The Quest for Autonomy and Discipline: Labor and Technology in the Book Trades

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THERE IS MUCH to be learned about the history of labor and technology *in* the book trades. There is also much to be learned *from* the history of labor and technology in the book trades. Understanding the production of printed goods and their components will not only help us understand the changing nature of demand, distribution, circulation, and impact of print, but these investigations will also increase our knowledge of general aspects of the American Industrial Revolution. Indeed, the history of the book trades should be seen as part of the larger history of American labor and technology.

Much of this larger history is composed of the evolving character of conflict and conciliation in the workplace. And while the role of the plebeian classes as participants in the culture of the printed word is a topic well worth exploring, the focus here is on the role of the producers of printed culture. Continuing through the third quarter of the nineteenth century, two themes stand out in this history. First is the quest for autonomy pursued by master artisans and capitalist employers in terms of their control over raw materials, product markets,

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and labor practices. We must also consider the quest for autonomy that was pursued by workers in terms of their control over craft knowledge and the labor process. The second theme is the attempt by employers to discipline their work forces and to maintain that subordination against workers' assertions of independence, while workers themselves sought to impose some discipline over an increasingly unruly economic system. Technology was both a weapon used in these contests and an arena in which these struggles occurred. In the contrasting pursuits of autonomy and discipline, freedom and order, we will find much of the meaning of the development of the book trades.

Pairing labor and technology suggests that the history of work, per se, is our central focus. Printing is not merely a method of communication; it is a form of production.[1] Our attention to labor and technology must ultimately raise questions about the sources and impact of the changing work experiences of men and women in printing offices, bookbinderies, papermills, and typefoundries. Asking questions about work and the factors that condition that experience and its interpretation allows us to investigate a wide range of issues. Rather than peering ever more intently at the esoteric concerns of engineers and inventors, we should begin with the experience of the worker and move both backward into the technologies themselves and forward toward the social and political implications of particular work structures, conditions, and experiences.

Following upon this coupling of the topics of labor and technology, a fruitful way to approach the history of work in the book trades is to pair five sets of social processes that encompass economic, technical, and cultural aspects of the trades. A developmental scheme of contrasting processes seems appropriate. Such a scheme might be organized along the following lines:

[1] Raymond Williams, 'Means of Communication as Means of Production,' in his study *Problems in Materialism and Culture* (London, 1980), pp. 50–63.

1. The transfer of Anglo-European goods and techniques and the creation of American traditions.
2. The expansion of established methods and the encountering of constraints (economic, cultural, technical, structural) to production or profitability.
3. The search for alternative production methods (be they organizational or technical) and the subsequent alteration of the labor process.
4. The restructuring of work and industrial organization and the diffusion of new methods that inevitably accompanied such reorganization.
5. The expansion of production and the subsequent creation of new production traditions, ultimately giving rise to new constraints to further expansion.

Although no single chronology is appropriate for all of these trades, it is possible, based on current knowledge, to suggest that the limits of Anglo-European technologies had been reached by the 1790s and that the first major crisis of reformation of the labor processes in printing, papermaking, and bookbinding came in the 1820s and 1830s, with typefounding lagging behind by about a decade. Papermaking reached the limits of mechanization before 1870 and experienced a profound reorganization by 1900. Typefounding, of course, also reorganized its industrial structure in the 1890s, largely as a response to the challenge of the Linotype machine as well as to the problems engendered by competition. Social relations in the printing trade were transformed in the 1830s and remained highly unstable for the next five decades. While presswork became more minutely subdivided and mechanized, composition remained handwork. But it was so thoroughly subdivided as to severely dilute skills and workers' autonomy.

Indeed, each of these five trades experienced some combination of the major transformations in social relations associated with the industrial revolution in the workplace: the rise of nonpractical, capitalist ownership and management; the mechanization of production and the move to factory organization; the subdivision, dilution, and feminization of skill; and the transition from customary to deliberate workplace regulation. During this era, tensions between differing definitions of autonomy and discipline were constantly at work. Thus, the essential questions are wide in scope:

1. What was the relationship between the expansion of printing and the rise of capitalism in America? How did the book trades come to be competitive capitalist trades, with their specific industrial structures? By what process did ownership of technology and control over productive processes come to reside in certain hands during the course of the nineteenth century? And in what ways did the expansion of the press contribute to bourgeois domination? This is baldly stated, simply because it seems to me that we must first and foremost recognize that we are discussing the epoch of the development of American capitalism. Issues of the control of technology and alterations of labor practices are at the heart of this historical transformation.

2. By what process did certain technologies become preeminent in their fields? What combination of technical difference, product superiority, marketing strategy, capital cost, ease of manufacture or use, and labor requirements or control recommended one technique over competing ones?

3. What was the changing relationship between technology and the work process? How did new technologies interact with work culture and discipline, the organization of work, labor market structure, workers' organizations, and employers' strategies? Why were some processes mechanized before others?

4. What were the relationships between changing product markets or audiences and technological-labor change? For instance, how did changes in typographical designs influence new methods of typecasting, thus altering the work and, ultimately, the technology of typefounding? Conversely, how did

new technologies affect graphic design, typography, and communications?

5. What were the sources of uneven economic development within individual trades and between separate trades? What impact did this have on their subsequent technological-labor histories? For instance, how did the mechanization of papermaking affect typefounding and printing?

Answering these questions will require us to investigate a number of constituent issues whose importance is best seen in relation to these conceptual questions. It is obvious that these questions have subordinate parts that can be explored independently of the full complex. Indeed, so intricate and different are the trades' histories that they must be dealt with individually for many issues. Yet I have the impression that some of the most exciting work in the next few years will focus on the complex interrelationships between trades. We will surely only recognize the importance of much of what we find if we have a conceptual base from which to work. Reviewing some of the actual details of the history of the book trades before 1876 will highlight the importance of the larger questions and suggest the range of subordinate issues.

Printing is by far the best understood of the book trades. Its history will alert us to some conceptual issues encountered in other trades. Printing is a classic case of the subdivision of labor, which abetted the mechanization of tasks, which led, in turn, to further degradation of skill and the use of semitrained labor.[2]

The work process in printing remained essentially unchanged from Gutenberg's day to the early nineteenth century. Composing consisted of taking individual pieces of type from their

[2] See the discussions of the printing trade in a number of recent histories of the urban classes: Sean Wilentz, *Chants Democratic: New York City and the Rise of the American Working Class, 1788–1850* (New York, 1984), pp. 129–32; Steven J. Ross, *Workers on the Edge: Work, Leisure, and Politics in Industrializing Cincinnati, 1788–1890* (New York, 1985), pp. 107–12; W. J. Rorabaugh, *The Craft Apprentice: From Franklin to the Machine Age in America* (New York, 1986), pp. 76–96, 146–54; Robert M. Jackson, *The Formation of Craft Labor Markets* (Orlando, Fla., 1984).

compartmentalized cases, placing them in a three-sided composing stick held in the left hand, and filling out each line with spacing pieces so that the lines were of equal length. When the stick was full, the composed matter was transferred to a table where it was arranged in proper order. It might be placed in a long tray and a proof taken to insure accuracy or immediately divided into pages and locked into place in a metal frame for placement on the press. The second operation in printing, called imposition, involved the correct ordering of the pages and their precise alignment within the frame. The matter was held tightly in the frame by the use of wooden strips and wedges knocked firmly into place. The frame, or chase, now weighing many times its weight when empty, was carried to the press and locked into place on the press bed. As the predominant method of composing matter, this process did not change substantially until the very end of the nineteenth century.

Presswork on a common handpress involved preparing the ink and wetting the paper, locking the chase onto the bed and insuring its alignment, performing all the tasks known as 'making ready' to prepare the press for even impressions, inking the form, positioning the paper, and creating the impression by forcing the heavy platen down. The common press was a large frame with crosspieces holding the screw that drove the platen down and a railing, along which ran the bed holding the form of inked type and the paper. The essential elements were the platen and screw, the bed on rails that could be winched in and out from under the platen, and the hinged frames that held the paper and positioned it over the inked type. This essential technological paradigm remained unchanged until the end of the eighteenth century.

The substitution of iron for wood frames in the early nineteenth century provided greater strength to the press, allowing a larger platen and greater stability. The substitution of a series of levers for the screw eased the work of the pressman. Still, in 1810 the iron handpress looked very much a member of the same family as the sixteenth-century wooden common press. And the processes of typesetting, imposition, and presswork were carried out in a routine, traditional fashion.

Mechanization of presswork began in England in the early nineteenth century with the development of the cylinder press by Frederick Koenig. The general principle of the cylinder machine consisted of the notion that a cylinder onto which the paper adhered could be revolved over the form holding the inked type more rapidly than the meeting of two parallel planes, as in the platen press. Keonig's machine was especially useful for newspapers, where time was essential but printing quality could be compromised because the product was meant to be ephemeral. The most noteworthy introduction of Koenig's machines came at *The Times* in London in 1814. Other manufacturers evolved their own style of cylinder presses; the first imported to the United States was a Napier press purchased by two New York City newspapers in 1825. These presses rapidly became the most popular for urban newspaper and periodical work.[3]

Other men, however, were convinced that the cylinder principle could not provide an absolutely precise impression. Also, many offices did not need the speed nor could they afford the expense of a cylinder press. Development of a machine bed-and-platen press occurred just after the invention of the cylinder press. This time, however, it was an American who developed the first successful innovation. Daniel Treadwell of Boston had become interested in printing presses as an application of mechanical principles to human movement, and by 1820 he had conceived of several improved presses. By 1830, two other New Englanders, the brothers Seth and Isaac Adams,

[3] Rollo G. Silver, 'An Early Time-sharing Project: The Introduction of the Napier Press in America,' *Journal of the Printing Historical Society* 4(1968):29–36; Frank E. Comparato, *Chronicles of Genius and Folly: R. Hoe and Company and the Printing Press as a Service to Democracy* (Culver City, Calif., 1979), pp. 13–15, 37–47; James Moran, *Printing Presses: History and Development from the 15th Century to Modern Times* (Berkeley, Calif., 1973), pp. 116–17.

had shifted their press-building operations from handpresses to bed-and-platens. They set the standard for the next three-quarters of a century. The Adams press moved its bed up and back from a stationary platen, the paper being taken to the point of impression by a frisket. Bed-and-platen presses became standard for all good bookwork by the 1840s, although some publishers preferred the iron handpress for fine work, and many smaller printers continued to use only handpresses. By the late 1830s, the increasing demand for commercial ephemera and the obvious financial and technical restrictions on the use of large power presses called for a small, flexible press. The platen jobber, often operated by foot treadle, with easily altered forms, and usually worked by a boy or woman, was the answer.

Within the era under consideration, there was one more thorough renovation of the conception of presswork. Iron handpresses, bed-and-platen, and cylinder presses all carried their type form on a flat plane. Pressmen retained much of their control over skilled adjustments of the press, gained in stature as machine technicians, and turned over the unskilled work to assistants. In the 1840s, the English press manufacturer Augustus Appelgath developed a press that had the type forms attached to a revolving cylinder. Placed around this cylinder were additional impression cylinders, which carried the sheets of paper to the central cylinder and made the impression. In 1847, the preeminent American press manufacturer, R. Hoe and Company, of New York, installed a new version of the type-revolving press. The Hoe press also used regular printing type, but rather than attaching flat plates to the type cylinder, the Hoe press used specially designed, wedge-shaped column rules to hold the type to a detachable part of the cylinder called a 'turtle.' The Hoe press had the additional advantage over the Appelgath of an automatic 'fly' to remove each sheet after printing. The final elaboration was the substitution of a roll of paper feeding directly to the press in place of individually fed sheets, a development of the late 1860s. These developments emphasize the importance to employers and inventors alike of such unskilled work as feeding and taking off. The type-revolving and web-fed presses were appropriate only for the largest metropolitan newspapers, but they constituted the epitome of fast printing in the nineteenth century.[4]

Two other technological developments influenced the work of printers. Stereotyping and electrotyping allowed the duplication of typeset forms. These processes allowed the storage of vast amounts of matter without the lost investment of storing foundry type. They permitted the duplication of material once set and the simultaneous multiple printing of matter. Stereotyping was first practiced in the United States in 1814, and electrotyping in the 1840s. The technologies had an indirect impact on the work in the printing office; they replicated the compositor's work, and denied him the opportunity to be paid for it, while increasing the profit opportunities for employers.[5]

Changes in the work routine and the organization of offices preceded and conditioned the impact of technological change. Master printers were dividing the work between compositors and pressmen, so that those became essentially separate occupations by the late eighteenth century. In the 1820s, the introduction of specially designated men as 'makers-up' broke the connection between these two work processes and denied many men the opportunity to learn this skilled aspect of the trade. Increasingly, distinctions were drawn between straight matter and more complex or artistic work. Different product markets grew for book and periodical work, job or commercial work, and newspapers. Out of this differentiation of products devel-

[4] Moran, *Printing Presses*, pp. 113–71, passim; Comparato, *Chronicles of Genius and Folly*, pp. 4–109, passim; Elizabeth F. Baker, *Printers and Technology: A History of the International Printing Pressmen and Assistant's Union* (New York, 1957), pp. 3–30.

[5] Michael Winship, 'Printing with Plates in the Nineteenth-Century United States,' *Printing History* 10(1983):15–26.

oped different types of offices, each with its own technology and work routine. Increasing competition among master printers sent many of them looking for cheaper sources of labor, and the use of partially trained, apprentice-aged boys and women increased dramatically in the first half of the century.

Compositors are generally considered to have enjoyed more control over their work than many other kinds of workers, and many enjoyed better-than-average wages. Their craft customs have received a certain amount of attention and are usually linked both to Anglo-European traditions and to the continuity of the work process. The separation of pressmen from compositors is often considered the major division of labor within the trade, but little attention has been paid to the type of work culture invented by pressmen, who were also among the most highly paid of nineteenth-century workers but whose labor was the product of new technology.

The interpretation of the impact of the structural differentiation of the printing trade on labor and technology is only just beginning. But it is clear that by the late 1820s, before the introduction of cylinder or bed-and-platen presses, the printing trade was no longer the artisan workshop of the early modern era. Technology altered the requirements for workers in the office and demanded new skills for pressmen, but it did not obviate the skill of the compositor. The separation of composing, imposing, and printing into different skills performed by different individuals in the larger offices allowed employers to pay for only the single skill a worker possessed rather than to encourage the 'all-around' printer. Technology contributed to, but it did not cause, a number of changes: the separation between employer and worker, increased capital requirements, reduced upward mobility, more complete division of labor, a flood of underemployed compositors, and increasing profit rates. The late 1820s and 1830s were the crucial era. For the next several decades the trade expanded but generally experienced only elaborations on these themes.

Press manufacturing and printing make interesting examples of the impact of uneven economic development. As competition increased among manufacturers in the 1830s, each one strove to acquire a secure yet growing share of the market. Their efforts included aggressive marketing, credit and patent policies, as well as manufacturing improvements and technical innovations. Individual manufacturers sought to establish market control through product differentiation. Thus, competition fueled technological change in the printing trade, increased the diversity of presses available, contributed to the specialization of labor, and encouraged both the expansion of and competition within the printing trade.

Still, the role of technological change in the evolving structure of the printing trade is not fully understood. We can focus on the important offices that first adopted innovative presses, but we have little concrete sense of when and where those presses next appeared. The diffusion of printing techniques has yet to be thoroughly explored. The relationship between the growth of newspaper readership and faster presses is often asserted but seldom analyzed. Alteration of the work process and the extent to which compositors, pressmen, and foremen influenced those changes is still not adequately appreciated. Printers were among the most highly organized tradesmen in the nineteenth century. The history of the union movement has been told several times, but we are only beginning to ask questions that move beyond institutional history and into the social and political origins and implications of union policies.

While printing offices preceded papermills in North America, papermaking was a much older craft. By the early eighteenth century, papermaking techniques were fairly standardized in the Western world and the craft was well understood. Papermakers guarded their secrets for procuring whiter paper, but there was in fact little variation among the recipes. Papermaking required lots of clean water, rags, some bleaching agents, and a minimum of machinery; but it also required specially made hand molds, and highly skilled workers. During the nineteenth century, social relations within the trade were radically altered and mechanization totally transformed the production process.

Before pulping, rags were sorted into piles of clean and white pieces for white paper and dirty and colored rags for less expensive or colored paper. The rags were soaked, bleached with an alkaline solution, and then beaten by hand with a mortar and pestle, beating machine or, after about 1750, a Hollander machine. The rags were mixed with water to create a pulpy mass called 'stuff.' A skilled vatman dipped a wire-bottomed mold into the stuff and allowed water to drain, meanwhile shaking the mold to interlace the fibers and form them into a uniform thickness. After removing the top of the mold, or 'deckle,' the vatman passed the mold to another worker, the 'coucher,' who inverted it, dropping the moist sheet of paper onto felted cloth. The coucher covered this sheet with another piece of cloth and dropped the succeeding sheet of paper onto that. A stack of cloth and paper sheets was then placed into a screw press and the water squeezed out. Individual sheets were later hung to dry in another room, preferably a well-ventilated loft. After drying for several days, the sheets were dipped in sizing made from animal bones and hooves, pressed, and dried again. Finally, they might be passed through a pair of rollers in a calendering process.

The equipment for such a hand-operated mill was minimal. The screw press was a basic form dating back centuries. The Hollander (if there was one) was a pulping machine, usually water powered, consisting of a vat with one set of knives mounted on the vat floor and another set on a wheel rotating past them, which tore and shredded the rags. Molds were two-piece affairs: a wire-bottomed mold and a detachable frame or 'deckle' that was used to form the edges of the paper. Not many Americans practiced the complex business of making wire molds. English and French molds were imported to America well into the nineteenth century. Mills approximated the appearance and the size of most textile mills of the era and were situated near water, markets, and sources of rags and labor. The mill buildings themselves were separated into a rag room, a beating room, a vat room, a drying loft, a size room, and a finishing room.

The hierarchy of the work force approximated the division of the mill's rooms. The sorting room and drying loft were occupied by low-paid women and boys, while the beating and vat rooms, where the stuff was prepared and the sheets actually made, was the domain of the skilled papermaker and his assistants. The coucher was in a responsible position, since his carelessness or clumsiness could destroy the vatman's products. The layboy, on the other hand, simply was trusted with moving moist sheets of paper and assisting the coucher and vatman. Early in the nineteenth century, vatmen and couchers might receive on the order of three to five dollars a week, layboys seventy-five cents and women sixty cents plus board. The owner of a small mill in Massachusetts paying these typical wages allowed himself nine dollars weekly.[6]

Paper production expanded rapidly during the early decades of the nineteenth century. The number of mills grew from eighty or ninety at the end of the Revolution to just one-hundred at the turn of the century, then doubled in the next decade. The two hundred mills in operation in 1810 produced perhaps four hundred thousand reams of paper yearly. Still, American papermakers could not keep up with demand and much paper was imported from England, France, and Holland. American mills remained small, using at most three or four vats, and employing twenty or so workers.[7] Eighteenth-century efforts to import skilled workmen generally failed, leaving

[6] Norman B. Wilkinson, *Papermaking in America* (Greenville, Del., 1975), p. 26; see also Jane L. Carter, *The Papermakers: Early Pennsylvanians and Their Water Mills* (Kennett Square, Penn., 1982).

[7] Wilkinson, *Papermaking*, p. 23; Isaiah Thomas, *The History of Printing in America*, ed. Marcus A. McCorison, 2d ed. (New York, 1970), pp. 26–28.

paper manufacturers to train local talent. Nineteenth-century expansion and the location of the industry enticed foreigners, especially Irish and Scottish artisans. Throughout the century, papermaking had a higher proportion of foreign-born workers than any other book trade. Capital investment, machinery, and annual production remained limited in many mills, although papermaking was and is still the most capital-intensive of all the book trades.

It was not merely capital or labor that perplexed manufacturers. Raw materials presented a major obstacle to consistent production. By the turn of the nineteenth century, Americans were searching far and wide and paying high prices for clean, white rags with which to make the whitest paper. The development of chlorine in the 1770s by French chemists reduced some of the necessity for white rags, but it was still no simple chore to obtain one and a half pounds of rags for every pound of paper produced. Moreover, the price of rags constituted the paper manufacturer's greatest cost and fluctuated violently, as did the availability of rags. The search for rag substitutes was a century-long concern of the paper trade and the elaboration of nineteenth-century techniques continued into the twentieth century. It was, of course, wood pulp that came to the rescue of papermakers in the 1860s, creating new technological questions for the paper industry and opening entirely new ecological issues.

However, the search for a mechanical means of papermaking began with labor problems. Nicholas Louis Robert was a clerk entrusted with improving productivity in a French papermill in the 1790s. His greatest problem was the workers' intransigence; they wanted nothing to do with his discipline and efficiency. Robert set out with his employer's blessing to devise a method of displacing the skilled workmen who controlled the labor process. After several years' work and a number of improvements on his original model, Robert patented a machine in 1798 for his employer, Didot. Didot lacked the financial resources to market the machine for a profit and ended up selling the rights to the English papermakers Henry and Sealy Fourdrinier. The Fourdriniers' mechanic, Bryan Donkin, improved Robert's machine in several ways, and in 1807 it was offered for sale to papermakers. Only a few Fourdrinier machines were sold during the subsequent fifteen years, but by midcentury there were hundreds worldwide.[8] A Fourdrinier machine was first imported to the United States in 1827, a full decade after the first American-developed papermaking machine was introduced by the Gilpin brothers of New Castle County, Delaware.

Joshua Gilpin opened his first papermill on Brandywine Creek in northern Delaware in partnership with his uncle in 1787.[9] He was later joined by his brother Thomas, and by 1800 the Gilpin's mill was using one hundred thousand pounds of rag and producing one thousand reams of paper annually. The Gilpins expanded their operations considerably during the next few years, establishing mill villages that included housing for workers and jobs for several members of individual families. Just how these villages compared to New England mill villages is a matter for further research.[10] Joshua Gilpin visited England and the Continent for two extended periods between 1795 and 1815 to obtain technical and industrial information. During two years of outright industrial espionage between 1814 and 1815, he obtained sufficient data to allow his brother to construct a papermaking machine. Modeled after an English machine developed by John Dickinson in 1809, the Gilpin machine operated on principles quite different from the Fourdrinier machine.

[8] R. H. Clapperton, *The Papermaking Machine: Its Invention, Evolution, and Development* (Oxford, N.Y., 1967), pp. 247–49.

[9] Harold B. Hancock and Norman B. Wilkinson, 'The Gilpins and their Endless Papermaking Machine,' *Pennsylvania Magazine of History and Biography* 81(1957): 391–405.

[10] See Anthony F. C. Wallace's comments on papermaking in *Rockdale: The Growth of an American Village in the Early Industrial Revolution* (New York, 1978), pp. 11, 80, 125, 162, 284.

The Fourdrinier was a web machine: the pulp poured onto a continuously moving web of wire screen that ran over rollers. The paper passed to a belt of felted material, where it moved through more rollers that squeezed out much of the water. The paper was finally rolled onto a cylinder. The Dickinson/Gilpin machine involved a copper-mesh cylinder that revolved while partially submerged in the vat of stuff. A suction device in the cylinder's center made the pulp adhere to the cylinder's outside. The paper was then passed to a felted belt, carried through a series of rollers on the belt, then separated from it, and finally wound onto a roll.

Scholars disagree on the actual rate at which papermakers adopted the machines. The cylinder machine cost much less than the Fourdrinier and was easier to operate, but it produced a generally lower-quality product. Opinions about the relative merits of the two machines changed over time. The cylinder seems to have been more popular until the final two decades of the century, when the Fourdrinier became increasingly dominant.[11] Research into the actual diffusion of these technologies will undoubtedly show great regional differentiation, a fact not unique to papermaking, although it was perhaps accentuated by the trade's particular requirements for raw materials.

Both machines dramatically increased mill productivity, decreased labor costs, and transferred the knowledge, skill, and control of the work process from the handcraftsman to the mill owner. Mechanization increased the employment of women and required the reskilling of many vatmen and couchers. It also vastly increased the use of steam engines and the capital investment required to establish a mill. By 1880, the average papermill in the United States (of which there were 692) was capitalized at sixty-six thousand dollars, more than three times the average capitalization of a printing office or ink manufactory, and ten thousand dollars more than the

[11] Lyman H. Weeks, *A History of Paper Manufacturing in the United States, 1690–1916* (New York, 1916), p. 296; Clapperton, *The Papermaking Machine*, passim.

average typefoundry. Papermills employed the second highest proportion of women (31.2 percent of the total 24,422 workers) but the lowest percentage of children (2.7 percent) of all the book trades.[12]

Judging by patent activity, it is evident that papermaking processes were constantly revised. While there were only ninety-two American patents in the paper trade before 1838, they included the basic mechanization of the production process, along with improvements in felting materials and the drying apparatus. After 1840, there were an average of thirty patents a year, centering on methods of improving the speed of the basic process and in using new fibers. Innovations in calendering, sizing, and cutting the paper product increased both quality and productivity in the middle decades of the century. By midcentury, the search for new fibers had produced a number of substitutes, but it was the creation of the mechanical means of producing usable wood chips that turned the tide. Ground wood pulp was first used for commercial newsprint in 1868 and gradually came to supply the bulk of paper stuff. The final quarter of the nineteenth century saw massive changes in the structure of the industry. Manufacturers increasingly adopted the corporate form, vertical and horizontal integration increased, and mill size expanded along with the use and size of Fourdrinier machines. The 1870s marked the end of the traditional, mechanized paper trade.

American typefounding was the third book trade most influenced by changes in the division of labor, mechanization, and internal factory organization. Typefounding consisted of several distinct and very precise operations. Although many have noted that early printers engaged in all aspects of the book trades, typefounding probably was removed from the printing

[12] U.S. Department of the Interior, *Report on the Manufactures of the United States at the Tenth Census* (Washington, D.C., 1883), p. 12. These and subsequent statistics from this source are presented merely to suggest the magnitude of these trades. Any analytical work must depend on manuscript sources and will undoubtedly show immense regional and urban-rural differences.

office by 1585. After that time, it was the unusual printer or the odd job that required casting in the printer's office. At least this was true in Europe. In colonial America, there was more overlap among trades, and printers occasionally engaged in typefounding. Still, most eighteenth-century type was imported from foreign commercial foundries, since domestic production only began in earnest after the Revolution.

The first step in typefounding was the most artistic. The letter cutter designed and cut the letter into the end of a soft steel shank. After hardening, the punch, as it was called, was driven into a blank piece of copper to create the matrix. This matrix, squared and precisely finished, was fitted into one of the more remarkable achievements of the fifteenth century, the adjustable type mold. The mold was composed of two pieces of wood with a slot for holding the matrix absolutely square and a channel with a mouthpiece for introducing the molten metal. The mold held constant the depth and height of the type but was adjustable for different width sorts. Cutting the letter, creating the matrix, and fashioning the mold to precise configurations were demanding operations, representing the typical unity of conception and execution in artisan production.

Once the matrix was set in the mold, the caster prepared a mixture of lead, tin, and antimony. The proportions changed with the size of type to be made. Smaller type contained a higher proportion of tin and antimony in order to produce a free-flowing alloy that hardened completely. The caster held the mold in his left hand, ladled the molten metal out of a crucible, and poured it into the mouth of the mold. Simultaneously, he jerked the mold upwards, forcing the metal to the very face of the matrix to create a full impression of the letter without any air holes. The metal solidified quickly, the mold was opened, and the type thrown out. The caster closed the mold and repeated the process, casting perhaps four hundred to five hundred sorts per hour.

The type came from the mold with a long, extraneous piece of metal attached. This 'jet' was broken off by an unskilled boy or woman, who passed the type to another unskilled boy or woman known as a rubber. The rubber quickly and deftly smoothed the type's two broad sides by passing it rapidly over a grindstone that lay flat on a table. The type was quickly placed in long wooden frames and taken to a dresser, a man who used a planelike device to square the narrow sides and then cut a groove where the jet had been attached at the bottom of the type body. He then inspected the type for any imperfections and wrapped them in page-sized bundles. Printers could order special amounts of individually needed sorts, full fonts of type, or type by weight.

There were few technical changes in this process, but those that did occur were profound. In 1811, the American founder, Archibald Binney, patented and popularized an improvement of the hand mold. Binney attached a small spring lever to the matrix that the caster depressed as he opened the mold. This had the effect of 'popping' the type out as the mold opened and increased the speed of the process. Until the 1820s, despite several attempts to create a casting machine, the process of typefounding remained unchanged.

In the 1820s, continual attempts to increase productivity and the need to cast newly popular, fine-lined faces encouraged more experimentation with pumps to force the molten metal into the mold. Several pumps were developed both in England and the United States, one of the most successful by David Bruce, Jr., an important New York typefounder. The pump was the first interruption of the traditional hand process, beginning the shift away from the 'workmanship of risk' to the 'workmanship of certainty,' to use David Pye's instructive terms.[13]

In the late 1830s, Bruce developed a commercially successful machine to cast type. The pivotal caster, so called because the mold and matrix pivoted back and forth up to the spout that

[13] David Pye, *The Nature and Art of Workmanship* (Cambridge, Eng., 1968).

delivered the metal, became the standard typecasting machine for the rest of the century. The machine caster increased productivity by a factor of ten and subsequently increased the employment of unskilled breakers and rubbers. Hand-cranked, the pivotal caster removed the skilled aspects of the work of casting (although not that of cutting punches or making matrices). But it left the remaining, less-skilled work processes unaffected. Large type and ornaments continued to be cast by hand, although both stereotyping and electrotyping cut into their production. Attempts to mechanize the cutting of punches and rubbing the cast type were generally unsuccessful in this era.

Eighteenth-century America lacked the materials and men with skills to produce type. The first attempt to commercially cast type came in 1769, but successful foundries were only established after the Revolution. John Baine immigrated from Scotland and established a foundry in 1789 in Philadelphia. Benjamin Franklin purchased and imported an entire typefoundry from France in 1786. Adam Mappa, an experienced typefounder, moved himself and his equipment to New York four years later. Archibald Binney and James Ronaldson arrived from Edinburgh in 1797. Binney, an established typefounder, brought his equipment with him. Another pair of Scotsmen, David and George Bruce, also immigrated to New York in the mid-1790s. Binney and Ronaldson had the only operating foundry in the country in 1800, but by 1810 the industry was well established. By 1820, domestic demand could be fully met by the five foundries operating in Baltimore, Philadelphia, New York, Boston, and Cincinnati.

We have only scattered data on the operations of these and subsequent foundries. Most seem to have employed several workmen and a dozen or more women. However, one of the largest utilized thirty casting machines in 1850.[14] Every foundry accepted orders from around the country, although each hoped

[14] *Godey's Ladies Book* 53(1856):301.

to dominate its regional market. Typefounders competed in choice and execution of design as well as in quality, timeliness, and cost of production. By 1880, the forty-eight foundries, capitalized at $2.8 million and producing $2.3 million in type annually, employed just under two thousand persons, including 400 women and 250 children.[15] By this time, typefounders were beset by the problem of cutthroat competition and declining prices. Soon, the Linotype's popularity would reduce demand for foundry type. The perceived solution to this lay in the formation of the consolidated American Typefounders Company in the 1890s. Typefounding thus presents almost stereotypical examples of the crises accompanying the transitions from petty commodity production to corporate capitalism.

Most early modern European printers made their own ink or purchased it from fellow printers who produced a surplus. After the fifteenth century, much of this ink was of very poor quality, since master printers often retailed their poorest-quality ink. Purveyors of paints also made ink, again, often of poor quality. There really were few secrets in the basics of inkmaking, although some printers did add special ingredients for specific effects. To boiled linseed oil was added some rosin for thickening, which was then combined with lampblack. Manganese was often added to speed drying and 'resin soap' added to form a distinct impression. The quality of linseed oil, the judgment in boiling it for the proper time, and the quality of the lampblack largely determined the quality of ink.

By the early eighteenth century, some master printers, publishers, and customers were fed up with inferior ink. Several master printers in England and on the Continent began experimenting with methods of producing ink that was darker and more stable in color, less liable to create brown, oily halos around letters, and less likely to turn to powder upon drying. This fostered a sense of competition with other printers and inkmakers. By the late eighteenth century, commercial ink-

[15] U.S. Department of the Interior, *Report on Manufactures*, p. 14.

makers were plying their trade throughout England and Europe, although a few master printers still preferred to make their own.

European and English inks were imported to America throughout the colonial era and well into the nineteenth century. There were several ill-fated attempts to establish commercial ink manufactories in America in the eighteenth century, but only three makers were in business at the beginning of the American Revolution. Several firms founded in the very early nineteenth century became leaders in the field and prospered through much of that century. By 1880, there were sixty-three commercial ink manufacturers employing only 480 persons and capitalized at just $1.25 million. Their annual product ran to $1.63 million, more than enough to supply American printers and authors.[16]

Technological change is not a major theme in the history of ink production. There occurred only one important development and several minor innovations involving the production process itself. On the other hand, major changes in ink production have come from the use of different raw materials, especially pigments for the production of colored inks, utilized in traditional processes by ink manufacturers. Boiling linseed oil, producing lampblack, adding some agents for specific effects, mixing and grinding the whole to a uniform, pastelike consistency remained the essence of the process. The major technological change was the introduction of a steam-powered grinding machine used to reduce the mixture to a homogenous whole. Even this did not require alteration of the common batch system of production.

The use of steam-powered mixers and grinders reduced much backbreaking labor but did not eliminate all of the onerous aspects of working in an ink factory. Boiling linseed oil and producing lampblack in large furnaces were still hardly congenial chores. Nor did the introduction of machinery reduce the skill required to boil the linseed oil just right or to add the

[16] Ibid., p. 11.

proper quantity of other materials to produce the desired consistency, viscosity, color, and drying rate.

A review of patents issued in England and the United States shows that most proposed changes in inkmaking were in the actual composition of the inks themselves rather than in any processing machinery or production techniques.[17] Many patents involved the development of oil substitutes or the use of new materials as pigments. The introduction of refinements in the composition of inks and their processing were important for the reproduction of fine woodcuts and lithographic printing. Various natural pigments were commonly used until the introduction of coal-tar colors in the middle of the nineteenth century. Coal-tar pigments vastly increased the range of colors readily available to inkmakers but did not greatly alter their production process or commercial operations, although colored inks required extremely fine grinding and the application of steam-powered rollers was an immense advantage.

We know very little about the actual labor process, as opposed to technical descriptions, of the production process of inkmaking. We know next to nothing about the sources, organization, work routines, or customs of American labor. For example, Anglo-European master printers made a ritualistic excursion out of the need to move to open ground to boil and 'flame' the linseed oil to produce ink. Pieces of bread and sometimes onion were placed in the boiling oil to absorb the excess grease. This fried bread was considered a great morsel when consumed hot, and journeymen and apprentices considered it a perquisite of their occupation. Also, Moxon noted that journeymen invited the 'typefounder, smith, joiner, and inkmaker' to the annual wayzgoose, or festival, expecting each of them to contribute money for the merriment.[18] The journeymen could expect a donation because it was they who decided which

[17] C. Ainsworth Mitchell and T. C. Hepworth, *Inks: Their Composition and Manufacture* (London, 1904).

[18] Frank B. Wiborg, *Printing Ink: A History with a Treatise on Modern Methods of Manufacture and Use* (New York, 1926), p. 97; Joseph Moxon, *Mechanick Exercises on the Whole Art of Printing* (1683; repr., Oxford, 1958), pp. 82–86, 327.

suppliers would provide the printing office with needed services and materials. How did such traditions influence American laborers? In nineteenth-century America, it was the office foreman who made most of these decisions. Since foremen were often charged with accepting bribes from the agents of inkmakers and typefounders, attitudes had obviously changed. One of the great needs in the cultural history of work is the investigation of how widely accepted notions of 'right' and 'obligation' were transformed between the sixteenth and nineteenth centuries by concepts of property, theft, and influence. It would be useful to examine how commercialization of ink production affected the nature and composition of workers' rituals, customs, and controls over the labor process.

The demands made of ink were and are great: it must be the proper color and tint and stay that way; it must not 'powder' off or 'bleed' into paper; it must dry quickly but not too quickly; and it must come off the type cleanly without smearing, and wash off the type easily. The various methods of obtaining these desired results were a combination of knowledge of the proper ingredients and their properties, and skill and dexterity in manipulating the physical processes of boiling, 'flaming,' and mixing. No wonder early printers attached a ritualistic aura to the occasion. Scientific advances did not contribute significantly to inkmaking until the application of coal-tar pigments in the mid-nineteenth century. The use of external power sources, especially the use of power rollers to grind the ink in the 1820s, was the major technical change in the trade. Power printing presses with automatic inking required uniformly finer ink than could be handground. Bloy notes that power grinders were further stimulated by their difficulty in obtaining workers willing to engage in the arduous and noxious work of hand grinding.[19] The development of colored inks was greatly stimulated by the introduction of another printing process, lithog-

[19] Colin Bloy, *A History of Printing Ink, Balls, and Rollers, 1440–1850* (London, 1967), pp. 51–52.

raphy. Printers who used typographic methods found lithography a serious competitor very soon after its commercial development in the 1820s, and they soon demanded more and better colors for letterpress printing.

The introduction of finer-quality inks as well as composition ink rollers was stimulated by the introduction of machine presses. A great stumbling block to faster printing was the limitation on the speed with which the form could be inked. Leather-covered cylinders were tried, but the inevitable seam down the length of the cylinder prevented uniform inking. At least one claim is made that printers derived the idea of a molasses-and-glue composition roller from the Staffordshire potters, who used similar rollers to apply designs to their ceramic wares. The new printing presses worked at such rapid speeds, and without the intervention of human judgment in the application of ink, that a more finely ground, uniform, and quicker-drying ink was needed. Frederick Koenig, the developer of the first cylinder press, developed his own ink to meet the needs of the press. The Hoe Company did essentially the same in the nineteenth century. Thus, developments in other book trades as well as techniques known in other industries contributed to the demand for technical change in inkmaking.

Bookbinding reflects the impact of uneven development within the book trades, as large, factorylike binderies grew alongside custom-oriented artisan shops. The process of handbinding books with 'solidity, elasticity, and elegance' is conveniently divided into three stages, each with a number of subordinate operations.[20] These stages are preparing, forwarding, and finishing. The sheets delivered from the printer had to be prepared, that is, gathered into piles, each comprising a whole work. The piles were then folded, collated to ensure the proper arrangement of pages, and, if necessary, plates were added. Well into the twentieth century, this low-skilled, low-paying

[20] John Hannett, *Bibliopegia; or, The Art of Bookbinding*, 4th ed. (London, 1848), p. 13.

work was performed by hand by women. After preparation, the book was beaten with a hammer to flatten and compress the folded sections. It was then placed into a sewing press and its sections sewn together, again, a task done by women. In many binderies, the preparation was accomplished in a separate room sometimes called the 'girls' room' or 'sheet room.' From here the book went to the forwarder.

The forwarder first beat the book again to ensure uniform thickness. Then he used a round-headed hammer to create the familiar rounded back. Next, the book was placed between boards in a vicelike press and the forwarder used another hammer to form the shoulder and groove, which held the millboard covers. The boards were then attached to the book by tying the cords running across the back of the book through holes punched in the boards. If the book was simply to be put in boards, this ended the work process.

Leatherbound books, however, required further highly skilled work. A book to be bound in leather was first trimmed on three sides using a plough, the bookbinder's essential edge-cutting tool. The plough consisted of two pieces of wood, called cheeks, that were linked by a wooden screw, with a pointed knife attached perpendicularly to the inside of one cheek. The book was placed in a vise with just as much of the edge exposed as was to be trimmed. The plough was placed over the book with one cheek running in a groove in the vise. The plough was run back and forth to trim a few sheets; then the screw was tightened to draw the knife across a few more sheets and the plough run back and forward again, and so on until the entire edge had been trimmed. This was repeated for the other sides. Higher-quality binders required that the book be trimmed 'in-boards,' meaning that the boards were already attached. The cover of calfskin (usually) was pulled over the boards, folded over, and held by end sheets pasted to the inside of the boards. From here, the book passed to the finisher who prepared and decorated the leather using a variety of heated tools to impress designs. The finisher was the most artistic member of the bindery. Using a number of heated rolls and fillets, the finisher tooled designs into the leather. These designs could simply be impressed, in which case it was 'blind-tooling,' or gold leaf could be affixed to the designs in the case of 'gold-tooling.'

In the mid-eighteenth century, minor changes were made in this process that changed the appearance and construction of the book. Preparers sawed grooves into the back of the book, so that the cords of the binding would lie flat against the back once they were sewn to the sections. By the early nineteenth century, many books were being bound 'out-of-boards,' that is, they were trimmed before the boards were attached. This reduced individual attention to specific volumes, allowed for more rapid trimming because books were trimmed in batches, and permitted a division of labor. Such changes in the details of construction and process encouraged flexibility in what a bound book meant and led the way to further changes in bookbinding methods.

Preparing, forwarding, and finishing remained the essence of decorative bookbinding just as they were in the sixteenth century. Several changes, however, made the processes mean something different for the majority of books placed between the covers after the early nineteenth century. These changes altered traditional hand practices without introducing new technologies. One new method was the out-of-boards technique, which reduced the cost of a bound book, even though it was substantially the same in construction and appearance as a book bound in-boards. Another important change was that of pasting the cords to the boards rather than punching holes in the boards and tying the cords to them. The cords were frayed at the ends, pasted to the boards, and endpapers pasted over them for appearance and further solidity. The introduction of cloth to replace the much more expensive leather as a covering for the millboards was a singularly important substitution. Accompanying these changes to the traditionally bound book was the introduction of yet another type of protection for the book. This involved the use of high-quality marbled or colored paper in place of leather or cloth as a covering and the use of printed labels with author and title data in place of impressions in leather. These techniques spread almost sequentially between 1800 and 1835. All of these alterations, involving new materials and processes, were efforts to cheapen the cost of binding. They opened the door to the notion of 'casing.'

Casing was simply the production of covered boards into a unit that could then be attached to a sewn book. Casing was introduced into the United States from England between 1825 and 1835 and has become the chief distinguishing characteristic of edition binding as opposed to handbinding. However, even the cases themselves were handmade until the 1890s. Initially, the cases were attached to the book by use of a piece of paper pasted to the back of the book and then to the case. By the 1860s, a piece of linen fabric, called a 'crash,' was commonly used. The cords then served only as the common bond to which the signatures were sewn. The use of cases allowed yet another division of labor, increased the productivity of binderies, and reduced the cost of a book.

Technological changes were widespread in the actual work of bookbinding during the nineteenth century. In the early 1820s, a rolling press was introduced to replace the burdensome process of handbeating during preparation. The use of this press stirred several hundred London journeymen binders to sign a petition protesting the unemployment caused by the machine, but, as far as we know, no similar protests were launched on this side of the Atlantic. In 1832, an embossing press was developed that allowed the creation of designs on cloth-covered boards, something unattainable before cloth was sized so that it would hold the impression. The sized cloth and embossing press allowed binders to offer the public cloth-bound books that approximated the look and feel of leather. The embossing machine did not displace any labor, since it was introduced just as cloth was becoming a common covering in America. One of the most skilled aspects of forwarding, the process of rounding and backing, attracted inventors' attention, and by 1845 there was a patented backing machine. But it provided little more than a method of holding the book while giving a guide for forming the groove for the cover. The binder still used his hammer to round and back the book. These machines reduced the amount of judgment and dexterity exercised by the binder and were standard equipment for nearly half a century. It is worth mentioning that none of these machines relied upon steam power.

The first machine that made a real difference in the work performed by women in binderies was the folding machine, developed by Cyrus Chambers, Jr., during the 1850s. The Chambers folder was a truly ingenious translation of the hand's motions into mechanical movements. The folder used a series of dull blades to force the paper through a pair of rollers to create a fold. By adding blades and rollers, the number of folds could be increased. The Chambers folder and others like it tripled productivity, folding 1,500 octavo (three-fold) sheets an hour, compared to a handfolder's five hundred sheets. Women operatives fed this and other folding machines, and thus lost their control over pace and routine.

David Smyth developed a mechanical sewing machine to replace the handsewers sitting at their bookpresses, but he did not successfully introduce it commercially until the 1880s. Women continued to be predominant in the preparation stage of binding even after the introduction of machinery, making up an increasing proportion of bindery workers between 1870 and 1900. The decade from 1875 to 1885 was a transitional one, as wire-stitching machines used for pamphlets, sewing machines, and folders proliferated. The quarter-century after 1876 was destined to be a period of intense labor struggle in the bookbinding trade, as in other trades, as employers sought to exploit fully the technologies introduced earlier in the century.

It is worth mentioning that binderies produced more than just bound, printed volumes. The eighteenth-century handbinder provided stationery and blank books, periodicals and pamphlets, rebound books and publishers' editions, as well as the individually bound volume. His nineteenth-century successor often produced a similar range of items. But technical changes in one area were not necessarily applicable to other aspects of the binder's work. A stabbing machine used to perforate holes in signatures prior to sewing and a wire stitcher introduced in the 1820s were important changes in pamphlet work but were unsuitable for bookwork. Ruling machines introduced in the 1840s produced the parallel lines in ledgers, account books, and stationery. Binders thus had to keep abreast of changes in several different technologies. Binderies displayed the mechanical marvels of the age, even though much of the work of bookbinding remained handwork and the journeyman binder retained much of the skill and autonomy of his eighteenth-century predecessor.

Nineteenth-century bookbinding resembled printing in that the sizes of offices varied greatly and the industry's structure included dominant large shops with a plethora of small operators. Some offices specialized while others took in all kinds of work, and while there was a combination of custom and standardized work, each job presented its own idiosyncracies. Further, both trades were distinctly local-market oriented and illustrated a great deal of regional variation. By 1880 the 588 binderies enumerated in the census of manufactures employed some 10,600 people (45.5 percent of them women) and $5.8 million in capital. Binderies employed the highest proportion of women among all the book trades and paid them about what the others did, one-third to one-quarter of men's average wages.[21]

This said, however, we need to know much more about the changes in the economic and structural nature of the book-

[21] U.S. Department of the Interior, *Report on Manufactures*, p. 9.

binding trade during the eighteenth and nineteenth centuries. This is especially true if we ever want to reach a better understanding about the larger question of how consumers bought and saved books for personal pleasure. Before the 1870s, mechanization in bookbinding did not require massive reskilling as it did in the papermaking and typefounding trades. Still, we know too little now to gauge the interaction of technological change and work routine, labor organization, gender relations, or workers' customs. Both master and journeymen bookbinders organized local trade societies during the 1820s and afterward. What they have to tell us about trade conditions and labor history is still unknown. We know little about bindery management or the relationships between master binders, capitalist investors, and inventors. Nor has anyone explored issues involving the rate of technical change and factors such as market and trade structure, labor organization, or capital investment. The trade's history has been sketched, but it has been barely analyzed.

It should be evident from this review that the invention, introduction, diffusion, and impact of technologies compose a large, untold story in the book trades. This is especially true of the diffusion process, where we may know the end points but not the process itself. We know something about the prominent individuals and companies, but not nearly enough about the broad social and economic effects of innovation. Also, each of the trades has its own history, its own set of continuities and changes, its own conflicts and convergences. There is no universal pattern to be seen in the book trades. Yet, broadly speaking, each of the trades experienced changes in the structures of competition, work, composition of labor, and ownership that enlarged and solidified the wage-labor system. Indeed, it was the expansion of wage labor, the division of labor, and the separation of craft knowledge from execution that affected the workers' lives far more than the uneven mechanization process in the book trades.

The 'big questions' in the history of technology and labor in the book trades prior to 1876 have to do with how technology contributed to the development and consolidation of wage labor and its specific conditions in the United States. How did changes in the work process, whether linked to technical advances or not, contribute to the formation, elaboration, and reformation of the class structure? In order to approach this question, the experience of work must be placed in the context of the broader social and political cultures in which workers were immersed.

How was technology combined with work processes to delineate certain forms of control and conflict? How did workers and employers adopt methods for dealing with change and come to accept new work routines imposed on both groups? What impact did this have on workers' social and economic views? Conversely, of course, we should be asking how technology was shaped and directed by larger social processes such as capital accumulation, class formation, and workplace conflict.

A much-needed approach to technological and labor history is the study of industrial health, hygiene, and safety. Type-rubbers, rag sorters, lampblack makers, and newspaper compositors were continually exposed to the most unhealthful conditions. Pressfeeders and paperfolders endured hours of stressful attention to demanding yet boring work routines. Vatmen in hand-operated mills suffered from deformed hands, and handpress operators were known by their overdeveloped right shoulder and foot; technological changes should have made these kinds of deformities anachronistic. Attention to these details, which should be approached as issues in labor history, may open new vistas on work and technological change.

Policies of local trade societies toward technology should be closely scrutinized, keeping in mind that these societies and, later, unions often preserved the privileged status of skilled, male workers to the detriment of subordinate male and female workers. We need to incorporate more fully discussion of these other worker groups into our explorations of technology and work. We need to consider systematically trends in wage ratios between skilled and unskilled workers. We need to know more about the sources and recruitment methods of unskilled workers, their wages, working conditions, and response or reaction to technological change.

We need to focus on capital accumulation more broadly in all the trades. We need a better understanding of credit arrangements and the role of supply firms and typefoundries, as well as political and social organizations, in providing credit for the establishment of printing offices.[22]

Historians could profit by asking any number of questions implied in the currently debated themes in the history of technology. By what methods and to what effect were Anglo-European technologies transferred to North America? What impact, if any, did scientific experimentations and ideas have on technology? What kind of decision-making process was involved in the choice of technologies by entrepreneurs? It is important to emphasize the fact that this was a process of human choice. For example, we need to understand how papermakers obtained information about the cylinder and Fourdrinier machines, how they interpreted that data and made decisions. We need to interpret their thought processes, calculations, and biases, without applying neoclassical economic constructs to the information.[23] Similar questions should be posed of typefounders, bookbinders, and printers.

There is every reason to value investigations of the technologies of the book trades as case studies of more general aspects of the history of technology. Thus, the Napier cylinder

[22] A promising start in this direction has been made by Carolyn Stewart Dyer in 'Economic Dependence and Concentration of Ownership Among Antebellum Wisconsin Newspapers,' *Journalism History* 7(1980):42–46.

[23] At the very time I first penned these words, Judith McGaw was (unbeknownst to me) preparing an article addressing just these questions. See her provocative 'Accounting for Innovation: Technological Change and Business Practice in the Berkshire County Paper Industry,' *Technology and Culture* 26(1985):703–25.

press and the Fourdrinier papermaking machine make illuminating examples of the transatlantic transfer of technology. They are all the more interesting in that their stories emphasize the importance of the actual machines themselves rather than the plans or ideas for these machines, and also because they highlight the importance of the American mechanics who were called upon to assemble the machines once they were imported. Similarly, the examples of Gilpin's tour of Europe in search of papermaking techniques and Bruce's inquiring after methods of stereotyping are interesting instances of other methods of transfer. Further, what we today call 'industrial espionage' was rather commonplace throughout the eighteenth and nineteenth centuries.

To state the obvious, invention is not an ahistorical process; it occurs in a particular time and place. It is only reasonable to assume that motivations differ from epoch to epoch, as well as from individual to individual. Some societies foster certain types of inventions and prove particularly fertile for particular types of innovations. Part of our investigation should be directed toward examining why and with what consequences Americans became known for inventing certain kinds of technologies, while Europeans focused their inventive energies in other directions. Thus, we need to understand the international division of labor more precisely. Why did capital support some types of inventive work and not others?

We should consider technology as a debate, sometimes an argument, and not infrequently, a street fight. More than merely a body of knowledge, it is a contest over knowledge, usually involving a particular division of knowledge, skill, power, and labor. Any individual machine, process, or technique is the product of a historically-specific process in which various participants (inventor, manufacturer, employer/capitalist, worker) share roles. Their contributions are, however, unequal, and the result is also unequal. In addition, any new technology expands the socially accessible body of information and constitutes itself as a new debate, a continuing contest over knowledge and power.

This new debate includes new participants and can focus on internal or external aspects of the hardware or process. It can lead to improvements in the operations of the process or to the elaboration of its operations. It might consist of the inventor's quest for perfection, the manufacturer's desire for simplicity or easy replicability, the employer's need for reliability or cost effectiveness, or the workers' desire for safety, ease of operation, or increased control over the workaday world. This new conversation might focus on the use or social or economic impact of the new technology. In any event, conflict is an inherent part of the process.

Thus, it should not come as a surprise that technology had both its enthusiasts and its detractors. Technology was seldom considered in the abstract, except by literary pundits. For most people, technology was or was to become a tangible presence, and their involvement with it and its transformations influenced their responses. For some, it allowed a larger market, greater profits, fewer problems. For others, it provided new products that seemed important or reduced the cost of items already desired. The new technologies were forces to be celebrated. For still others, technology meant dislocation, unemployment, or the opportunity for low-paying, repetitious work, with little or no opportunity for job mobility. It could hardly stimulate rapturous reminiscences or descriptions. Technology was reported secondhand by many but experienced firsthand at the point of production, and therefore it elicited different responses precisely because it was experienced differently by those on opposite sides of the labor process.

The responses to technology of journeymen and master artisans varied. When the Bruce brothers wanted to begin stereotyping, fellow typefounders refused to supply the needed type for fear of reducing future demand for foundry type. Daniel Treadwell was forced to establish his own printing office in

Boston in the early 1820s after master printers refused to accept the superiority of his machine press. His office was subsequently burned down, reportedly by 'irate pressmen who feared for their jobs.' In 1854, George Sanborn had to escape out of a window after being threatened by skilled bookbinders when he attempted to introduce his rounding and backing machine. When a papermaking-machine tender heard that his machine was to be altered to increase its speed by ten feet per minute, he charged that 'when a machine was run faster than a man could walk, it was time to quit,' which he promptly did. A newly installed Hoe type-revolving press was subjected to such abuse and minor sabotage in the Government Printing Office in Washington in 1863 that the Hoe Company was required to remove it. David Bruce, Jr., succinctly explained the attitude of skilled workers toward the introduction of the mechanical typecaster: 'There seemed to exist among the casters a certain *esprit de corps* which held it disgraceful to descend to the turning of a crank, and upon the "turnspit" principle, thus annihilate all their acquired science of "throwing" for faces.'[24] Similar considerations of craft culture and skill no doubt motivated other craftsmen.

It may be true that America did not see an antimachinery movement equivalent to the Luddites, but that does not mean that technologies were automatically endorsed. There was antimachinery sentiment in various forms in nineteenth-century America. Violence, however, was isolated, sporadic, and not highly publicized. Its full dimensions and consequences remain to be investigated. It is worthwhile to remember in this discussion of the book trades that one of the best-known twen-

[24] For sources of these anecdotes, see *The Printer* 1(1859):258; Comparato, *Chronicles of Genius and Folly*, p. 16, and *Books for the Millions* (Harrisburg, Penn., 1971), p. 110; *The Progress of Paper* (New York, 1947), p. 91; Stephen D. Tucker, 'History of R. Hoe and Company, 1834–1885,' edited by Rollo G. Silver, *Proceedings of the American Antiquarian Society* 82(1972):416; *Inland Printer* 6(1888):206; and David Bruce, Jr.'s manuscript 'The Progress of Typography,' Typographic Library, Columbia University, n.p.

tieth-century examples of antimachinery violence was the 1975 attack on the presses of the *Washington Post.*[25]

Looming over the issues of technological change and work experience is the history of the book trades as a metaphor for the development of American society during its industrial transformation. In the separation of the manual and intellectual, mechanical and artistic, employed and employer, the book trades are emblematic of bourgeois America. Since communication is a form of production, we should not be surprised to find that the book trades represent specific forms of production and reproduction. It is also true that the choice of production techniques conveys images of authority and value, and thus represents a form of communication. The book trades illustrate the contest over bourgeois values and forms of order and discipline (or disorder and anarchy) that many saw as representative of American society in 1876.

Primary Sources

The primary sources for such studies as I have outlined here are spread far and wide. One might begin with the trade journals and technical manuals for each trade. Such nineteenth-century trade journals as *American Bookmaker* (New York, 1885–), *American Printer and Lithographer* (New York, 1874–), *Inland Printer* (Chicago, 1887–), *The Printer* (New York, 1858–), *Printers' Circular,* (Philadelphia, 1866–), *Proof Sheet* (Philadelphia, 1867–), *Rounds' Printer's Cabinet* (Chicago, 1857–), *Typographic Advertiser* (Philadelphia, 1855–), and *Typographic Messenger* (New York, 1865–) should be used more extensively and carefully. The fact that many items appear after the era under consideration should not prejudice them. These journals contain many letters, reminiscences, and essays of considerable historical value. The published and unpub-

[25] Andrew Zimbalist, 'Technology and the Labor Process in the Printing Industry,' in A. Zimbalist, ed., *Case Studies on the Labor Process* (New York, 1979), pp. 103–26, esp. pp. 117–21; David Noble, 'Present Tense Technology: Part Three,' *Democracy* 3(1983):71–93, esp. pp. 73–76.

lished diaries and reminiscences of workers in the book trades are very useful, as Rollo Silver and others have demonstrated.

The essential archival collections in the book trades are well known, although often their specific holdings are less understood and even less used. The American Typefounders Library at Columbia University is the preeminent collection of book trades materials. Still, has anyone exhausted the Binney and Ronaldson papers and ledgers there, or the Bruce family letters? The collections of the American Antiquarian Society are, of course, unparalleled. The Newberry Library has tremendous holdings of published materials, trade journals, and type specimen books. The Kemble Collection at the California Historical Society, San Francisco, offers great opportunities for the study of the Western expansion of the book trades. For instance, the Towne and Bacon Papers, the records of an important San Francisco printing and binding firm, have yet to be mined. The Rochester Institute of Technology has a major collection of bookbinding materials.

Judith McGaw has made intelligent use of paper company records still held in the hands of papermaking firms in Berkshire County, Massachusetts. Local historical societies often contain the ledgers, account books, or papers from local printing offices, newspapers, mills, or manufactories. For example, the payroll book of the St. Paul *Dispatch Pioneer-Press* from 1862 to 1865, in the manuscript division of the Minnesota Historical Society, provides a rare look at the attendance, daily production, and earnings of ten piecework compositors during the Civil War. Local typographical union records are held in several local libraries or historical societies such as the Rhode Island Historical Society, Cornell University Labor-Management Center, the Bancroft Library at the University of California-Berkeley, and the Pennsylvania Historical Society. The International Typographical Union office in Colorado Springs still has some material. Since national unions in the other trades did not emerge until after the period under discussion, one will have to be content with finding local trade society materials, if they exist.

Despite Rollo Silver's imaginative use of them, the importance of the Patent Office Records, Record Group 241, in the National Archives, still has not been recognized. Not only do the original applications and drawings contain much technical data, but the patent extension records offer much social and economic information. Moreover, we might begin to look more deeply into the role of the patent system in the nineteenth century. As with technology, patents were both weapons and sources of conflict. State and local records should be examined for contracts relating to printing and other services for government agencies.

Museum and library collections offer even more underutilized material. Major collections of printing technology can be found at a number of small, special-interest museums, as well as at the Smithsonian Institution's National Museum of American History, the Henry Ford Museum, the Sacramento (Calif.) Historical Society, and the privately owned Lindner Collection in Los Angeles. It may be that historic archaeology will answer questions concerning the use of new machinery and power sources in rural papermills and urban printing offices. Of course, libraries contain the physical products of the book trades. Books, paper, type specimens, and ink samples all contain evidence of past practices. The kinds of questions that material culture studies raise and answer are only now becoming a major topic for discussion among historians. The methods and concerns of analytical bibliography are a useful beginning. The machines and products of the book trades remain plentiful and await further consideration.

Bibliography

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Essential guides to printing history are the *American Dictionary of Printing and Bookbinding* (New York, 1894) and J. Luther Ringwalt, ed., *American Encyclopedia of Printing* (Philadelphia, 1871). Technical manuals, starting with Joseph Moxon, *Mechanick Exercised* (1683; new ed., London, 1958), should be used carefully to trace technologies, trade conditions, and methods of doing and teaching. That boys and girls could learn the rudiments of printing from printed matter is in itself an interesting connection between knowledge, printing, and labor studies.

Unfortunately, few journalistic or business histories of newspapers or publishing houses have much to say about labor or technology. There is important data on smaller master printers in Leona M. Powell, *The History of the United Typothetae of America* (Chicago, 1926), and Charlotte Morgan, *The Origin and History of the Employing Printers' Association* (New York, 1930), and a recent revision of some of Morgan's ideas in Irene Tichenor, 'Master Printers Organize: The Typothetae of the City of New York, 1865–1906,' in Stuart W. Bruchey, ed., *Small Business in American Life* (New York, 1980).

Histories of printing labor begin with Ethelbert Stewart, 'A Documentary History of the Early Organization of Printers,' in U.S. Department of Labor, 11, bulletin #61 (Washington, D.C., 1905). George A. Stevens, *New York Typographical Union #6* (Albany, 1913), and George A. Tracy, *History of the Typographical Union* (Indianapolis, 1913) are extremely useful conventional institutional histories. George E. Barnett's *The Printers: A Study in American Trade Unionism* (Cambridge, 1909) is the most thorough and original interpretation of the growth of the national union. Elizabeth Faulkner Baker's *Printers and Technology: A History of the International Printing Pressmen and Assistants' Union* (New York, 1957) is an important interpretation of the split between the typographers and pressmen and the subsequent developments within the pressmen's union. *A Study of the History of the International Typographical Union*, 2 vols. (Colorado Springs, Colo., 1964), by the executive council of the ITU, is a very useful 'official' history of the union that quotes at length from convention proceedings and other contemporary materials. Seymour M. Lipset, Martin A. Trow, and James S. Coleman, *Union Democracy* (Garden City, N.Y. 1952), is a path-breaking sociological study of the internal politics and craft culture of twentieth-century printers, and it should be read for its questions and methods. Helpful for comparative purposes on organized labor are A. E. Musson, *The Typographical Association* [England] (Oxford, 1954), J. Hagan, *Printers and Politics: A History of the Australian Printing Unions, 1850–1950* (Canberra, 1966), and Sally F. Zerker, *The Rise and Fall of the Toronto Typographical Union, 1832–1972: A Case Study of Foreign Domination* (Toronto, 1982). We badly need a study of the German-American printing trade and labor union movement.

Recently, historians have begun to look beyond the union hall and the organized worker to the workplace itself and, conversely, to the wider structures of class and community. Henry P. Rosemont's 'Benjamin Franklin and the Philadelphia Strikers of 1786,' *Labor History* 22(1981):398–429, reassesses the wage action that led to the first strike and subsequent association of Philadelphia journeymen. Wayne Roberts argues that printers retained much of their artisanal culture, control, and attitudes right into the twentieth century in 'The Last Artisans: Toronto Printers, 1896–1914,' in Gregory Kealey and Peter Warrian, eds., *Essays in Canadain Working Class History* (Toronto, 1976); pp. 125–42. Gregory Kealey presents a more modest assessment of the journeymen's autonomy in 'The Honest Workingman and Workers' Control: The Experience of Toronto Skilled Workers, 1860–1892,' *Labour/Le Travailleur* 1(1976):32–68. William S. Pretzer argues that the tramping system for which printers (as well as papermakers, typefounders, and other skilled tradesmen) were so well known was a crucial link between economic structure and craft culture in 'Tramp Printers: Craft Culture, Trade Unions, and Technology,' *Printing History* 12(1984):3–16. Leonard Walloch has traced the divisions within the journeymen's ranks to a dual labor market and to cultural differences found in the Philadelphia working class in general in 'The Limits of Solidarity: Philadelphia's Journeymen Printers in the Mid-Nineteenth Century' (a paper presented to the Organization of American Historians, Los Angeles, April 1984). Pretzer focuses on the concepts of 'artisan republicanism' and the shift from informal to formal work controls in reinterpreting one of the more famous nineteenth-century labor disputes in his essay ' "The British, Duff Green, the Rats, and the Devil": Custom, Capitalism, and Conflict in the Washington Printing Trade, 1834–36,' *Labor History* 27(1986):5–30. Ava Baron has presented a provocative thesis on the relationship between gender, labor process, and class development in 'Women and the Making of the American Working Class: A Study of the Proletarianization of Printers,' *Review of Radical Political Economics* 14(1982):23–42. An informative comparative study is J. Hagan and C. Fisher, 'Piece Work and Some of its Consequences in the Printing and Coal Mining Industries in Australia,' *Labour History* (Canberra) 25 (1973):19–39. Natalie Z. Davis, *Society and Culture in Early Modern France* (Stanford, 1975), and Robert Darnton, *The Business of Enlightenment* (Cambridge, Mass., 1979) offer stimulating and important observations on the workshop practices, customs, and ideology of French journeymen printers. Their numerous essays should also be consulted.

On the technological history of printing, we have several 'biographies' of individual presses, that is, histories dealing with the technical and commercial development of presses common in the eighteenth or nineteenth centuries. Elizabeth Harris's study (with drawings by Clinton Sisson) *The Common Press* (Boston, 1978) is a unique artifactual analysis of an early eighteenth-century handpress. Milton Hamilton, *Adam Ramage and his Presses* (Portland, Me., 1942) is very useful. Ralph Green was an amateur historian with great technical experience and knowledge. His technical descriptions and drawings are unsurpassed. His *The Iron Hand Press in America* (Rowayton, Conn., 1948), 'Early American Power Printing Presses,' *Studies in Bibliography* 4(1951):143–53, and *A History of the Platen Jobber* (Chicago, 1953) are the best short histories available. Jacob Kainen, *George Clymer and the Columbian Press* (San Francisco, 1950), is a general discussion of the first American iron-made press. Rollo G. Silver has published two articles dealing with the invention and introduction of specific models of power presses: 'An Early Time-Sharing Project: The Introduction of the Napier Press in America,' *Journal of the Printing Historical Society* 4(1968):29–36, and 'Efficiency Improved: The Genesis of the Web Press in America,' *Proceedings of the American Antiquarian Society* 80(1970):325–50. Frank Comparato has included much of the data presented in these case studies in his history of the Hoe Company entitled *Chronicles of Genius and Folly* (Culver City, Calif., 1979). More comprehensive and more reliable is the authoritative *Printing Presses: History and Development from the 15th Century to Modern Times* (Berkeley, 1973), by James Moran.

The series 'The Printing Press' by Stephen McNamara in *The Inland Printer* (1884–87) is full of insight and bias, as is Robert Hoe's *A Short History of the Printing Press* (New York, 1902). Stephen Tucker's reminiscences in Rollo G. Silver, ed., 'History of R. Hoe and Company, 1834–1885,' *Proceedings of the American Antiquarian Society* 82(1972):351–453, is a superb introduction to nineteenth-century machine shop practices and the processes of press development. These studies can be supplemented by Comparato's *Chronicles of Genius and Folly.* As a business history, *Chronicles* may be serviceable, but it does not exhaust the story of labor and technology in the Hoe Company's history. For a comparable history of an important British firm, see Charles Wilson and William Reader, *Men and Machines: A History of D. Napier and Sons Ltd., 1808–1958* (London, 1958).

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The literature of typefounding focuses on two general issues. One is the aesthetics and legibility of typefaces; the other is the business history of typefoundries. Neither tradition pays enough attention to technology or any attention to labor. The single outstanding exception is the magisterial *Typographical Printing Surfaces: The Technology and Mechanism of their Production* (London, 1916), by Lucien A. Legros and John C. Grant. Daniel B. Updike's *Printing Types: Their History, Forms, and Use*, 2 vols. (Cambridge, Mass., 1922), is seminal on issues of comparative aesthetics and the sources of designs. A. F. Johnson's revised edition of T. B. Reed's *A History of the Old English Letter Foundries* (London, 1952) is the best general history of nineteenth-century typefounding. Orginally published in 1887, it is technical/business history at its narrative best.

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For actual foundry descriptions, see *Godey's Ladies Book* 53 (1856): 299–305, and *The American Bookmaker* 1 (1885):77. Founder's specimen books, listed in detail in Annenberg (above), are useful as guides to styles and ornamentation and also to technical and economic details. Stereotyping, electrotyping, and the production of large ornamental or wooden type are distinct yet related trades not dealt with in this essay. But see Michael Winship's essay (footnote 5), and Rollo G. Silver, 'Trans-Atlantic Crossing: The Beginning of Electrotyping in America,' *Journal of the Printing Historical Society* 10 (1974).

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Hellmut Lehmann-Haupt, ed., *Bookbinding in America*, (1941; rev. ed., New York, 1967), contains seminal essays by Hannah D.

French and Joseph W. Rogers, as does the recently published edition of a number of Hannah French's essays, *Bookbinding in Early America: Seven Essays on Masters and Methods* (Worcester, Mass., 1986). These works, along with Douglas Leighton, *Modern Bookbinding: A Survey and a Prospect* (London, 1935), form the base from which all discussions of the nineteenth-century trade begin. Frank Comparato's *Books for the Millions* (Harrisburg, Penn., 1971) is a wide-ranging account of the mechanization of bookbinding that contains much useful historical information and a good bibliography. The best general introduction to the processes and history of binding is Bernard Middleton, *A History of English Craft Bookbinding Technique* (London, 1963). Sue Allen presents a convincing if brief analysis of the technical and stylistic traditions in American machine-stamped binding in 'Machine-Stamped Bookbindings, 1834–1860,' *Antiques* 115(1979):564–72. For an analysis using the extant artifacts as primary evidence, see her 'Floral-Patterned Endpapers in Nineteenth-Century American Books,' *Winterthur Portfolio* 12(1977):182–224.

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Helpful historiographical discussions that include suggestions for thematic approaches to technological history are found in the following: Brooke Hindle, *Technology in Early America* (Chapel Hill, 1966); Eugene S. Ferguson, 'Toward a Discipline of the History of Technology,' *Technology and Culture* 15(1974):13–30, and his 'The American-ness of American Technology,' *Technology and Culture* 20(1979):3–24; Thomas P. Hughes, 'Emerging Themes in the History of Technology,' *Technology and Culture* 20 (1979): 697–711; Carroll W. Pursell, Jr., 'History of Technology,' in Paul T. Durbin, ed., *A Guide to the Culture of Science, Technology, and Medicine* (New York, 1980), pp. 70–120; David Hounshell, 'On the Discipline of the History of American Technology,' *Journal of American History* 67(1981):854–65; David Hounshell, ed., *The History of American Technology: Exhilaration or Discontent?* (Wilmington, Del., 1984). More narrowly focused, but still very helpful, is Paul Uselding, 'Studies of Technology in Economic History,' in Robert E. Gallman, ed., *Research in Economic History, Supplement 1: Recent Developments in the Study of Business and Economic History: Essays in Memory of Herman E. Kross* (Greenwich, Conn., 1977), pp. 159–219.

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