RIFLE THEORY

Engels and the History of Technology

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Around the end of 1860, Friedrich Engels composed a long essay on the history of the rifle. Marx and Engels studied technology and its development throughout their lives, independently and together; the theoretical tradition of historical materialism inaugurated by their work developed across the nineteenth and twentieth centuries in large part as a distinctive approach to understanding science and technology.[1] Aside from Marx's own political-economic studies of machinery and automation, Engels's "History of the Rifle" is the longest single piece of writing about technology that either of them produced. Yet it has been almost entirely forgotten.

In the final aphorism of *One-Way Street,* Walter Benjamin tells us that the imperialists view "the mastery of nature" as "the purpose of all technology." Against this ideological interpretation of the infrastructure of our technical practice, Benjamin asks us to imagine, to affirm, an alternative vision, one according to which "technology is the mastery of not nature but of the relation between nature and man."[2] In his study of the rifle, that forgotten episode in his uneven journalistic efforts, Engels—I will argue—sketched the outlines of a historiography of technology adequate to such a political demand.

My discussion has three parts. In view of the work's unfamiliarity, I begin with textual details: notes on its origin, on its content, and on its rather limited reception. I then turn to the question of what kind of history is presented in "The History of the Rifle," and I reconstruct five principles for the materialist study of technology that are implicit in Engels's

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[1] Historical materialism, arguably, constitutes a third major independent tradition of thought on modern science and technology in history and society, distinct from, though related to, both "the history and philosophy of science" (HPS) and "science and technology studies" (STS) as contemporary disciplinary configurations. On this see Helena Sheehan, *Marxism and the Philosophy of Science: A Critical History* and "Marxism and Science Studies: A Sweep Across the Decades."

[2] Benjamin, *Selected Writings* vol. 1, p 487. The aphorism is titled "To the planetarium."

discussion. Finally, reflecting on the text's rather puzzling conclusion, I turn to the political implications of such a materialist historiography: its social end, I argue, is the demystification of the destructive fetish of the technological commodity itself.

I.

In a letter to Marx of 1 August 1860, Engels mentioned that he was considering writing a study of the rifle and its history, and he asked his friend to see whether the *New-York Daily Tribune* might be interested in publishing it.[3] Charles Dana, one of the *Tribune*'s editors, had printed substantial material by Marx and Engels already; Engels contributed numerous pieces on military affairs and related technical matters, which appeared in both the newspaper itself and in another of Dana's editorial ventures, the *New American Cyclopedia,* across the 1850s. Engels probably expected a favorable response: only a few months earlier (in April–May 1860), the *Tribune* had serialized his four-part study of artillery, under the title "On Rifled Cannon."[4] No response to Engels's inquiry appears to be extant, but for whatever reason, the *Tribune* did not take him up on the offer. A few months later, he published the study instead in an English magazine, the *Volunteer Journal for Lancaster and Cheshire.*

The *Volunteer Journal* circulated among members of a new quasi-militia movement in England. The aggressive ambitions of the second French empire of Napoleon III—the Bonaparte not of tragedy but of farce—had sparked increasing unease in Britain, and there was popular fear of an invasion of the island itself. Engels seems to have viewed the volunteer-riflemen movement that sprang up in response as a potentially significant anti-

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[3] MECW 41, p. 177.

[4] See "On Rifled Cannon," MECW 17, pp. 354–66.

Bonapartist political development, and he began writing analyses of military matters for the *Journal* as a result. Though he had at first imagined "The History of the Rifle" as a text for an American audience, he repurposed it for the volunteers instead; serialized in eight parts, it was by far the longest of his contributions to that forum. Engels's writings for the *Journal* were well-received in British military quarters as well, and five of the articles were collected together and republished as a standalone pamphlet in 1861, under the title *Essays Addressed to Volunteers*.[5] The study of the rifle appeared as the first entry in that slim volume.

"The History of the Rifle" consists of eight parts, together totaling about thirty pages. After brief attention to the rifle's origins in fifteenth-century Germany and its uneven adoption across the succeeding two hundred years (Part I), Engels focuses on the evolution of its design and construction in the nineteenth century, examining how it was improved to such a degree that it came into general use among European infantry forces. A rifle is a gun with (spiraling) grooves inside the barrel, which, through close contact with the bullet itself as it is fired, cause it to spin, dramatically stabilizing its flight. The soft lead of the bullet must actually be pressed into the grooves for the rifle to be effective in this way, and this imposes certain constraints on how the rifle must be loaded and used. Part II presents 1828 as a pivotal year: a French officer named Delvigne designed a rifle with a chamber at the breach, of smaller diameter than the barrel; the powder would be poured down into this chamber from the muzzle end, and the bullet dropped down after it. The bullet, being wider

[5] I cite "The History of the Rifle" as it appears in MECW 18, pp. 433–59 (henceforth "Rifle"). Another critical edition appears in MEGA I/18, *Werke, Artikel, Entwürfe, Oktober 1859 bis Dezember 1860,* pp. 577–601. For editorial information on the essay and on the minor textual variants between the two early editions, see MEGA I/18 (Apparat), pp. 1008-10. Further details of the essay's serial publication history can be traced in letters to Engels from Joseph Howard Nodal, editor of the *Volunteer Journal*, reproduced in MEGA III/11, *Briefe Juni 1860 bis Dezember 1861*. For Engels's preface to *Essays Addressed to Volunteers,* see MECW 18, p. 476. That pamphlet (like the articles in the *Journal*) appeared without his name, and he signed the preface only with his initials, "F.E."

than the chamber, would rest on top of it in the barrel, and then be struck with the ramrod to deform it slightly, in such a way that it would be fitted into the grooves. But this deformation in turn made the bullet's aerodynamics less predictable. The response was to develop elongated, "cylindrico-conical" shot, which would keep a more consistent form when pressed by the ramrod—a pivotal shift in the design of the technical system. Engels also discusses some variations in how the bullet could be held in place above the powder. Part III then details another shift in bullet-shape, popularized especially by the Minié rifle: if the end of the bullet were hollowed out, the bullet itself would be directly *expanded* by the explosion of the powder and be forced into the grooves without the need for the repeated force of the ramrod. Engels describes the development of this "expansion system" and provides some information on the widespread embrace of such rifles by European armies in the 1850s. Part IV then outlines the various additional technical innovations in the design of expansion-bullets that the wide adoption of the Minié rifle prompted in the various places where it was used.

In Part V, we are introduced to a newer alternative to the expansion-system, the *compression bullet*; when a bullet of the right dimensions has sufficient weight, the inertial resistance it offers to the explosion causes it be compressed in length and thus to increase in diameter, taking the grooves as a result. Engels discusses the complexity of evaluating whether the apparently improved results of this compression-system, in range and accuracy, are a result of its inherent advantages or instead merely a byproduct of other aspects of the production-techniques required for its implementation. In Part VI, he turns from the design of the bullet to the mechanism by which it is loaded in the gun; early mass-produced rifles had been muzzle-loaders, in which the bullet and powder were dropped into the gun from the muzzle of the barrel; in breech-loading systems (which had been earlier developed for

artillery), the gun opens in such a way that the shot and powder can be inserted at the very place where the explosion is triggered. Breach-loading systems introduce new mechanical stresses on the firearm and require more precise production techniques, but they vastly increase the possible rate of fire and make it much easier to load the weapon under field conditions of limited cover or mobility. This discussion of breach-loading concludes the main part of the article's survey of technical principles and their development over time; Part VII is a kind of excursus on a new and fashionable design, the Whitworth rifle, which abandoned the grooves entirely in favor of a spiraling barrel with a *hexagonal* cross-section. Engels assesses its features, and its limitations, in view of the lessons of the rifle's history.

In the brief final section, Part VIII, Engels summarizes the various approaches to rifle-design and the principles that have gradually come to govern their further development. Aerodynamically, a "long and thin shot is far better fitted than a short and thick one of the same weight," and in view of how many rounds and how hany pounds a soldier can be expected to carry, "the maximum weight of the bullet for military purposes is also a given quantity"; such factors together constrain the design options for future innovation, such that, as a general principle, "the smaller the bore, the better the rifle."[6] Engels then writes:

> With these observations we take leave of a subject which may have appeared rather dry to many of our readers. Still its importance is very great. No intelligent soldier ought to be ignorant of the principles on which his arms are constructed, and are expected to act. What we have attempted to expose here, the non-commissioned officers of most continental armies are expected to know; and surely, the majority of the volunteers, 'the intelligence of the country,' ought to be as well up in the knowledge of their fire-arms as they![7]

With this wry exhortation, his essay concludes.

Despite its unusual length—Engels's journalistic writings in this period were rarely

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[6] "Rifle," p. 458.

[7] "Rifle," p. 459.

more than a few pages—"The History of the Rifle" has had almost no reception in the later history of Marxian scholarship in Europe and North America. When it is referred to at all, it is at almost always mentioned only in passing; even these brief references are exceptionally rare in the English, French, and German scholarly literatures. Such citations typically appear in the context of broader analyses of Engels's extensive military writings, even though the text's singular focus on a specific technical object—the rifle—makes it rather unusual within that area of his work.[8] Engels's biographers tend not to mention the essay at all. Gustav Meyer's classic two-volume *Friedrich Engels: Eine Biographie* (1920/1933), for example, does not refer to it; quite possibly the text, written as it was in English and published in a minor venue, was simply unknown to continental scholarship in that period. It seems first to have been translated into German around 1961, when it was included in the *Marx-Engels Werke* (MEW).[9] In addition to its appearances in the *Werke*, in the English-language *Collected Works* (MECW), and in the second version of the Marx/Engels *Gesamtausgabe* (MEGA), it has been anthologized at least twice, appearing in a little-noticed English-language collection of Engels's military writings in 1959 and in a larger East German collection of 1964.[10] Yet these various republications seem to have done little to increase its visibility in the decades since Meyer's pioneering biography. Tristram Hunt, for example, does not seem to be aware of it,

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[8] See, e.g., Martin Berger, *Engels, Armies, and Revolution* (Archon Books, 1977), pp. 52, 185; Martin Kitchen, "Friedrich Engels's Theory of War," *Military Affairs* 41 (1977), p. 120; John Mearsheimer, "Review of Marxism and the Science of War by Bernard Semmel," *Naval War College Review*, 36 (1983), p. 87 (Semmel's volume contained an excerpt from the history essay); Dennis Showalter, "Infantry Weapons, Infantry Tactics, and the Armies of Germany", p. 121; Barton C. Hacker and Sally L. Hacker, "Military Institutions and the Labor Process: Noneconomic Sources of Technological Change, Women's Subordination, and the Organization of Work," *Technology and Culture* 28 (1987), pp. 751, 773; Barton C. Hacker, "Engineering a New Order: Military Institutions, Technical Education, and the Rise of the Industrial State," *Technology and Culture* 34 (1993), p. 3.

[9] "Die Geschichte des gezogenen Gewehrs," MEW 15, pp. 195-225.

[10] *Engels as Military Critic,* introduced by W. H. Chaloner and W. O. Henderson, Manchester University Press, 1959; Friedrich Engels, *Ausgewählte militärische Schriften* Bd. 2 (Berlin, 1964).

though he titled the American edition of his biography of Engels *The General.* Paul Blackledge likewise does not mention it in his otherwise wide-ranging study of Engels's social and political thought, despite dedicating a chapter to the military writings.

Terrell Carver appears to be alone in having actually quoted directly from the essay in a general study of its author.[11] W. O. Henderson's influential two-volume biography does refer to the piece, but only indirectly, and his treatment, unlike Carver's, is at best dismissive. In a passing mention, he distances the text from the theory of historical materialism in the same breath as he reduces Engels's properly historical writings themselves to the status of attempts at proving the truth of ideas received from Marx:

> Engels often wrote about the past to confirm the accuracy of Marx's interpretation of history. But sometimes he had other reasons for writing history. His accounts of campaigns, his biographies of generals, and his essays on the rifle were straightforward writings on military history which did not necessarily illustrate the doctrine of historical materialism.[12]

To the tiny degree that "The History of Rifle" has received attention in western Marxist scholarship at all, Henderson's judgment appears, more to less, to sum up the usual reaction. Interpreters have treated the text as a footnote to Engels's longer engagement with military history, and from this perspective it amounts to an inchoate mass of factical detail, its sheer bulk testifying mostly to the overwrought enthusiasm of Engels's autodidactic erudition. From such a perspective the essay can be, indeed, safely ignored. But if the text is read instead in terms of the theory of technological change, rather than the theory of military force, we can see a different project unfolding in its pages. Indeed, to see why there is more

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[11] Carver, *Friedrich Engels: His Life and Thought,* p. 226. Carver quotes from the article's conclusion, on which more below.

[12] Henderson, *The Life of Friedrich Engels*, volume 2, p. 610. He does however go on to say more admiringly that "Engels became a military historian and critic so as to advise the workers on the science of war and the tactics of urban insurrection."

to its content than its dry narration has led so many to assume, we must ask that different kind of question: what kind of history of technology is at work in "The History of the Rifle"?

II.

In a footnote to the fifteenth chapter of *Capital,* Marx wrote that a "critical history of technology would show how little any of the inventions of the eighteenth century are the work of a single individual," and he suggested that Darwin's revolutionary account of "the history of natural technology, i.e. the formation of the organs of plants and animals," would provide the right model for such a study.[13] Engels's "History of the Rifle" exhibits precisely this character. He began work on it less than a year after he had read the *Origin of Species,* and he completed it in exactly the period when Marx himself had finally turned to Darwin's ideas.[14]

Engels's account of the rifle's development is an evolutionary one. In all its technical details, the rifle is not the "work of a single individual" but instead the result of "a great many modifications [that] have been made by many inventors."[15] The individual artifact emerges in a historical process, the product of a long interplay of innovations, social pressures, production techniques, and contexts of use. From his fine-grained picture of how

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[13] Marx, *Capital,* volume 1, trans. Fowkes, p. 494.

[14] Engels acquired a copy of Darwin's *Origin of Species* immediately upon its release in November 1859 and appears to have read it quickly, recommending it enthusiastically to Marx in a letter of early December of that year (MECW 40, pp 550-1). Marx seems only to have read the book a year later; in a letter to Engels of 19 December 1860, he mentioned that "during the past 4 weeks" he had "read all manner of things. *Inter alia* Darwin's book on *Natural Selection.* … [T]his is the book which, in the field of natural history, provides the basis for our views" (MECW 41, p. 232). Engels was at work on "The History of the Rifle" in this period, writing it between October 1860 and January 1861.

[15] The first phrase is Marx's; the second comes from Engels, "Rifle," p. 442.

the rifle was made into what it had become by his time, we can reconstruct the principles of a materialist theory of technology in history. These are implicit principles, not explicit ones; they are best expressed anachronistically, in terms that are not those of Engels's text itself. "The History of the Rifle," in other words, is most intelligible when in retrospect it is seen to contain the elements of a theory much more complex than what its surface exhibits on first glance. That theory can be summarized in the following way. Technology takes shape through the ensemble of designs and uses; its development is determined by joint-maximization problems, in a dialectic of quantity and quality; technological systems tend over time from simplicity to complexity and back to simplicity again; the transformation of the technical object is conditioned by the unanticipated effects of prior innovations; yet the sequence of technological forms is historically contingent, not given necessarily in advance.

II.1. The ensemble of designs and uses

The efficiency—even efficacy—of a technical object is not an inherent characteristic of the artifact itself but of the total situation in which the object appears. The shifting and contextual relationship between a technology's *design* and its *use* determines what kind of technical solution will be brought to bear on any given problem. How to decide, for example, between a muzzle-loading and a breach-loading gun? The competing designs themselves cannot settle the question; only the interaction between the details of the design and the repertoire of its use can determine the right choice. A muzzle-loader is more durable; a breach-loader can be reloaded more easily. If the rifle is to be used for hunting, or otherwise under conditions in which it can be reloaded without interference or haste, breach-loading presents no obvious advantage. But for infantry, who must be able to reload in tight quarters or fire several times in a minute, the muzzle-loader is far inferior, despite its

greater durability. The particular *kind* of use expected of an object can in this way shape how it is developed; but the *scale* of use required may also determine the choice between competing technical possibilities. The Minié rifle, for example, was widely adopted over a competing design (the needle-gun) in large part because "by a very simple process, all old smooth-bore muskets could be transformed into rifles fit for Minié bullets," and so when the Crimean war led to rapid mobilization of the Prussian infantry, "300,000 old muskets were rifled and rendered fit for Minié ammunition in less than a year."[16]

New technical designs make new situational uses possible—sharpshooting itself as a military tactic emerged through the combination of precision and range that rifled barrels enabled. But the interaction goes both ways, and it is the dynamic *ensemble* of designs and uses that constitutes the essence of every technological artifact.[17]

II.2. The dialectic of quantity and quality in joint-maximization problems

The transformation of the technical object, which expresses in itself the ensemble of design and use, is guided by the attempt to realize simultaneously the ideal value of multiple variables under conditions in which they appear to be in tension with each other; this can be characterized as a series of joint-maximization problems. The variables can be dictated

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[16] "Rifle," pp. 440-1.

[17] Engels's account of the rifle thus implies an analogy between the essence of technology and Marx's view, in the "Theses on Feuerbach," of the "essence of man [which] is no abstraction inherent in the single individual" but is instead "the ensemble of the social relations" (MECW 5, p 7). The emphasis on contexts of use anticipates in some respects David Edgerton's influential recent argument that the history of technology should be understood as a history of uses, rather than of inventions and innovations—as a history of reception rather than of authorship. See Edgerton, *The Shock of the Old: Technology and Global History since 1900*. Use-factors and design-elements are alike socially and historically contextual—these are *open* categories, inclusive, under the right circumstances, of everything from the routines of bodily movement to the technical conditions of industrial production. On how different varieties of—and limitations on—bodily movement shape use and thus also design, see e.g., "Rifle" pp. 437, 439.

almost purely by use contexts—for-example, the soldier should be able to carry as many rounds as possible, even as the bullet must have a particular minimum weight to impart the desired destructive force.[18] Or the variables can be given by physical factors: in the design of expansion-shot, for example, it proved difficult "to fix a shape for the hollow part of the bullet which would prevent crushing while it allowed expansion," and it was "almost impossible to unite the two elements, solidity and expansibility," without the innovation of adding a separate "plug," of a different material, to the hollow area.[19] This adaptation itself, however, introduced new problems for the use of the weapon (e.g., the plug could detach, launching in hazardous directions), inducing further rounds of redesign and reuse.[20]

The resolution of such problems of joint-maximization involves a dialectical interplay between quantitative factors and qualitative forms. The ideal weight of the bullet demands that it must have a particular shape; that particular shape of the bullet demands a particular number of rifled grooves. The quantitative variables turn into qualitative wholes, and the chosen qualities demand new quantitative measures in turn. *Dialectic of quantity and quality*—to put it in this way is perhaps to express a rather mundane fact in unduly philosophical language; but Engels's materialism, if it was characterized by anything at all, was certainly characterized by an enthusiasm for the philosophical significance of the only apparently mundane. The "transformation of quality into quantity and vice versa" was a fundamental dialectical principle for Engels.[21] But of course, as Michael Heinrich has noted,

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[18] "Rifle," p. 458.

[19] "Rifle," p. 443.

[20] "Rifle," pp. 442ff.

[21] *Dialectics of Nature,* MECW 25, p. 356.

"Engels was clear that with such general statements nothing is understood about individual processes."[22] So-called "dialectical principles" provide an orientation toward inquiry, not a finished system of results. And in his study of the rifle, as elsewhere, Engels draws attention to how the dialectical interplay of quantity and quality is always *historically specific,* not a transcendent feature of the abstract concept of what any given technology is. The dilemmas of breach-loading exemplify the fundamentally historical character of any joint-maximization problem:

> The great difficulty always was to join the moveable breech in such a way to the barrel that it could be easily separated and put on again, and that the mode of fixing it was solid enough to stand the explosion. With the deficient mechanical contrivances of those times [of early rifle-manufacture], these two requisites could not be combined.

Thus the muzzle-leader remained preferable; "the ramrod ruled supreme."[23] Only when the technical conditions of production transformed in the wider social developments of industrialization could breach-loading systems be designed in such a way as to maximize both the ease of opening the breech and its durability against the explosion it contained. Which particular forms of quantity (e.g., explosive force) and quality (e.g., breech-design) interact at all, and in what way, can only be determined contextually.

II.3. Tendential development from complexity to simplicity

Technology, as the ensemble of uses and designs developing in a dynamic interaction of quantitative factors and qualitative forms, becomes more complex over time. This seems obvious. The smooth bore of the musket gives way to the twisted grooves of the rifle's barrel, and as a result, there develops a complicated system for holding the bullet in place

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[22] Heinrich, *Introduction to the Three Volumes of Marx's Capital,* p. 37

[23] Preceding quotations: Engels, "Rifle," pp. 447-8.

above the powder while it is pounded into the grooves by the ramrod. But such complexity can give way to simplicity once again. When the forcible-loading system of the ramrod was replaced by the expansion-bullet, which took the grooves directly by the explosion of the powder itself, it was no longer necessary to design a way to hold the shot above the powder, and thus was "restored to the rifle the simplicity which it had possessed" beforehand.[24] This is a movement from complexity to simplicity at the level of the physical design of the object, but such a development can take place in the sphere of the object's use-practices as well. The replacement of muzzle-loading by breach-loading, for example, drastically simplifies the action of reloading the gun. Such movement from complexity to simplicity can characterize the development of *principles* of technique as well. Engels outlines, for pages and pages, the many different factors affecting how rifles were improved in one way or another—only to conclude, at the end of the essay, that this long process of development produced a technical situation in which no matter what basic system of design is chosen, a single rule of thumb will guide its further development: "The smaller the bore, the better the rifle."

But in every case, the movement from simplicity to complexity and back to simplicity again is not a mere obliteration of that intermediary complexity, but a recuperation of it in a different form. This is a kind of negation of the negation, as Engels might elsewhere have called it. As a technology develops over time, a single and apparently simple aspect can simultaneously fulfill many different functions or satisfy many different demands. Engels's analysis anticipates what the twentieth-century philosopher of technology Gilbert Simondon would describe as the "process of concretization" in "the conditions of technical evolution."[25] "In the technical object," Simondon writes, "over-determination of the system

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[24] "Rifle," p. 440.

[25] Simondon, *On the Mode of Existence of Technical Objects, pp.* 29ff.

of structures within the regime of their functioning makes the technical object more concrete by stabilizing its functioning without adding a new structure";[26] under the right conditions, the technical object can become simpler in structure as it becomes more complex in function. As Engels presents it, this is a *tendency* of technology in history, but certainly not an invariable "law" of development in all places and times. Engels, indeed, is not prepared to admit that there is any historical process that functions always and everywhere in the same way.

II.4. Conditioning by the unanticipated effects of prior innovations

As a technology develops in these ways—as the ensemble of designs and uses, as the interplay of quality and quantity, as a movement from complexity to simplicity—its trajectory from moment to moment is fundamentally conditioned by the *unexpected* implications of earlier changes. Engels's concern for the unanticipated effects of apparently careful decisions recurs again and again in his writings on both social and natural history. (In one of the fragmentary essays composed in connection with his unfinished *Dialectics of Nature* project, he considers such unintended effects in what we would now call ecological terms, writing of how, in all human action upon the natural world, "the uncontrolled forces are far more powerful than those set into motion according to plan.")[27] Marx once wrote that while human beings make history, "they do not make it under circumstances chosen by themselves, but under circumstances directly encountered, given and transmitted from the past."[28] In Engels's study of the rifle, this dynamic is uncovered in technological history as

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[26] Simondon, *Technical Objects,* p. 35.

[27] *Dialectics of Nature,* MECW 25, p. 330. His examples range from deforestation to potato blight.
[28] Marx, *The Eighteenth Brumaire,* MECW 11, p. 103.

well, but now as a potentially beneficial and generative process, rather than an only destructive and limiting one. The invention of elongated shot, for example, was intended merely to improve how the bullet took the imprint of the rifled grooves and thus to stabilize its flight; but this new kind of bullet turned out to be able to work effectively with "a reduced pitch of the rifling as well as of a reduced depth of groove," and "these circumstances facilitate the cleaning of the arm, and at the same time permit the use of full charges without increasing the recoil of the gun."[29] A whole repertoire of technical possibilities opens up as a result; a whole set of conditions of use are transformed. The *unintended* result thus conditions further developments of the technical object. The path of technological development depends less on whether things go according to plan than on what is made possible by all the ways they do not.

II.5. Historical contingency of the sequence of technological forms

The dynamic interrelation between use and design, the structuring significance of joint-maximization dilemmas, the tendency to develop from an initial complexity to a higher simplicity, and the conditioning role of every change's unforeseen effects—these principles, in Engels's presentation, add up to a materialist historiography of technology that is fundamentally non-determinist and anti-teleological. The sequence of development from one technological form to another is not given in advance by the terms in which a technical problem is set; it is, instead, always historically contingent, its results emerging from the interplay of elements whose dynamics cannot be predicted in advance. From Engels's discussion of how the expansion and compression systems emerged as substitutes for the

[29] Engels, "Rifle," p. 438.

deliberate deformation of the bullet by the ramrod, one might conclude that the inherent defects of the latter left it nowhere preferable to the alternatives; but in fact Engels notes that the ramrod-system persisted in the extraordinarily high-quality rifles of Swiss sharpshooters, which were used in rather different conditions than those of field infantry and thus could be designed in a way that allowed for more careful and less rapid loading of the weapon. In the right use-conditions, an apparently "older" technolgoical form will persist or even reemerge. Likewise with the relation between breech-loading and muzzle-loading: it might seem that the former would inevitably succeed the latter as any firearm developed over time, but Engels rejects this idea out of hand, noting that in the development of the cannon, the sequence proceeded in the other way, breech-loaders coming first.[30] The sequence of forms is always socially specific, historically specific, and *technologically* specific: what appears to hold in one family of objects may be the opposite of what characterizes another.[31] Engels's technological materialism entails neither a logic of simple supersession nor a principle of linear determinism. It is not that technologies are always constrained by social relations; rather, every technology is itself a site of social relationality.

Engels's "History of the Rifle" suggests a rifle theory of technology: like the grooves in the barrel of the gun, the change over time of every technical object takes always a spiral motion, a spinning forcefulness, propelled at first by some initial impulse but shaped and redirected

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[30] "Rifle," p. 447.

[31] Naive visions of inevitable technological "stages" were a recurrent target of Marx and Engels alike. In "Saint Max," the critique of Max Stirner that constitutes the bulk of the manuscripts known today as *The German Ideology,* they wrote sardonically of such ideas: "The inactive petty bourgeois, for whom railways dropped from the sky and who for that very reason imagines that he invented them himself, begins to indulge in fantasies about aerial flight after having once travelled by railway. Actually, the balloon came *first* and then the railways." (MECW 5, p. 303, emphasis original.)

by its material surround, which too it leaves behind. The spiral development of technology spins never inward toward some destiny preordained, but flies always out, to ends as yet unknown. — Animating Engels's essay on the rifle is an anti-idealism in the field of the history of technology; the study brings into the sphere of technical change the repudiation of idealist historiography that Marx and Engels first worked out clearly in the manuscripts now known as the *German Ideology*. No technological process is perfectly guided by the unfolding of a singular *idea,* of a unified plan formed in advance by a great mind; technology evolves through the dynamics of the material, social situation in which it assumes its always-shifting forms.

III.

The mass of technical detail that comprises the text of Engels's "History of the Rifle" suggests the outline of a critical materialism of technology. But the textual form of that history presents a puzzle about why it concludes in the way that it does. In the final paragraph of the essay, Engels justifies such long and detailed attention to his "rather dry" subject by proclaiming that "no intelligent soldier ought to be ignorant of the principles on which his arms are constructed, and are expected to act."[32] This is a strange way to conclude a thirty-page description of why the rifle is not built in the obsolete ways that it once was. If soldiers must understand their weapons, would not a diagram or two serve them better by far?[33]

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[32] Engels, "Rifle," 459.

[33] And Engels was not averse to including diagrams in the works he circulated among the volunteers; his later article "Rifles and Rifle-Shooting" (MECW 18, pp 495-499) reproduces a diagram of a bullet design from another article on the subject that he quotes from at length.

Perhaps Engels's appeal to the importance of know-how is a mere rhetorical flourish, appended as a legitimating fig-leaf for the appearance in a militia-movement magazine of a text he had dreamed up from his own preoccupations, quite apart from any popular fears of the dastardly French.[34] But perhaps not. If we take Engels's exhortation literally, if we simply treat it as what it presents itself to be—the moral of the story, the concluding lesson of his lengthy tale—a whole perspective on the meaning of technical knowledge and on the politics of the technological artifact comes at once into view.

In the *Capital*-footnote, Marx suggests that "technology reveals the active relation of man to nature," and that in this way technology "also lays bare the process of the production of the social relations of his life, and of the *mental conceptions that flow from those relations*."[35] Chief among the "mental conceptions" of technological capitalism, as any reader of *Capital* knows too well, is the fetish of the commodity. As Moishe Postone argues, Marx's account of fetishization analyzes the way in which the commodity, in capitalist society, stands in for the social *relations* in which it emerges, such that "the manifest forms [i.e., the commodities] are taken to be the whole," in a "systematic misrecognition"[36] of their historical nature. Marx's critique of the fetish "does not refer merely to socially constructed illusions, but attempts to socially account for various forms of subjectivity,"[37] forms in which external objects provide the proxies in our consciousness for the historical processes (and forms of social domination) they express. Commodities in this way have an epistemic character in

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[34] Recall that Engels originally hoped to publish the piece for an *American* audience, not for the volunteer-movement at all.

[35] Marx, *Capital,* volume 1, p. 494, emphasis added (the same footnote referred to above).

[36] Postone, *Time, Labor and Social Domination,* p. 70.

[37] Postone, *Social Domination*, p. 224.

capitalism, functioning (as William Clare Roberts suggests) "as the conduits of social power and of the information necessary" for action.[38] When we fetishize commodities, we grasp a truth—the truth that the social relations of capitalism are mediated by *things*—but we grasp that truth falsely, in a way that makes it appear natural to the world and alien to us; its human origins, its historical contingency, is obscured rather than revealed. In his critique of commodity fetishism, Marx attempts to provide a way to grasp simultaneously the truth that the fetish expresses (that in capitalism mere things factically embody our real relations) *and* the truth that it obscures (that this character of the commodity is the result of a social and historical process, one that is mutable and not "natural" or inevitable).

When Engels spends thirty pages detailing the complex history of the rifle, and then concludes by proclaiming that every soldier should know how his rifle works, he is making a claim about the relationship between knowledge of a technical object and knowledge of the social processes that have made that object what it is. Just as Marx tries to get behind our fetishism of the commodity by demystifying the processes through which it comes to be the "very strange thing, abounding in metaphysical subtleties and theological niceties" that it is,[39] so too does Engels work against the everyday view of the commodified weapon as a repository of power independent of human action in the world. "People again begin to see that men, and not muskets, must win battles"; the firearm is a social fact, not an independent power whose character and meaning could perdure outside its context of production and use.[40] The historiographical principles implicit in Engels's study of the rifle—the materialist theory of technology it displays—counteract any fetishism of the implements of force whose

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[38] Roberts, *Marx's Inferno,* 82.

[39] Marx, *Capital,* volume 1, p. 163

[40] Engels, "Rifle," 452.

development the essay recounts. No longer can the volunteer regard his weapon in a mystified way, as an alien power set against him or as an external source of an alien power to set against others. Instead, the rifle is revealed as the product of social relations and as an element within them—as a constitutive dimension of historical forces that the volunteer may, must, claim as his own. This is why "no intelligent soldier ought to be ignorant of the principles" of his weapon, and why such knowledge requires attention to the rifle's history and not only to the mechanical details of its function as an isolated object. Engels's historiography becomes a critique of the mystifications of the weapon-fetish, the form that the commodity-fetish takes when the commodity is not only the product of the means of production-—but the instrument of the means of destruction as well.[41]

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A decade and a half after writing the "History," Engels returned briefly to the rifle, but now in a more languorously philosophical mood. In a fragment composed around 1874, in connection with his project on nature and dialectics, Engels imagined the rifle as a model for our knowledge of causality in the material world. He admits the force of Hume's skepticism, conceding "that a regular *post hoc* can never establish a *propter hoc."* But what the skeptic of our knowledge of causes forgets, Engels suggests, is that we do not simply reflect passively on what we see around us, but interact with it ourselves, putting our ideas about the workings of the world to the test of the world's workings themselves. The passage is worth

[41] I take the phrase "means of destruction" from Wolfgang Streeck, "Engels's Second Theory: Technology, Warfare, and the Growth of the State." This brief and remarkable essay, though without attention to the "History of the Rifle," provides an excellent account of the significance for historical materialism today of Engels's writings on military history and technology. Streeck argues that Engels's attention to the "internal dynamics of military-technological advance" can help "provide a more realistic historical-materialist theory of capitalist society," accounting for the "capitalist mode of destruction" (80-1).

quoting at length:

> If we bring together in a rifle the priming, the explosive charge, and the bullet and then fire it, we count upon the effect known in advance from previous experience, because we can follow in all its details the whole process of ignition, combustion, explosion by the sudden conversion into gas and pressure of the gas on the bullet. And here the sceptic cannot even say that because of previous experience it does not follow that it will be the same next time. For, as a matter of fact, it does sometimes happen that it is *not* the same, that the priming or the gunpowder fails to work, that the barrel bursts, etc. But it is precisely this which *proves* causality instead of refuting it, because we can find out the cause of each such deviation from the rule by appropriate investigation: chemical decomposition of the priming, dampness, etc., of the gunpowder, defect in the barrel, etc., etc., so that here the test of causality is so to say a *double* one.
>
> Natural science, like philosophy, has hitherto entirely neglected the influence of men's activity on their thought; both know only nature on the one hand and thought on the other. But it is precisely the *alteration of nature by men,* not solely nature as such, which is the most essential and immediate basis of human thought, and it is in the measure that man has learned to change nature that his intelligence has increased. The naturalistic conception of history, as found, for instance, to a greater or lesser extent in Draper and other scientists, as if nature exclusively reacts on man, and natural conditions everywhere exclusively determined his historical development, is therefore one-sided and forgets that man also reacts on nature, changing it and creating new conditions of existence for himself. There is devilishly little left of "nature" as it was in Germany at the time when the Germanic peoples immigrated into it. The earth's surface, climate, vegetation, fauna, and the human beings themselves have infinitely changed, and all this owing to human activity, while the changes of nature in Germany which have occurred in this period of time without human interference are incalculably small.[42]

Here there is no promethean valorization of the *domination* of nature by means of technology. What is praised, instead, is how our *knowledge* of nature is formed by transformative interaction with the material world. The rifle is not imagined as a tool for mastering nature, nor even as a tool for mastering other human beings; as a technological artifact, it crystalizes a particular set of material relations, and in our use of that artifact we come to know the workings of the world as revealed in those particular relations themselves. For Engels, as for Benjamin, technology becomes a way of mastering the human relation to nature, not simply a tool for mastering nature itself.

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[42] Engels, *Dialectics of Nature,* MECW 25, 510-11, emphases original.

In *Intellectual and Manual Labor*—a critique of epistemology modeled on Marx's critique of political economy—Alfred Sohn-Rethel announces a similar ambition. He decries the way in which "the existing technology serves as machinery for the exploitation of one class by another" and for the exploitation of nature as well; quoting Ernst Bloch, he writes that "the science and technology of our age rule over nature like 'an occupying army in enemy country,' whereas in socialism we must aim to establish 'an alliance of society with nature.' This cannot be done by dispensing with science, but demands the aid of a science backed by the unity of mental and manual work."[43] Sohn-Rethel could as easily have quoted Engels as Bloch in this passage, for elsewhere in the *Dialectics of Nature* Engels derides the incessant human delusion that we "rule over nature like a conqueror over a foreign people, like someone standing outside nature"; instead, "we, with flesh, blood and brain, belong to nature, and exist in its midst … all our mastery of it consists in … being able to learn its laws and apply them correctly."[44] A form of technological praxis in which intellectual and manual labor, knowledge and know-how, are united rather than divided: this is the generalized form of what the concluding exhortation of Engels's "History of the Rifle" suggests. The volunteers must understand the principles on which their weapons operate, rather than leave such understanding to the privileged minds of their educated officers—and they can only do so by grasping the weapon's *history,* and not only its mechanics. This is Engels's version of what Sohn-Rethel describes as the unity of head and hand: to grasp the apparent abstraction of the artifact in terms of its emergence in social and historical evolution. Only in this way can technology be made the instrument not of the mastery of nature and of other human beings, but of the mastery of our relation to the natural and human world itself.

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[43] Sohn-Rethel, *Intellectual and Manual Labor,* 180-81.

[44] Engels, *Dialectics of Nature,* MECW 25, p. 461.