Craft Labor and Mechanization in Nineteenth-Century American Canning

Martin Brown; Peter Philips

The Journal of Economic History, Vol. 46, No. 3. (Sep., 1986), pp. 743-756.

Stable URL:
http://links.jstor.org/sici?sici=0022-0507%28198609%2946%3A3%3C743%3ACLAMIN%3E2.0.CO%3B2-H

The Journal of Economic History is currently published by Economic History Association.

Craft Labor and Mechanization in Nineteenth-Century American Canning

MARTIN BROWN AND PETER PHILIPS

The development of new machinery in nineteenth-century American canning followed two paths. Automative, labor-saving devices were developed to replace labor in unskilled tasks while deskilling, human-capital-saving machinery was designed to make craft labor more replaceable. Cannery operators appear to have focused on deskilling machinery as the key to greater managerial control over production. Craft workers through organizational power and pressing for higher wages seem to have stimulated the early and sustained search for deskilling machinery. Because human-capital-saving machinery allowed wage cuts, they could be adopted prior to their being used as labor-saving devices.

We present here a case study of technological innovation and diffusion. Firms in the post-Civil War American canned-food industry made substantial profits because of rapidly growing demand. However, cannery operators saw their potential profits increasingly distributed as rents to owners of factor inputs. In the case of the labor input, the bargaining leverage of craft workers, rooted in their ability to exercise substantial control over the production process, not only earned these workers high rents but also limited the flexibility of cannery operators to make production decisions which might enhance future as well as current profits.

In response to the problems of craft labor, cannery operators pursued a policy of technical innovation and diffusion designed to reduce worker control over production decisions. The nature of craft power meant that craft workers had both the means and motivation to resist the strategy of technical innovation. Ironically, the intensity of craft-worker resistance to technical innovation increased the expected payoff of the strategy to cannery owners. Broader market forces triggered the emergence of a cannery capital-goods industry whose existence enhanced the economic viability of technical innovation.

Skill and secret knowledge formed the basis for craft bargaining power in the early American canning industry.[1] The two key craft

Journal of Economic History, Vol. XLVI, No. 3 (Sept. 1986). ISSN 0022–0507.

The authors are Martin Brown, Assistant Professor of Economics, Howard University and Peter Philips, Assistant Professor of Economics, University of Utah.

[1] While there are a number of industry sources giving brief histories of the emergence of American canning, the only scholarly source is Edward F. Keuchel, "The Development of the Canning Industry in New York State to 1960" (Ph.D. diss., Cornell University, 1970). The most widely available industry source is Earl Chapin May, *The Canning Clan* (New York, 1937). The most useful industry source is Arthur I. Judge, ed., *A History of the Canning Industry by its Most Prominent Men* (Baltimore, 1913).

occupations in the post-Civil War canneries were capping and processing. After produce had been worked up and put into cans by piece-rate, unskilled, and mainly female hand labor, the cans were sealed by cappers, who were specialized tinsmiths. Processors, in turn, cooked the sealed cans in water or a steam bath before the unskilled tasks of cooling, labeling, boxing, and warehousing of the canned goods (see Table 1).

With demand for canned goods expanding traditional technology and slow growth in the supply of processors and cappers, skilled workmen were in a position to capture some of the cannery owners' profits in the form of premium wages. The growing ability of craft workers to capture such rents was reflected in the decreasing ratio of value-added to wages in the early years of the American canning industry. In 1860 this ratio stood at 4.97, but by 1880 it had fallen to 2.07.[2]

The ability of craft workers to collect these rents was a function of the scarcity of craft labor. Skilled processing labor was kept scarce because the art of processing was secret knowledge carefully guarded by processing craftsmen. The art of processing hermetically-sealed cans of food stemmed from the experiments of manufacturers beginning with Nicolas Appert around 1810. Why this technique was successful in processing foods was poorly understood and subject to common but unanticipated failures.[3] A canner's ability to acquire and hold customers depended on reputation. As longer and safer cook times generally resulted in more food deterioration, the processor had a tradeoff between safety and quality with an uncertain understanding of the technical relationship between the two. Either the proprietor did the

[2] Ratios of value added to wages, raw materials, and capital describe the diffusion of an increasingly capital-intensive, labor-saving and materials-neutral technology after the 1880s. The ratio of value added to production-line wages, which fell from 1860 to 1880 (4.97 to 2.07), generally rose after 1880 (2.07 to 3.13 in 1919) indicating a relative easing of wage costs. In contrast, the ratio of value added to materials cost, largely raw produce, was roughly constant from 1890 to 1919, suggesting rising material flow-through per worker with mechanization. The ratio of the stock of capital to value added fell from 1870 to 1880 suggesting a rapid diffusion of pressure cookers. The ratio does not again fall, in the aggregate, until after 1900 indicating that the new technologies which were introduced in preparation and capping in the mid-1880s in Baltimore were only in national use some 15 years later. U.S. Census Bureau, Eighth Census, 1860, *Manufactures of the U.S.* (Washington, D.C., 1865), pp. 29, 230, 255, 351, 417, 542; U.S. Census Bureau, Ninth Census, 1870, Vol. III, *Wealth and Industry* (Washington, D.C. 1872), p. 395; U.S. Census Bureau, Twelfth Census, 1900, *Manufactures*, Part 1, "United States by Industry" (Washington, D.C., 1902), p. 8; U.S. Census Bureau, Thirteenth Census, 1910, Vol. 10, *Manufactures, 1909*, (Washington, D.C. 1913), p. 383; U.S. Census Bureau, *Census of Manufactures, 1914*, Vol. II, "Reports for Selected Industries" (Washington, D.C., 1919), p. 365.

[3] W. Lyman Underwood, "Incidents in the Canning Industry of New England," in A. Judge, *History of the Canning Trade*, p. 13. Underwood was a professor at MIT in the 1890s and a relative of the first American canner, William Underwood. Lyman Underwood along with S. C. Prescott helped pioneer university study of the canning processing techniques. The mid-1890s saw the first American scientific study of why the canning process worked.

processing, or he relied on the experience and judgment of the processor.[4]

Processors were the highest-paid cannery workers (see Table 1). Would-be canners tried to buy the processor's secrets as one of the start-up costs of business. In 1867, one cannery owner paid $5,000 (20 to 25 percent of the total capital costs of an average cannery at the time) to acquire the pack time and temperature along with associated secrets from a respected processor.[5] Often, new cannery operators had been processors. But there is no evidence of anyone, prior to 1874, selling the processor's knowledge to the public at large.

Both the processor and the informed cannery owner exploited their secret knowledge. The processor rented out the current value of his knowledge through a higher wage and passed on his proprietal knowledge either by sale or family inheritance. The canner who bought this knowledge made good his investment through the better quality of his product. In principle, a processor could have written and sold a canning manual and reaped his reward through book sales. The fact that this did not occur until the 1890s is probably due to the risks canners may have attached to buying information from an untested source. Also, as it was easy to copy or repeat information found in a book, it was difficult to profit from one's secrets by publishing them.[6] In any case, by 1874, despite the absence of an entrepreneur publishing the secrets of the art of canning, the secrets of the processor began to be sold to the public. But the purveyor of knowledge was not a person; it was the emerging capital-goods industry.

The technique of pressurized cooking to superheat foods had been known in France since the early 1850s.[7] In 1874 Shriver's kettle was first produced and sold in the United States to superheat packs through pressurized cooking. The reason for the slow diffusion of the pressure cooker is uncertain. However, the rapid growth in American canning after 1860 was a necessary condition for the emergence of the canning capital-goods industry. With the development of the pressure cooker in the 1870s, inventive effort began to shift from the cannery and the proprietorial and secretive perspectives of cannery owners and craft workers to firms specializing in the production and sale of capital goods.

Unlike the processor and canner, marketers of pressure cookers could profit from their product only by selling the instructions needed

[4] Hugh S. Orem, "Baltimore Master of the Art of Canning," in A. Judge, *History of the Canning Trade*, p. 10.

[5] Edward F. Keuchel, *Canning Industry in New York*, p. 34; U.S. Census Bureau, Ninth Census, p. 436.

[6] The first published source of canning processing techniques in the United States was Ernest F. Schwaab, *The Secrets of Canning* (Baltimore, 1890). This book was published after processing techniques had become relatively well known.

[7] Edith Swank, *The Story of Food Preservation* (New York, 1943).

TABLE 1
EFFECTS OF MECHANIZATION AND DIVISION OF LABOR ON PRODUCTIVITY AND UNIT LABOR COSTS IN A TOMATO CANNERY, 1865 AND 1894

	1865[b]				1894[b]			
	Age, Number, Sex	Average Wage	Cans per Worker	Cans per Cent of Labor Cost	Age, Number, Sex	Average Wage	Cans per Worker	Cans per Cent of Labor Cost
Preparation								
Scalder[a]	1M	$2.00	5,000	25	1M	$1.50	40,000	267
Peeler	25F	1.25	200	1.6	90F	1.25	444	3.5
Packer[a]	3F	1.25	1,667	13.3	2M	1.25	20,000	160
Wiper	1F	1.00	5,000	50	2B	0.75	20,000	267
Cookroom								
Capper[a]	1M	3.00	5,000	17	6M, 2B	1.44	5,000	35
Cooker[a]	1M	3.50	5,000	14	2M	2.00	20,000	100
Warehousing								
Labeler	2F	0.75	2,500	33	8F	1.25	5,000	40
Nailer	1M	1.50	5,000	33	2M	1.50	20,000	133
Trucker	1M	1.25	5,000	40	4M	1.75	10,000	57

[a] Indicates job in which mechanization occurred. M = Males. F = Females. B = Boys.
[b] Daily plant capacity in 1865 was 5,000 cans; in 1894 it was 40,000 cans.
Source: U.S. Commissioner of Labor, *Eleventh Annual Report*, "Hand and Machine Labor" (Washington, D.C., 1898), vol. 2, pp. 1078–79.

for its operation. Customers buying pressure cookers had to pay the additional price for information which specified appropriate cooking times for various products even if they managed to get these recipes by word of mouth. Because instructions for pressure cookers were not as easily copied as recipes in a book, early manufacturers were the first to expect profits from public sale of canning secrets. Consequently, these companies gathered, bought, and developed what information they could regarding pack time and temperature by crop. The dissemination of processing knowledge in effect lifted the constraints that had been placed on the supply of qualified processing labor.

The capper was also a skilled workman in short supply. The capper's tasks were complex and strategic. During the packing season, once the produce had been worked up and put into cans, the capper sealed tins shut with a soldering iron. When prepared and put into open cans, food was highly perishable. Cannery operators were, therefore, quite vulnerable to quick, unannounced strikes by cappers. James D. Cox, the inventor of an 1887 device designed to deskill the capping step, recalled of this premechanized period:

> . . . in those days, the capping all having to be done by hand, a Boss-Capper took the contract to do the work, furnishing his men for the purpose, and even the owner stood in great awe of him, for of what use was it to purchase tomatoes and prepare them, if, at the important moment, the Capper decided he would go on strike; or having received his pay, required more time to sober up than the boss thought necessary. He knew his importance and he used his advantage to the full, and to the too frequent annoyance and heavy loss of the canner. It was this helplessness of the canner that made him a willing advocate of every mechanical means, and made possible the working out, through frequent failures and heavy losses, the perfected mechanical means now in use. The Boss-Capper helped hasten the day of his own exit through his overbearing thoughtlessness.[8]

Capping machines, however, were not easily introduced to solve the problem of the boss capper. The task of capping was sufficiently complex to make its mechanization difficult. Furthermore, cappers resisted mechanizing efforts. Edward Judge, editor of the first canning industry trade journal which was founded in 1878, noted that the cannery owner had to be sensitive to shop-floor power relationships if he hoped to introduce new machinery peacefully:

[8] James D. Cox, "The Evolution of Tomato Canning Machinery," in A. Judge *History of the Canning Industry*, p. 83. Cox's recollections are shared by A. H. F. Going who was a Baltimore cannery owner from 1864 to 1899. In 1899 he recalled that the Can Makers Mutual Protective Association was formed around 1870 for the purpose of raising wages. Journeymen can makers through organized demands pushed wages up over 100 percent. "But finally machinery commenced to assert itself in the manufacture of cans, on account of the frequency of these strikes and on account of the strength of this combination. Men became restive under these influences and the manufacturer of cans commenced figuring to get away from being dictated to by his employees." U.S. Industrial Commission, *Preliminary Report on Trusts and Combinations* (Washington, D.C., 1900), vol. 1, p. 919.

When a capping machine came out [in the early 1880s] to do this capping expeditiously and mechanically the boss cappers put their condemnation upon it; and it was almost impossible to find anyone who would dare to work upon or with the machine. When, however, an improved capping iron came out which the boss capper could furnish to his employees in hand work, as it increased his pay without increasing that of the hands who used it, it was rapidly adopted. . . .[9]

Thus, the boss capper sought to restrict the kinds of machines introduced in order to protect and enhance his position within the shop-floor hierarchy.

In the 1870s and 1880s cannery owners sought to alter the conditions of capping labor supply to their advantage by instituting internal labor-contracting systems. By employing the boss capper through a service contract, canners hoped to pass on to the lead capper the problems of capping. These problems included not only the technical considerations of organizing the capping of cans, but the managerial consideration of keeping other cappers steadily and busily at work during the peak season. However, because the boss capper would flip-flop between the roles of supervisor and union leader, the cannery owner was continually uncertain as to whether the capper would enforce contracted output quotas or lead his men out on strike in violation of his contract. In the end, the expedient of internal labor contracting required that future revenues would have to be increasingly shared with skilled cappers. A few boss cappers took the contracts for many canneries in Baltimore in the late 1870s.[10] By stimulating the occupational organization of cappers across several firms, internal labor contracting helped trigger the development of capper craft unions. During the 1870s and 1880s the Can Makers Mutual Protection Association in Baltimore was representing cappers working in the major canneries of the area. This craft association enhanced the bargaining power of the lead capper as an oligopolistic supplier of labor. Thus, in seeking to improve internal labor-supply conditions, employers inadvertently worsened their position with respect to the external supply of skilled labor.

One solution could have been to train more cappers. On-the-job training might have been difficult due to the resistance of in-place craft labor. Still, an experienced capper could have been hired to run a trade school. However, if these newly-trained cappers were not hired, they were not likely to remain in the local area as an unpaid but useful threat to in-place craftworkers. The general character of the capper's skills meant owners were unlikely to pay the training costs of workers who might go elsewhere. Lesser-paid workers conceivably could have

[9] Edward S. Judge, "The Past, Present and Future of the Canning Industry," in A. Judge, ed., *History of the Canning Industry*, p. 54.

[10] Edward S. Judge, "The Past, Present and Future of the Canning Industry," p. 54.

financed their own training perhaps under the auspices of employer groups. However, the market responded with the emergence of a capital-goods sector rather than vocational training. What appeared needed was an affordable and workable machine which would not necessarily replace labor in the capping of cans, but would, by lowering the skill requirements of this task, make cappers more easily replaceable from the general pool of unskilled labor and consequently force down wages.

By the 1880s, the existence of a cannery capital-goods sector, made possible by the growing scale of the canning industry and the demand for the pressure cooker, demonstrated to would-be independent inventors the potential for an economic payoff to anyone who could develop an effective and reasonably-priced capping machine. With boss cappers at the height of their power, the potential demand for such an innovation was high, even if cannery operators and canners alike estimated that the technical barriers were formidable. The man who successfully responded to this demand was J. D. Cox. Cox's capper, when first introduced, did not raise the physical productivity of the capper at all. But, it was still successful because cannery operators could use it to undermine the power of the capper.[11] As in the case of the pressure cooker, adoption of Cox's capper and subsequent capping machines soon resulted in substantial reduction in the wages of cappers.

In contrast to the pressure cooker and capping machine, devices which mechanized unskilled floor-labor tasks had to significantly raise labor productivity. Floor labor was scarce in the sense that workers were not always forthcoming at the right time and at traditional wages. Seasonal scarcity put an upward pressure on unskilled wages which were the largest part of the canner's overall wage bill. Furthermore, the capacity requirements of newly-introduced cookroom machinery exacerbated the problem of scarce seasonal labor supplies. Short of an organized attempt to recruit labor from other areas, the supply of potential labor for unskilled cannery jobs was fixed, upward sloping, and equal to the overall area's labor supply.

Some canneries, particularly in rural areas, did try labor recruitment tactics.[12] The solution was short term and usually affected only rural canneries. In urban areas canneries which recruited labor were likely to lose their recruits to less seasonal industries. In contrast, the newly emerging machine-goods industry could offer "iron slaves" which could not run away. However, to solve the problem of scarce unskilled labor, efforts to mechanize preparation, labeling, and boxing tasks could not focus on lowering required labor skills. To succeed, they actually had to

[11] Ibid., p. 55.

[12] California Bureau of Labor Statistics, *Labor Conditions in the Canning Industry* (Sacramento, 1913), p. 28.

replace unskilled labor with machinery by raising unit labor productivity. The introduction of the automatic labeler is instructive.

Hand labeling was an unskilled piece-rate job, usually done by low-paid women workers. In 1884 an Englishman named Hutchins introduced a labeling machine to Baltimore canners. However, Edward Judge noted the labeling machines could not outperform hand labor and consequently, were not adopted. The difficulty with early labelers was the glue. After continuous use, the glue gummed up the machines and required frequent shut-downs for cleaning. When the Knapp labeler solved the glue problem in 1893, it succeeded in raising physical labor productivity for labeling. After this improvement, according to Judge, mechanical labeling "forever distanced all hand competition that might arise."[13] In contrast to Cox's capper, which was introduced before it could raise unit labor productivity, labeling machines were not widely used until they could raise output per worker significantly.

Thus, the standard for adopting new machinery differed. The lower productivity requirements required of deskilling machinery may have speeded their introduction and diffusion. The higher productivity requirements of automative machinery aimed at lesser-skilled tasks, ceteris paribus, may have made their successful development more difficult. In either case, machinery adopted between 1880 and 1920 had to lower unit labor costs and also total factor costs if profits were to be enhanced by innovation. The profitability of a new machine depended on the machinery's cost, its use of material inputs, and its expected depreciation rate as well as what it did to labor productivity. Lacking data on physical depreciation, we assume that widely-adopted machines were profitable and met these additional criteria.[14] Here, however, we are concerned with documenting how new machinery affected labor requirements and eased the constraints different kinds of labor imposed on management.

Data exist which corroborate the testimony of contemporary observers that craft machines initially deskilled labor while floor-labor machines displaced labor. Table 1 shows a tomato cannery in 1865 prior to mechanization and in 1894 after the pressure cooker of the late 1870s, the capper of the mid-1880s, and various preparation machines of the 1880s and 1890s had been introduced. With the exception of the cooker, the new machines were first introduced between 1885 and 1895.

[13] Edward S. Judge, "The Past, Present and Future of the Canning Industry," p. 56.

[14] An indirect indication of the profits derived from cannery mechanization by cutting labor costs can be seen in census data. After 1880 both the ratios of value added to salaries and clerical wages, value added to materials and value added to capital stock hold constant or fall up to 1920. In contrast, the ratio of value added to production line wages steadily rises. This suggests that through the period when continuous flow, craft deskilling, mechanical line production was developed in the canneries, labor savings along the production line were the primary source of new revenues for profits. See fn. 2.

TABLE 2
PHYSICAL-LABOR PRODUCTIVITY GAINS AND UNIT-LABOR COST SAVINGS ASSOCIATED WITH MECHANIZATION OF A TOMATO CANNERY, 1865–1894

Occupation	Proportionate Change in Physical Labor Productivity 1894/1865	Proportionate Change in Unit Labor Costs 1894/1865
Preparation		
Scalder[a]	8	10.6
Peeler	2	2
Packer[a]	12	5.3
Wiper	4	12
Cookroom		
Capper[a]	1	2.1
Cooker[a]	4	7
Warehousing		
Labeler	2	1.2
Nailer	4	4
Trucker	2	1.4

[a] Mechanized task.
Source: Table 1.

First, note that cans per worker per day of operation rose for all mechanized preparation tasks. Mechanization of packing resulted in the replacement of low-wage female hand workers by higher-wage male machine operators. But savings on unit labor costs were still substantial due to the large increase in physical labor productivity. While not apparent from a single cannery, a similar process occurred in other initially female noncraft occupations such as peeling and cutting in other canneries (see Table 3). Mechanization made it possible to pay scalders, who were semi-craft male workers, a somewhat lower wage. Thus the unit labor cost improved even more than physical labor productivity in scalding. The physical labor productivity of unmechanized preparation and warehousing also increased due to economies associated with larger plant size. For truckers and peelers increases doubled, and for nailers and wipers they quadrupled (see Table 2).

Second, note that the two deskilled craft occupations in the cookroom showed relatively little increase in physical productivity. Using machinery first developed in the 1870s, cookers in the mid-1890s still had not increased their individual physical labor productivities more than four times above the mark achieved in 1865, a factor increase comparable to that achieved for nonmechanized tasks. Cappers, using more recently invented machinery from the late 1880s, had yet to improve upon the cans-per-day outputs associated with craft production in 1865 (see Table 2). Thus, while the mechanization of some floor-labor tasks significantly raised physical labor productivity, mechanized craft-labor occupations did not achieve productivity gains which could better the gains associated with the floor-labor occupations which remained unmechanized.

TABLE 3
PHYSICAL-LABOR PRODUCTIVITY GAINS AND UNIT-LABOR COST SAVINGS ASSOCIATED WITH MECHANIZATION IN SEVEN FRUIT AND VEGETABLE CANNERIES, 1860s–1890s

Occupation	Average Proportionate Increase in Physical Labor Productivity 1890s/1860s	Average Proportionate Decline in Unit Labor Cost 1860s/1890s
Husker, parer, packer, peeler[a]	1.7	2.1
	(0.7)	(1.4)
Peeler, cutter[b]	52.3	36.6
	(44.8)	(22.7)
Packer[b]	9.9	8.1
	(2.1)	(2.9)
Capper[b]	2.5	4.5
	(1.3)	(2.5)
Cooker[b]	5.1	7.6
	(3.2)	(4.7)

[a] Unmechanized.
[b] Mechanized.
Note: Standard deviations are in parentheses.
Source: U.S. Department of Commerce, Commissioner of Labor, *Eleventh Annual Report*, "Hand and Machine Labor" (Washington, D.C., 1898), vol. 2, pp. 1068–83.

Despite the very different physical effects on labor productivity associated with craft and floor mechanization, both forms of innovations cut unit labor costs and presumably unit total factor costs as well. By 1894, cooking machines, which had been around for twenty years, cut average wages among processors from $3.50 to $2.00 per day and replaced skilled adult males with less-skilled men and boys. The more recently introduced capping machines cut average wages from $3.00 to $1.44 using a combination of men and boys. Thus, floor-labor mechanization cut unit labor costs by raising physical labor productivity while craft mechanization, at least in the short run, cut unit labor costs by lowering wages. Later improvements would significantly raise physical labor productivity even in craft occupations, but this took years to achieve.[15]

The foregoing discussion can be restated into a hypothesis regarding the initial impact of mechanization on floor and craft labor occupations

[15] Edward S. Judge, "The Past, Present and Future of the Canning Industry," p. 56. These data for one tomato cannery are consistent with the recollections of the *Canning Trade* editor, Edward Judge. When Judge stated that Cox's cappers could do no more work than the "ordinary man" but when "properly served and operated" cut capping costs by "about one-third," Judge was confirming the findings in Tables 1 and 2. Capper productivity, if anything, remains constant after mechanization, but because wages fell from $3.00 to $1.44 per day, total unit costs (allowing for the cost and durability of Cox's capper) probably fell by Judge's assertion of "about one-third." An 1885 Maryland report on the effects of can-making machinery on wages and productivity is also consistent with these data for one tomato cannery. Maryland Bureau of Industrial Statistics and Information, *First Biennial Report, 1884–1885* (Baltimore, 1886), p. 74.

in canning and applied to the histories of seven distinct canneries. We would expect that for mechanized floor-labor tasks, physical labor productivity would rise significantly while in craft occupations, mechanization would not initially bring about large increases in physical labor productivity. By the 1890s, pressure cookers adopted in the 1870s should show greater labor productivity gains than capping machines invented in the 1880s. Capping machines in the 1890s would show little labor productivity gains over nonmechanized tasks because machine developers should have had little time to improve cappers from human-capital-saving machinery into labor-saving machinery. However, in craft occupations we would expect unit labor costs to show greater improvements than those allowed by meager gains in physical labor productivity due to wage declines associated with deskilling. For floor labor tasks we would expect the opposite as machinery may have been skill neutral or even skill enhancing leading to constant or higher wages in these tasks after mechanization.

These propositions can be tested using data for mechanized canneries between 1865 and 1896. The firms include two corn canneries, two pea canneries, one pineapple cannery, and two tomato canneries (including that in Table 1). Table 3 presents the average proportionate increases in physical labor productivity and proportionate decreases in unit labor costs in four general cannery occupations which were mechanized. For comparison, it also includes unskilled preparation work which was not mechanized. In the two unskilled, mechanized tasks labor productivity rose significantly while in the two craft occupations labor productivity rose by much smaller amounts. The wide standard deviations around the averages for peeling and cutting are due to the distinctly different technical aspects associated with peeling tomatoes, cutting pineapples, podding peas, and shucking corn. In both unskilled cases improvements in unit labor costs were less than rises in physical labor productivity due to wage increases associated with mechanization. The reverse held true in the craft occupations of capping and cooking where wage declines associated with deskilling allowed improvements in unit labor costs to exceed modest gains in physical labor productivity. The gains in capping labor productivity are similar to gains in labor productivity found in unskilled and unmechanized preparation tasks shown in Table 3. Productivity gains in these unmechanized, unskilled tasks are probably associated with scale economies and learned organizational improvements associated with the development of the industry between 1870 and 1890. Unmechanized productivity improvements set a baseline for judging observed labor productivity gains in the cookroom. The argument we present is not that deskilling machines would never become labor enhancing. Rather, we hypothesize that when a machine can cut wages through deskilling, this skill-saving machine may be introduced before its perfection as a labor-saving device. The use of

deskilling devices which are not labor saving will usually be short-lived because typically it will still pay the employer or capital-goods industry to perfect later generations of the machine into a labor-savings device. The tomato cannery in Tables 1 and 2 which shows no labor productivity gains in capping is not an exception to this process, but rather an example of early adoption when wages have been cut but simple labor productivity has not been enhanced. Table 3 also reflects this dynamic. Assuming the average labor productivity gain for capping is in fact greater than the baseline set by unmechanized tasks, a slight increase should be associated with improvements in the capper in the ten years since its adoption. The greater gains of the cooker reflect the fact that it has been on line twenty years. The cooker is still less labor enhancing than any of the more recent machinery in unskilled preparation work. Thus, evidence from these seven canneries is consistent with our hypothesis that for a machine to be adopted in the high-wage cookroom, it was sufficient that the machine cut wages through deskilling (assuming appropriate initial machine costs and depreciation figures). However, in low-wage occupations a necessary condition for the adoption of new machinery was that it be labor enhancing.

The effect of mechanization on craft unionism can be traced through the records on strikes and wages of can makers and cappers in Baltimore from 1870 to 1900. The Can Makers Mutual Protection Association was formed around 1870 and, according to employer recollections, the worker combination was often successful in raising wages.[16] Maryland's Bureau of Statistics and Information reports Baltimore-area strikes after 1881. In 1881 there were two can makers and cappers strikes involving 300 workers and forcing wages up from $1.20 per day to $1.50 and then $1.83 per day. In 1883 a similar pattern is reported. Three strikes involving around 600 workers drove wages up from an early-season rate of $1.20 to an end-of-season $1.87 per day. Three strikes in 1885 drove the piece rate up from $0.25 per hundred cans in May to $0.60 per hundred cans at the end of the season in October, about the time that capping machines were first being introduced. In 1886 the only reported strike was at a firm attempting to pay below-industry wage levels. Workers were successful at regaining the industry wage.

In the reports of 1892, 1899, and 1901 no can makers strikes are reported although other industries experienced strikes. One can makers strike is reported for 1895. Workers struck in October against a reduction from $0.25 to $0.15 per hundred cans and lost. In contrast,

[16] The beginnings of the Can Makers Mutual Protection Association in 1870 is suggested in Baltimore Federation of Labor, *Illustrated History of the Baltimore Federation of Labor* (Baltimore, 1900), p. 440 and in the U.S. Industrial Commission, *Trusts and Industrial Combinations* (Washington, D.C. 1900), vol. 1, p. 919.

during the mid-1880s October, the peak season and the high point of worker bargaining power, piece rates were driven from $0.25 per hundred up to $0.60 per hundred cans. In 1902 the Can Makers Union Local 211 of Baltimore reported no strikes but a wage decrease of 50 cents per day. Out of 72 unions reporting, only three, including the can makers, reported wage declines in 1902 while 33 unions reported increases.[17] These data concur with a picture of union decline due to mechanization as told by the can makers and cappers, themselves. By 1900 the Can Makers Mutual Protection Association had joined the AFL. Its "object was to revive the use of hand-made tin cans so as to open an opportunity to permit adults to work instead of the major part of all labor performed about the machine being done by women and children at utterly inadequate and irregular wages. . . ."[18] In 1900, a labor representative told the Industrial Commission that in the 1880s in the canning industry "We had an assembly at that time, before the machines were introduced, of 1,100 or 1,200 men. . . . What was called 'jumpers' were introduced, that is, the manufacture of cans by machinery, and it really destroyed the assembly. . . ."[19] That this was precisely what the employers had in mind when they adopted capping machinery fifteen years earlier is suggested in an 1887 advertisement for Cox's Capper which boasted: "Why Cap Longer by Old Methods when Cox's Capper Fills the Bill—It Saves Labor—It Saves Solder—It Never Tires—It Never Strikes."[20]

We contend that in nineteenth-century American canning, innovative mechanization enhanced the profitability of firms in a growing product market through two distinct mechanisms. One type of mechanization, which appears to have taken precedence in the innovative strategies of cannery operators, was designed to reduce the extent of control that craft workers enjoyed over the production process. The primary positive impacts of this type of mechanization on profitability were achieved by allowing for redivision of labor. Consequently, it both reduced the

[17] Maryland Bureau of Statistics and Information, *First Biennial Report*, p. 207; Maryland, Bureau of Statistics and Information, *Second Biennial Report*, (Annapolis, 1888), pp. 60–62, 75; Maryland Bureau of Statistics and Information, *First Annual Report, 1892* (Baltimore, 1893), p. 200. The *First Annual Report* states: "The year 1892 will long be remembered in labor circles as being prolific of strikes and lockouts . . ." yet no can maker and capper strikes were reported. Maryland Bureau of Statistics and Information, *Third Annual Report, 1894* (Baltimore, 1895), p. 172; Maryland Bureau of Statistics and Information, *Fourth Annual Report, 1895* (Baltimore, 1896), p. 169; Maryland Bureau of Statistics and Information, *Eighth Annual Report, 1899* (Baltimore, 1900), p. 1; Maryland Bureau of Statistics and Information, *Ninth Annual Report, 1900* (Baltimore, 1901), p. 16; Maryland Bureau of Statistics and Information, *Tenth Annual Report, 1901* (Baltimore, 1902), pp. 12–13; Maryland Bureau of Statistics and Information, *Eleventh Annual Report, 1902* (Baltimore, 1903), p. 52. The union and nonunion can makers wages were reported to be the same in 1902.

[18] Baltimore Federation of Labor, *Illustrated History*, p. 440.

[19] U.S. Industrial Commission, *Capital and Labor* (Washington, D.C., 1902), vol. 7, p. 431.

[20] Reprinted in *Food Production Management*, 101 (July 1978), p. 70.

social power of craft labor as a constraint on profit-maximizing managerial decisions and it allowed employment of a lower-wage work force in formerly craft occupations. The second innovative strategy was aimed at the problem of unreliable seasonal supplies of unskilled workers. This type of mechanization increased profitability by greatly increasing the throughput of product per worker. Because different barriers to profitability were solved through mechanization, criteria for their adoption were different.

The success of innovative strategies was not inevitable but was contingent upon favorable circumstances regarding the relationship between capital costs, wages, and productivity. The constellation of these circumstances could not have been foreseen perfectly by either the cannery operators or craft workers, and each side undoubtedly made experimental decisions in an atmosphere of uncertainty. The historical account suggests that cannery craft workers overplayed their hand and probably contributed to a more rapid pace of technical innovation. The expectations of craft workers were probably shortsighted because their substantial degree of control over production decisions made it hard to imagine how their advantageous social position could be effectively eroded by as yet developed machinery. It was difficult for craft workers to anticipate how overall industry growth would result in the emergence of a cannery capital-goods industry. The emergence of the capital-goods sector, of course, contributed to the success of the innovative strategy of the cannery owners because it became the source of better and cheaper mechanical innovations. High growth rate in the canning industry also contributed to the success of the skill-displacing strategy because the power of craft unions (as well as the informal craft power of nonunion craft workers) eroded through the entrance of new nonunion firms, employing the new technology. This made it easier to lower craft wages as new technology was introduced and so contributed to investment returns in skill-displacing technology.

Thus, the circumstances which favored innovative strategies in nineteenth-century American canning were not solely the creation of managerial initiative but were also the product of industry-wide developments in which the broad and unforeseen results of market forces played an important role.