

The Civil War and the Mechanization of Western Farms

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1 Introduction

Agricultural implements played a key role in the mechanization of the West after the Civil War, both in manufacturing and in farming. Civil War experience changed many citizens and many economic factors in both areas, and these experiences drove industrialization. While many have advocated railroads as the model from industrialization, military organization and the Civil War seems to have had much more impact, at least in the West. Military organization forged soldiers into cohesive units and provided a model of a low-skill, interchangeable-laborer industry, which led to ex-soldiers' greater suitability to factory jobs but also to an increased sense of the value of their labor. Wartime labor shortages, combined with the Homestead Act, drove adoption of new technologies on the farm, leading to an upheaval in traditional farm labor structure. Finally, wartime innovations in precision manufacturing, coupled with incremental technological advances, led to increased production capacity and decreased labor costs especially at the McCormick Harvesting Machine Company, resulting in higher-quality, labor-saving, feasible agricultural implements for the Great Plains.

2 The military as a model for industry

Civil War military organization likely influenced later manufacturing companies such as McCormick both as a model of organization and as a shaping influence on the workforce. Comparing the infantry in the Civil War with later highly-mechanized industrial models gives clear similarities and in-

fluences: both took in workers usually unskilled in the field, needed to train them to use their designated machinery rapidly, needed easily-interchangeable workers, and highly valued rapid operation of machinery. Other branches of the army also involved similar goals, but had somewhat more autonomy in choice and effected a smaller body of individuals. While the army's machine was primarily the gun, either rifle or musket, and machine tools were diverse, both the army and industry sought to bring new workers up to speed quickly. Both industry and army were organized into workers and managers, usually drawn from distinct social pools and with little mobility between the two classes. Neither valued previous experience highly: guns were usually used in volleys, where soldiers' aiming was detrimental to rapid firing, while in industry, experience was likely not translatable to a new machine and likely made the worker care about each piece more, instead of merely permitting the machine to create a uniform, fast, but slightly lower-quality result. These similarities have been used to propose that military service in the Civil War, not railroads, was a model for industry (Johnson, 2003, p. 182); however, Civil War service also altered societal organization in ways favoring later industrialization.

2.1 Organization effects of military service

Military service in the Civil War was a pivotal experience for many people and shaped them for a later future in industry. Rank based on social and ethnic factors, with little mobility, led to greater peer and ethnic unity and reduced later job experimentation and upward mobility. Military training

involving breaking large tasks down into minuscule, timed subtasks made machine operation a rote job, available to anyone who could follow orders, instead of requiring some individual, artisan skill in operating one's personal tools, gun, or machine. These effects made ex-soldiers more adapted to later manufacturing styles, leading to distinguishable effects in later occupational status of ex-soldiers.

2.1.1 Management of unskilled, interchangeable worker-soldiers

Soldiers entering the military during the Civil War were overwhelmingly unskilled and untrained in war, leading to an upheaval in military organization and the de-skilling of military work. The American army had long been a volunteer service, and thus new soldiers were added slowly and had time to become individually trained in operating their machine. However, the Civil War swelled the army such that it could no longer train new soldiers individually, but must train whole companies or larger units at once. To deal with this change, the army began training units to deliver volleys as a group, rather than individually picking out targets, and therefore training units to fire as rapidly as possible. The Hardee infantry manual, written in 1855, broke down the operation of firing a gun into nine subtasks, complete with time requirements down to 1/90th of a second, thus training soldiers in how to fire a gun without needing to fire the gun outside of battle or needing to aim the gun (Johnson, 2003, p. 153). These changes gave officers absolute control over every individual motion of their soldiers, removed individual skill from being a soldier, and made soldiers and their guns relatively in-

terchangeable with each other, given no particular skill connection to the machines' operation.

2.1.2 Group loyalty to peers

Officership in the Civil War was highly tied to social class, and there was little ascension in the ranks for those who did not begin as officers. Thus, the body of fighting men was disproportionately Irish and German, while the officers were more frequently native-born, as would later be seen in factory management. The shared sense of ethnic pride was built further by advertisements urging enlistment to fight for one's community (Johnson, 2003, p. 296), which led to greater identification with one's ethnicity and occupation.

The Civil War also reduced soldiers' individuality, adding an element of group loyalty to those in similar positions that would lead to the evolution of labor unions. Due to shared experiences and suffering, together with being treated as a unit by officers, enlisted men in the army gave up a measure of individuality and began associating themselves more with other soldiers. Even in mutiny, soldiers felt support for each other --- Johnson relates a mutiny of sixty paroled men which were exchanged but refused to rejoin their regiment until proper papers were provided saying they had been exchanged. Half eventually rejoined, even though they expressed desire to hold out (Johnson, 2003, p. 232), while half eventually were dishonorably discharged for continuing to refuse work. This subordination of individual to group provided cohesive units, but laid the groundwork for later identification with community in factories.

2.2 Results of War

These organizational effects of the Civil War carried over into post-war professional life. Ex-soldiers were, as a group, less geographically mobile, less socially mobile, and more likely to be factory workers than their peers, likely from their experiences in the army. Dubuque, Iowa, provides a useful case study of these trends, due to Johnson's research; Dubuque was less industrially developed than Chicago before the war, but as a similar Midwestern city, his conclusions about the Civil War's effects on veteran status are likely applicable throughout the region. Based on these results of military experience, the army reconfigured occupational experience to be more conducive to later mechanization of manufacturing.

2.2.1 Group dynamics

Veterans in Dubuque were much less likely to leave Dubuque after the war than non-veterans, possibly as a result of greater ties to the community that they had been told they had been fighting to preserve during the Civil War. Among all age groups, more than 50% of veterans remained in Dubuque in 1870, compared to only 42% of their non-veteran peers (Johnson, 2003, p. 292); among younger veterans, the group usually more likely to leave, veterans were 20% more likely to remain in Dubuque in 1870 than their peers. While there is not data corresponding this to unionization, it seems likely that this loyalty to local peers would easily translate into loyalty to coworkers, leading to increased unionization.

2.2.2 Increased fitness as artisans

After the Civil War, no matter social class before the civil war, veterans were more likely than comparable non-veterans to move into manufacturing and other 'artisanal' jobs. In a representative Midwestern city, Dubuque, Iowa, veterans in all occupation classes after the war were around 20% more likely than their nonveteran peers to move into or stay in artisanal occupations (Johnson, 2003, p. 349). Data from Chicago was not analyzed, but of Dubuque industrial workers, 66 of 444 were veterans and at least 54% of these veterans were semiskilled factory machine operators (Johnson, 2003, p. 314). Army work required obedience and routine, and factory machine operation offered essentially the same experience (Johnson, 2003, p. 286).

2.2.3 Social mobility

Although artisans typically earned more than unskilled laborers, farmers, and others of these social classes, Dubuque data indicated low long-term social mobility in either direction for veterans, less mobility than non-veterans. The major exception to this was previously unskilled laborers, who were much more likely to become artisans or farmers after the war and thus move up in social status; however, there remained little mobility in either direction. Soldiers may have been more likely to be content doing a repetitive job given their experience doing so in the Army, and thus less likely to move up to a managerial position. The army too had little upward mobility in the Civil War (Johnson, 2003, p. 189), and this experience in the Army may have reduced ambition and reduced mobility.

3 Implications of the Civil War on agriculture

While the Civil War had major implications for veterans, it also created major upheaval in traditional farming culture, leading to the mechanization of the farm. Traditional farm society had involved hired laborers in a subsidiary capacity, but they had been long-term employees with a variety of farming skills working toward their own farms (Argersinger and Argersinger, 1984, p. 394). Mechanization resulted in redistribution of labor needs so that many, unskilled laborers were needed for only a few weeks at a time, resulting in much more transient labor. This process began before the Civil War with the introduction of the reaper, invented in the 1830s, but was greatly sped by the Civil War, and encouraged further technological development.

3.1 Seeds of change during the War

During the Civil War, two primary factors promoted increased agricultural implement manufacture and use in the West: labor scarcity and lower Eastern farm investment. Lack of labor, especially farming-skilled labor, pushed agriculture production toward less intensive crops such as wheat, but there was still little flexibility in harvesting these crops. Lower Eastern farm investment meant that sale of harvesters and other agricultural implements was predominantly Western, leading to manufacture in the West. McCormick also took advantage of Chicago's status as a rail hub in order to ship machines to the rest of the country (Hutchinson, 1935, p. 361), while Eastern manufacturers such as Hussey relied on water transport, giving McCormick

a significant advantage during the War. These factors assisted the rise in popularity of harvesters during and after the war, leading to expanded manufacturing and technological advances later.

3.1.1 Labor scarcity

During the Civil War, the military absorbed many of the able-bodied men who had previously found work as farmers, leading to labor shortages. The army predominantly lured unskilled laborers, such as farm laborers, in the Midwest, overturning the traditional arrangement of farm work. Finding replacement workers with agricultural skill was difficult yet critical to gathering crops, but new harvesting machines made laborers without farming experience useful during the harvest season. Grain, the primary agricultural product in the West, was minimally labor-intensive during most of its growing season, but it required a large labor force during harvest in order to harvest it before it rotted. The McCormick company was one of the main producers of agricultural implements, and its primary product was a harvesting machine that would reduce the men required by a factor of four. Because of this labor shortage, then, harvesting machines remained popular throughout the war and after.

3.1.2 Lower farm investment in the East

Northern grain production was concentrated in Pennsylvania, where it was relatively near to the front lines of the war and where farms were smaller, leading to lower adoption of harvesting machines. Although one of the first

harvesting machines was invented in Maryland in the 1830s, the size of Western farms made a harvesting machine both more affordable and more critical to a farmers' ability to harvest his entire crop in limited time, while Eastern grain farms were smaller, making a harvester a larger investment for them relative to their crop. Furthermore, due to the uncertainties of war, harvesters were relatively fragile machines, making them a poor investment for fought-over territory such as Gettysburg and other grain-producing regions of Pennsylvania, while very little military action occurred in the Midwest. Due to these effects, manufacture of harvesters in the West was much more profitable than Eastern manufacture, and McCormick was the largest of the western harvester manufacturers during the War.

3.2 Post-War Implications

While the Civil War lasted only a few years, it continued to shape technological adoption and innovation after its conclusion. Labor-saving adaptations on farms during the war caused continued adoption and improvement of these harvesting, mowing, and similar technologies. The increased suitability of workers to factory work, and the innovations in managerial control that the Army provided during the war, led to increased production capabilities through the predecessors of scientific management. The Homestead Act drove farms to increase in size, and made mechanical harvesting a necessity throughout the entire Midwest. On the darker side, however, the war maimed many farmers and workers, and these injuries drove other technological modifications. These implications shaped both the agricultural

implement industry and the farming industry into more mechanized and specialized production processes.

3.2.1 Adaptation to War Injuries

While Civil War wounds had a high death rate, many soldiers survived with various disabilities, impacting their ability to earn a living. Since most soldiers made their living manually, either in farming or in unskilled labor, their wounds made earning a living more difficult, if not impossible, with pre-war technology. Some provision was, it is true, made for pensions for those disabled, but these pensions were intended to supplement, not replace, independent earnings and family support (Johnson, 2003, p. 280). In the entire state of Illinois, according to the 1880 census (the only one in the near-War time period asking about maiming), .652% of men were maimed (Steven Ruggles and J. Trent Alexander and Katie Genadek and Ronald Goeken and Matthew B. Schroeder and Matthew Sobek (2010)). However, in agricultural occupations, 1.02% of men were maimed; of manufacturing-related laborers, .93%; and of agricultural implement makers, 1 of 87 workers responding to the census --- all above the disability rate over all occupations. Remaining in farming often required additional help, either via hired labor or via mechanization; and mechanization was frequently cheaper (Dahlstrom and Dahlstrom, 2005, p. 44). McCormick introduced a riding reaper around 1861, toward the early days of the war; initial attempts at building a riding reaper were unsuccessful, but McCormick later bought a rivals' riding system for his own reapers. While technological advances could make ma-

chines more convenient for the farmer, they could also be the difference between farming and not farming for a maimed veteran.

3.2.2 Homestead Act

The Homestead Act, passed in 1862, gave many new immigrants and low-skill non-landowners in the East a chance to farm land of their own for only the price of living on it. Farms in the East were smaller, due to several generations of farming and population increase, and the West offered large parcels of flat, easily farmable land. Due to the constraints of the area, however, perishable crops were infeasible due to distance from major cities, pushing Western development toward grain, which could easily be transported to cities for consumption. This emphasis on growing large plots of grain created a new requirement for labor-saving machines such as Deere's plow to till the acreage provided, while the ability of these machines to sow ever-larger plots made harvest an ever-larger labor problem and encouraged better and faster harvesting machines such as McCormick's'. These machines required large amounts of unskilled, fast labor in order to sow and harvest a crop within the limited time permitted by weather and Nature.

The Homestead Act was critical for the adoption of agricultural technology in the West. Eastern farms, by being smaller and less flat, were much more difficult to plow and harvest mechanically, while revenue from the smaller acreage was unlikely to pay for machines quickly. Western farms, by being larger and flatter, were better suited for mechanical harvesting, and by dint of size, were able to pay for machinery faster. While both origi-

nal mechanical harvester manufacturers started in the East and initially contracted out manufacture of their reapers to local firms, McCormick moved to Chicago in the 1850s and centralized manufacture, while Hussey continued to try to manufacture at local blacksmith shops in Maryland. As a result, McCormick quickly grew to be the most prominent harvester manufacturer throughout the nation, and grew even larger when the Homestead Act made more large farms legally available in the West (Hounshell, 1984, p.161).

3.2.3 Labor implications of new technologies

While the new harvester made farmers' jobs easier, it also introduced the concept of the farmer-landowner as manager of laborers on their farm. The farmer now hired help for specific tasks, not for general farm help, and managed the machinery, while the laborers now fed and tended the machinery (Argersinger and Argersinger, 1984, p. 396). As a corollary of the farmers' new financial constraints, both by having purchased a machine and by having to tend their farm under the Homestead Act, the farmer was now much more profit-focused and sought to control laborers' work much more closely. As a result, the farm, like industry, grew toward the Army's model of unskilled yet specialized labor.

3.2.3.1 Seasonal mechanization and the implications for low-skill workers

This seasonal mechanization resulting from the industrialization of the farm led to decreased social mobility, lower skills and greater machine specialization, and increased laborer organization among farm labor. Since

farm labor was now hired specifically to work machines, workers did not gain farming skills and were paid less than previously. Socially, laborers were unable to gain skills or property and advance, and were considered to be the lowest class of society and demeaningly decried as 'tramps'. However, due to their common plight and

3.2.3.1.1 Wage reduction After the Civil War's labor shortage, increased mechanization left farms with a labor glut, leading to (Argersinger and Argersinger, 1984, p. 398) a precipitous drop in farm wages to pre-war levels. The lack of needed skill meant that all farm laborers were treated and paid as unskilled, and increasing social disdain for farm laborers further encouraged displacing their jobs with machinery. Many farmers sought to pay laborers less than pre-war levels, especially during the depression in 1877, and when these wages were refused, sought to replace their laborers with machinery (Argersinger and Argersinger, 1984, p. 400). Unlike industrial jobs, where specializing on a machine gave some long-term advantages to workers and employers, farm jobs gave no premium to long employment to either party.

3.2.3.1.2 'Tramps' as the lowest class Because the harvest season and thus employment was short, farm laborers began after the Civil War to travel with the harvest, going south as the harvest went south. Unlike veterans' training during the war leading them to less geographic mobility, these workers' jobs traveled into unfamiliar towns for brief periods. In the post-Civil War Midwest, with a war-heightened sense of community, these outsiders

were unwelcome, accused of crimes, and labeled as "tramps"(Argersinger and Argersinger, 1984, p. 401). As a result, these workers found community with each other, and organized both against those taking their jobs and against those seeking to underpay them.

Ludditism Because of the decrease in jobs due to machinery, laborers, like many other displaced workers throughout history, sought to return to the status quo by destroying machinery. Argerberger has tracked many instances in newspapers of violent threats to farmers who were using new machines or who used machines to displace jobs, and these threats were followed with machine destruction in many cases. Interestingly, while 1878 had an incident involving the armory being robbed in Terre Haute, Indiana, no blood was shed by the machine breakers, although a farmer killed two men burning his harvester. On the other hand, many instances of destruction are recorded in newspapers of this period, including one instance of an implement factory being burned (Argersinger and Argersinger, 1984, p. 404). Unlike the response to industrialization in major cities, the seasonal nature of these machines' use caused much more widespread backlash and social disruption to workers' lives, resulting in acts of domestic terrorism.

Agricultural organization Surprisingly, increased adoption of agricultural machinery also lead to organization on the part of laborers working this machinery. While there were few areas where organization was complete enough to cause farm disruption, Argerberger does relate several occasions where fifty laborers picketed on a bridge for higher wages in 1878. Regrettably, there appears little record of the identity of these organizers,

so it is difficult to see if Civil War experiences directly influenced their willingness to protest; it does seem longtime farm laborers were more likely to protest, however (Argersinger and Argersinger, 1984, p. 401). It seems that predominantly these workers avoided organizing from a belief that agricultural work was a temporary status, until they could become a factory worker or farmer themselves; this seems similar to other experiences with unionization coming only in long-term places of employment. This organization matches well the increased sense of duty to peer provided by the Civil War, but records are insufficient to verify this.

3.2.3.2 Farm and factory: distinct industrial experiences for workers As seen, industrialization of manufacturing and industrialization of farming had two distinctly different outcomes for workers. In factories, industrialization proceeded slowly, with slow reduction of artisanal work; on farms, however, industrialization proceeded swiftly as a result of technological advancement and the Civil War, and resulted in a great mass of displaced workers without jobs. Despite increased production per worker, jobs and prosperity went down among farm workers from increased machine adoption and farm size in the West. This social disruption led to unrest, and eventually led to some primitive organization before workers moved to other unskilled jobs.

4 Industrial response to military experience

Based on the model of the Civil War army, the American System of precise, interchangeable parts; close management of labor by foremen; and the deskilling of artisanal labor by machinery, led to rapid mechanization and eventually mass production of many machines, such as cars and reapers. Interchangeability eliminated the role of the fitter and sped assembly of finished products; close labor management provided for labor optimizations to be applied to whole segments of the workers at once; and deskilling by machinery provided for faster, more precise results than hand work. However, these changes eliminated the traditional artisanal nature of factory work, and led to lower skill and sometimes organization by workers in similar positions in favor of higher wages, to correspond with their higher productivity for the company, just as units in similar situations sometimes sought organization to protest perceived injustices.

4.1 McCormick mechanization

The McCormick Harvesting Machine Company became the Midwests' primary manufacturer of agricultural implements, as a result of clever technological improvements to its products. It moved to Chicago in 1849 and increased in size several times; it was consistently led by a relative of the McCormick family as superintendent, except for a single one-year period, leading to a late adoption of Eastern innovations in manufacturing techniques. While perhaps one of many pioneers in interchangeability, and significantly

ahead of its contemporaries such as John Deere, McCormick lagged far behind the East in precision manufacture and machine tool innovation, likely due to its flexible production techniques and frequent technology modifications. These changes made McCormicks' mechanization a sudden process, leading to later labor disputes.

4.1.1 Technological progress and flexible manufacturing

McCormick was among the first companies to adopt the later General Motors (Hounshell, 1984, p. 263) approach of having annual models. Due to the rapid innovation occurring in harvesting implements, McCormick agents would buy the best local improvement patents in their area (Hutchinson, 1935, p. 361) and send them to McCormick manufacturing in Chicago to make minor changes each year. As a result, while McCormick reaper models with the same name would persist for up to nine years, in the case of the Civil War model (Hounshell, 1984, p. 165), their parts may not have been interchangeable even between the same year. These annual models thus required changes to be made every year, encouraging non-specialization for a long period.

Given the annual models, and multiple products assembled in the same area, McCormick seems to have had few specialized machines for a long period after the civil war, remaining a "large blacksmith shop", in Hounshell's description. While being a large blacksmith shop did yield efficiencies of scale, it prevented true mass production while retaining a several-month (Hutchinson, 1935, p. 483) ramp-up period for each change. On the other

hand, the same basic arrangement of work, with only a little additional specialization, gave the potential to ramp up production significantly as the demands of the farmers required, with little training required for new workers and machinists.

4.1.2 McCormick and the American System

McCormick has long been held up as one of the major mechanizers of the agricultural implement industry, but Hounshell has recast the company as a late adopter of the American system. According to Hounshell, interchangeability and specialized machinery, taught to Northern armories in the Civil War, did not come to McCormick until 1880, and the McCormick Company was essentially a large blacksmith shop up until that time. These adaptations, of interchangeability and specialization of machinery, are direct results of Civil War experience, and benefited those who were best able to tend the machines instead of those who were best able to work the machines with skill. The conclusion that the American System came to McCormick around 1880 is partially born out by data, but does not see the whole picture of specialization that existed, misdates the production increase, and was more likely due to advertisement than efficiency.

1 indicates, as does Hounshell, that a major increase in machines produced by the McCormick Company occurred in 1880-1 and '81-2. Hounshell states this increase is the result of precision manufacture, introduced by Wilkinson, a replacement shop manager, hired in 1880 (Hounshell, 1984, p. 180), who had previously worked at the Colt armory. Colt certainly had pre-

Year	Rakers	Mowers	Droppers	Harvesters	Binders	Total	Total w/o binders
1878	1822	2513	776	6391	6316	17818	11502
1879	1129	3165	862	7798	5806	18760	12946
1880	2499	6098	507	7205	5246	21555	16309
1881	2513	9474	1020	8618	9168	30793	21625
1882	2739	15040	1514	13210	14180	46683	32503
1883	4255	14347	552	14045	14821	48020	33199
1884	3703	13697	681	18128	18632	54841	36209
1885	2221	14436	1152	15565	15528	48902	33372

Figure 1: McCormick Production, 1878-1885. Starts upon Leander McCormicks' firing, when Hounshell believes interchangeable parts came to McCormick. Mostly from (Hounshell, 1984, p. 161, direct from McCormick papers).

cision manufacture at that point (Hounshell, 1984, p. 154), and McCormick Jr. began noting the tools of precision manufacture about this time in his diary. Wilkinson had the superintendent job for only one year; thus, it is difficult to pin the transition to precision manufacture on Wilkinson and Colt influence precisely.

Several dated improvements are known. Wilkinson is known to have accomplished "several improvements" (Hounshell, 1984, p. 179) and began operating the factory at night in 1880, but more precise improvements are not known. Cyrus Jr. took over in 1881, and in early '81 cited single-purpose tools that McCormick was using in manufacturing (Hounshell, 1984, p. 180). In '86, McCormick had developed boring machines that placed all requisite holes in a piece of wood at once (McCormick, 1931, p. 77); in '89, McCormick had begun dipping the frames of its machines in paint tanks instead of hand-painting them.

On the other hand, other factors may have also contributed to the in-

crease in productivity. In 1879, an upper executive wrote that "the firm has no head and each employee makes his own hours" (Hutchinson, 1935, p. 688). By 1880 all parts except sickle knives were being made at the factory (Hutchinson, 1935, p. 700); removing other firms' control over production could increase productivity. By 1881, casters, molders, and 'twinebindermen' (perhaps assembly men?) were being paid on a piecework basis (Hutchinson, 1935, p. 695), while skilled mechanics were being paid on an hourly basis; this indicates that casters, molders, and twinebindermen were still jobs where individuals could be of different speeds and skills at their individual task, not just machine-tenders without skill.

Furthermore, McCormicks' and Hounshells' accounting of machines made does not account for the nature of the machines. While binders and reapers are counted separately by both, they were not often sold together, as they were functionally a single machine; the binder was a single adaptation placed atop the reaper. This is born out in 1, where the number of reapers is very close to the number of binders in each year. The added column to the right, accounting only the machines produced not counting binders separately, demonstrates a ramp-up of 3000 machines in 79-80, 5000 in 80-81, and 10000 in 81-82. 79-80 corresponds to the beginning of night-work and the dismissal of Leander McCormick, a long-time anti-expansion superintendent (Hounshell, 1984, p. 190); 80-81 is the era of Wilkinson's improvements, and 81 onward is due to McCormick Jr.'s leadership. These increases are slow, however, amounting to 15%, 30%, and 45% increases over the previous years' production, respectively. None of these increases, however, is as drastic

as the increases that the raw machine numbers give, which focus attention much more on the 81-82 transition: the corresponding percent increases of raw numbers are 15%, 40%, and 55% each over the previous year. While 45% is still a large single-year increase, it is not nearly as significant a jump as Hounshell casts it.

Year	Labor cost	Machine cost	Machines made	Total labor	Total cost
72		121.52	2996		364074
77		55	6593		362615
78		29	17818		516722
79	14.82	38.25	18760	278023	717570
82	13.99	41.78	46683	653095	1950416
10	10.07	56.32			

Figure 2: Labor cost per machine and total cost per machine, over time. Data from (Hounshell, 1984, pp. 162, 176), (Hutchinson, 1935, p. 699), (Department of Commerce and Labor, 1913, p. 260).

Labor costs also provide a powerful implication that significant adoption of the American System, which should speed production of each machine, did not occur during the '79-82 period. 2 indicates that, while '72 and '77 were very poor years for McCormick production, labor costs did not significantly change between 78 and 82, although throughput did increase significantly. This likely indicates that approximately the same amount of labor was being used to manufacture each machine, although the ability of the factory to produce more machines simultaneously went up; unfortunately, there is no data available showing the number of workers employed each year, which would be the key arbiter of machine efficiency versus increased labor expenditure.

The jump in reaper production occurs with the '82 reapers, the first to

use the much more popular twine-binders. This occurred when McCormick successfully fielded a twine binder, an innovation that other companies had beaten it with. Previously, McCormick had used wire-binders, which were unpopular and had been widely disparaged as killing cattle by wire bits; the twine-binding consortium had a pool of patents, but McCormick had finally managed to buy its own twine-binding patent. As a result, the jump in reaper production may have occurred only from a more popular product demanding higher production.

Taken together, these factors lessen the relevance of Wilkinson's past armory experience, and provide several potential explanations for the sharp increase that Hounshell takes as evidence of the American System. While specialization was certainly going on during this time period, and organizational repercussions of the Civil War encouraged greater specialization and lower skill in manufacturing, the American System likely did not have as significant impact on McCormick as Hounshell advocates. McCormick centralized and organized managerial duties to closely control workers and more fully utilize existing machines, and these changes likely provided the extra capacity required by the popularity of their products.

4.1.2.1 Interchangeability of parts As a manufacturer of a breakable machine, McCormick advertised the ability of farmers to obtain replacement parts directly from their factory. Machine repair was an important service, and McCormick provided replacement parts for its diversity of machines by preserving a parts library (Hounshell, 1984, p. 159) containing patterns for

machines, based on year and type of machine.

Hounshell argues that McCormick did not have truly interchangeable parts until 1880: he argues that the part library, especially an 1859 hunt for spare parts to replenish the part library, is evidence that McCormick did not have truly accurate parts, and believes without citation that the farmer played the role of fitter for repairs to his machine. Given the lack of evidence of jigs, gauges, etc. until 1880 (Hounshell, 1984, p. 180), Hounshell believes McCormick did not truly attain mass production in the sense of not requiring a fitter.

However, McCormick claimed interchangeable parts for quite some time, although their understanding at the time may have been different. The McCormick Company bragged in advertising materials about its interchangeable parts and part library in 1868 (Hounshell, 1984, p. 364), and McCormick's grandson argued the part library was evidence of interchangeability (McCormick, 1931, p. 42) and did not mention farmers needing to do any fitting in the field. While he is a biased source, it seems unlikely that fitting could be done outside of a factory without a great deal of trouble, and McCormick III mentioning "a local mechanic" installing the replacement part instead of "the farmer" would have taken little away from the glory of being able to make an arbitrary replacement part. Finally, Hounshells' reading of the letter in 1859 is that McCormick Co. was seeking to buy old machines for parts, but the letter itself is unclear; it could merely be indicating an organization effort for the parts library. Thus, McCormicks' interchangeability claim is not entirely implausible, and demands further verification.

4.1.2.2 Labor interactions Despite the late occurrence of the Civil War-inspired American System, the entire set of responses seen during the Civil War occurred when work resembled the army. It is indisputable that significant mechanization occurred at McCormick by 1885, together with much closer labor management, produced semiskilled machine operators instead of the previous artisans --- and also generated labor organization, which had not previously been seen at McCormick since the Civil War.

Opportunistic strikes occurred at McCormick occasionally before mechanization. During the Civil War, molders struck at least 4 times during 1864(Hutchinson, 1935, p. 89), leading Chicago-area manufacturers to form an industrial agreement on maximum pay for ironworkers. On the other hand, during the '67 strike for the 8 hour day, the McCormick factory was one of the few that continued work, although with time for workers to join a parade (Hutchinson, 1935, p. 485). In '76, corresponding to the depression in the farming industry, the Chicago Molders' Union asked McCormick to join them (Hutchinson, 1935, p. 695), which was rejected under McCormick being an open shop, but no strikes resulted. Deere molders, on the other hand, struck in '76, partially complaining that McCormick paid better wages for similar work(Dahlstrom and Dahlstrom, 2005, p. 118). All of these strikes were minor and typical of the large blacksmith shop style of work of that time.

However, in 1885, there was a major strike of the molders, who were on a piecework basis by that time (Hutchinson, 1935, p. 696), under McCormick Jr., seeking additional pay for the additional productivity from the partial

mechanization of their work. While the McCormicks admitted the justice of some complaint, they also increased the mechanization of the factory in response, installing pneumatic molders to replace the strikers (Hounshell, 1984, p. 364). In 1886, molders from McCormick struck, contributing to the May Day demonstrations, leading to the Haymarket affair and greater union organization. This organization was typical of rapidly-mechanizing industries, just as had happened in farming ten years previous, and as had been observed in the Civil War.

5 Conclusion

Agricultural implements played a key role in the mechanization of the West after the Civil War, both in manufacturing and in farming. Civil War experience changed many citizens and many economic factors in both areas, and these experiences drove industrialization. While many have advocated railroads as the model from industrialization, military organization and the Civil War seems to have had much more impact, at least in the West. Military organization forged soldiers into cohesive units and provided a model of a low-skill, interchangeable-laborer industry, which led to ex-soldiers' greater suitability to factory jobs but also to an increased sense of the value of their labor. Wartime labor shortages, combined with the Homestead Act, drove adoption of new technologies on the farm, leading to an upheaval in traditional farm labor structure. Finally, wartime innovations in precision manufacturing, coupled with incremental technological advances, led to in-

creased production capacity and decreased labor costs especially at the McCormick Harvesting Machine Company, resulting in higher-quality, labor-saving, feasible agricultural implements for the Great Plains.

The Civil War was a key catalyst for agricultural technology adoption, both on farms and in factories. It provided an army model for work organization that gave rise to factories and union organization, leading to the American System spreading throughout the Midwest, reducing skill levels required to become a factory worker, and encouraging strict obedience to minor instructions by management. It trained soldiers and ex-soldiers in being excellent machine operators and factory workers, but also in organization techniques and loyalty to peers. It provided the Homestead Act, making agricultural technology more relevant and essential, and driving Western development. Finally, it drove adoption of technology on these new midwest farms, giving rise to industrial farming via machinery, reducing the social status of non-landowning farm laborers, and leading to the semi-permanent construction of a marginal social class of 'tramps'. These repercussions make the Civil War key in understanding the development of agricultural implements, both manufacture and usage, and in the later demographic preferences of factory work as a whole.

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