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Research article

The Dialectics of Labour, Machinery, and Capital – An Interpretation Centered on Marx’s *Notes on Johann Beckmann II and Capital*

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Abstract

The historical essence of machinery and of its capitalist application, along with the dialectics of labour, machinery, and capital, has always been a crucial subject in Marx’s critical theory of capitalism. In “Beiheft C” (1863) Marx compiled excerpts from *A History of Inventions* by the German technologist Johann Beckmann. Beckmann’s account of the dual social impact of machinery during the manufacturing period, particularly his historical narrative of workers’ intense struggles against machinery, brought Marx to confront the so-called “Beckmann Dilemma”: How are the primordial dual aspects of machinery possible? Within the overarching framework of historical materialism and the critique of political economy, Marx progressively deepened his theoretical perspective and intellectual logic for resolving the “Beckmann Dilemma” in the *Economic Manuscripts of 1861–1863*. There he examined themes such as the relationship between machinery and wages, as well as machinery and primitive accumulation. In *Capital*, Marx comprehensively revealed the historical logic and essential laws governing machinery and its capitalist deployment, correctly distinguishing between machinery as such and its capitalist deployment. He exposed the determinate social forms of machinery and its emancipatory potential, while profoundly clarifying the real essence of the contradiction between workers and machines and proposing the corresponding strategies of struggle – thereby achieving both a scientific resolution and a fundamental transcendence of the “Beckmann Dilemma.” The excavation and critical analysis of Marx’s and Beckmann’s theories of machinery will provide valuable insights for reflecting on contemporary human-machine relations in the era of digital intelligence.

Keywords: Marx; Johann Beckmann; Machinery; Technologie; *Notes on Johann Beckmann; Capital*

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Научная статья

Диалектика труда, машин и капитала – Интерпретация, основанная на “Записках Иоганна Бекмана II” Маркса и “Капитале”

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Аннотация

Историческая сущность машин и их капиталистического применения, наряду с диалектикой труда, машин и капитала, всегда были важнейшей темой в критической теории капитализма Маркса. В книге “Beiheft C” (1863) Маркс переработал отрывки из истории изобретений немецкого технолога Иоганна Бекмана. Рассказ Бекмана о двойственном социальном воздействии машин в период промышленного производства, в частности, его историческое повествование об ожесточенной борьбе рабочих против машин, поставили Маркса перед так называемой “дилеммой Бекмана”: Как возможны изначальные двойственные аспекты машин? В “Экономических рукописях” 1861-1863 годов Маркс, опираясь на всеобъемлющие принципы исторического материализма и критику политической экономии, постепенно углублял свою теоретическую перспективу и интеллектуальную логику решения “дилеммы Бекмана”, исследуя такие темы, как взаимосвязь между машинами и заработной платой, а также между машинами и первоначальным накоплением. В “Капитале” Маркс всесторонне раскрыл историческую логику и основные законы, управляющие техникой и ее капиталистическим применением, правильно проведя различие между техникой как таковой и ее капиталистическим внедрением. Он раскрыл специфические социальные формы машинного производства и его освободительный потенциал, глубоко прояснив при этом реальную суть противоречия между рабочими и машинами и предложив соответствующие стратегии борьбы, тем самым достигнув как научного разрешения, так и фундаментального преодоления “дилеммы Бекмана”. Изучение и критический анализ теорий машинного оборудования Маркса и Бекмана даст ценную информацию для размышлений о современных отношениях между человеком и машиной в эпоху цифрового интеллекта.

Ключевые слова: Маркс; Иоганн Бекман; Техника; Технология; “Заметки Иоганна Бекмана”; “Капитал”

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INTRODUCTION

It remains one of the crucial questions for inheriting and developing Marx's critique of capitalism how to properly understand the social effects and historical essence of machinery in the formation and development of the capitalist mode of production. Marx's excerpts from and usage of Johann Beckmann's *A History of Inventions*, as well as his intellectual journey centered on the “Beckmann Dilemma”, provide us with a paradigmatic micro-perspective for examining Marx's exploration of this question. In a letter to Engels on January 28, 1863, Marx noted: “I am inserting certain things into the section on machinery. There are some curious questions which I originally failed to deal with” (Marx & Engels, 2010d, p. 449). This indicates that beginning in January 1863, Marx returned to his research on the historical development of machine and technology and their socio-historical impacts. In doing so, he not only reorganized the extensive notebooks about technology and political economy which he had compiled in an earlier phase, but also re-examined and supplemented excerpts from numerous works he deemed of paramount importance. According to the research by Artur Schnickmann, editor of the MEGA²(second Marx-Engels-Gesamtausgabe), during May and June 1863, in the later stages of writing the *Economic Manuscripts of 1861-1863* (hereafter just the *Manuscripts of 1861-1863*), Marx compiled eight notebooks titled *Beihefte*, labeled with letters “A” to “H,” in order to further collect and supplement materials on political economy and *Technologie*. This group of texts totals 786 pages, with nearly 700 pages dedicated to political economy issues that are drawn from over 150 works (Schnickmann, 1979). Among these, Marx excerpted from Johann Beckmann's *A History of Inventions* (1780-1805) in “*Beiheft C*”. All these excerpted materials were subsequently used by Marx in *Notebooks XXI-XXIII* of the *Manuscripts of 1861-1863*.

Johann Beckmann is recognized as a pioneering figure in 18th-century German technological science (*Technologie*) and commodity science (*Warenkunde*). His works on *Technologie*, in conjunction with those of his student J. H. M. Poppe, provided Marx with crucial theoretical resources for understanding the history of technological inventions during the periods of handicraft and manufactures, as well as the resulting transformations in the labour process, material modes of production, social relations, and ideological conceptions. During his work on *Notebook XV* of the *London Notebooks* in 1851, Marx first briefly excerpted from Beckmann's *A History of Inventions*, which can be termed as *Notes on Johann Beckmann I*. In 1863, while composing “*Beiheft C*,” Marx revisited and expanded his excerpts from the same work, significantly broadening their thematic scope and content, which can be termed as *Notes on Johann Beckmann II*, constituting a crucial component of Marx's third study on *Technologie* conducted in the 1860s.¹

¹ Marx's study on *Technologie* can be broadly divided into three phases: the first is the extracts from the writings of Auguste de Gasparin, Charles Babbage, and Andrew Ure in *Notebook 5* of the *Brussels Notebooks* in 1845; the second is the extracts from the writings of J. H. M. Poppe, Andrew Ure, and Johann Beckmann in *Notebook XV* of the *London Notebooks* in 1851; and the third phase is the re-examination of earlier notebooks on *Technologie* and re-excerpts from the writings of Charles Babbage, Johann Beckmann and others in the 1860s.



Until now, Marx's *Notes on Johann Beckmann II* have not yet been published in MEGA², and even the original manuscripts of the entire *Beiheft C* remains in private hands. Fortunately, the German scholar Hans-Peter Müller obtained a copy of *Notes on Johann Beckmann II* and published them for the first time, providing us an opportunity to examine the real content of this text. These materials provide us with a unique micro-perspective for understanding Marx's theoretical research, intellectual development, and working methods during this period. In particular, Marx's use of *Notes on Johann Beckmann II* in *Capital* offers us a paradigmatic case study for delving deeper into the critical perspective of political economy and the scientific method of historical materialism that Marx employed when examining the historical essence of machinery and its capitalist application.

Based on Müller's edition of *Notes on Johann Beckmann II* and situated within relevant textual sources and intellectual-historical contexts, this paper attempts to explore the issues in three aspects:

Firstly, through a textual analysis of the *Notes on Johann Beckmann II* to clarify Marx's focal problematic and theoretical intentions at this stage, analyzing the crucial theoretical challenge posed to Marx by Beckmann's account of the dual socio-economic effects of machinery, which could be designated as the "Beckmann Dilemma," while highlighting the substantial theoretical limitations inherent in Beckmann's account of the history of technology.

Secondly, by contextualizing Marx's repeated engagements with the *Notes on Johann Beckmann II* in the *Manuscripts of 1861–1863*, dissecting Marx's preliminary resolution of the "Beckmann Dilemma," highlighting his philosophical methodology, shifts in theoretical perspective, and progressive logical developments.

Thirdly, through a rigorous analysis of *Capital*, demonstrating Marx's scientific solution and fundamental transcendence of the "Beckmann Dilemma," while drawing out its contemporary implications.

NOTES ON JOHANN BECKMANN II AND THE "BECKMANN DILEMMA": WHAT MAKES THE "JANUS METAPHOR" OF MACHINERY POSSIBLE?

In *Notebook XV* of the *London Notebooks* (1851), Marx only briefly summarized sections from Volumes 1 and 2 of Beckmann's five-volume *A History of Inventions* [*Beiträge zur Geschichte der Erfindungen*] (Beckmann, 1780-1805), which addressed non-productive inventions or discoveries, such as distilled spirits and tulips (Marx & Engels, 2023, p. 141). This might create the impression that Beckmann's influence was marginal compared to classical political economists and *Technologie* writers like Poppe, Andrew Ure, and Charles Babbage (Müller, 1999, p. 228). But in *Beiheft C* Marx re-excerpted in 1863 the complete five volumes of Beckmann's *A History of Inventions*. This indicates Marx's growing recognition of Beckmann's significance as a distinct theoretical resource.

The Beckman's dilemma arises from two opposing dimensions: On the one hand, the industrial application of machinery has greatly accelerated the



transformation of the mode of material production and livelihood, laying the material foundation for human development and liberation.

(1) Machinery significantly enhances the productivity of labour. For example, the ribbon-loom “can weaves 4 to 6 pieces at once,” and “using this machine, one person can easily produce more in the same amount of time than several individuals did previously” (Müller, 1999, pp. 233-234). This aspect was not addressed in the 1851 *Notes on Poppe* (Müller, 1981, pp. 79-80), as Poppe’s *History of Technology* similarly omitted it (Poppe, 1807, pp. 484-485), but Marx later focused on it specifically in the *Manuscripts of 1861-1863*.

(2) Machinery promotes the advancement of socio-economic development. Marx noted that improvements in saw-mills accelerated the rapid development of wood processing and export trade. For example, “in 1530, timber-rich Norway developed its first cutting machine [...] As a result, timber exports increased significantly” (Müller, 1999, p. 235). This indicates that a series of productivity-enhancing technological innovations had already emerged in the pre-industrial era, driving the growth of related industries and socio-economic development.

Machinery thus promotes the abundance of material means of subsistence, providing a critical foundation for human emancipation. When Marx excerpted material pertaining to the history of the corn-mill (*Getreide-Mühlen*), he first cited the poem by the ancient Greek poet Antipater of Thessalonica:

Cease your work, ye maids, ye who laboured in the mill;
sleep now, and let the birds sing to the ruddy morning; for
Ceres has commanded the water-nymphs to perform your task:
these, obedient to her call, throw themselves on the wheel,
force round the axle-tree, and by these means the heavy mill (Müller, 1999, p. 234).²

Beckmann noted that in this hymn “neither humans (*Menschen*) nor livestock (*Vieh*) are visible” (Müller, 1999, p. 229). This reveals both the mechanization of grain milling, shifting from human/animal power to natural forces, and the ancient Greeks’ optimistic view of machinery’s potential to liberate human labour – Marx directly quoted and analyzed this poem in *Capital*.

Marx then excerpted content about the economic mill (not covered in his 1851 *Notes on Poppe*), noting its adoption due to population growth and rising flour prices. The economic mill significantly improved grinding precision and output, securing material subsistence for expanding populations (Müller, 1999, p. 234). Müller observed: “The economic mill is primarily a technology born out of necessity” (Müller, 1999, p. 229). More precisely, this fact reaffirms Marx’s view that technological inventions fundamentally arise not from individual curiosity or technical logic, but from the developmental imperatives of specific socio-economic relations.

² The English translations of these verses can be found in Johann Beckmann’s *A History of Inventions*. (Beckmann, 1846, p. 152)



On the other hand, the productive application of machinery harmed workers' interests, sparking intense conflicts between workers and machines, as well as panic and prohibitions by feudal ruling classes. For instance, the introduction of the ribbon-loom "provoked disturbances and complaints from the weavers, until the town council finally prohibited the use of this instrument [...] fearing that this invention would reduce numerous workers to beggary, the city council prohibited its use and secretly had the inventor strangled or drowned" (Müller, 1999, pp. 233-234).

When Marx excerpted content on sawmills, he again highlighted the antagonism between machinery and workers – a theme mentioned in Poppe's *History of Technology* but omitted in the *Notes on Poppe*. He noted: "In England, saw-mills had at first the same fate that printing had in Constantinople, the ribbon-loom in the Roman Empire, and the crane in Strasbourg. When attempts were made to introduce them they were violently opposed, because it was apprehended that the sawyers would be deprived by them of their employment opportunities and daily wages. For this reason it was found necessary to abandon a saw-mill created by a dutchman near London, in 1633; and in the year 1700, Houghton expressed his apprehension that it might excite the rage of the populace" (Müller, 1999, pp. 235-236).

This reveals a paradoxical real contradiction in Beckmann's historical narrative: while the productive application of machinery enhances productive powers of labour, promotes economic development and social prosperity, and liberates human labour, it simultaneously becomes labour's competitor, thus provoking the workers' struggle and then the ruling class's opposition to the new machines. Müller argues that this phenomenon reflects how technological changes since the early modern period disrupted and challenged the consensus rules established between the rulers and the ruled to maintain the stability of traditional modes of production and social structures. Here, the logic of economic gain clashed with the logic of subsistence, arousing strong opposition from those involved (Müller, 1999, S. 229). However, this seemingly reasonable explanation oversimplifies the extremely complex class relations and historical processes underlying the phenomenon, thereby obscuring the critical theoretical issues embedded within it.

In fact, the contradictory phenomenon caused by capitalist production based on machinery, particularly the antagonism between workers and machinery, had already been widely discussed in the literature of political economy and *Technologie* at that time. Why did Marx pay special attention to Beckmann's account? From the perspective of intellectual history concerning the worker-machine problem, Beckmann's narrative occupies a unique position: His argument differs from the views of Ricardo and Ure regarding the age of modern industry who acknowledged and defended the sharp opposition between workers and machines, and it differs also from Smith regarding the period of manufacturing who emphasized that machines were subordinate to the division of labour and were in harmony with workers in the sense of enhancing the well-being of the general society. In contrast, Beckmann was keenly aware of the paradoxical consequences of the initial application of machines during the period of manufacture, clearly highlighting the antagonism between workers and machines. This would undoubtedly have had a strong impact on Marx, who had been familiar with Smith,



Ricardo, Ure and others, and led to a crucial theoretical problem: How is this originary dual character of machinery possible? Here, we tentatively designate this issue as the “Beckmann Dilemma” – which, in essence, constitutes a central question in the philosophy of technology. For example, Bernard Stiegler used Janus, the two-faced god of Roman mythology who symbolized origins, as a metaphor for the two-faced nature of technology (Stiegler, 2020, p. 231).

However, Beckmann’s narrative of the history of technology and its implicit “Beckmann Dilemma” reveal major theoretical flaws of bourgeois ideology. Firstly, there is a latent techno-determinism, techno-fetishism and techno-original-sin rooted in an implicitly idealist conception of history. In Beckmann’s historical narrative, machines are treated as the sole determining factor of socio-historical development, while the antagonistic relationship between machines and labour across different spatio-temporal contexts is homogenized. This fundamentally repeats the same error committed by political economists: They just observe the abstract unity while obscuring the essential differences (Marx & Engels, 2010a, p. 23), thereby conflating machinery as such with its specific social applications, and thus lapsing into a non-historical, implicitly idealist conception of technological determinism. Based on this, Beckmann’s account of workers resisting and authorities prohibiting machinery implicitly reflects a notion akin to techno-original-sin – that is, attributing the adverse effects of machines on workers entirely to the machines themselves, as if technological inventions inherently possess an originary evil. Secondly, there is the conception of individual-heroism on machine invention. In Beckmann’s narrative, machines are portrayed as the creations of genius-like individuals, this perspective disregarding the broader historical accumulation and specific social relations that underpin these inventions. Thirdly, an implicit bourgeois standpoint permeates Beckmann’s narrative. For example, Beckmann frames workers’ resistance to machines as “mob riots,” while portraying feudal rulers’ prohibitions on machinery in a negative light.

In summary, although Beckmann had earlier perceived the two-sided nature of the machinery, he was bound by his basic position and methodology and was not yet able to correctly reveal the historical logic and essential laws underlying this phenomenon. In contrast, when Marx encountered the “Beckmann Dilemma”, he would not just stay on the surface of the problem, but would inevitably ask about its inherent laws and developmental tendencies from the perspective of historical materialism. This inquiry can be broken down into three dimensions:

Firstly, Beckmann suggested that workers opposed machines primarily because the application of machines led to unemployment or wage depression. But is this causal relationship necessarily true? What is the internal mechanism behind it? Secondly, Beckmann’s narrative demonstrates that the productive application of machinery, from its inception, universally provoked worker resistance and the repression of the ruling-class. This fact not only validates a fundamental principle of Marx’s historical materialism: transformations in the means of labour necessarily bring about changes in the mode of production and social relations, but also raises a deeper question: Is machinery inherently opposed to labour? If the answer is no, then what are the historical preconditions and root causes that lead to this opposition of humans and machines?



Thirdly, how should workers correctly understand and respond to the real effects of machinery? These three questions ultimately converge on a central issue: How can we properly understand the historical nature of machines and their capitalist applications? Marx's resolution of the "Beckmann Dilemma" simultaneously overcomes and transcends Beckmann's theoretical limitations.

THE *ECONOMIC MANUSCRIPTS OF 1861–1863* AND THE EXPLORATORY JOURNEY TO DECIPHER THE "BECKMANN DILEMMA"

As previously discussed, Marx's *Beihefte* served as preparatory materials for the theoretical issues he intended to explore. This characteristic equally applies to the *Notes on Johann Beckmann II*. Marx's repeated engagement with these *Notes* in the *Manuscripts of 1861–1863* and *Capital* were not only tied to its explicit thematic content but also instrumental to his reflections on pivotal theoretical questions. In other words, Marx deployed the *Notes on Johann Beckmann II* within the overarching framework of his critique of political economy. Therefore, by analyzing the specific contextual applications of the *Notes* in the *Manuscripts of 1861–1863*, we can trace the foundation of scientific methodology, shifts in problematics, and logical progression of thought of Marx gradually cracking the "Beckmann Dilemma."

Firstly, Marx sought to address the "Beckmann Dilemma" by employing the method of "from the abstract to the concrete", that is, to transcend the narrow logic of *Technologie* narratives and to situate the problem of machinery's capitalist application within the broader socio-economic context. Specifically, while drafting the *Manuscripts of 1861–1863*, Marx routinely appended thematic indices to the inside front cover of his notebooks. For *Notebooks XXI–XXIII*, he added a "List of Excerpted Works" to mark their usage in the manuscripts. For instance, in the "List of Excerpted Works" of *Notebook XXIII*, Beckmann appears as an independently noted author under the 19th item (Marx & Engels, 2010b, p. 476). Crucially, the contextual placement of the item "Beckmann" reveals Marx's methodological intention: he grouped Beckmann with Smith's labour theory of value, Malthus and Ensor's theories of population, Sismondi's theory of commercial wealth, as well as Dudley North's theory of merchant capital. This collocation demonstrates Marx's effort to disclose the historical enigma of capitalist production by uncovering the hidden connections between these seemingly disparate theoretical issues.

Secondly, Marx conducted a preliminary exploration of the problem of machinery bringing down wages from the perspective of capital-labour exploitation and the labour theory of value. In *Notebook XXI*, while analyzing the causes of the decline in wages, he drew on the "*Notes on Johann Beckmann II*", specifically engaging with the first dimension of the "Beckmann Dilemma": the relationship between machinery and the declines in wages. Marx began by criticizing Malthus and others for their chaotic and self-contradictory explanations, which attributed the declines in wages to factors like rent, production costs, population growth, the rise in the price of grain and the depreciation of banknotes (Marx & Engels, 2010b, pp. 158-162). Subsequently, he observed that in



textile factories, machine improvements consistently exerted downward pressure on wages (Marx & Engels, 2010b, pp. 162-165). At this point, Marx wrote down a critical commentary: “The only correct point in the theory of population is that the development of capital throws the mass of the population into conditions” of extreme destitution for the purpose of facilitating reproduction (Marx & Engels, 2010b, p. 165). This indicates that Marx began to attribute the root of pauperisation and declines in wages to Capital. With this Marx commented “Capital. Capital as person with Adam Smith too” (Marx & Engels, 2010b, p. 165), and substantiated his argument by quoting a line from Smith’s *The Wealth of Nations*: “Stock cultivates land; stock employs labour” (Marx & Engels, 2010b, p. 131). With this Marx aimed to demonstrate that the root cause of declines in wages lies in capital’s usurpation of labour as the dominant subject, which in turn enslaves labour itself. This is precisely capital dividing labour into “productive and unproductive labour” (Marx & Engels, 2010b, p. 165) since he had previously indicated: “Productive labour, therefore, is labour which – in the system of capitalist production—produces surplus value for its employer” (Marx & Engels, 2010b, p. 131). Thus, the intention of Marx here is fundamentally to situate the issue of declines in wages within the framework of capital-labour exploitation. Where Beckmann saw only the general application of machinery, Marx penetrated deeper to discern its specifically capitalist application. Consequently, it evoked as an issue what kind of role machinery plays in this process? To address this, Marx quotes a passage from the *Notes on Johann Beckmann II*:

In this town about twenty years ago certain people invented an instrument for weaving, with which a single person could weave more cloth, and more easily, than many others in the same length of time. As a result there arose disturbances and complaints from the weavers, until the town council finally prohibited the use of this instrument. (Marx & Engels, 2010b, p. 165)

Marx succinctly summarized this passage as “Shortening of labour time by machinery” (Marx & Engels, 2010b, p. 165). Later, under the heading “Machinery and AVERAGE WAGES” he cited another excerpted passage: “Wages are decreased in the same proportion as the powers of production increase. Machinery, it is true, cheapens the necessities of life, but it also cheapens the labourer” (Marx & Engels, 2010b, p. 166). Hence, Marx sought to illustrate the internal mechanism by which the capitalist application of machinery declines wages, grounding his analysis in the labour theory of value and theory of surplus value. As he had previously established, the average wage represents the value form of labour-power. On a given working day, capital deploys machinery to raise labour productivity and extend surplus labour time with the shortening of necessary labour time, because “surplus value could only increase to the extent that there was a fall in the value of labour capacity and therefore in wages” (Marx & Engels, 2010b, p. 65). Undoubtedly, this only addresses the issue from the perspective of the production of relative surplus value, representing just one internal cause of machinery-driven declines in wage. Beyond this, there exists a more acute and immediate factor: the competition between machinery and labour that drives workers’ actual wages far below the average wage. As Marx notes: “The moment the machine comes into competition with human labour, the wages of that labour begin to adjust themselves to the lesser cost



of production by [the] machine” (Marx & Engels, 2010b, p. 166). This precisely encapsulates what Beckmann identified as the immediate cause of workers’ resistance to machinery. Here we encounter the second dimension of the “Beckmann Dilemma”: Does the capitalist application of machinery inherently conflict with labour? And if so, does this imply the necessity of “a check to improvement” and abandonment of “the progress of human ingenuity” (Marx & Engels, 2010b, p. 166)? In order to resolve these questions fundamentally, Marx recognized the necessity to probe the historical preconditions and developmental tendencies underlying the capitalist application of machinery.

Thirdly, Marx traces the historical origins of the capitalist application of machinery through the lens of “capital’s personification” and primitive accumulation. In *Notebook XXIII*, he again turned to excerpts from Smith and Beckmann while examining the problem of primitive accumulation. Notably, Marx began with citing Smith’s account of England’s enclosure movements since the 15th century for the acceleration of primitive accumulation. Under the heading “Clearing of Estates” he revisited of Smith’s phrase: “Stock cultivates land; stock employs labour” and generalized it as “Personification of Capital” (Marx & Engels, 2010b, p. 271). Subsequently, Marx summarized the main content of the “*Notes on Johann Beckmann II*”:

Shortening of labour by means of machinery. The workers’ struggle against this. Beckmann, Ribbon mills. The gaining of extra wheat by better grinding. Struggle in England against the sawmills. German inventions. (Marx & Engels, 2010b, p. 271)

These elements might appear unrelated at first glance, while within the whole context it seems that Marx actually had an insight into the deep historical implications of Smith’s expression: the phrases “stock cultivates land” and “stock employs labour” represent the dual dimensions of capital’s personification. The former reflects the early modern British historical process wherein landowners and agrarian capitalists destroyed feudal land tenure and established capitalist agriculture by “clearing of estates.” Crucially, this primitive accumulation forcibly separated direct producers from their means of subsistence, creating a mass of “free” labour-power – the foundational precondition for industrial capitalism. As Marx notes: “The dispossessed tenants either ‘seek a subsistence in the manufacturing towns, or ... emigrate to America’” (Marx & Engels, 2010b, p. 271). The latter phrase “stock employs labour” reflects the historical process of exclusion, degradation and exploitation of labour by industrial capitalists with the help of machines. Marx recognized that the rural “clearing of estates” merely established the most basic precondition for capitalism. As he asserted:

As long as capitalist production has not yet produced for itself all the conditions of its free development – and the most essential one is the formation of a class of WAGE LABOURERS absolutely dependent on capital – capital regulates and intervenes, until it has made the conditions adequate to its needs. (Marx & Engels, 2010b, p. 262)



This absolute free movement of capital, according to its own immanent laws, expresses itself at the same time as utter ruthlessness towards the labouring population. (Marx & Engels, 2010b, p. 262)

In the urban context, this movement of capital manifests as capital's application of machinery to expel labour – a process that, borrowing the terminology of “clearing of estates,” might be termed “the clearing of manufactures and factories.” As a result, capital perpetually generates a relative surplus population, condemning masses of so-called “free” labourers to perpetual destitution, thereby enforcing labour's absolute dependence and submission to capital. From this point of view, Beckmann provided Marx with unique theoretical resources for understanding the early historical origins of industrial capitalism and the process of capital accumulation. Through Beckmann, Marx came to clearly recognize that in the development of industrial capitalism, capital's employment and exploitation of labour were largely achieved through the introduction of machinery – a process that, from the very beginning, was marked by intense contradictions and conflicts among labour, machinery, and capital. In other words, the capitalist application of machinery not only had fundamental historical preconditions but also constituted, from the outset, an integral part of the (primitive) accumulation process of capital. Meanwhile, Marx transcended Beckmann's narrow perspective of *Technologie*, penetrating deeper to recognize that the antagonism between machinery and workers stemmed neither from machines themselves nor from capitalists – who are merely the personifications of capital-relations – but from the inherent demands of the capital-relations.

To sum up, within the writing of the *Manuscripts of 1861–1863*, Marx attempted to focus on the perspective of historical materialism and the critique of political economy to probe preliminarily into the essence of specific social relations among the application of machinery, as well as its historical preconditions and inherent law. This theoretical work provides a steady base of scientific methodology and perspective for the final resolution of the “Beckmann Dilemma”.

THE CAPITAL: THE SCIENTIFIC SOLUTION OF THE “BECKMANN DILEMMA”

In *Capital*, Marx repeatedly drew upon the content of the *Notes on Johann Beckmann II*. By explaining the historical logic and essential laws governing machinery and its capitalist application, he comprehensively and scientifically resolved the “Beckmann Dilemma,” thereby achieving a fundamental transcendence of bourgeois *Technologie* and technical theories.

Firstly, the struggle between workers and machinery is an inevitable result of the historical development of the capitalist mode of production. In the section “The Strife Between Workman and Machine,” Marx extensively cites historical narratives from *Notes on Johann Beckmann II* regarding workers' resistance to machinery. From the perspective of historical materialism, he asserts:

The contest between the capitalist and the wage labourer dates back to the very origin of capital. It raged on throughout the whole manufacturing period. But only since



the introduction of machinery has the workman fought against the instrument of labour itself, the material embodiment of capital. He revolts against this particular form of the means of production as being the material basis of the capitalist mode of production (Marx & Engels, 2010c, p. 430).

This statement signifies two crucial points: On the one hand, the struggle between workers and machinery is merely the external manifestation of capital-labour contradictions under capitalist relations. Where Beckmann saw only the superficial conflict between workers and physical machine, Marx penetrated the material appearance of machinery to uncover its underlying historical essence of specific social relations. Thus, rather than workers opposing the machine, they are in fact resisting the economic reification of capital-relations. In this sense, Marx overcame and transcended Beckmann's techno-fetishism. On the other hand, the antagonism between machine and workers is not an inherent, natural attribute of machinery, but results from the particular form that emerged from the development of the material basis of capitalist production (means of production). In order to deeply grasp the contradictory relationship between machinery and worker, it is essential to understand the historical development of capital-relations and the capitalist mode of production in the first place, particularly the historical formation of large-scale machine industry under capitalism and its inherent laws. This can be analyzed in three dimensions:

(1) Primitive accumulation provided the essential historical preconditions and external guarantees for the formation and development of capital-relations and the capitalist mode of production. As Marx noted: "The so-called primitive accumulation, therefore, is nothing else than the historical process of divorcing the producer from the means of production" (Marx & Engels, 2010c, pp. 705-706). This divorce constitutes the premise of capital-relations and is perpetuated and expanded through capitalist production. The foundation and primary factor of this historical process was the violent dispossession of rural inhabitants' land through measures like "clearing the estates" which forcibly severed masses of people from their means of subsistence, transforming them into a legally unprotected proletariat and hurling them onto the labour market. This development not only propelled the making of capitalist agriculture but also provided the essential labour force required for the emergence of industrial capital and manufacturing.

Simultaneously, capital-relations established a domestic market for capital through the process of forcibly transforming these "free" labourers into wage-workers obedient to capitalist production discipline through bloody legislation. This process not only partially dismantled the obstacles posed by rural feudal systems and urban guild systems but also ignited conflicts between emerging manufacturing and traditional artisan guilds. Marx precisely observed that the initial opposition to manufacturing itself came "from the guilds and privileged towns, not from the workpeople" (Marx & Engels, 2010c, p. 432). And thus, Marx noted that "the manufactures proper opened out new fields of production to the rural population, driven from the land by the dissolution of the feudal system. At that time, therefore, division of labour and co-operation in the workshops, were viewed more from the positive aspect, that they made the workpeople more productive" (Marx & Engels, 2010c, pp. 432-433).



However, the limitations of manufacturing hindered capital's valorization demands, driving capital to seek new material-technical means. As increasingly advanced machinery was introduced into workshops, the contradictions between workers and machines intensified. This struggle manifested in two forms: One is the direct contest of workers against machines within machine-adopting manufacturing, another is the resistance that targeted machine production among traditional artisans and manufacturing workers. Beckmann's so-called “mob riots” against machinery and authorities' bans on machines were but one episode in this protracted, multilayered inter-class struggle. Furthermore, external factors such as the discovery of gold and silver in America, commercial wars, colonial expansion, the national debt, a modern of taxation, and the protectionist system (Marx & Engels, 2010c, p. 739) drastically accelerated this process. From this point onwards, the struggle between workers and machinery emerges as a historical phenomenon that erupts at a specific stage of the protracted, expansive, and increasingly complex overall process of primitive accumulation.

(2) Machinery and its capitalist application are products of the internal contradictory movement of the capitalist mode of production. As Marx observed: “It [manufacture] towered up as an economic work of art, on the broad foundation of the town handicrafts, and of the rural domestic industries” (Marx & Engels, 2010c, p. 373). The foundation of manufacture remained handicraft production, reliant on manual skill and dexterity, which imposed insurmountable limitations such as the narrowness of the technical basis, the expense of production methods, and the lack of labour discipline. These constraints prevented capital from fully appropriating surplus labour-time, instead leaving it perpetually constrained by living labour's resistance. As a result, “at a given stage in its development, the narrow technical basis on which manufacture rested, came into conflict with requirements of production that were created by manufacture itself” (Marx & Engels, 2010c, p. 373). This gave birth to large-scale industrial machinery under capitalism. In other words, machinery and its capitalist application represent both the inherent demand and inevitable outcome of capital-relations, shattering the narrow technical basis of manufacture and establishing a new material-technical basis and mode of production commensurate with its own logic. In this sense, machinery is not merely the achievement of individual inventors, but rather the product of specific socio-historical conditions. As Marx noted: “The inventions of Vaucanson, Arkwright, Watt, and others, were, however, practicable, only because those inventors found, ready to hand, a considerable number of skilled mechanical workmen, placed at their disposal by the manufacturing period” (Marx & Engels, 2010c, p. 385). Thus, “a critical history of technology would show how little any of the inventions of the 18th century are the work of a single individual. Hitherto there is no such book” (Marx & Engels, 2010c, p. 385). This statement clearly targets the individualist heroism of Beckmann and others when they discussed the context of material production.

(3) The capitalist application of machinery generates a new form of labour alienation. From the contradictory dynamics of the capitalist mode of production, it is evident that capital-relations predetermined machinery to emerge as an objectified alien force utterly hostile to workers from the outset. As Marx observed:



The character of independence and estrangement which the capitalist mode of production as a whole gives to the instruments of labour and to the product, as against the workman, is developed by means of machinery into a thorough antagonism. Therefore, it is with the advent of machinery that the workman for the first time brutally revolts against the instruments of labour (Marx & Engels, 2010c, p. 435).

The capitalist application of machinery manifests labour alienation in two key aspects: On the one hand, machinery is “a power inimical to him [workman], and as such capital proclaims it from the rooftops and as such makes use of it” (Marx & Engels, 2010c, p. 438) As the objectified product of labour, the machine emerged as the most potent instrument through which capital subdued labour. On the other hand, it creates an economic paradox: “the most powerful instrument for shortening labour time, becomes the most unailing means for placing every moment of the labourer’s time and that of his family, at the disposal of the capitalist for the purpose of expanding the value of his capital” (Marx & Engels, 2010c, p. 411). To illustrate this, Marx cited Beckmann’s observation: “Antipatros, a Greek poet of the time of Cicero, hailed the invention of the water-wheel for grinding corn, an invention that is the elementary form of all machinery, as the giver of freedom to female slaves, and the bringer back of the golden age” (Marx & Engels, 2010c, p. 411). At the same time, he sneered at modern vulgar economists like Bastiat and McCulloch: “They understood nothing of Political Economy and Christianity. They did not, for example, comprehend that machinery is the surest means of lengthening the working day” (Marx & Engels, 2010c, p. 412). This stark contrast between ancient and modern thought reveals how, under capitalism, machinery’s emancipatory potential is alienated into a means of exploitation – becoming “the bringer back” of ancient slavery in a new form. Of course, the Greek poet’s praise for machine-liberation was merely romantic idealism, under slave systems, machinery could never automatically emancipate slaves.

Secondly, the capitalist application of machinery inevitably generates a downward pressure on wages. Marx explains:

The instrument of labour, when it takes the form of a machine, immediately becomes a competitor of the workman himself. The self-expansion of capital by means of machinery is thenceforward directly proportional to the number of the workpeople, whose means of livelihood have been destroyed by that machinery. The whole system of capitalist production is based on the fact that the workman sells his labour power as a commodity. Division of labour specializes this labour power, by reducing it to skill in handling a particular tool. So soon as the handling of this tool becomes the work of a machine, then, with the use value, the exchange value too, of the workman’s labour power vanishes; the workman becomes unsaleable, like paper money thrown out of currency by legal enactment. That portion of the working class, thus by machinery rendered superfluous, i. e., no longer immediately necessary for the self-expansion of capital, either goes to the wall in the unequal contest of the old handicrafts and manufactures with machinery, or else floods all the more



easily accessible branches of industry, swamps the labour market, and sinks the price of labour power below its value. (Marx & Engels, 2010c, pp. 433-434).

Here, Marx provides a scientific analysis from the perspective of the labour theory of value, revealing the intrinsic mechanism by which capitalist machinery drives wage depression. And thus the following crucial issue emerges: How should workers confront this objective and persistent condition?

Thirdly, it is essential to rigorously distinguish between machinery as such and its capitalist application. As demonstrated above, the root cause of machinery's destructive impact on workers lies in its capitalist employment, not in its technical essence. As Marx emphasized:

It is an undoubted fact that machinery, as such, is not responsible for “setting free” the workman from the means of subsistence [...] The contradictions and antagonisms inseparable from the capitalist employment of machinery, do not exist, they say, since they do not arise out of machinery, as such, but out of its capitalist employment! (Marx & Engels, 2010c, p. 444)

For machinery in itself shortens labour-time, lightens toil, and enriches producers, demonstrating humanity's triumph over natural forces, whereas its capitalist application produces the opposite, harmful effects. Based on this, Marx definitively clarifies the revolutionary target and strategy for workers “learnt to distinguish between machinery and its employment by capital, and to direct their attacks, not against the material instruments of production, but against the mode in which they are used [*gesellschaftliche Exploitationsform*—Author]” (Marx & Engels, 2010c, p. 432). Here, Marx achieves a complete overcoming and transcendence of the implicit techno-original-sin committed by Beckmann and others which conflated machines with their capitalist use.

CONCLUSION

In summary, Marx's engagement with the *Notes on Johann Beckmann II* and his scientific investigation of the “Beckmann Dilemma” underwent a complex and deepening process. On the one hand, Beckmann's historical narratives on machinery provided Marx with unique theoretical resources for further exploring the historical essence of machinery and its capitalist application. On the other hand, through his historical materialist analysis of machinery's socially determined nature and related theoretical issues, Marx thoroughly overcame the theoretical limitations and bourgeois ideological illusions inherent in Beckmann's approach. Based on this, he furnished the proletariat with a scientific theoretical direction for revolutionary struggle and the future prospects of human emancipation. Meanwhile, this engagement offers us a crucial entry point for deeply understanding the methodological significance and contemporary relevance of Marx's philosophy of technology. This includes two aspects:

Firstly, Marx's philosophy of technology is a critical theory of technology that is fundamentally rooted in historical materialism as its primary methodological approach and is situated within the overarching framework of the critique of political economy. To comprehend the historical essence of modern science and technology, one must not



remain confined to empirical-positivist analyses of technical objects, or metaphysical meditations about “technology-in-itself.” Instead, analysis must return to the total historical praxis of the immanent contradictions of modern society – interpreting technology through the holistic context of political-economic critique. Only thus one avoids relapsing into the trap of idealist conceptions of technology.

Secondly, Marx’s demarcation between machinery and machinery’s capitalist employment demonstrates that technological innovation and specific social relations are historically constitutive. This means that technological inventions never exist or function independently – they are always intrinsically fused with determinate social relations, and embedded within concrete socio-historical practices, and this dialectical unity cannot be treated in a separate perspective. Therefore, both technological determinism and the neutrality view of technology fundamentally deviate from the profound implications of Marx’s view of technology. For Marx, the so-called “two-sidedness of technology” does not reside in technology itself but in the specific social relations behind it. This scientific perspective of technology not only provides the proletariat with a scientific framework for correctly confronting the consequences of capitalist employment of technology, but also offers a theoretical foundation for genuinely advancing people-centered scientific innovation and “technology for the good” within the practical context of contemporary societies.

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