth century’s most influential business management experts, particularly in *The Practice of Management* (New York: Harper & Row, 1954): 121-136 and in *Management: Tasks, Responsibilities, Practices* (New York: Harper & Row, 1974): 419-429.

²⁷ Cortada, *The Digital Hand*; Yates, *Structuring the Information Age*, and the many essays in Jones and Zeitlin, *The Oxford Handbook of Business History*.

²⁸ Bud-Frierman, *Information Acumen*, 23.

²⁹ The discussion among historians is unfolding painfully slow within the pages of two major journals, *Technology and Culture*, and *IEEE Annals of the History of Computing*, over the past decade in over two dozen articles. In the spirit of candor, I have commented about this issue through four books, *Digital Hand* (3 vols), and *The Digital Flood: The Diffusion of Information Technology Across the U.S., Europe, and Asia* (New York: Oxford University Press, 2012). Sociologists have discussed this issue extensively, largely centered on whole theories of the evolution of the Information Society. For an introduction to this conversation, see Frank Webster, *Theories of the Information Society*, 3rd ed. (London: Routledge, 2006).

³⁰ Economists and other disciplines are also beginning to create descriptions of information age economic activities that can be useful to historians, such as George Gilder, *Knowledge and Power: The Information Theory of Capitalism and How It Is Revolutionizing Our World* (New York: Regnery, 2013); Peter F. Cowhey and Jonathan D. Aronson, *Transforming Global Information and Communication Markets: The Political Economy of Innovation* (Cambridge, Mass.: MIT Press, 2009); Robert E. Litan and Alice M. Rivlan (eds.), *The Economic Payoff from the Internet Revolution* (Washington, D.C.: Brookings Institution Press, 2001); Dominique Foray, *The Economics of Knowledge* (Cambridge, Mass.: MIT Press, 2000); Thomas H. Davenport, *Information Ecology: Mastering the Information and Knowledge Environment* (New York: Oxford University Press, 1997); and for collections of pioneering studies, see Dale Neef (ed.), *The Knowledge Economy* (Boston, Mass.: Butterworth-Heinemann, 1998) and Dale Neef, G. Anthony Siesfeld, and Jacquelyn Cefola (eds.), *The Economic Impact of Knowledge* (Boston, Mass.: Butterworth-Heinemann, 1998).

³¹ For an early attempt to integrate all of these into an historical context, see Alfred D. Chandler, Jr. and James W. Cortada (eds.), *A Nation Transformed by Information: How Information Has Shaped the United States From Colonial Times to The Present* (New York: Oxford University Press, 2000).

³² Arthur L. Norberg and Judy E. O'Neill, *Transforming Computer Technology: Information Processing for the Pentagon, 1962-1986* (Baltimore, Md.: Johns Hopkins University Press, 2000).

³³ For a few examples, see David Hochfelder, *The Telegraph in America, 1832-1920* (Baltimore, Md.: Johns Hopkins University Press, 2012); Walter G. Vincenti, *What Engineers Know and How They Know It: Analytical Studies from Aeronautical History* (Baltimore, Md.: Johns Hopkins University Press, 1990); Edward W. Stevens, Jr., *The Grammar of the Machine: Technical Literacy and Early Industrial Expansion in the United States* (New Haven Conn.: Yale University Press, 1995); Gary John Previt and Barbara Dubis Merino, *A History of Accountancy in the United States: The Cultural Significance of Accounting* (Columbus, Ohio: Ohio State University Press, 1998); Trish Loughran, *The Republic in Print: Print Culture in the Age of U.S. Nation Building, 1770-1870* (New York: Columbia University Press, 2007); Markus Krajewski, *Paper Machines: About Cards and Catalogs, 1548-1929* (Cambridge, Mass.: MIT Press, 2011).

³⁴ William Aspray and Barbara M. Hayes (eds.), *Everyday Information: The Evolution of Information Seeking in America* (Cambridge, Mass.: MIT Press, 2011).

³⁵ A point made obvious in early studies of professions, most notably that of Andrew Abbott, *The System of Professions: An Essay on the Division of Expert Labor* (Chicago, Ill.: University of Chicago Press, 1988); Eliot Freidson, *Professionalism: The Third Logic* (Chicago, Ill.: University of Chicago Press, 2001); Luis Galambos, *The Creative Society and The Price Americans Paid For It* (Cambridge: Cambridge University Press, 2012); but there is an older study not to be overlooked, Oleson Voss, *The Organization of Knowledge in Modern America, 1860-1920* (Baltimore, Md.: Johns Hopkins University Press, 1979).

³⁶ Walter A. Friedman, *Birth of a Salesman: The Transformation of Selling in America* (Cambridge, Mass.: Harvard University Press, 2005); Kevin Borg, *Auto Mechanics: Technology and Expertise in Twentieth-Century America* (Baltimore, Md.: Johns Hopkins University Press, 2007); Christopher D. McKenna, *The World's Newest Profession: Management Consulting in the Twentieth Century* (Cambridge: Cambridge University Press, 2006); Sharon Hartman Strom, *Beyond the Typewriter: Gender, Class, and the Origins of Modern American Office Work, 1900-1930* (Urbana, Ill.: University of Illinois Press, 1992); David M. Gordon, Richard Edwards, and Michael Reich, *Segmented Work, Divided Workers: The Historical Transformation of Labor in the United States* (Cambridge: Cambridge University Press, 1982); Mike Rose, *The Mind at Work: Valuing the Intelligence of the American Worker* (New York: Viking, 2004); Eliot Freidson, *Profession of Medicine: A Study of the Sociology of Applied Knowledge* (New York: Harper & Row, 1970); a set of two studies that broaden the scope of investigation beyond individual professions, Naomi R. Lamoreaux and Daniel M. G. Raff (eds.), *Coordination and Information: Historical Perspectives on the Organization of Enterprise* (Chicago, Ill.: University of Chicago Press, 1995) and Lamoreaux, Raff, and Peter Temin (eds.), *Learning By Doing in Markets, Firms, and Countries* (Chicago, Ill.: University of Chicago Press, 1999); for an example of a contemporary discussion, Frank Levy and Richard J. Murnane, *The New Division of Labor: How Computers Are Creating the Next Job Market* (New York: Russell Sage Foundation and Princeton, N.J.: Princeton University Press, 2004), and by an economist, Martin Carnoy, *Sustaining the New Economy: Work, Family, and*

Community in the Information Age (New York: Russell Sage Foundation and Cambridge, Mass.: Harvard University Press, 2000).

³⁷ For introductions to many of the arguments in favor, see Webster, *Theories of the Information Society*; Reijo Savolainen, *Everyday Information Practices: A Social Phenomenological Perspective* (Lanham, Md.: Scarecrow Press, 2008), Manuel Castells, *Communication Power* (Oxford: Oxford University Press, 2011), and for a contrasting view, Christopher May, *The Information Society: A Sceptical View* (Cambridge: Polity Press, 2002).

³⁸ Kevin Ashton, “[That 'Internet of Things' Thing](#),” *RFID Journal*, 22 July 2009 (last viewed 7/7/2013). For an early and innovative analysis of what content is in the Internet and a framework for assessing it, see Martin Dodge and Rob Kitchin, *Mapping Cyberspace* (London: Routledge, 2001).

³⁹ As demonstrated by the contributors to Bud-Frierman, *Information Acumen*; and in Peter Temin (ed.), *Inside the Business Enterprise: Historical Perspectives on the Use of Information* (Chicago, Ill.: University of Chicago Press, 1991), and by individual scholars, such as Yates, *Structuring the Information Age*; Margaret Levenstein, *Accounting for Growth: Information Systems and the Creation of the Large Corporation* (Stanford, Cal.: Stanford University Press, 1998).

⁴⁰ There is an excellent collection of 7 essays on the current historiography of business functions, e.g., banking, technology, engineering, marketing, and so forth, replete with citations of the appropriate literature in Jones and Zeitlin, *The Oxford Handbook of Business History*, 319-497. Exceptions to this type of historiography are cited in various notes to this article.

⁴¹ Robert A. Rothman, “Deprofessionalization: The Case of Law in America,” *Work and Occupations* 11, no. 2 (May 1984): 183-206; David H. Autor, Frank Levy, and Richard J. Murnane, “The Skill Content of Recent Technological Change: An Empirical Exploration,” *The Quarterly Journal of Economics* 118, no. 1 (November 2003): 1279-1333; Gary Alan Fine, *Authors of the Storm: Meteorologists and the Culture of Prediction* (Chicago, Ill.: University of Chicago Press, 2007); Elizabeth H. Gorman and Rebecca L. Sandefur, “‘Golden Age,’ Quiescence, and Revival: How the Sociology of Professions Became the Study of Knowledge-Based Work,” *Work and Occupations* 38, no. 3 (2011): 275-302; Bruce E. Kaufman, *Managing the Human Factor: The Early Years of Human Resource Management in American Industry* (Ithaca, N.Y.: ILR Press, 2008) and his *Hired Hands or Human Resources?: Case Studies of HRM Programs and Practices in Early American Industry* (Ithaca, N.Y.: ILR Press, 2009).

⁴² Histories of consultants focus on their enterprises, rather than upon their methodologies. One exception is Kiechel, *The Lords of Strategy*, but even this author focuses only one way aspect of consulting—strategy work—while there are many other areas to explore, from early Taylorism to modern process reengineering. To get a sense of the work of process redesign, see Thomas H. Davenport, *Process Innovation: Reengineering Work Through Information Technology* (Boston, Mass.: Harvard Business Review Press, 1992). The literature on process redesign—a major activity of business consultants in the 1980s-early 2000s—is extensive. For useful examples, see Dorine C. Andrews and Susan K. Stalick, *Business Reengineering: The Survival Guide* (Englewood Cliffs, N.J.: Yourdon Press, 1994); Raymond L. Manganelli and Mark M. Klein, *The Reengineering Handbook: A Step-By-*

Step Guide to Business Transformation (New York: AMACOM, 1994); Robert F. Rhyder, *Manufacturing Process Design and Optimization* (New York: Marcel Dekker, 1997).

⁴³ Kiechel, *The Lords of Strategy*.

⁴⁴ The central task undertaken in Cortada, *The Digital Hand*, vol. 1, *How Computers Changed the Work of American Manufacturing, Transportation, and Retail Industries*.

⁴⁵ Accountants seeing this phenomenon or globalization of standards and work practices, largely as a result of increased collaboration of banking and accounting regulators and industry associations since the 1980s. Already reflected in text books, which historically take a decade to codify and explain practices long underway, for example, see Donald E. Kieso, Jerry J. Weygandt, and Terry D. Warfield, *Intermediate Accounting*, vol. 1 (Hoboken, N.J.: John Wiley & Sons, 2011): 7, 10-11. Thomas Johnson and Robert S. Kaplan, *Relevance Lost: The Rise and Fall of Management Accounting* (Boston, Mass.: Harvard Business Review Press, 1991); their sequel is worth examining too, *Relevance Regained: From Top-Down Control to Bottom-Up Empowerment* (New York: Free Press, 1992).

⁴⁶ Examples include Tom McNichol, *AC/DC: The Savage Tale of the First Standards War* (San Francisco, Cal.: Jossey-Bass, 2006); Peter Gibbon, Stefano Ponte, and Jakob Vestergaard, *Governing through Standards: Origins, Drivers and Limitations* (New York: Palgrave Macmillan, 2011); Marc Levinson, *The Box: How the Shipping Container Made the World Smaller and the World Economy Bigger* (Princeton, N.J.: Princeton University Press, 2006); George Barnett Johnson, *Drafting Culture: A Social History of Architectural Graphic Standards* (Cambridge, Mass.: MIT Press,

2008); Agatha C. Hughes and Thomas P. Hughes (eds.), *Systems, Experts, and Computers: The Systems Approach in Management and Engineering, World War II and After* (Cambridge, Mass.: MIT Press, 2000); Wiebe E. Biker, Thomas P. Hughes, and Trevor Pinch (eds.), *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology* (Cambridge, Mass.: MIT Press, 1987, reprinted 2012).

⁴⁷ Many examples of this literature cited in earlier endnotes.

⁴⁸ Much of the research has centered on job losses and obsolescence. Looked at another way, through the lens of information and skills history, one can find considerable documentation and discussion about the changing nature of information. See, for example, Amy Sue Bix, *Inventing Ourselves Out of Jobs?: America's Debate over Technological Unemployment, 1929-1981* (Baltimore, Md.: Johns Hopkins University Press, 2001) and the growing literature on professions, such as Kenneth M. Ludmerer, *Time to Heal: American Medical Education from the Turn of the Century to the Era of Managed Care* (New York: Oxford University Press, 1999); Christopher D. McKenna, *The World's Newest Profession: Management Consulting in the Twentieth Century* (Cambridge: Cambridge University Press, 2006); Lawrence M. Friedman, *A History of American Law* (New York: Simon & Schuster, 2005); Kevn L. Borg, *Auto Mechanics: Technology and Expertise in Twentieth-Century America* (Baltimore, Md.: Johns Hopkins University Press, 2007).

⁴⁹ In addition to those already cited above, see for different approaches, Stephen R. Barley and Julian E. Orr (eds.), *Between Craft and Science: Technical Work in U.S. Settings* (Ithaca, N.Y.: ILR Press, 1997); Paul K. Conkin, *A Revolution Down on the*

Farm: The Transition of American Agriculture Since 1929 (Lexington, Ken.: University of Kentucky Press, 2008); Sarah Stage and Virginia B. Vincenti (eds.), *Rethinking Home Economics: Women and the History of a Profession* (Ithaca, N.Y.: Cornell University Press, 1997); Shoshana Zuboff, *In the Age of the Smart Machine: The Future of Work and Power* (New York: Basic Books, 1989).

⁵⁰ These are beginning to appear on a regular basis, for example, in the pages of *Information and Culture: A Journal of History*; but see also, Weller, *Information History*.

⁵¹ Done more by business management experts, sociologists, consultants, and economists, but essentially none emphasizing information sharing. For a review of the state of historiographical research on big businesses, see Youssef Cassis, "Big Business," in Jones and Zeitlin, *The Oxford Handbook of Business History*, 171-193; also W. Mark Fruin, "Business Groups and Interfirm Networks," *Ibid.*, 244-267, and Luca Lanzalaco, "Business Interest Associations," *Ibid.*, 293-315.

⁵² Chandler, *Visible Hand*.

⁵³ For example work by historians, John F. Stover, *American Railroads* (Chicago, Ill.: University of Chicago Press, 1997); H. Roger Grant, *Railroads and the American People* (Bloomington, IN.: Indiana University Press, 2012); Steven W. Usselman, *Regulating Railroad Innovation: Business, Technology, and Politics in America, 1840-1920* (Cambridge: Cambridge University Press, 2002); Coleen A. Dunlavy, *Politics and Early Industrialization: Early Railroads in the United States and Prussia* (Princeton, N.J.: Princeton University Press, 1994).

⁵⁴ While there are many “how to” books on conducting oral histories, for a thoughtful discussion of its benefits, consequences, and methodological implications, see Per Lundin, *Computers in Swedish Society: Documenting Early Uses and Trends* (London: Springer-Verlag, 2012): 18-30.

⁵⁵ Misa and Yost, *FastLane*, once settled on title and publisher, insert.

⁵⁶ One of the first scholars (in this case business management) in modern times to raise the profile of industries as something to study is Michael E. Porter, most notably in *Competitive Strategy: Techniques for Analyzing Industries and Competitors* (New York: Free Press, 1980) and in a sequel, Porter (ed.), *Competition in Global Industries* (Cambridge, Mass.: Harvard Graduate School of Business Administration, 1985). On the tension between professionalism vs. industry or firm perspectives, see Edward Layton, *Revolt of the Engineers: Social Responsibility and the American Engineering Profession* (Cleveland, OH: Case Western Reserve University Press, 1971).

⁵⁷ <http://www.shrm.org/Pages/default.aspx> ; American Society of Association Executives (ASAE), <http://www.asaecenter.org/index.cfm> (both last accessed 7/7/2013).

⁵⁸ This community had a trade magazine for a while, *Business Screen* (1938-1972) containing statistics on number of films made and shown, company case studies, discussions about how to make such films, about suppliers of film equipment, and advertisements.

⁵⁹ I used these as a core source material for my study of how three dozen industries used computers, 1950s-2000s, Cortada, *The Digital Hand*, 3 vols.

⁶⁰ Abbott, *The System of Professions*; and for a history sponsored by a corporation that discussed standards and professionalization, see David Grayson Allen and Kathleen McDermott, *Accounting for Success: A History of Price Waterhouse in America, 1890-1990* (Boston, Mass.: Harvard Business School Press, 1993); Gary John Previts and Barbara Dubis Merino, *A History of Accountancy in the United States: The Cultural Significance of Accounting* (Columbus, Ohio: Ohio State University Press, 1998).

⁶¹ Partially accomplished by Cortada, "Carrying a Bag," forthcoming.

⁶² In the United States, U.S. Bureau of the Census and the U.S., Bureau of Labor Statistics are examples; OECD and central banks of all industrialized countries do the same. The *Monthly Labor Review*, a publication of the Bureau of Labor Statistics, has routinely discussed how to do this for decades, <http://www.bls.gov/mlr/> (last accessed 7/7/2013).

⁶³ Weaknesses in how economists track firms, industries, and economic activities in a time when information and its effects on society are of great interest, was recently the subject of a useful study of the issue by George Gilder, *Knowledge and Power: The Information Theory of Capitalism and How It Is Revolutionizing Our World* (New York: Reagnery, 2013).

⁶⁴ There is now a useful study of this type of information organization, Thomas Medvetz, *Think Tanks in America* (Chicago, Ill.: University of Chicago Press, 2012), especially on their role and structure, pp. 23-43.

⁶⁵ Examples include Herbert M. Kliebard, *Schooled to Work: Vocationalism and the American Curriculum, 1876-1946* (New York: Teachers College, Columbia University,

1999); Joseph Watras, *A History of American Education* (Boston, Mass.: Pearson Education, 2008); Wayne J. Urban and Jennings L. Wagoner, Jr., *American Education: A History*, 4th ed. (New York: Routledge, 2009); Herbert M. Kliebard, *The Struggle for the American Curriculum, 1893-1958* (New York: Routledge, 1995). William J. Reese, *America's Public Schools: From the Common School to "No Child Left Behind"* (Baltimore, Md.: Johns Hopkins University Press, 2005). Reese adds more about information content of curriculums than do the other authors, albeit quite little.

⁶⁶ For a current set of examples of this kind of software history, see *IEEE Annals of the History of Computing*, 35, no. 2 (April-June, 2013), entire issue is devoted to publishing articles just on this topic, and earlier issues devoted to the same topic, *Ibid.* 31, no. 4 (2009), *Ibid.*, 34, no. 4 (2012).