The pressure was on to go beyond these barriers. It is, of course, "machines that abolish the role of the handicraftsman as the regulating principle of social production" (491). This takes us into the next chapter, in which machines and the organizational form of the modern factory move to center stage.

CHAPTER SEVEN

What Technology Reveals

CHAPTER 15: MACHINERY AND LARGE-SCALE INDUSTRY

In the introduction, I noted that Marx rarely comments on his methodology. It has therefore to be reconstructed by way of careful perusal of occasional side comments, supplemented by a study of his practices. Chapter 15, "Machinery and Large-Scale Industry," provides an opportunity to grapple with this question at the same time as it advances the general arguments as to the character of a capitalist mode of production. The chapter is long, but the sections are logically ordered. It repays to go over this logical ordering both before and after studying this chapter.

An Important Footnote

I begin, however, with the chapter's fourth footnote, where Marx, in the cryptic fashion he often deploys in describing methodological considerations, links together a slew of concepts in a configuration that actually provides a general framework for dialectical and historical materialism. The footnote unfolds in three phases. The first focuses on Marx's relation with Darwin. Marx had read *On the Origin of Species* and was impressed with the historical method of evolutionary reconstruction that Darwin had outlined. Marx clearly envisaged his work as some sort of continuation of Darwin's, with the emphasis on human as well as (rather than opposed to) natural history. His aim, he stated in the preface to the first edition, is to view "the development of the economic formation of society" from "the standpoint" of "natural history." From this standpoint, the individual cannot be held "responsible for relations whose creature he remains, socially speaking, however much he may subjectively raise himself above them" (92).

In the footnote, Marx first focuses on "a critical history of technology." This

> would show how little any of the inventions of the eighteenth century are the work of a single individual. As yet such a book does not exist.

> Darwin has directed attention to the history of natural technology, i.e. the formation of the organs of plants and animals, which serve as the instruments of production for sustaining their life. Does not the history of the productive organs of man in society, of organs that are the material basis of every particular organization of society, deserve equal attention? And would not such a history be easier to compile, since, as Vico says, human history differs from natural history in that we have made the former, but not the latter? (493)

Vico's argument was that natural history was God's domain and that since God moved in mysterious ways, it was beyond human understanding, but we could certainly understand our own history since we had made it. Marx earlier broached the historical approach to technological change and noted some vital transitions associated with transformations in the mode of production. Having followed Benjamin Franklin in defining man "as a tool-making animal" in chapter 7, he went on to observe that the

> relics of bygone instruments of labour possess the same importance for the investigation of extinct economic formations as do fossil bones for the determination of extinct species of animals. It is not what is made but how, and by what instruments of labour, that distinguishes different economic epochs. Instruments of labour not only supply a standard of the degree of development which human labour has attained, but they also indicate the social relations within which men work.

Then, in a footnote: "the writers of history have so far paid very little attention to the development of material production, which is the basis of all social life, and therefore of all real history" (286). In chapter 14 he argued that

> the Roman Empire handed down the elementary form of all machinery in the shape of the water wheel. The handicraft period bequeathed to us the great inventions of the compass, gunpowder, type-printing and the automatic clock. But on the whole, machinery played that subordinate part which Adam Smith assigns to it in comparison with division of labour. (468)

This idea that there has been a human evolutionary process in which we can discern radical shifts not only in technologies but in whole modes of social life is clearly very important to Marx.

Marx did not read Darwin uncritically. "It is remarkable," he wrote to Engels, "how Darwin recognizes among beasts and plants his English society with its division of labour, competition, opening up of new markets, 'inventions' and the Malthusian struggle for existence."[1] The problem, as Marx sees it, is Darwin's ahistorical approach to a purely natural evolution without reference to the role of human action in changing the face of the earth. The reference to Malthus is also telling because in his introduction to *On the Origin of Species*, Darwin attributed some of his key ideas to Malthus. And since Marx couldn't abide Malthus, it must have been hard for Marx to swallow the thought that Malthus had so inspired Darwin. Interestingly, the Russian evolutionists who were not exposed to ruthless British industrialism (Darwin was married to a daughter of Josiah Wedgwood, the famous pottery industrialist, and so was familiar at first hand with competition and the division of labor and of function) put much greater emphasis on cooperation and mutual aid, ideas which were translated by the Russian geographer Kropotkin into the fundamentals of social anarchism.

But what Marx appreciated was Darwin's approach to evolution as a process open to historical reconstruction and theoretical investigation. Marx is committed to understanding the human evolutionary process in like fashion. This is where Marx's emphasis on processes rather than things comes in. The chapter on machinery and large-scale industry should be read as an essay on the history of technology in this spirit. It is about how the industrial form of capitalism emerged out of the world of handicraft and manufacturing. Up until this point, nobody had really thought of writing such a history, so this chapter constitutes a pioneering effort that later spawned a whole field of academic study called the history of science and technology. Read in this way, the chapter's argument makes a lot more sense. But like Darwin's theory, there is far more here than just history. There is a theoretical engagement with processes of social transformation, and as such, there is a good deal to debate and discuss.

The second part of the footnote proffers a short, but in my view extremely important, statement that requires elaboration:

> Technology reveals the active relation of man to nature, the direct process of the production of his life, and thereby it also lays bare the process of the

1. Marx to Engels, June 18, 1862, in *Selected Correspondence*, ed. S. W. Ryazanskaya, trans. I. Lasker (Moscow: Progress, 1965), 128.

> production of the social relations of his life, and of the mental conceptions that flow from those relations. (493)

Marx here links in one sentence six identifiable conceptual elements. There is, first of all, technology. There is the relation to nature. There is the actual process of production and then, in rather shadowy form, the production and reproduction of daily life. There are social relations and mental conceptions. These elements are plainly not static but in motion, linked through "processes of production" that guide human evolution. The only element he doesn't explicitly describe in production terms is the relation to nature. Obviously, the relation to nature has been evolving over time. The idea that nature is also something continuously in the course of being produced in part through human action has also been long-standing; in its Marxist version (outlined in chapter 7), it is best represented in my colleague Neil Smith's book *Uneven Development*,[2] where capitalist processes of production of nature and of space are explicitly theorized.

How, then, are we to construe the relationships between these six conceptual elements? Though his language is suggestive, Marx leaves the question open, which is unfortunate since it leaves lots of space for all manner of interpretations. Marx is often depicted, by both friends and foes alike, as a technological determinist, who thinks changes in the productive forces dictate the course of human history, including the evolution of social relations, mental conceptions, the relation to nature and the like. The neoliberal journalist Thomas Friedman, for example, in his book *The World Is Flat*,[3] happily admits to the charge of being a technological determinist; when someone pointed out to him (erroneously) that this was Marx's position, he expressed his admiration for Marx and approvingly cited a lengthy passage from the *Communist Manifesto* to prove his point. In a review of Friedman's book, the conservative political philosopher John Gray confirmed Marx's technological determinism and argued that Friedman was indeed merely following in Marx's footsteps.[4] These observations by those generally unsympathetic to Marx

2. Neil Smith, *Uneven Development: Nature, Capital, and the Production of Space*, 3rd edn. (Athens, GA: University of Georgia Press, 2008 [1984]).

3. Thomas Friedman, *The World Is Flat: A Brief History of the Twenty-first Century* (New York: Farrar, Straus and Giroux, 2005), 201-4.

4. John Gray, "The World Is Round," *The New York Review of Books* 52, No. 13 (August 11, 2005).

are paralleled within the Marxist tradition. The strongest version of the thesis that the productive forces are the leading agent in history comes from G. A. Cohen in his book *Karl Marx's Theory of History: A Defence*.[5] Cohen, having inspected all Marx's texts from the standpoint of analytic philosophy, defends this interpretation of Marx's theory.

I do not share this interpretation. I find it inconsistent with Marx's dialectical method (dismissed by analytic philosophers such as Cohen as rubbish). Marx generally eschews causal language (I defy you to find much of it in *Capital*). In this footnote, he does not say technology "causes" or "determines," but that technology "reveals" or, in another translation, "discloses" the relation to nature. To be sure, Marx pays a lot of attention to the study of technologies (including organizational forms), but this does not warrant treating them as leading agents in human evolution. What Marx is saying (and plenty of people will disagree with me on this) is that technologies and organizational forms *internalize* a certain relation to nature as well as to mental conceptions and social relations, daily life and labor processes. By virtue of this internalization, the study of technologies and organizational forms is bound to "reveal" or "disclose" a great deal about all the other elements. Conversely, all these other elements internalize something of what technology is about. A detailed study of daily life under capitalism will, for example, "reveal" a great deal about our relation to nature, technologies, social relations, mental conceptions and the labor processes of production. Similarly, the study of our contemporary relation to nature cannot go very far without examining the nature of our social relations, our production systems, our mental conceptions of the world, the technologies deployed and how daily life is conducted. All these elements constitute a totality, and we have to understand how the mutual interactions between them work.

I find this a helpful way to think about the world. For instance, I was on a jury to select ideas for the design of a new city in South Korea. We, the members of the jury, had all the designs in front of us. The jury was made up mainly of engineers and planners, with a few distinguished architects and landscape designers. The latter dominated the initial discussion on the criteria we should deploy in reaching our decisions, and it mainly

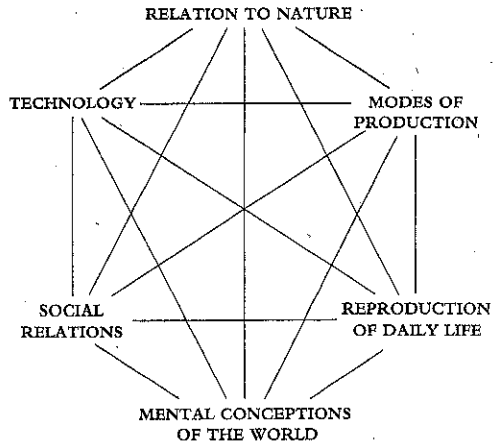
5. G. A. Cohen, *Karl Marx's Theory of History: A Defence*, expanded edn. (Princeton, NJ: Princeton University Press, 2000 [1978]).

devolved into a discussion of the relative symbolic strengths and practical implications of circles and cubes in built forms. In other words, decisions were to be made largely on the basis of geometric and symbolic criteria. At some point, I intervened to ask: if you are building a new city, what are the things you would want to know? I would want to know, what kind of relation to nature is going to be created here (the ecological footprint, etc.)? What kinds of technologies are going to be embodied in this city, and why? What kinds of social relations are envisaged? What systems of production and reproduction are going to be incorporated? What is daily life going to be like, and is that the kind of daily life we would want? And what mental conceptions, symbolic and all the rest of it, are going to be engaged here? Is this going to be built as a nationalist monument or as a cosmopolitan place?

The other jurors seemed to find this formulation both innovative and interesting. We discussed it for a while until it got a bit too complicated relative to the time at our disposal. One of the architects then suggested that out of the six criteria, only mental conceptions really mattered, which came down to the symbolism of forms, which brought us neatly back to the question of the relative strengths of circles and cubes! But afterward I was asked where they could find out more about such an interesting way of thinking. I made the mistake of saying it's in footnote 4 of chapter 15 of Marx's *Capital*. I should have known better, because there are two typical reactions to saying this kind of thing. One is nervous and even fearful, for to concede that Marx might have said something so powerfully obvious and interesting is tantamount to admitting Marxist sympathies, and that would be horrible for one's professional and even personal prospects. The other is to regard me as an idiot, so lacking in ideas that I can only parrot Marx and, even worse in this instance, fall so low as to cite a mere footnote! So the conversation stopped. But this is, I think, an interesting way to evaluate urban design and to critique the qualities of urban life.

This framework helps ground the theory of historical materialism in a fundamental way, and there is strong evidence, as I hope to show, that it grounds much of Marx's tangible approach to understanding the evolution of capitalism. Let me expand on this for a moment. Imagine a framework of thought in which these six elements hang together in a single space but in intense interrelation (see figure opposite). Each of the elements is internally dynamic such that we consider each constituting a "moment" in the process of human evolution. We can study this evolution

from the perspective of one of the moments or examine interactions among them, such as transformations in technologies and organizational forms in relationship to social relations and mental conceptions. How are our mental conceptions altered by the technologies available to us? Do we not see the world differently once we have microscopes, telescopes and satellites, X-rays and CAT scans? We understand and think about the world in a very, very different way now, because of the technologies we have. But by the same token, somebody somewhere must have had the mental conception that making a telescope was an interesting thing to do (recall Marx's take on the labor process and the worst of architects). And when that person had that idea, he had to be able to find lens grinders and glassmakers and all the elements necessary in order to make the idea a reality through the production of the telescope. Technologies and organizational forms do not descend from the sky. They get produced out of mental conceptions. They also arise out of our social relations and concretely arise in response to the practical needs of daily life or of labor processes.



I like the way Marx sets this up, provided it is viewed dialectically, not causally. This way of thinking permeates *Capital*, and the book should be read with this framework in mind. It also provides a standard of critique, because we can analyze Marx's own performance by how well he links these different elements together. How exactly does Marx bring together mental conceptions, social relations and technologies, and does he do it

adequately? Are there aspects, such as the politics of daily life, that are left in the shadows? In other words, the dialectic between this formulation and Marx's practices needs to be scrutinized.

So let me summarize. The six elements constitute distinctive moments in the overall process of human evolution understood as a totality. No one moment prevails over the others, even as there exists within each moment the possibility for autonomous development (nature independently mutates and evolves, as do ideas, social relations, forms of daily life, etc.). All these elements coevolve and are subject to perpetual renewal and transformation as dynamic moments within the totality. But it is not a Hegelian totality in which each moment tightly internalizes all the others. It is more like an ecological totality, what Lefebvre refers to as an "ensemble" or Deleuze as an "assemblage," of moments coevolving in an open, dialectical manner. Uneven development between and among the elements produces contingency in human evolution (in much the same way that unpredictable mutations produce contingency in Darwinian theory).

The danger for social theory is to see one of the elements as determinant of all the others. Technological determinism is as wrongheaded as environmental determinism (nature dictates), class-struggle determinism, idealism (mental conceptions are in the vanguard), labor-process determinism or determinism arising out of (cultural) shifts in everyday life (this is the political position taken by Paul Hawken in his influential text *Blessed Unrest*[6]). Major transformations, such as the movement from feudalism (or some other precapitalist configuration) to capitalism, occur through a dialectic of transformations across all the moments. This coevolution developed unevenly in space and time to produce all manner of local contingencies, albeit contingencies limited by the interplay within the assemblage of elements implicated in the evolutionary process and the growing spatial (and sometimes competitive) integration of economic-development processes in the world market. Perhaps one of the biggest failures of the conscious attempt to build socialism and communism on the basis of capitalism was the failure to recognize the need to engage politically across all these moments in a way that was sensitive to geographical specificities. The temptation for revolutionary

6. Paul Hawken, *Blessed Unrest: How the Largest Movement in the World Came into Being and Why No One Saw It Coming* (New York: Viking, 2007).

communism was to reduce the dialectic to a simple causal model in which one or another moment was placed in the vanguard of change, and that was supposed to be that. This approach inevitably failed.

On the surface, the third phase of the footnote appears to contradict my interpretation of the second:

> Even a history of religion that is written in abstraction from this material basis is uncritical. It is, in reality, much easier to discover by analysis the earthly kernel of the misty creations of religion than to do the opposite, i.e. to develop from the actual, given relations of life the forms in which these have been apotheosized. The latter method is the only materialist, and therefore the only scientific one. (493–4)

Marx considered himself a scientist, and he is here asserting that this means a commitment to materialism. But his materialism is different from that of the natural scientists. It is historical. "The weaknesses of the abstract materialism of natural science, a materialism which excludes the historical process, are immediately evident from the abstract and ideological conceptions expressed by its spokesmen whenever they venture beyond the bounds of their own speciality" (494). Darwin's findings on evolution were flawed because he ignored the impact of the historical context on his theorizing (the power of the metaphors that he drew from British capitalism) and failed to carry over his argument onto and integrate his findings with human evolution. Marx was writing before Social Darwinism became popular, of course, but he prefigures a critical response to the way in which the Social Darwinists legitimized capitalism as "natural" by appealing to Darwin's theory of evolution. Since Darwin's theory drew its guiding metaphors from capitalism and was inspired by the social theory of Malthus, it was hardly surprising to see capitalism confirmed as wholly consistent with supposedly natural processes of competition, struggle for survival and, of course, survival of the fittest (without paying attention to Kropotkin's mutual aid).

Marx's general point is that natural scientists, because they failed to understand their historical moment and were barred by their methodological commitments from integrating human history into their models of the world, frequently ended up with at best partial and at worst serious misinterpretations of that world. At worst, they concealed their historical and political assumptions under a supposedly neutral

and objective science. This critical perspective, which Marx pioneered, is now standard practice within the field of science studies, where it has repeatedly been shown that the importation into science of social metaphors about gender, sexuality or social hierarchies leads to all kinds of misreadings of what the natural world is actually about, even as it is understood that without metaphors scientific inquiry would go nowhere.

But there is a much deeper issue here that needs to be addressed. In the first lecture, I talked about Marx's way of moving by descent: you start with the surface appearance, then dive deep down beneath the fetishisms to uncover a theoretical conceptual apparatus that can capture the underlying motion of social processes. That theoretical apparatus is then brought step by step back to the surface to interpret the dynamics of daily life in new ways. This is, Marx confirms in the footnote, "the only materialist and therefore the only scientific (method)." We have already seen a specific example of this method at work in the chapter on the working day. Value as socially necessary labor-time internalizes a specific capitalist temporality, and a vast field of social struggles on the surface of society ensues, concerning the appropriation of the time of others. The fact that "moments are the elements of profit" leads capitalists to be obsessed with time discipline and time control (and will shortly also explain why they are obsessed with speed-up).

But how are we to think about the relation between, say, the deep-value theory and the unpredictable ferment of surface struggles over the length of the working day? Back on page 175, Marx approvingly cites (in yet another footnote!) a famous passage from an earlier work, *A Contribution to the Critique of Political Economy*:

> My view is that each particular mode of production, and the relations of production corresponding to it at each given moment, in short 'the economic structure of society', is 'the real foundation, on which arises a legal and political superstructure and to which correspond definite forms of social consciousness' [mental conceptions, if you like], and that 'the mode of production of material life conditions the general process of social, political, and intellectual life.

He leaves out the following sentence from the *Critique*, which explains that it is in the superstructure that we become conscious of political issues and fight them out.

This is what is usually referred to as the base-superstructure model. The supposition is that there is an economic base on which there arise frameworks of thought as well as a political and legal superstructure that collectively define how we become conscious of problems and fight them out. This formulation is sometimes read deterministically: the economic base *determines* the political and legal infrastructure, determines the forms of struggle that are found there and, to the degree that there are transformations occurring in the economic base, actually determines the outcomes of political struggles. But I can't see how the argument can be viewed as deterministic or even causal. This is not how the chapter on the working day unfolds at all. There are class alliances, conjunctural possibilities, discursive shifts in sentiments, and the outcome is never certain. But there is always such a deep concern over the appropriation of the time of others that the issue never goes away. It is a perpetual point of contestation "between equal rights" within capitalism that can never arrive at some ultimate solution. Struggles over time are fundamental to the capitalist mode of production. This is what the deep theory tells us, and no matter what happens in the superstructure, that imperative cannot be overcome without overthrowing capitalism.

In any case, productive forces and social relations cannot exist without expression and representation in the political and legal superstructure. We have seen this with money, which is a representation of value surrounded by all manner of institutional and legal arrangements, and certainly an object of struggle and political manipulation (as is also the case with legal frameworks of private property rights). But Marx has also shown that without money (or a legal framework of private property rights), value could not exist as a foundational economic relation. Things get worked out in the monetary sphere in very particular ways depending on the dynamics of class struggle, and this has implications for how the value theory works. Is money in the political superstructure or down in the economic base? The answer, surely, has to be both.

Similarly, one would not say, from the chapter on the working day, that the outcome of the working-day struggle was determined by movements in the economic base. Furthermore, the political restriction on the length of the working day in part led capitalists to look for another way to gain surplus-value, i.e., relative surplus-value. Marx clearly does not intend this base-superstructure model to operate mechanically or causally, but he does use it dialectically.

Yet it is also true that the "working out" that goes on in the realm of struggle over the length of the working day is a working out of the fundamental fact that moments are the elements of profit, which derives from the definition of value as socially necessary labor-time. There was not a concerted struggle over the length of the working day in precapitalist societies or even in ancient Rome. Only within the rules of a capitalist mode of production does this sort of struggle make sense. Formal issues such as the length of the working day (week, year, lifetime) get thrown up precisely because of the deep structure of what capitalism has become. How these struggles get resolved depends on you and me and everybody else. And indeed, the struggle could potentially be resolved in such a way as to entail the abolition of the capitalist mode of production. A society would be constructed in which moments are *not* the elements of profit. Can you imagine what that would look like? Sounds rather nice, no?

My main point here is that the ways in which these things get worked out—through political and legal means, the balance of class forces, hegemonic mental conceptions and the like—are not ineffectual in relation to the deep concept of the circulation of value as capital. The real scientific method is to identify those deep elements which explain to you why certain things go on in our society the way they do. We saw that in the struggle over the length of the working day. We also see it in the struggle over relative surplus-value, which explains why capitalism has to be so technologically dynamic. We seem not to have choices over whether or not to grow or to invent because that's what the deep structure of capitalism mandates. The only interesting question is, therefore, how is growth going to occur, and with what kinds of technological change? This forces us to consider the implications for mental conceptions, the relation to nature and all the other moments. If we don't like these implications then we have no recourse except to engage in struggle with respect not only to one or another of the moments but to all of them simultaneously, until we ultimately come to terms with having to transform the very rule of value itself.

The circulation of capital is, however, the driver of the dynamics under capitalism. But what is socially necessary for this process to be sustained? Consider, for example, the necessary mental conceptions. If you go down to Wall Street with a big banner saying, "Growth Is Bad, Stop It Now," would that be considered an anticapitalist sentiment? You bet it would. You would be dismissed, however, not necessarily for being

anticapitalist but for being antigrowth, because growth is considered both inevitable and good. Zero growth signals serious problems. Japan hasn't grown much at all in recent times, poor folk. But the growth in China has been spectacular, so the Chinese are the grand success story. How can we emulate them? We all happily sit around and say growth is good, technological change is good and so capitalism, which requires both, must also be good. This is the sort of common belief system that Gramsci often referred to as "hegemony." The same sorts of issues arise concerning institutional arrangements. Capitalism requires adequate legal arrangements to function effectively. The more the Chinese moved down a capitalistic path, the less plausible it was for them to maintain a legal system that didn't acknowledge some sorts of private property rights. But there is a great deal of latitude and contingency in the institutional arrangements that might work.

Sections 1–3: Machine Development, Value Transfers and Effects on Workers

So, finally, let us take up the materials assembled in this long chapter. I suggest you pay careful attention to the sequence of the section headings. These define a logical line of argument that structures Marx's inquiry into the rise of the factory system and the use of machinery. He begins, however, with John Stuart Mill's surprise at the fact that mechanical inventions, supposedly designed to lighten the load of labor, had done nothing of the kind. In fact, they had generally made matters worse. Marx himself is in no way surprised, since machines are used to produce surplus-value, not to lighten the load of labor. But this means, notice, that "the machine is a means for producing surplus-value" (492). This sounds odd, since Marx has argued that machines are dead labor (constant capital) and cannot produce value. Yet they can, however, be a source of surplus-value. The reduction in the value of labor-power through rising productivity in the wage-goods sector yields relative surplus-value to the capitalist class, while the capitalist with the best machinery will acquire the temporary form of relative surplus-value that accrues to the producer with higher productivity. No wonder capitalists hold to the fetish belief that machines produce value!

Marx then considers the difference between tools and machines. To "call a tool a simple machine and a machine a complex tool" and "see no essential difference between them" misses something essential, most