Capital

CRITIQUE OF POLITICAL ECONOMY
VOLUME 1

Karl Marx

TRANSLATED BY **PAUL REITTER**

EDITED BY **PAUL NORTH & PAUL REITTER**

FOREWORD BY **WENDY BROWN**

AFTERWORD BY **WILLIAM CLARE ROBERTS**

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CHAPTER THIRTEEN

Machinery and Large-Scale Industry

1. How Machinery Developed

In his *Principles of Political Economy*, John Stuart Mill writes, "It is questionable if all the mechanical inventions yet made have lightened the day's toil of any human being."[1,i] That, however, is hardly the goal when machines are used in capitalist production.[ii] Like everything else that was created to increase the productive power of labor, machinery is supposed to make commodities less expensive, and thereby shorten the part of the workday the worker needs for himself, in order to extend the workday's other part—the part the worker gives the capitalist for free. Machinery is a means of producing surplus-value.

When the mode of production is revolutionized in the manufacturing system, labor-power is the starting point; but when it is revolutionized in large-scale industry, its transformation begins with the means of labor. So first we will examine how a means of labor ceases to be a tool and becomes a machine, or how a machine differs from the tools a craftsman works with. Only broad and general characteristics matter here, for there aren't strict, abstract boundaries separating historical epochs any more than there are for geological eras.

Mathematicians and engineers make the claim (which English political economists sometimes repeat) that a tool is just a simple machine, and a machine is just a complex tool. They see no essential difference between the two things: they even apply the label "machine" to such simple mechanical devices as levers, inclined planes, screws, wedges, and so on.[2] Every machine is in fact made up of simple devices, however disguised or

1. Mill should have said, "of any human being not fed by other people's labour," for machinery has without question greatly increased the number of elegant loafers.

2. See, for example, "Hutton's Course on Mathematics." [Editor's note: This refers to Charles Hutton, *A Course in Mathematics in Two Volumes composed for the use of the Royal Military Academy* (London: Longman, Reese, 1836).]

combined. Yet from an economic standpoint, this explanation doesn't help us at all, since it lacks a historical component. According to another line of thought, the key difference is that tools get their motive force from human beings, whereas machines are powered by nonhuman natural forces: animals, water, wind, and so on.[3] From this it would follow that the plow pulled by an ox, something common to diverse epochs of production, is a machine, but Claussen's circular loom is merely a tool, even though it can weave 96,000 picks per minute when powered only by the hands of a single worker. One and the same loom would be a tool when powered by human hands but a machine when powered by steam; and since harnessing the power of animals is one of humanity's oldest inventions, the use of machines in production would actually predate handicraft production. When John Wyatt introduced his spinning machine in 1735, launching the eighteenth century's industrial revolution, he didn't mention that a donkey rather than a person would supply the power, yet that role did fall to a donkey. A machine "to spin without fingers" is how he phrased it.[4]

All advanced machinery is made up of three fundamentally different parts: the motive mechanism, the transmitting mechanism, and, finally,

3. "From this point of view, it is also possible to strictly distinguish between tools and machines. Spades, hammers, chisels, etc., combinations of levers and screws—any case where no matter how complex a device is, human beings provide motive force . . . should be categorized as a tool. But the plow, relying as it does on animal power, as well as wind mills and so on, count as machines" (Wilhelm Schulz, "Die Bewegung der Produktion. Zürich, 1843," p. 38). In some respects, this is a praiseworthy work.

4. Even before Wyatt, machines, albeit rudimentary ones, were used for spinning, a practice that likely began in Italy. A critical history of technology would show how little any eighteenth-century invention should be attributed to a single individual. Currently, no such work exists. Darwin has drawn our attention to the natural history of technology—i.e., the development of plant and animal organs as the instruments for producing their respective lives. Shouldn't we devote just as much attention to how the productive organs of human beings in society developed historically—that is, how the material basis of every organization of society developed historically? And wouldn't this history be easier to write, since, as Vico says, what distinguishes human history from natural history is that we make the one but not the other? Technology reveals the active relation of human beings to nature, or the process whereby their lives are directly produced. In doing so, it also reveals the process through which the social relations of their lives—and the intellectual creations that arise from those relations—are brought about. Even a history of religion that abstracts from this material basis is . . . *uncritical*. In truth, it is much easier to discover the foggy creations of religion by analyzing the earthly kernel than it is to proceed the other way around: i.e., to begin with the actual, existing relations of life and, proceeding from them, explicate their heavenly forms. The latter approach is the only materialist and therefore truly systematic method. Just by looking at the abstract and ideological notions that its spokesmen express as soon as they stray from their expertise, we see the shortcomings of the abstract materialism of natural science, a method that excludes the historical process.

the tool machine or working part of the machine. The motive mechanism powers the entire machine. In some cases—for example, the steam engine, the calorie machine, and the electromagnetic machine—it produces its own motive force. In all other cases, the motor gets its power from an external natural force—a waterwheel is powered by the natural movement of water, a windmill is powered by the wind, and so on. The transmitting mechanism is an assemblage of flywheels, shafts, toothed wheels, pulleys, straps, ropes, bands, and all kinds of gears. It serves to control the machine's movement, changing the form of that movement whenever necessary—e.g., from linear to circular; it also distributes that movement, conveying it to the tool machinery. The first two parts of the mechanism exist only to move to the last part, which acts upon an object of labor and purposefully alters it. It was with this part, namely, the tool machinery, that the industrial revolution began in the eighteenth century. Its function as a starting point is still being renewed every day, or whenever craft labor and manufacturing workshops are transformed into machine-driven industry.

If we take a closer look at a working machine, we will see that here, as a rule, the tools and devices used by craftsmen and manufacturing workers reappear, although often in an extensively modified form. Furthermore, they are now not tools for a human being, but rather tools for a mechanism: mechanical tools. Either the whole machine is just a mechanical version of a traditional artisan's tool that has been altered to a greater or lesser degree—for example, the power loom[5]—or the working organs attached to the frame of the machine are our old friends, such as spindles in a spinning machine, needles in a stocking loom, saw blades in a power saw, or knives in a chopping machine. The difference between these tools and the main body of the working machine extends all the way to how they are born. In general, the tool parts are still produced by artisanal labor or in the manufacturing workshop, and only afterward are they attached to the bodies of working machines that are themselves produced by machines.[6] A tool machine is thus a mechanism that, upon being set in

5. This is especially the case with original form of the power loom, in which we can immediately recognize the old loom. Only in its modern form does the power loom look fundamentally different.

6. In England, machines have been used to make an ever-increasing portion of these tools of the working machines only over the past 15 years or so, and the people who produce the actual working machines don't also make their tools. Some examples of the machines employed to make tools for other machines: the automatic bobbin-making engine, the card-setting engine, shuttle-making machines, and machines for forging mule and throstle spindles.

motion, uses tools to carry out the very same operations a worker once performed with similar tools. Whether its motive force comes from a human being or another machine makes no difference here. The moment that a tool is removed from a person's hands and mounted as part of a mechanism, a machine has taken the place of a mere instrument. The change jumps out at us right away, even when human beings are functioning as the machine's first motive mechanism. A person's natural instruments of production, i.e., his own physical organs, limit the number of instruments of labor he can wield at the same time. In Germany, spinners were initially made to work two spinning wheels simultaneously, which meant working with both hands and both feet; but that proved too strenuous. Later, the treadle spinning wheel with two spindles was invented, but virtuoso spinners who could spin two threads at once were about as common as two-headed people. The Jenny, however, spun with 12–18 spindles even in its earliest form; the stocking loom knitted with many thousands of needles operating at the same time; and so on. From the start, tool machines were freed from the organic constraints that limit the number of tools a worker can handle.

With many manual tools, the difference between a person's functions as the mere supplier of the motive force and as the worker who actually uses the instrument is marked by a physical separation. Take, for example, the spinning wheel. The worker's foot acts only as a motive force, pumping the footpedal, while his hand pulls and twists, carrying out the real operation of spinning. It was the latter part of the craftsman's tool that the industrial revolution took control of first, leaving the human worker to perform the new labor of using his eyes to oversee the machine and his hands to fix its mistakes while, above all, he still played the purely mechanical role of supplying the motive force. In contrast, where human workers had always done nothing but provide that force—say, by turning the crank of a mill,[7] pumping, moving the arm of a bellows up and down, pounding with a mortar, and so on, animals, water, or wind[8] were soon

7. Moses of Egypt said, "You shall not muzzle an ox while it is treading out the grain." [Editor's note: Deuteronomy 25:4.] But Christian German philanthropists put a wooden board around the necks of the serfs they employed for grinding, so that the latter wouldn't be able to put grain in their mouths using their hands.

8. What compelled the Dutch to use wind as a motive force was in part that they lacked streams with a sufficient fall, and in part that they had to struggle against excess bodies of water. They borrowed the model for their windmills from Germany, where this invention prompted quite a fight, in which the nobility, clergy, and the Emperor were pitted against one another. At issue was which of the three the wind "belonged to." The line "the air makes you a slave" resounded in Germany as the wind was making Holland free. What was made

employed to drive a device's movement. Partly within the manufacturing period, partly (if also sporadically) long before it, such devices rose to the level of machines, but they didn't revolutionize the mode of production. That they were machines even when they were still a craftsman's tools became apparent during the period of large-scale industry. For example, the pumps that the Dutch used to empty the Lake of Harlem (in 1836–37) were built according to the same principle as ordinary ones, the sole difference being that their pistons were powered by gigantic steam engines instead of human hands. In England, the blacksmith's ordinary and crude bellows has sometimes been turned into a blowing engine simply by connecting its arm to a steam engine. The steam engine was invented at the end of the seventeenth century, or during the manufacturing period, and early forms of it even existed until the 1780s without bringing about an industrial revolution.[9] In fact, the reverse happened: the creation of tool-wielding machinery made it necessary to revolutionize the steam engine. The moment that a human being starts to function merely as a tool machine's motive force, instead of acting upon the object of labor with his own tool, it becomes accidental whether human muscle supplies the machine's force or water, wind, or steam does. But this hardly means that such a shift won't lead to major technological changes in a mechanism originally designed to run on human muscle alone. Nowadays, almost all genuinely new machines, such as the sewing machine and the bread-making machine, are made to run on both human and purely mechanical motive forces. The exceptions are machines with particular features that prevent them from being used on a small scale.

As the starting point of the industrial revolution, the machine took the place of the worker. A person who handled just one tool was replaced by a mechanism wielding many similar tools simultaneously and powered by a single motive force of whatever type.[10] Here we have the machine, but only as a simple element in machine-driven production.

A machine that has been enlarged and wields more tools at the same time needs a larger mechanism to supply its movement. In addition, for

unfree in Holland wasn't the Dutchman himself, but rather the land, and it was for the Dutchman that it was subjected to bondage. As late as 1836, 12,000 windmills with 60,000 horsepower were used to prevent two-thirds of the country from being transformed back into a bog.

9. It was improved a great deal by Watt's first so-called single-acting engine, but even in this form it was still simply a machine for raising water and brine.

10. "The union of all these tools, actuated by one moving power, constitutes a machine" (Babbage op. cit. p. 136).

an enlarged motive mechanism to overcome its own inertia, the force that drives it has to be more powerful than human beings can be (to say nothing of the fact that when it comes to producing continuous, uniform movement, human beings leave much to be desired). Once a tool machine has replaced the worker's tool, and a human worker functions only to supply the motive force, natural powers can take his place there, too. Of all the great motive forces handed down from the manufacturing era, horsepower is the worst. For one thing, a horse has a mind of its own, and for another, horses are expensive and can be used in factories only to a limited extent.[11] Yet horses were often put to work during the infancy of large-scale industry. Both the jeremiads of the agronomists of that time and the term for mechanical power still current today, "horsepower," testify to this use. Wind, for its part, was too unsteady and hard to control, and, moreover, waterpower predominated in England, the birthplace of large-scale industry, even during the manufacturing period. As early as the seventeenth century, attempts were made to turn two pairs of millstones with a single waterwheel. But the enlarged transmitting mechanism proved to be too much for the waterpower—one of the factors that led people to analyze friction more precisely. Likewise, the uneven effects of motive forces on mills set in motion by pushing and pulling a lever led to the theory—and also the use—of the flywheel,[12] an invention that went on to play a very important role in large-scale industry. Thus it happened that the first scientific and technological elements of large-scale industry

11. In December of 1859, with the Society of Arts as his audience, John C. Morton read a paper titled "The Forces Employed in Agriculture." Here he states, "Purely mechanical force may be more extensively used with nearly every permanent improvement of the land which tends to give uniformity to its condition, and is supplied by the steam-engine. . . . Horsepower is required wherever crooked hedge-rows and other obstacles prevent uniform action. These obstacles are constantly diminishing. In operations requiring more exercise of will, but less actual power, the only competent force is directed from moment to moment by the human mind—manual labour." Mr. Morton then proceeds to reduce steam power, horsepower, and manpower to the unit generally used for steam engines: the force required to lift 33,000 pounds one foot in one minute, and he calculates the cost of one horsepower from a steam engine to be 3d. per hour and from a horse to be 5½d. In addition, a horse won't remain healthy if it works more than eight hours a day. With steam power, one can replace at least three out of every seven horses used on farmed lands during the year, at a cost no greater than that of the three horses during those three or four months when they can be worked to good effect. Finally, compared with horsepower, a better product is produced where steam power can be used in agriculture. Sixty-six workers would be needed to do the work of one steam engine, at a total cost of 15 shillings an hour, and thirty-two workers would be needed to do the work of a horse, at a total cost of 8 shillings an hour.

12. Faulhaber 1625, De Cous 1688.

were developed during the manufacturing period. Water always served as the motive force for Arkwright's throstle-spinning mill; yet relying on waterpower as the main motive force made for certain difficulties. The flow of water couldn't be increased as needed, and thus insufficient flow, which occurred during certain seasons, was hard to remedy. Above all, it was by nature local.[13] Not until Watt invented the so-called dual-acting steam engine was there a motor that could produce its own motive force by consuming coal and water; that could give its users full control over the power output; that was mobile and could serve as a means of locomotion; that could be urban, unlike the rural waterwheel, making it possible to concentrate production in towns, whereas the rural waterwheel had meant production had to be scattered throughout the countryside;[14] and that was of universal technological applicability. Finally, local circumstances played a relatively small role in determining where Watt's motor resided. Watt's great genius was displayed in the specification written into his patent of April 1784, which presented his steam engine not as an invention meant to achieve particular ends but as an agent that would generally advance large-scale industry. He pointed to various applications, some of which wouldn't be introduced for another fifty years—for example, the steam-hammer. However, Watt also doubted that his engine could be used to power ships and was of course wrong. At London's Industry Expo of 1851, his successors, Boulton and Watt, exhibited their colossal steam engine for ocean steamers.

Once the tools of a human organism were transformed into the tools of a mechanical apparatus, i.e., the tool machine, the motive mechanism also acquired its own independent form—a form not held back at all by the limits of human strength. As a result, the individual tool machine we have been examining sank in stature, becoming a mere element in machine-driven production. Now a single motive mechanism could power many working

13. The modern invention of turbines has allowed the industrial exploitation of water to overcome many of the things that formerly held it back.

14. "In the early days of textile manufacturers, the locality of the factory depended upon the existence of a stream having a sufficient fall to turn a water wheel; and, although the establishment of the water mills was the commencement of the breaking up of the domestic system of manufacture, yet the mills necessarily situated upon streams, and frequently at considerable distances the one from the other, formed part of a rural rather than an urban system; and it was not until the introduction of the steam-power as a substitute for the stream, that factories were congregated in towns and localities where the coal and water required for the production of steam were found in sufficient quantities. The steam-engine is the parent of manufacturing towns" (A. Redgrave in "Reports of the Insp. of Fact. 30th April 1860," p. 36).

machines at the same time. The motive mechanism grew in step with the number of working machines being powered simultaneously, and the transmitting mechanism became an extensive apparatus.

We now have to distinguish between cooperation involving many machines of the same kind and a system of machines.

In the one case, a single machine drives the entire process of production, executing all the different operations that a craftsman once performed with a single tool (say, a weaver with a loom), or that multiple craftsmen once performed one after the other using different tools, either independently or in a manufacturing workshop.[15] Take the production of envelopes in the modern manufacturing system. One worker folded the paper with the folder, another applied the gum, a third turned over the flap on which the emblem was impressed, a fourth embossed the emblem, and so on. Before each specialized operation could be carried out, each individual envelope had to change hands. A single envelope machine now performs all the operations at once, and it can make more than 3,000 envelopes in an hour. On display at the London Industry Expo of 1862 was an American machine that produces paper cornets. It cuts the paper, pastes it, and folds it, turning out 300 units per minute. A total process that the manufacturing system divided into a series of operations is carried out here by a single working machine that combines different tools. Such a machine might be just a complex manual tool reborn as a mechanical mechanism, or it could be a combination of different simple instruments that the manufacturing workshop adapted to particular tasks. Either way, simple cooperation reappears in the factory—i.e., a workshop based on machine-driven production, and if we disregard the actual workers, it reappears above all as a conglomeration of similar working machines in use at the same time and in the same space. Thus a weaving factory is made up of many mechanical looms operating side by side, and a sewing factory is made up of many sewing machines placed next to one another in the same building. However, there is a technological unity because the many identical working machines are driven by the heartbeat of a shared

15. From the standpoint of the division in the manufacturing system, weaving isn't a simple form of craft labor, but rather a complex one, and thus the loom is a machine that does a wide variety of things. It is quite wrong to think that modern machinery first takes hold of operations that have been simplified by the division of labor in the manufacturing system. During the manufacturing period, spinning and weaving were split up into new types, and their tools were improved and diversified, but the labor process itself wasn't divided in any way and remained artisanal. Labor isn't the machine's starting point: the means of labor are.

prime mover, whose force is imparted to them simultaneously and in equal amounts by a transmitting mechanism that they also share, at least to some extent, since its means of conveying movement branch off to each working machine. Just as multiple tools constitute the organs of a working machine, so multiple working machines are now simply the identical organs of a single motive mechanism.

In this case, a true system of machines hasn't replaced the independent individual machine. For that to happen, an object of labor has to pass through a series of connected, graduated processes that are executed by a chain of diverse yet complementary tool machines. The manufacturing system's signature form of cooperation—cooperation based on the division of labor—reappears, but as a combination of machines that perform specialized tasks. The specific tools of different specialized workers—for example, beaters, combers, shearers, and spinners in the production of wool—now become the tools of specialized machines, each of which operates within a system of combined tool machines and serves as the particular organ of a particular function. In the branches of industry where the machine system is introduced first, the manufacturing system generally provides a natural foundation for dividing, and thus organizing, the production process.[16] Yet an essential difference emerges right away. In the manufacturing system, a worker, whether on his own or with a group, has to carry out a particular specialized process using a manual tool. We can therefore say that the process appropriates the worker, but prior to this, it had to be adapted to him. This human principle in dividing labor has no place in machine-driven production. Here the whole process is oriented around things and

16. Prior to the epoch of large-scale industry, wool manufacturing was the dominant branch of the manufacturing system in England. Thus during the first half of the eighteenth century, it was there that most experiments took place. The cotton that required less effort to prepare because of mechanical preparation benefited from the experience gained with sheep's wool, just as, later, the reverse happened, and the mechanical wool industry developed on the foundation of mechanical cotton spinning and weaving. Certain individual elements of wool manufacturing weren't incorporated into the factory system until the past decades—for example, wool combing. "The application of power to the process of combing wool . . . extensively in operation since the introduction of the 'combing machine,' especially Lister's . . . undoubtedly had the effect of throwing a very large number of men out of work. Wool was formerly combed by hand, most frequently in the cottage of the comber. It is now very generally combed in the factory, and handlabour is superseded, except in some particular kinds of work, in which hand-combed wool is still preferred. Many of the handcombers found employment in the factories, but the produce of the handcomber bears so small a proportion to that of the machine, that the employment of a very large number of combers has passed away" ("Rep. of Insp. of Fact. for 31st Oct. 1856," p. 16).

considered in and for itself, and it is broken down into its constitutive stages, while the technological problems of how to execute each specialized process and link the different specialized processes together are solved by applying knowledge from mechanics, chemistry, and so on[17]—although, as elsewhere, theoretical concepts have to be complemented by practical experience accumulated on a large scale. Every specialized machine provides the next machine in the system with its raw material, and since the machines are all in use at the same time, the product is always being worked on at some stage of its production and always going from one stage to another. And just as the direct cooperation of specialized workers in the manufacturing workshop establishes definite ratios of the workers needed in different groups, so the specialized machines in an organized system, where one machine is constantly being put to work by another, establish a definite ratio of the machines needed, as well as what their sizes and speeds have to be. The combined working machine is now an organized system made up of different kinds of working machines, either individual machines or groups of them, and the system becomes all the more perfect the more continuous the total process is, or the less often the raw material is interrupted as it is passed from the first stage of its production to the last. In other words, the system is perfected the more that machines rather than human hands transport the raw material from one stage of production to another. If the principle of isolating different specialized processes goes with the division of labor in the manufacturing system, a key principle in the fully developed factory is, in contrast, the continuity of specialized processes.

Whether a system of machines is based on the cooperation of identical machines, as in weaving, or a combination of different kinds of machines, as in spinning, it becomes a giant automaton the moment it is driven by a self-acting prime mover. Of course, even where a whole system of machines is driven by, say, a steam engine, individual tool machines might need a worker's help for certain movements. Before the self-acting mule was invented, a worker had to help insert the mule carriage, and he still has to do that in fine-spinning mills. Or a worker might have to manipulate some parts of a machine as though they were hand tools in order for the machine to perform its work: this happened in machine-making work-

17. "The principle of the factory system, then, is to substitute . . . the partition of a process into its essential constituents for the division or graduation of labour among artisans" (Ure op. cit. Vol. 1, p. 30). [Editor's note: English original, p. 20.]

shops before the slide-rest was turned into a self-actor. But once a working machine no longer needs human help to complete all the movements that transform its raw material, once it requires only incidental assistance, we have an automatic system of machines whose individual components can always be improved. The apparatus that immediately shuts off a spinning machine whenever the silver breaks is thus a very modern invention, as is the self-acting stop that shuts off the improved steam loom whenever the shuttle bobbin runs out of weft. The modern paper factory exemplifies both the continuity of production and the way the automatic principle has been implemented. In fact, paper production supplies us with rich material for studying in detail both the differences between modes of production that are based on different means of production and the connection between those modes and the social relations of production. For the old German papermaking trade is a model of artisanal production, while paper production in seventeenth-century Holland and its counterpart in eighteenth-century France are models of the actual manufacturing system, and in modern England, papermaking is a model of automatic production. Moreover, in China and India two distinct ancient Asian forms of this industry still exist.

Machine-driven industry in its most advanced form operates as an organized system of working machines whose motive force is imparted from an automatic center solely by the transmitting mechanism. The individual machine has been replaced by a mechanical monster whose body fills an entire factory building and whose demonic power, obscured at first by the measured, almost solemn movements of its gigantic parts, is now on display in the wild, whirling, feverish dance of its countless working organs.

There were mules and steam engines before there were workers whose sole occupation was to produce mules, steam engines, and so on—just as people wore clothes before there were tailors. But the machines invented by figures such as Vaucanson, Arkwright, and Watt could be implemented only because the manufacturing period supplied each inventor with a large quantity of skilled mechanical workers. Some of those workers were independent artisans who had practiced different trades. Others had been grouped together in the manufacturing workshop, where, as mentioned, the division of labor was particularly strict. As new inventions proliferated, and the demand for newly invented machines grew, machine production split off more and more into diverse independent branches, while, at the same time, labor was increasingly divided in the manufacturing workshops that built the machines. So it is here, in the manufacturing workshop, that we find the immediate technological foundation of large-scale industry. The manufacturing system produced the very machines that large-scale industry used to supplant the artisanal and manufacturing systems in the spheres of production it took over first. Machine-driven production thus arose spontaneously on a material foundation that was poorly suited to meet its needs. Once it became more advanced, it had to revolutionize that foundation and create one more compatible with its own mode of production, although its original, ready-made foundation did evolve somewhat in its old form during the early part of large-scale industry's rise. Just as the individual machine remained a dwarf as long as it was powered by human beings, and just as systems of machines couldn't evolve freely until natural motive forces—animals, wind, and water—were replaced by the steam engine, just so, the development of large-scale industry was held back in every way when its characteristic means of production, the machine itself, owed its existence to personal power and skill—i.e., when the production of machines took place outside large-scale industry and turned on how well trained human muscles were, how sharp a person's vision was, and how skillful artisans and specialized workers in the manufacturing system were in handling their dwarf's instruments. Aside from the fact that producing machines by hand is expensive (a consideration that has weighed decisively on capital), all that determined how much industries already driven by machines could expand, as well as the extent to which machines could take over new branches of industry, was how much a category of semiartistic workers could grow, and given the nature of the workers' occupations, that category could be added to only gradually—not by leaps and bounds. But once large-scale industry developed to a certain point, it also began to conflict with the technological foundation that it had taken from artisanal labor and the manufacturing workshop. Motive mechanisms, transmitting mechanisms, and working machines were enlarged. Their components became more numerous and complex, and more standardized, too, as working machines came to be built more and more according to new models, not the ones used in the artisanal system, and acquired an independent form determined only by their mechanical task.[18] The automatic system developed further, while materials that are

18. The first power loom was primarily a device made of wood. The modern, improved form is fashioned mostly from iron. At first, the old form of a means of production shaped its new form; among other things, the most superficial comparison between the modern power loom and the old one, or between modern blowing tools in iron foundries and the

difficult to work with, such as iron instead of wood, couldn't be avoided in the same way as before. On all sides, attempts to solve these spontaneously arising problems ran up against the human limitations that even the combined worker in the manufacturing workshop could only partly overcome. Such machines as the modern hydraulic press, the modern power loom, and the carding machine could never have been made within the manufacturing system.

When the mode of production is revolutionized in one sphere of industry, it has to be revolutionized in others as well. This holds above all for branches of industry that interlock as stages of a total process, despite being so isolated by the social division of labor that each produces an independent commodity. Thus machine spinning necessitated machine weaving, and together they necessitated the mechanical-chemical revolution in bleaching, printing, and dyeing. Thus, too, massive change in the cotton industry called forth the invention of the gin, which separates the seeds from the fiber and has enabled cotton producers to operate on the large scale that the present day requires.[19] In addition to this, when the mode of production was revolutionized in industry and agriculture, it became necessary to revolutionize the general conditions of the social process of production. The means of communication and transportation, for instance, were once created for a society where small-scale agriculture and its domestic subindustries and urban craft trades were the "pivot," to borrow Fourier's phrase. Those means couldn't begin to satisfy the production needs of the manufacturing period, with its expanded division of labor, concentration of the means of labor and workers, and colonial markets. Similarly, the means of transportation and communication handed down from the manufacturing

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ponderous first mechanical reproduction of the ordinary bellows, illustrates the extent of this influence. But what illustrates it perhaps best of all is an attempt to produce a locomotive that played out before the current one was invented. The attempted version had two feet that it lifted up one at a time: it moved like a horse. Only after mechanics had developed much further and more practical experience had been accumulated did the forms of machines come to be fully determined by mechanical principle—and were thus fully emancipated from the traditional forms of tools that were now turned into machines.

19. Until recently, the original cotton gin invented by the Yankee Eli Whitney underwent fewer fundamental changes than any other machine invented in the eighteenth century. Only in the past few decades has it been rendered out of date by a simple and effective improvement, which is the work of another American—Mr. Emery of Albany, New York.

period quickly became an unacceptable drag on large-scale industry, which operates at a feverish pace and on a massive scale, constantly thrusts quantities of capital and workers from one sphere of production to another, and creates many new connections through the world market. The communications and transportation industries were therefore gradually adapted to large-scale industry's mode of production through a system of river steamships, railroads, ocean steamships, and telegraphs (to say nothing of how shipbuilding itself was completely revolutionized). However, the frightful quantities of iron that now had to be forged, welded, cut, bored, and molded required, for their part, gargantuan machines—machines the manufacturing system simply couldn't make.

Large-scale industry had to take over the production of its characteristic means of production, the machine, using machines to build machines. In this way, it created the first technological foundation that was equal to its needs and thus began to stand on its own two feet. As machine-driven industry expanded in the first decades of the nineteenth century, it gradually took over the production of the tool machines themselves. Yet only during the past few decades has the immense scale of construction in the railroad and shipping industries called forth the mechanical behemoths that now produce motive mechanisms.

The most essential condition for making machines with machines is a motive mechanism whose output of power is both limitless and easy to control. Such a mechanism already existed: the steam engine. But there was also a need for machines that could produce the precise geometrical shapes—lines, planes, circles, cones, and spheres—that the individual parts of machines require. Henry Maudslay solved this problem in the first decade of the nineteenth century when he invented the slide-rest. It soon became automatic and in a modified form was used to do things beyond its original purpose (namely, to make lathes), such as produce a variety of construction machines. This mechanical device didn't replace some particular tool, but rather the human hand, which creates a given form by holding, tracing, and guiding the blade of cutting instruments along or above the material being worked on, e.g., iron. The geometrical shapes of the individual parts of machines could now be produced "with a degree of ease, accuracy, and rapidity, that no amount of experience could have imparted to the hand of the most expert workman."[20]

20. "The Industry of Nations Lond. 1855," Part II, p. 239. It says there on the very same page, "Simple and outwardly unimportant as this appendage to lathes may appear, it is not, we believe, averring too much to state, that its influence in improving and extending the

Let us turn to the actual tool machine of the machines used to produce machines. The artisan's tool reappears here, only now as a colossus. For example, the tool component in the drilling machine is a gigantic drill that is driven by a steam engine but that makes it possible in turn to produce the cylinders of large steam engines and hydraulic presses. The machine lathe is the ordinary foot lathe reborn with the strength of a Titan. The planing machine is an iron carpenter that works on iron with the same tools a carpenter uses on wood. The tool that cuts veneers on London's wharves is an enormous razor. The tool part of a shearing machine, which cuts iron just as easily as a tailor's scissors cut cloth, is a huge pair of scissors. And while the head of a steam hammer is just an ordinary hammer head, it is so heavy that Thor himself couldn't swing it.[21] One type of these steam hammers, which were invented by Nasmyth, weighs more than six tons and strikes with a vertical fall of seven feet on an anvil weighing 36 tons. Pulverizing a granite block is child's play for it, but it is no less capable of driving a nail into soft wood with a series of light blows.[22]

When means of labor become machines, they take on a material mode of being that makes it necessary to replace human strength with natural forces and to replace traditional practices with the conscious application of natural science. In the manufacturing system, the organization of the social labor process is purely a matter of organizing people: it amounts to combining specialized workers. In the machine system, in contrast, large-scale industry has an organism of production that is wholly made up of things, and that the worker encounters as an already finished material condition of production. In simple cooperation, and even where cooperation has become specialized through the division of labor, the associated worker's supplanting of the isolated worker still appears as more or less accidental. But apart from a few exceptions (to be mentioned later), machinery can function only in the hands of directly associated labor, or labor in common. The cooperative character of the labor process is now a technological necessity dictated by the nature of the means of labor.

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use of machinery has been as great as that produced by Watt's improvements of the steam-engine itself. Its introduction went at once to perfect all machinery, to cheapen it, and to stimulate invention and improvement."

21. Used for forging paddle-wheel shafts in London, one of these machines has in fact been given the name "Thor." It forges a shaft weighing 16½ tons as easily as a blacksmith forges a horseshoe.

22. Of the woodworking machines that are capable of small-scale use, most were invented in America.

period of the twelve-hour day. This difference is in fact much greater than the amount by which the advances made from 1833 to 1847 exceed those of the half century that followed the introduction of the factory system—i.e., the period of the unlimited workday.[94]

4. The Factory

At the beginning of this chapter, we examined the factory's body, or how a system of machines is organized. We saw that machinery enlarges capital's human material by appropriating the labor of women and children. We also saw how machines seize a worker's whole lifetime by heedlessly extending the workday, and how their technological progress, which makes it possible to produce a rapidly growing amount of product in an ever-shrinking amount of time, comes to serve as a systematic means of setting more labor in motion at all times, of exploiting labor-power more and more intensely. Let us now turn to the factory as a whole in its most advanced form.

94. The following few statistics show the progress of "factories" proper in the United Kingdom since 1848.

Table 1

	Quantity exported 1848	Quantity Exported 1851	Quantity Exported 1860	Quantity Exported 1865
Cotton				
Cotton yarn (in lbs.)	135,831,162	143,966,106	197,343,655	103,751,455
Sewing thread (in lbs.)		4,392,176	6,297,554	4,648,611
Cotton cloth (in yds)	1,091,373,930	1,543,161,789	2,776,218,427	2,015,237,851
Flax and Hemp				
Yarn (in lbs.)	11,722,182	18,841,326	31,210,612	37,777,334
Cloth (yards)	88,901,519	129,106,753	143,996,773	247,021,529
Silk				
Yarn (in lbs.)	194,815	462,513	897,402	812,589
Cloth (in lbs.)		1,181,455	1,307,293	2,869,837
Wool				
Woollen and worsted yarn (in lbs.) Cloth (yds.)		14,670,880 151,231,153	27,533,968 190,371,537	31,669,267 278,837,418

Dr. Ure, the Pindar of the automatic factory, describes it, on the one hand, as the "combined cooperation of many orders of work-people, adult and young, in tending with assiduous skill a system of productive machines continuously impelled by a central power [the prime mover]," and, on the other hand, as "a vast automaton composed of various mechanical and intellectual organs, acting in uninterrupted concert for the production of a common object, all of them being subordinate to a self-regulated moving force." These two statements hardly say the same thing. In one, the combined collective worker or social organism of labor is presented as the dominant subject and the mechanical automaton is presented as the object. In the other, the automaton itself is the subject, and the workers are merely conscious organs that are coordinated with its unconscious ones, while both sets of organs are subordinated to the same central motive force. The first state-

Table 2

	Value exported 1848 Pd. St.	Value exported 1851 Pd. St.	Value exported 1860 Pd. St.	Value exported 1865 Pd. St.
Cotton				
Yarn	5,927,831	6,634,026	9,870,875	10,351,049
Cloth	16,753,369	23,454,810	42,141,505	46,903,796
Flax and Hemp				
Yarn	493,449	951,426	1,801,272	2,505,497
Cloth	2,802,789	4,107,396	4,804,803	9,155,318
Silk				
Yarn	77,789	196,380	826,107	768,064
Cloth		1,130,398	1,587,303	1,409,221
Wool				
Yarn	776,975	1,484,544	3,843,450	5,424,017
Cloth	5,733,828	8,377,183	12,156,998	20,102,259

(See the two Blue Books, "Statistical Abstract for the U. Kingd." No. 8 and No. 13. Lond. 1861, and 1866.) Between 1839 and 1850, the number of mills in Lancashire increased by just 4%. It increased by 19% between 1850 and 1856, while the period between 1856 and 1862 saw a 33% increase. The number of people working in the mills during the two eleven-year periods rose in absolute terms but fell in relative ones. See "Reports of the Insp. of Fact. for 31st Oct. 1862," p. 63. In Lancashire, the cotton trade dominates the economic landscape. However, the crucial role cotton plays in the textile industry as a whole can be seen from the following comparative figures: cotton factories make up 45.2% of all textile factories in the United Kingdom. They account for 83.3% of the spindles, 81.4% of the power looms, 72.6% of the horsepower that drives their movement, and 58.2% of all the workers employed in these factories (ibid. pp. 62, 63).

ment holds for every possible application of machinery on a large scale; the second describes the capitalist application of it, thus also the modern factory system. It seems that Ure liked to portray the central motive machine as not just an automaton but an autocrat, too: "In these spacious halls the benignant power of steam summons around him his myriads of willing menials."[95]

As tools are transferred to machines, so are the skills needed to use them. A tool's capacity for producing productive effects is now emancipated from the limitations of human labor-power. When this happens, the technical foundation of the division of labor in the manufacturing workshop is swept away. In the automatic factory, the hierarchy of specialized workers characteristic of the manufacturing workshop is replaced by a tendency to flatten the tasks performed by the workers who assist machines, and, for the most part, natural differences of age and sex take the place of artificially created distinctions between specialized workers.[96]

The division of labor reappears in the automatic factory, to some extent, but now it entails mainly that workers are distributed among specialized machines and larger numbers of workers are distributed among the different departments of the factory, where, instead of forming organized groups, they work side by side at tool machines of the same type. Simple cooperation is thus the only kind that occurs. The manufacturing workshop's organized groups of workers are replaced by the connection between the head worker and his few assistants. The essential division is the one between the workers who actually operate the different tool machines (plus some who look after or feed the motive mechanism) and the people (almost exclusively children) who merely attend the machine operators. As for the so-called "feeders," who just hand the machines the material to be worked on, they more or less all count among the attendants. Alongside these chief classes, there is also a numerically insignificant category of worker whose job is to watch over all the machines and repair them constantly: engineers, mechanics, joiners, and so on belong to this higher class of workers. Some members of the higher class have a scientific education while others are trained as artisans. All stand outside the circle of ordinary factory workers and are added to them only in a larger aggregate.[97] This division of labor is purely a function of technology.

95. Ure op. cit. Vol. 1 pp. 19, 20, 26. [Editor's note: English original, pp. 13, 14, 18.]

96. Ibid. pp. 31, 32. [Editor's note: Ure, English original, pp. 21–22.] See Karl Marx op. cit. pp. 140, 141. [Editor's note: Marx is referring to his book *The Poverty of Philosophy*, in *MECW*, vol. 6, p. 190.]

97. It is characteristic of attempts to use statistics to deceive—and this can be demonstrated in detail elsewhere, too—that English factory legislation is designed to exclude

All work at actual machines demands of workers that they start young so that they learn to adapt their own movements to the continuous and uniform movement of an automaton. Insofar as the total machinery constitutes a system of many different combined machines operating simultaneously, the cooperation based on it requires that different groups of workers be divided among different kinds of machines. But whereas the manufacturing system has to consolidate its division of labor by always assigning a worker to the same function, machine-driven industry has no such need.[98] The whole movement of the factory proceeds from a machine rather than a worker, and so labor personnel can be constantly moved around without disrupting the labor process. The most striking evidence of this is the relay system implemented during the manufacturers' revolt of 1848–50. Finally, since it takes young workers very little time to learn to work at machines, machine-driven industry also eliminates the need to train a special class of workers to be exclusively machine workers.[99] The services performed by mere attendants can be partially replaced by the use of machines,[100] while the simplicity of their work also makes

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from its protections precisely the class of workers just mentioned, treating them as "not factory workers," while the "Returns" published by Parliament just as expressly count as factory workers not only engineers, mechanics, and so on, but also managers, salesmen, messengers, warehousemen, packers, etc., that is, everyone except the actual factory owner.

98. Ure concedes this. He writes that "in case of need on any emergency," the manager can at will move workers from one machine to another, and he declares triumphantly, "Such translations are utterly at variance with the old practice of the division of labour, which fixed one man to shaping the head of a pin, and another to sharpening its point." Instead he should have asked himself why the automatic factory abandons this "old practice" only "on any emergency." [Editor's note: English original, p. 22.]

99. In times of great crisis, such as during the American Civil War, the bourgeoisie make an exception and use factory workers for the crudest tasks, such as building roads. The English "ateliers nationaux" for unemployed cotton workers (in 1862 and the years that followed) differed from the French versions (of 1848) in that in the latter the worker carried out unproductive labor at the state's expense, whereas in the former, workers had to do productive municipal labor that benefitted the bourgeois—and they had to do it for less money than regular workers, with whom they were thrown into competition. "The physical appearance of the cotton operatives is unquestionably improved. This I attribute . . . as do the men, to outdoor labour on public works." "Rep. of Insp. of Fact. 31st October 1863," p. 59. (The workers in question here are the Preston Factory workers, who were employed on "Preston Moor.")

100. An example would be the different mechanical apparatuses that have been introduced in the woolen mills since the Factory Act of 1844 to replace the labor of children. The moment that the children of the manufacturers themselves have to go through their own "training" as factory assistants, remarkable progress will be made in this almost entirely neglected area of mechanics.

it possible to quickly and constantly switch out the people who have to endure this drudgery.

If machinery throws the technology of the old division of labor onto the scrap pile, the old system manages initially to hang on in the factory as a tradition inherited from the manufacturing workshop—only for capital to then treat it as a systematic means of exploiting labor-power, with the result that it is reproduced and consolidated in an even more grotesque form. The lifelong specialty of working with a specialized tool is replaced by the lifelong specialty of serving a specialized machine. Machinery is misappropriated as a means of permanently transforming young workers into a part of specialized machines.[101] Not only does it now cost significantly less to reproduce the worker, he is at the same time made more dependent—in fact, completely dependent—on the factory as a whole and thus the capitalist. Here, as always, one must distinguish between the increase in productivity due to the development of the social production process and the increase due to the capitalist exploitation of that process.

In the manufacturing workshop and in craft labor, tools serve the worker; in the factory, the worker serves the machine. In one case, he moves the means of labor; in the other, his job is to follow their movement. In the manufacturing workshop, workers are the limbs of a living mechanism; in the factory, a dead mechanism exists independently of them, and they are incorporated into it as living appendages. "The dull routine of a ceaseless drudgery, in which the same mechanical process is incessantly repeated, resembles the torment of Sisyphus—the toil, like the rock, recoils perpetually on the wearied operative."[102] As machine labor assaults the nervous system in the most extreme way, it also suppresses the many-sided play of a person's muscles and in fact makes all free activity—physical and

101. Let us therefore honor Proudhon's fabulous insight: he "construes" machinery not as a synthesis of different means of labor, but as a synthesis of different specialized operations that is brought about for the sake of the worker himself.

102. F. Engels op. cit. p. 217. [Editor's note: English edition: Engels, *The Condition of the Working Class in England*, in *Marx-Engels Collected Works*, vol. 4 (Moscow: Progress Publishers, 1978), p. 467 note.] Even Mr. Molinari, a very ordinary, optimistic free-trader, has observed, "A man wears out more quickly by monitoring, fifteen hours a day, the uniform evolution of a mechanism, than by exercising, in the same period of time, his physical strength. This task of monitoring, which would perhaps serve as useful gymnastics for the intelligence, if it were not too prolonged, destroys in the long run, by its excess, both the intelligence and the body itself" (G. de Molinari, "Études Économiques, Paris. 1846").

mental—impossible.[103] Labor becomes less strenuous, but even this functions as a means of torture. For instead of liberating a worker from his labor, machines liberate his labor from its substance. All capitalist production is both the process of labor and capital's valorization process, and insofar as it is the latter, the worker does not make use of the things needed for the production process: they make use of him. But only with the rise of machinery does this inversion become a palpable technological reality. The means of labor have been transformed into an automaton; as a result, the worker encounters them as capital during the labor process—as dead labor that rules over living labor-power, sucking it dry. In large-scale industry driven by machines, the intellectual faculties involved in the production process become completely separated from manual labor, as indicated earlier, and now these faculties are fully transformed into powers that capital uses to control labor. The special skill of the hollowed-out individual machine worker shrinks to the point of invisibility before the science, the immense natural forces, and the mass quantity of social labor embodied in the machine system. Along with the system itself, these things make up the power of "the master," in whose mind machinery and his monopoly over it are inextricably intertwined. Thus whenever he clashes with his "hands," he says to them contemptuously, "The factory operatives should keep in wholesome remembrance the fact that theirs is really a low species of skilled labour; and that there is none which is more easily acquired, or of its quality more amply remunerated, or which, by a short training of the least expert can be more quickly as well as abundantly acquired. The master's machinery really plays a far more important part in the business of production than the labour and the skill of the operative, which six months' education can teach, and a common labourer can learn."[104]

In the new technical hierarchy, the worker is subordinated to the unvarying movements of the means of labor, and this, along with the unique makeup of the working organism, constituted as it is by individuals of both sexes and different ages, brings about a barracks-like discipline, which develops into an entire disciplinary regime in the factory. The supervisory labor mentioned earlier reaches its fully developed state, where industrial workers are divided into manual workers and supervisors, or common soldiers and officers. "The main difficulty [in the automatic factory] lay in

103. F. Engels op. cit. p. 216. [Editor's note: English edition, p. 467.]

104. "The Master Spinners' and Manufacturers' Defence Fund. Report of the Committee. Manchester 1854," pp. 17, 18. Later, we will see that the master starts singing a different tune as soon as he is threatened with the loss of his "living" automaton.

training human beings to renounce their desultory habits of work, and to identify themselves with the unvarying regularity of the complex automaton. To devise and administer a successful code of factory discipline, suited to the necessities of factory diligence, was the Herculean enterprise, the noble achievement of Arkwright! Even at the present day when the system is perfectly organized and its labour lightened to the utmost, it is found nearly impossible to convert persons past the age of puberty . . . into useful factory hands."[105] What is the factory code? According to which capital formulates its autocratic rule over the workers and in so doing acts as a private lawmaker, following only the dictates of its own will and dispensing with the separation of powers that bourgeois society otherwise loves so much, not to mention the system of representation that it loves even more? It is merely a capitalist caricature of society's regulation of the labor process, which becomes necessary when cooperation takes place on a large scale, and the means of labor, especially machines, are used collectively. The supervisor's list of penalties functions as once did the slave-owner's whip. But now, naturally, all punishments take the form of fines and wage deductions, and the legislative acumen of the factory Lycurgus is such that when workers violate his laws, his profits will become even greater, provided that is still possible.[106]

105. Ure op. cit. pp. 22, 23. [Editor's note: English original, p. 15.] Whoever is familiar with Arkwright's biography won't be tempted to apply the term "noble" to this genius barber. Of all the great inventors of the eighteenth century, he stole the most from others and was also the cruelest person.

106. "The slavery in which the bourgeoisie holds the proletariat chained, is nowhere more conspicuous than in the factory system. Here ends all freedom in the law and in fact. The operative must be in the mill at half-past five in the morning; if he comes a couple of minutes too late, he is fined; if he comes ten minutes too late, he is not let in until breakfast is over, and a quarter of the day's wages is withheld. . . . He must eat, drink, and sleep at command. . . . The despotic bell calls him from his bed, his breakfast, his dinner. What a time of it he has of it, too, inside the factory! Here the employer is absolute law-giver; he makes regulations at will, changes and adds to his codex at pleasure; and even if he inserts the craziest stuff, the courts say to the working man: 'You were your own master, no one forced you to agree to such a contract if you did not wish to; but now, when you have freely entered into it, you must be bound by it.' . . . These operatives are condemned from their ninth year to their death to live under the sword, physically and mentally" (F. Engels op. cit. p. 217). [Editor's note: English translation, pp. 467–68.] I will use the following two events to illustrate "what the courts say." One took place in Sheffield at the end of 1866. A worker had signed a contract binding him to work in a metal factory for two years. A row with the owner prompted him to quit: under no circumstances, he insisted, would he continue to work for that manufacturer. Prosecuted for breaking the contract, the worker was sentenced to two months in prison. (If the manufacturer breaks the contract, only a civil action can be taken against him, and so all he risks is that he will have to pay damages.) After the worker had spent two months in prison, the manufacturer invited him

Here we will only touch on the material conditions of factory labor. All sensory organs suffer the same kind of damage from artificially high temperatures, fine bits of raw material filling the air, deafening noise, and so on, to say nothing of the mortal danger that comes with working in

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back to factory so that he could honor the old contract. The worker said no, declaring that he had already been penalized for breach of contract. The manufacturer pressed charges him anew, and the worker was convicted anew, although one of the judges, Mr. Shee, did openly denounce the verdict as a juridical monstrosity whereby a man could be periodically punished for the same mistake (or crime) for his whole life. This judgment was handed down not by the "Great Unpaid," the provincial "Dogberries," but in London, by one of the highest courts. [Editor's note: The "Great Unpaid," as Marx tells us in chapter 8, was a term for nonremunerated, well-to-do county magistrates.] The second event occurred in Wiltshire at the end of November 1863. About 30 female power loom weavers, who were employed by a certain Harrup, a cloth manufacturer at Bower's Mill, Westbury Leigh, went on strike because this same Harrup had the lovely habit of fining them if they were late in the morning—and in fact he deducted 6d. from their wages if they were two minutes late, 1 shilling if they were three minutes late, and 1 shilling 6d. if they were ten minutes late. This amounted to 9 shillings per hour and £4 10 shillings per day when the average weekly wage for the year never edged above 10 to 12 shillings. Harrup also had a boy blow a whistle to signal the starting time, which he often did before 6 A.M., and when the boy stopped blowing, the doors were closed, and the "hands" who were shut out were fined.

Since there was no clock in the building, the timekeeper Harrup had thought to put in place had total control over the unfortunate "hands." The "hands" participating in the strike, mothers and girls, declared that they would go back to work if the timekeeper were replaced by a clock and a more reasonable system of fines was instituted. Harrup brought 19 women and girls before the magistrate on the charge of breach of contract. They were each sentenced to pay a fine of 6d. as well as 2 shillings 6d. for court costs. The spectators at the trial were outraged, and as Harrup was led away from the court, a large crowd hissed at him. One of the manufacturers' favorite practices is to punish workers with wage deductions for defects in the material they have been given to work on. In 1866, this practice led to a large strike in England's pottery districts. The reports of the "Ch. Employm. Commiss." (1863–66) present cases where a worker not only received no wages, but through his labor and the penal code, wound up as the "debtor" of his honorable "master." The recent cotton crisis has also supplied revealing examples of the factory autocrats' cleverness in making wage deductions. The factory inspector Mr. R. Baker says, "I have myself had lately to direct prosecutions against one cotton mill occupier for having in these pinching and painful times deducted 10d. a piece from some of the young workers employed by him, for the surgeon's certificate (for which he himself had only paid 6d.), when only allowed by law to deduct 3d., and by custom nothing at all. . . . And, I have been informed of another, who, in order to keep without the law, but to attain the same object, charges the poor children who work for him a shilling each, as a fee for learning them the art and mystery of cotton spinning so soon they are declared by the surgeon fit and proper persons for that occupation. There may, therefore, be undercurrent causes for such extraordinary exhibitions as strikes, not only wherever they arise, but particularly at such times as the present, which, without explanation, render them inexplicable to the public understanding." Here he is referring to the power loom weavers' strike at Darwen in June 1863. "Reports of Insp. of Fact, for 30th April 1863." (The factory reports always cover a larger period than their official dates suggest.)

spaces crowded with machines: industrial lists of the fallen are produced with the regularity of the seasons. As it is carried out by capital, the practice of making the social means of production more economical, which ripens to full maturity only in the hothouse environment of the factory system, is also the practice of systematically stealing the things a worker needs to stay alive while he works: space, air, light, and the equipment that protects him from the deadly or unhealthy conditions of the production process—not to mention the things put in place for the sake of his comfort.[107] Was Fourier wrong to call factories "mitigated jails?"[108]

5. The Struggle between Workers and Machines

The struggle between capitalists and wage laborers began when the capital relation took shape, and it raged on throughout the era of the manufacturing workshop.[109] But the worker started to battle the actual means of labor, or capital's material mode of existence, only once machinery was introduced. He revolted against this particular form of the means of produc-

107. In the first chapter of volume 3, I will report on the campaign English manufacturers recently waged against the clauses of the Factory Act that protect the limbs of factory "hands" from mortally dangerous machinery. Here I will simply give a quotation from Leonard Horner's official report: this will suffice for now. Horner, a factory inspector, writes, "I have heard some mill-owners speak with inexcusable levity of the accidents; such for instance, as the loss of a finger being a trifling matter. A working man's living and prospects depend so much upon his fingers, that any loss of them is a very serious matter to him. When I have heard such inconsiderate remarks made, I have usually put this question: 'Suppose you were in want of an additional workman, and two were to apply, both equally well qualified in other respects, but one had lost a thumb or forefinger, which would you engage?' There was never a hesitation as to the answer." The manufacturers "have mistaken prejudices against what they have heard represented as a pseudo-philanthropic legislation" ("Reports of Insp. of Fact. for 31st Oct. 1855"). These manufacturers were "clever folk," and it was not for nothing that they gushed about the slave-holders' rebellion!

108. In the factories where the Factory Act has been in effect longest, limiting labor-time and imposing other restrictions, some ills have disappeared. At a certain point, improving the machinery necessitates an "improved construction of the factory buildings," which benefits workers. (See "Reports etc. for 31st Oct. 1863," p. 109.)

109. See, for example, John Houghton, "Husbandry and Trade improved, Lond., 1727," "The Adventures of the East India Trade 1720," John Bellers, op. cit. "The masters and the men are unhappily in a perpetual war with each other. The invariable object of the former is to get their work done as cheap as possibly; and they do not fail to employ every artifice to this purpose, whilst the latter are equally attentive to every occasion of distressing their masters into a compliance with higher demands." "An Inquiry into the causes of the Present High Prices of Provisions." (By Rev. Mr. Nathaniel Foster, who was very much on the workers' side.) [Editor's note: "Possibly" is "possible" in the source text.]

tion because it constitutes the material foundation on which the capitalist mode of production rests.

All over seventeenth-century Europe, workers rose up against the so-called ribbon mill, a machine for weaving ribbons and lace that was also known as the string mill or mill chair.[110] Toward the end of the 1630s, a rampaging mob destroyed a wind-driven sawmill built by a Dutchman near London. Even at the beginning of the next century, water-driven sawmills barely managed to overcome the popular resistance they elicited, which was encouraged by Parliament. When Everet made the first water-powered machine for shearing wool in 1758, a hundred thousand unemployed workers promptly set it ablaze. Fifty thousand workers who lost their livelihood (carding wool) to Arkwright's scribbling mills and carding machines petitioned Parliament in protest. During the first decade and a half of the nineteenth century, groups known as Luddites laid waste to countless machines in England's manufacturing districts. This was largely a response to the use of the power loom, and it gave the anti-Jacobin government, made up of such figures as Sidmouth and Castlereagh, a pretext for carrying out the most violent reactionary measures. Workers needed time and experience before they could distinguish between machinery and

110. The ribbon loom was invented in Germany. The Italian Abby Lancellotti says, in a work published in Venice in 1636 (but written in 1629), "Anthony Müller of Danzig about fifty years ago saw in a town a very ingenious machine, which weaves four to six pieces at once. But the mayor of the town worried that this invention might throw a large number of workmen into the streets, and therefore had the invention suppressed and the inventor secretly strangled or drowned." [Editor's note: Marx is citing from Johann Beckmann's *Beyträge zur Geschichte der Erfindungen* (Leipzig, 1786).] In Leyden, this machine was first employed in 1621. In response, lace-makers rioted, forcing the town council to make it illegal to work with it. Having restricted its use in various ways through the decrees of 1623, 1639, and so on, the States General of Holland finally allowed it, though not without limits, under the decree of December 5, 1661. "In this city," says Boxhorn ("Inst. Pol. 1663"), speaking of the moment when the ribbon loom was introduced in Leyden, "approximately two decades ago, certain people invented a new device for weaving; with it, one person could weave more cloth with less effort than many people could in the same amount of time. The weavers were thus aggrieved, and they rose up, until finally the magistrate banned the use of the device." The same machine was prohibited in Cologne just as it was being introduced in England, where it immediately led to workers' protests. An Imperial edict of February 19, 1685 made the use of it illegal in all of Germany. In Hamburg, such machines were burned on the public order of the magistrate. On February 9, 1719, Karl IV renewed the edict of 1685, and the use of the machine wasn't allowed in the Electorate of Saxony until 1765. This machine, which caused so much unrest in the world, was in fact the precursor to the mule and the power loom and, thus, heralded the industrial revolution of the eighteenth century. A boy who had no weaving experience could now set the whole loom—with all its shuttles—in motion merely by moving a rod back and forth. And once the ribbon loom had been improved, it produced 40 to 50 pieces at the same time.

the capitalist application of it—and thus also learn to shift their attacks from the material means of production themselves to the social form in which those means were being employed.[111]

Workers who fought for higher wages in the manufacturing workshop generally accepted the manufacturing system: they were in no way trying to end it. Where opposition to new workshops arose, it came from guild masters and privileged towns, not wage laborers. Contemporary writers thus tended to treat the division of labor as a means of virtually replacing workers but not of dislodging actual workers from their jobs. The distinction is quite clear. If someone says that in England it would take 100 million people using the old spinning wheel to spin as much cotton as 500,000 people can now spin with a mule, this doesn't mean that the mule displaced all those millions of workers who never existed. It means only that many millions of workers would be needed to replace the spinning machinery. On the other hand, if someone says that the power loom put 800,000 weavers out of work in England, he is speaking not of real machinery that a certain number of workers would be needed to replace, but rather of real workers who were actually put out of a job by machines. During the era of the manufacturing workshop, the core principle of production remained artisanal trades, even if they were now split up. The demands of the new colonial markets couldn't be satisfied by the relatively small number of urban workers handed down from the Middle Ages, and at the same time, the manufacturing system proper made new areas of production available to the rural population that had been driven off the land when the feudal system collapsed. For the most part, then, it was the positive side of the division of labor and cooperation in the workshops that came into the foreground: namely, they made workers more productive.[112] Well before large-scale production emerged, cooperation

111. In old-fashioned manufacturing workshops, workers still occasionally revolt against machinery in this crude way—as they did in Sheffield's file grinding industry in 1865.

112. For Sir James Steuart, the impact of machinery was as follows: "Machines therefore I consider as a method of augmenting (virtually) the number of the industrious, without the expence of feeding an additional number. . . . How does the effect of a machine differ from that of new inhabitants?" (Fr. Tr., Vol. 1, Bk I, Ch. 19). [Editor's note: Marx takes the quote from a French translation. Steuart's formulation, which does not include the second sentence, can be found on p. 123 of the English original.] Petty, who says machinery replaces "polygamy," is much more naïve. This point of view applies at most to certain parts of the United States. On the other hand, "machinery can seldom be used with success to abridge the labour of an individual; more time would be lost in its construction than would be saved by its application. It is only really useful when it acts on great masses, when a single machine can assist the work of thousands. It is accordingly in the most populous coun-

and the concentration of the means of labor in the hands of a few were instituted in agriculture, and in many countries where this happened, the mode of production was suddenly and violently revolutionized, which had the effect of transforming the rural population's conditions of existence and means of employment. At first, however, the struggle pitted large landowners against small ones more than capital against wage labor. On the other hand, when workers were displaced by the means of labor—horses, sheep, and so on—direct acts of violence functioned chiefly to make the industrial revolution possible. Workers were forced off the land; then the sheep arrived. The large-scale theft of land seen in England (and elsewhere) supplied large-scale agriculture with the space it needed to operate. When this transformation of agriculture was in its early stages, it thus looked more like a political revolution than a revolution in production.

The moment a means of labor takes the form of a machine, it starts to compete against the worker.[113] For the amount by which capital valorizes itself, when it does so using machines, is directly proportional to the number of workers whose conditions of existence the machinery has destroyed. The whole system of capitalist production rests on the circumstance that the worker sells his labor-power as a commodity; the division of labor narrows his labor-power to the point where it becomes a very particular competence in handling a specialized tool; then, when his tool falls prey to a machine, the exchange-value of his labor-power immediately vanishes along with its use-value. The worker becomes unsellable, just like paper money that has lost its status as legal tender. Some members of the working class are rendered superfluous by machinery: they are turned into a population that capital no longer needs to valorize itself. Either these people go under, winding up as casualties in the lopsided battle between machine-driven production and the old-fashioned kind driven by craft labor and the manufacturing system, or they stream into the branches of industry that require the least amount of skill, flooding the labor market and thereby causing the price of labor-power to fall below its value. The pauperized worker is supposed to find great solace in the fact that his suffering is merely a "temporary inconvenience," as well as in the other fact that because machines take over a whole field of production only gradually, the extent and intensity of their destructive effects are

tries, where there are most idle men, that it is most abundant. . . . It is not called into use by a scarcity of men, but by the facility with which they can be brought to work in masses" (Piercy Ravenstone, "Thoughts on the Funding System and its Effects, Lond. 1824," p. 45).

113. "Machinery and labour are in constant competition" (Ricardo op. cit. p. 479).

milder than they would have been if the process happened more rapidly. These forms of solace contradict each other. Where machines gradually come to dominate an area of industry, the workers competing against those machines are condemned to chronic destitution. Where the takeover occurs rapidly, the effects are widely felt and acute. The world has never witnessed a spectacle more horrifying than the slow demise of England's hand loom weavers, which dragged on for decades and finally came to an end in 1838. Many weavers starved to death. Together with their families, many languished for quite a while on 2½d. per day.[114] England's cotton machinery, in contrast, had the acute type of impact on East India, whose general governor observed in 1834–35, "The misery hardly has an equal in the history of commerce. The bones of the cotton-weavers whited the plains of India."[ix] Of course, the weavers who departed our temporal realm did in fact experience the machines as a "temporary inconvenience," but since machinery is always taking over new areas of production, its "temporary" effect amounts to a permanent one. In all capitalist production, a worker encounters the conditions and product of his labor as things that are independent of and alien to him; however, this independence and alienation develops into total antagonism only with the rise of machines.[115]

114. Before the Poor Law was in enacted in England in 1834, the competition between hand weaving and power weaving was prolonged there by the practice of using parish relief to supplement wages, which had fallen far below the minimum. "The Rev. Mr. Turner was in 1827 rector of Wilmstowe, in Chesire, a manufacturing district. The questions of the Committee of Emigration, and Mr. Turner's answers show how the competition of human labor is maintained against machinery. Question: 'Has not the use of the power-loom superseded the use of the hand-loom?' Answer: 'Undoubtedly; it would have superseded them much more than it has done, if the hand-loom weavers were not enabled to submit to a reduction of wages.' Question: 'But in submitting he has accepted wages which are insufficient to support him, and looks to parochial contribution as the remainder of his support?' Answer: 'Yes, and in fact the competition between the hand-loom and the power-loom is maintained out of the poor rates.' Thus degrading pauperism or expatriation, is the benefit which the industrious receive from the introduction of machinery, to be reduced from the respectable and in some degree independent mechanic, to the cringing wretch who lives on the debasing bread of charity. This they call a temporary inconvenience" ("A Prize Essay on the Comparative Merits of competition and co-operation. Lond. 1834," p. 29). [Editor's note: "Much more than it has done" is "much more rapidly than it has done" in the source text.]

115. "The same cause which may increase the revenue of the country [that is, as Ricardo explains in the same passage, the revenues of landlords and capitalists, whose wealth = Wealth of the Nation, economically speaking] may at the same time render the population redundant and deteriorate the condition of the labourer" (Ricardo op. cit. p. 469). "It is in fact, the constant aim and tendency of every improvement in machinery to supersede human labour altogether, or to diminish its cost, by substituting the industry

It is thus when machinery is introduced that the worker begins to violently revolt against the means of labor.

The means of labor now kill the worker. The direct antagonism between the two is at its most visible wherever newly introduced machines compete against industry driven by traditional craft labor or the old manufacturing workshop. But within large-scale industry, too, the unceasing improvement of machines and the further development of the automatic system do something analogous: "The object of improved machinery is to diminish manual labour, to provide for the completion of a link in a manufacture by the aid of an iron instead of the human apparatus."[116] "The adaption of power to machinery heretofore moved by hand is almost of daily occurrence . . . the minor improvements in machinery having for their object the economy of power, the production of better work, the turning off more work in the same time, or in supplying the place of a child, a female, or a man, are constant, and though sometimes apparently of no great moment, have somewhat important results."[117] "Whenever a process requires a particular dexterity and steadiness of hand, it is withdrawn, as soon as possible, from the cunning workman, who is prone to irregularities of many kinds, and it is placed in charge of a peculiar mechanism, so self-regulating that a child can superintend it."[118] "On the automatic plan skilled labour gets progressively superseded."[119] "The effect of improvements in machinery, not merely in superseding the necessity for the employment of the same quantity of adult labour as before, in order to produce a given result, but in substituting one description of human labour for another, the less skilled for the more skilled, juvenile for adult,

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of women and children for that of men or that of ordinary labourers, for trained artisans" (Ure op. cit. pp. 34, 35). [Editor's note: English original, p. 23.]

116. "Reports of Insp. of Fact. 31st Oct. 1858," p. 43.

117. "Reports etc. Oct. 1856," p. 15.

118. Ure op. cit. Vol. 1, p. 29. [Editors note: English original, p. 19.] "The great advantage of the machinery employed in brick-making is that they enable you to be wholly independent of the skilled labourers" (Ch. Empl. Comm. Fifth Report, Lond. 1866," p. 130, n. 46). Mr. A. Sturrock, superintendent of the machine department of the Great Northern Railway, says with respect to the building of machines (locomotives, etc.), "The expensive English workmen are being less used every day. The production of the workshops in England is being increased by the use of improved tools and those tools are again worked by a low class of labour. . . . I was speaking of a time when their skilled labour necessarily produced all the parts of engines. Now the parts of the engines are produced by labour with less skill but good tools. . . . By tools you mean the engineers' machinery? Yes, lathes, planing machines, drills, and so on" (Royal Commission on Railway. Minutes of Evidence, n. 17,862 and n. 17,863, London, 1867).

119. Ure op. cit. p. 30.

female for male, causes a fresh disturbance in the rate of wages."[120] "The effect of substituting the self-acting mule for the common mule, is to discharge the greater part of the men spinners, and to retain adolescents and children."[121] The rapid progress made by the machine system under the pressure of the shortened workday has shown us that the system has extraordinary elasticity, owing to accumulated practical experience, the extent of the mechanical means already available, and continuous technological innovation. But in 1860, when England's cotton industry was reaching its zenith, who could have imagined that the American Civil War would spur the dramatic advances in machinery achieved over the next three years and, accordingly, cause so much manual labor to become superfluous? A few examples of the factory inspectors' official evidence on this point will suffice. One Manchester manufacturer says, "We formerly had seventy-five carding engines now we have twelve doing the same quantity of work, which is fully equal if not superior to what we made before. We are doing with fewer hands by fourteen at a saving in wages of £10 per week. Our estimated saving in waste is about 10 percent in the quantity of cotton consumed." In a fine-spinning mill in Manchester, the inspector was informed that "through increased speed and the adoption of some self-acting processes a reduction had been made in number of a fourth in one department and of above half in another, and that the introduction of the combing machine in place of the second carding had considerably reduced the number of hands formerly employed in the carding room." Another spinning mill estimates that it reduced its "hands" by 10 %. Messrs. Gilmore, spinners in Manchester, remark, "In our blowing room department we consider our expense with new machinery is fully one third less in wages and hands . . . in the jack frame and drawing frame room, about one-third less in expense. But this is not all; when our yarn goes to the manufacturers, it is so much better by the application of our new machinery that they will produce a greater quantity of cloth, and cheaper than from the yarn produced by old machinery."[122] The factory inspector Alexander Redgrave observes about this, "The reduction of hands against increased production is in fact constantly taking place; in woollen mills the reduction commenced some time since, and is continuing; a few days since the master of a school in the neighbourhood of Rochdale said to me that 'the great falling off in the girls school is not only

120. Ibid. Vol. 2, p. 67. [Editor's note: English original, p. 321.]
121. Ibid.
122. "Reports of Insp. of Fact. 31st Oct. 1863," p. 108ff.

caused by the distress, but by the changes of machinery in the woollen mills, of which a reduction of seventy short-timers had taken place.'"[123]

But machinery doesn't simply act as the unstoppable competition forever about to make the wage laborer "redundant." For workers, it is a hostile force. Loudly and widely proclaiming it as such, capital uses it accordingly. Machinery is the most powerful weapon for putting down workers' periodic revolts against capital's autocratic rule—strikes and so on.[124] Gaskell maintains that the steam engine has always been an enemy of "human labor," and when workers' aspirations became more ambitious, and were threatening to send the early factory system into crisis, it was the steam engine that enabled capitalists to crush those aspirations.[125] Much of what has been invented since 1830—certainly enough to fill a whole volume—was brought into the world expressly to serve capital as a weapon for combatting workers' mutinies. The self-acting mule is the first thing to mention here, since it launched the new epoch of the automatic system.[126] Ure remarks about the coloring machines made for calico printing, "At length capitalists sought deliverance from this intolerable bondage [namely, those so onerous conditions set forth in their contracts with workers] in the resources of science, and were speedily re-instated in their legitimate rule, that of the head over the inferior members." On the topic of a machine for making dressing wraps, which was invented in response to a strike, he says, "The combined malcontents, who fancied themselves impregnably intrenched behind the old lines of division of labour, found their flanks turned and their defenses rendered useless by the new mechanical tactics, and were obliged to surrender at discretion."

123. Ibid. p. 109. During the cotton crisis, machinery improved rapidly, and this allowed English manufacturers to glut the world market once again—something it took them little time to do right after the American Civil War. It became nearly impossible to sell cloth during the last six months of 1866. The English then began sending goods to China and India on consignment, which of course made the "glut" even worse. Early in 1867, the manufacturers turned to their customary means of relief: they lowered wages by 5 %. The workers protested and took the theoretically correct position that short time, or working four days a week, was the only cure. After resisting for a long time, the self-proclaimed captains of industry finally decided to implement short time, in some cases with a 5 % wage reduction and in some cases without one.

124. "The relation of master and man in the blown flint and bottle trades amounts to chronic strike." Hence the favorable conditions for manufacturing pressed glass where the main operations are performed by machines. One firm in Newcastle, which had produced 350,000 pounds of blown flint glass annually, now produces 3,000,350 pounds of pressed glass. ("Ch. Empl. Comm. Fourth Rep. 1865," pp. 262–3.)

125. Gaskell, "The Manufacturing Population of England. Lond. 1833," pp. 34, 35.

126. Owing to strikes in his own machine-building factory, Mr. Fairbairn discovered several very important ways to use machines to build machines.

He has this to say about the invention of the self-acting mule: "A creation destined to restore order among the industrious classes. . . . This invention confirms the great doctrine already propounded, that when capital enlists science into her service, the refractory hand of labour will always be taught docility."[127] Although Ure's book appeared 30 years ago, or at a time when the factory system was still in its early stages, it remains the classic expression of the factory spirit, with its frank cynicism but also owing to the naïveté with which the author parades the mindless contradictions in capital's head. He articulates the "doctrine" that capital, having put science on its payroll, will always teach the "refractory hand of labour" to be "docile," but then he waxes indignant because the "physico-mechanical science has been accused of lending itself to the rich capitalist as an instrument for harassing the poor." And he sermonizes at length about the advantages workers derive from the rapid development of machinery, only to warn that if they go on strike, machinery will develop even faster. "Violent revulsions of this nature," he says, "display short-sighted man in the contemptible character of a self-tormentor." The opposite is the case just a few pages earlier: "Had it not been for the violent collisions and interruptions resulting from erroneous views among the factory operatives, the factory system would have been developed still more rapidly and beneficially for all concerned." Ure proceeds to exclaim again, "Fortunately for the state of society in the cotton districts of Great Britain, the improvements in machinery are gradual." "It [the introduction of such improvements] is said to lower the rate of earnings of adults by displacing a portion of them, and thus rendering their number superabundant as compared with the demand for their labour. It certainly augments the demand for the labour of children and increases the rate of *their* wages." On the other hand, having offered such consolation, this same writer defends the paltriness of children's wages, arguing that if they were higher, parents would send their children to the factory at too young an age. The whole point of Ure's book is to justify the unrestricted workday. Legislation that prevents thirteen-year-old children from being worked to the bone twelve hours a day reminds his liberal soul of the darkest moments of the Middle Ages. This doesn't stop him, however, from admonishing factory workers to say prayers of thanks to Providence, which uses machinery as a means of supplying workers with "the leisure to think of their immortal interests."[128]

127. Ure op. cit. Vol. 2 pp. 141, 142, 138, 140. [Editor's note: English original, pp. 369, 370, 367, 368.]

128. Ibid. and pp. 10, 5, 143, 6, 68, 67, 143. [Editor's note: English original, pp. 268, 7, 370, 280, 322, 321, 370.]