The Social Study of Science: The Resurgence of Historical Materialism

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Article

The Social Study of Science: The Resurgence of Historical Materialism

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Abstract

The Social Study of Science (SSS) constitutes an interdisciplinary domain dedicated to examining the profound influence of social, political, and cultural factors on the development of scientific research and practice. Rejecting conceptions of science as an autonomous, self-directed enterprise, SSS posits that scientific knowledge is fundamentally a social product, deeply embedded within specific historical and cultural contexts. This field employs analytical frameworks from sociology, history, philosophy, and anthropology to elucidate the practices, institutions, history, and intellectual content of science. The scrutiny of science's social dimensions has fundamentally reconfigured understandings of scientific work and methodology. During the 1960s and 1970s, the field was significantly shaped by contemporaneous protest movements, with historical materialism emerging as a critical framework for sociologists and historians of science seeking to critique power structures and alienation inherent in scientific practices. However, a subsequent intellectual shift witnessed a movement away from this materialist approach towards postmodern and constructivist analyses. Recently, a resurgence of interest in Marxian historical materialism has become evident. This is marked by a renewed engagement with pre-War II Marxist theorists such as Boris Hessen and Edgar Zilsel, whose works are being republished and re-evaluated in light of the ongoing technological revolution in automation and machine intelligence. This paper delineates this development within SSS, highlighting the contributions of these foundational Marxist thinkers to the critical assessment and understanding of the social ramifications of the new technological revolution.

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Introduction: The Contested Epistemology of Science

Throughout much of the twentieth century, the dominant epistemological framework for understanding science was characterized by an internalist and idealist perspective. This "standard view," heavily indebted to logical positivism and later to Popperian falsificationism, conceived of scientific progress as a rational, cumulative, and internally driven process. Within this paradigm, science was construed as a uniquely privileged form of knowledge, its authority deriving from a singular, rigorous methodology capable of filtering out social and subjective bias.

The emergence of the Social Study of Science (SSS) represented a seminal challenge to this orthodoxy. As an interdisciplinary project synthesizing sociology, history, philosophy, and anthropology, its foundational axiom is that scientific knowledge is not discovered in a social vacuum but is actively *produced* through complex social processes (Jasanoff, Markle, Petersen, & Pinch, 2001). Science, from this perspective, is a human institution like any other, its contours shaped by the interests, resources, biases, and power structures of the society. The formulation of research questions, the validation of methods, the acceptance of theories, and the development of technologies are all understood as being mediated by socio-cultural and economic conditions. This is not to advocate for a radical constructivism that denies the reality of a natural world, but rather to insist

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that our *comprehension* of the natural world is socially and materially mediated (Collins & Evans, 2002).

The initiation of SSS can be traced in the 2nd International Congress of the History of Science organized by the International Academy of History of Science in London, from June 29 to July 3, 1931. The paper mostly highlighted in this Congress was Boris Hessen's *The Social and Economic Roots of Newton's Principia* which marked the beginnings of the field of SSS (Skordoulis, 2022).

The formative period of SSS, coinciding with the political upheaval of the 1960s and 1970s, was deeply infused with a critical, often explicitly Marxist, orientation. Scholars utilized the analytical tools of historical materialism to describe science as an institution of power, to elucidate its function within ideological and capital accumulation processes, and to reveal alienation within its own practices. This period represented a subversive project, aligned with New Left critiques of established authority.

However, as the revolutionary impulses of the 1960s faded and the postmodern turn gained ascendancy in the 1980s and 1990s, the epistemological centre of gravity within SSS shifted markedly. The approach of Marxism, with its emphasis on class, mode of production, and political economy, was frequently dismissed as "reductionist" or "totalizing." It was replaced by approaches such as the Sociology of Scientific Knowledge (SSK) and Actor-Network Theory (ANT), which prioritized micro-sociological analyses, ethnographic studies of laboratory life, and the discursive practices through which scientific facts are supposed to be constructed (Latour & Woolgar, 1979; Knorr-Cetina, 1981). While these approaches yielded valuable insights into the workings of scientific practice, this methodological shift often occurred at the expense of a broader critique of the political-economic structures that contextualize and fund that practice.

Presently, a significant renaissance of historical materialist analysis within SSS is observable. The profound socio-economic transformations precipitated by the new technological revolution - encompassing automation, artificial intelligence (AI) and data analytics - have necessitated a theoretical reevaluation. The questions posed by Marxist theorists in the second half of the 20th century concerning technology, labour, and power have acquired a renewed and urgent contemporaneity. Consequently, there is a resurgent scholarly interest in the foundational texts of Marxist science studies, particularly the pioneering work of Boris Hessen and Edgar Zilsel. Their materialist analyses, which root the content and trajectory of science in the economic base of society, provide indispensable critical tools for understanding the social consequences of twenty-first-century technological revolution.

This paper traces this intellectual resurgence. It will first delineate the core tenets of the historical materialist framework for the analysis of science. It will subsequently explore the pivotal contributions of Hessen and Zilsel, analysing their arguments and their seminal impact. The paper will then chart the postmodern turn in SSS and the consequent eclipse of the materialist tradition. Finally, it will argue for the potent relevance of a revived historical materialism in analysing the social dimensions of the current technological revolution, contending that the work of these early Marxists offers a critical lens for examining the intertwined features of science, technology, capital, and society in the 21st century.

The Historical Materialist Approach: Situating Science within Base and Superstructure

A comprehensive understanding of the Marxist approach to science necessitates commencing with its foundational theory of history: historical materialism. For Marx and Engels, the fundamental premise of human history is the social production of existence. As they asserted, "The first historical act is thus the production of the means to satisfy these needs, the production of material life itself" (Marx & Engels, 1970, p. 48). The organization of this production - the "mode of production," comprising the means of production (tools, machinery, land) and the social relations of production (class relations between owners and workers) - constitutes the economic "base" of society.

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Upon this economic foundation arises a "superstructure," which encompasses all other aspects of society, including its political and legal systems, its religious and philosophical beliefs, and its cultural and intellectual life dominating all forms of social consciousness. A key function of the superstructure is to reflect and justify the interests of the ruling class that dominates the economic base, thereby helping to maintain the existing social order. The base is understood as ultimately conditioning and determining the general character of the superstructure. This relationship is described in Marx's (1859/1977, p. 389) seminal assertion: "It is not the consciousness of men that determines their existence, but it is their social existence that determines their consciousness."

The precise location of science within this base-superstructure model has been a subject of extensive scholarly debate within Marxist theory. Is it an element of the superstructure, an ideology akin to any other? Or is it a "productive force," directly integral to the base?

Engels, in his later correspondence, introduced the concept of "relative autonomy," arguing that while the economic base remains ultimately determinant, the base determines the superstructure "only in the last instance," and changes in the superstructure can, in turn, influence the base (Engels, 1890/1975). The dialectical approach inherent in this framework emphasizes the dynamic and contradictory nature of this relationship, where the evolution of the forces of production can create internal conflicts that eventually lead to a fundamental transformation of the entire social structure.

Marxist analysis consequently conceptualizes science as social practice (Skordoulis, 2016) often situated at the intersection of the base and superstructure, which can be analyzed through three interconnected lenses:

(a) Scientific knowledge, upon its application to production through technology, becomes a direct *productive force*, constituting a central driver in the development of the means of production. Marx himself was acutely cognizant of this, writing extensively on the role of machinery under capitalism. For Marx, science and technology function as key instruments deployed by capital to increase surplus value, deskill labour, and intensify the exploitation of the working class (Marx, 1867/1990).

(b) Scientific practice is intrinsically shaped by the prevailing *social relations* of production. The questions of who funds science, for what purposes, and who benefits from it are resolved by the class structure of society. Scientific institutions (e.g., universities, corporate R&D laboratories) are sites of social labour, frequently characterized by hierarchical, alienating, and exploitative relations that mirror those pervasive within the wider capitalist economy (Levidow, 1983).

(c) Scientific ideas can be, and historically have been, mobilized *ideologically* to naturalize and legitimize the existing social order. Nineteenth-century social Darwinism, which served to justify imperialism and social inequality as manifestations of "the survival of the fittest," provides a classic example. More subtly, the representation of science as a purely neutral and objective endeavour can serve to befog its embeddedness within power structures (Young, 1985).

This tripartite framework (science as a force of production, science as social relations, science as ideology) provides a powerful apparatus for a critical sociology of science. It refuses to portray science as an autonomous realm of pure intellect, insisting instead on its situatedness within the concrete historical and economic conditions of its production. It was this potent mode of analysis that was adopted and radically advanced by Marxist scholars in the second half of the twentieth century.

Hessen, Zilsel, and the Materialist Genealogy of SSS

Prior to the formal institutionalization of SSS, the groundwork for a social, materialist history of science was being methodically laid by thinkers operating explicitly within the Marxist tradition. Their work would subsequently become a foundational reference for the radical science movements of the 1960s.

Boris Hessen: The Socio-Economic Roots of Newton's Principia

The most influential event in the early history of the Marxist study of science was the presentation of Boris Hessen's paper, *The Social and Economic Roots of Newton's Principia*, at the Second

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International Congress of the History of Science and Technology in London, 1931. Hessen, a Soviet physicist and historian of science, delivered a paper that profoundly impressed its Western academic audience (Werskey, 2007).

Hessen was a member of the Soviet Delegation headed by N. Bukharin who at the same Congress presented the paper: *Theory and Practice from the standpoint of Dialectical Materialism*. Although Hessen's paper has been the subject of detailed and extensive study (Freudenthal and Mclaughlin, 2009) and has been referenced numerous times, especially in the SSS literature, Bukharin's paper has not received the attention it deserves despite the fact that it provides the theoretical framework for Hessen's paper.

The main reason is that Bukharin has been falsely associated with a positivist or mechanistic interpretation of Marxism due to the ideas expressed in his early work *Historical Materialism: A System of Sociology* (Skordoulis, 2015).

The prevailing historiography of science of the period was predominantly internalist and idealist, focusing on the intellectual lineage of ideas. Isaac Newton was portrayed as a solitary genius whose monumental work, the *Philosophiæ Naturalis Principia Mathematica*, emerged sui generis from his unparalleled intellect. Hessen's (1931/1971) analysis dismantled this icon. He contended that a comprehensive understanding of the *Principia* required looking beyond the history of ideas to the history of material production in seventeenth-century England.

Hessen's thesis was that the problems Newton addressed - and the very conceptual tools he employed - were not selected arbitrarily but were directly or indirectly stimulated by the economic and technological necessities of the rising bourgeois class in England. He methodically correlated the central themes of Newtonian mechanics to the pressing material concerns of the era of mercantile capitalism and primitive accumulation.

More specifically, the investigation of projectile motion was central in understanding the advancements in military technology and artillery, the problems of astronomy were crucial for navigation at sea at night for overseas trade and colonial expansion, and finally the physics of fluids, and of vacuum, pertained directly to the development of pumping and other hydraulic machinery essential for resource extraction, a key sector of the emerging economy.

For Hessen, Newton was not a transcendent figure operating beyond his historical time but rather its "concentrated expression." Newton's genius resided in his capacity to synthesize and resolve a set of problems that were, in the last analysis, generated by the economic base of his society. The mode of production effectively set the agenda for scientific inquiry. While heavily criticized by contemporaries for its alleged "vulgar economism," Hessen's paper was a theoretical innovation. It showed that the very content of science, its conceptual structure, could be subjected to rigorous socio-economic analysis. It was a programmatic call for an externalist history of science that would greatly influence a generation of left-wing scientists and historians, including J.D. Bernal, whose seminal work *The Social Function of Science* (1939) extended Hessen's arguments into a comprehensive analysis of science, and also of its history and pedagogy, under capitalism (Skordoulis, 2018).

Edgar Zilsel: The Sociological Origins of the Scientific Method

Working independently yet within a similar historical materialist framework, the Austrian philosopher Edgar Zilsel undertook a profound investigation into the socio-genesis of modern science during the Renaissance. Zilsel was member of the Left Vienna Cycle and worked as an adult educator in the period that the municipality of Vienna was governed by the Austrian Socialdemocratic Workers Party. His work, culminating in his seminal essay "The Social Roots of Science" (1942), addressed a deceptively simple question: Why did modern science, characterized by its unique combination of empirical experiment and mathematical law, emerge in Western Europe during the sixteenth and seventeenth centuries?

Zilsel (1942/2000) rejected explanations predicated on the "genius" of individuals or the sudden awakening of a "scientific spirit." Instead, he located the causal mechanism in a fundamental shift in social structure: the dissolution of the feudal order and the ascent of early capitalism.

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The "Zilsel thesis" argues that modern experimental science was born in the 16th and 17th centuries when the social barriers between three distinct groups - university scholars, humanists, and "superior artisans" - eroded due to the rise of free-enterprise capitalism.

The rising capitalist mode of production generated demands for enhanced technology, navigation, and machinery. This economic imperative fostered a novel epistemological attitude: the application of rational, scholarly methods to the practical knowledge of craftsmen.

This new respect for manual work and empirical knowledge allowed for the fusion of the methodical intellectual training of the scholars with the hands-on, experimental knowledge of the artisans. A classic example is William Gilbert, whose groundbreaking work on magnetism drew directly from the empirical knowledge of a compass maker. The resulting synthesis of theory and practice produced the unique endeavor we call modern science.

The "scientific method" emerged from this social synthesis. Experimentation represented the systematization of the craftsman's trial-and-error practice. The formulation of mathematical laws of nature constituted the application of the scholar's logical tools to the quantitative data produced by these experiments. For Zilsel, the epistemology of modern science - its insistence on verifying theory against empirical reality - was the product of a specific socio-economic context that necessitated a merger between previously estranged social strata and their respective epistemic forms.

From distinct yet complementary vantage points, Hessen and Zilsel established the core principles of a materialist SSS: the content and direction of science are conditioned by the economic base; the categories of scientific thought possess social origins; and the institution of science is inextricable from the class structure and productive forces of its host society.

The Postmodern Turn and the Retreat of the Materialist Approach in SSS

The radical potential inherent in the tradition of Hessen and Zilsel was, for a period, actualized in the science studies that emerged from the political upheavals of the 1960s. The "Science for the People" movement, for example, which was active from 1969 to 1989, explicitly employed a historical materialist framework to critique the militarization of scientific research and the corporate control of technological development. Movements such as the British Society for Social Responsibility in Science (BSSRS) and intellectuals associated with the "Radical Science Journal" collective also employed Marxist categories to critique the militarization of science, the ideology of scientific neutrality, and the alienating conditions of scientific labour (Rose & Rose, 1976). Science was analysed as a force of production subordinated to the dictates of capital and the state.

From the late 1970s onwards, however, the intellectual landscape underwent a profound transformation. The ascendancy of neoliberalism as a political-economic project was paralleled by an intellectual shift away from macro-level theories like Marxism towards micro-oriented, discursive, and multiplicity approaches. In sociology, this was epitomized by the rise of the "Strong Program" in the Sociology of Scientific Knowledge (SSK) at the University of Edinburgh.

Pioneered by David Bloor (1976), the Strong Program advanced four tenets: it should be 1) *causal*, identifying the conditions for beliefs; 2) *impartial*, explaining both true and false beliefs; 3) *symmetrical*, employing the same types of cause to explain both true and false beliefs; and 4) *reflexive*, applicable to sociology itself. This manifesto broke decisively with the Mertonian sociology of science, which had focused on the norms of science and invoked social factors only to explain deviance, treating successful science as the product of a rational method. The Strong Program's principle of symmetry declared that *all* scientific knowledge, irrespective of its veracity, must be explained by social causes.

This engendered a wealth of micro-sociological and ethnographic studies, most notably Bruno Latour and Steve Woolgar's *Laboratory Life* (1979), which demonstrated how scientific facts are not discovered but are *constructed* through processes of negotiation, persuasion, and rhetoric within the laboratory.

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Karin Knorr-Cetina's (1981) work similarly revealed the "manufacture" of knowledge through local, contingent, and questionable practices. The analytical focus shifted from the political economy of science to the description of its endogenous practices.

While this corpus provided an invaluable deconstruction of the myths of scientific heroism and instant rationality, it frequently incurred a significant cost. The intense focus on micro-processes, "networks," "actor-actants," and discursive construction neglected the larger structures - capitalism, the state, class - that had been central to historical materialist analysis. As Steven Shapin (1995, p. 304) astutely noted, there was a tendency towards a "social history of science with the politics left out." The "social" in SSK often denoted the micro-social interactions within a laboratory, not the macro-social structures of political economy.

This shift was combined by the ascent of postmodernism and post-structuralism, which exhibited deep scepticism towards all "metanarratives," including Marxism. Concepts such as "truth," "objectivity," and "reality" were placed under erasure, treated as discursive effects (Lyotard, 1979). While a useful correction to a regime of scientific absolutism, this often culminated in a form of epistemic relativism that weighed down the critical evaluation of scientific claims, particularly those advanced by powerful interests. The critique of science became so thoroughgoing that it risked self-neutralization, unable to justify why one constructed fact (e.g., the reality of anthropogenic climate change) should be privileged over another (climate change denial) if both were merely the products of their respective social networks.

By the 1990s, the historical materialist analysis pioneered by Hessen and Zilsel, with its focus on mode of production, class conflict, and ideology, had been substantially marginalized within mainstream SSS. It was frequently perceived as anachronistic, reductionist, and insufficiently attentive to the nuances of scientific practice. The field had successfully demonstrated the social construction of facts but had often neglected to ask: Construction in whose interests, and within what overarching economic system?

The Resurgence of Historical Materialism in the Era of the 21st Century Technological Revolution

The first decades of the twenty-first century have engendered conditions favourable to a powerful resurgence of historical materialist thought. The impetus for this is fundamentally material. The technological revolution of the 21st century centered on digital computation, big data, artificial intelligence, and automation has precipitated transformations of such magnitude that they demand an analytical framework transcending the micro-sociology of the laboratory. These new technologies are actively reconfiguring the global mode of production, restructuring class relations, and generating novel forms of power and alienation – thus bringing in the forefront the classical concerns of Marxist theory.

The prominent questions of the new era are, in essence, Hessen's and Zilsel's questions, transposed to a new technological register:

What Economic Imperatives Drive Contemporary AI Research?

This is a question in analogy to Hessen's inquiry into the economic drivers of Newtonian mechanics. The answer is unequivocal: the agenda is predominantly set by the requirements of capital accumulation.

The theory of Late Capitalism (Mandel, 1975) acknowledges that each successive wavelike expansion of the capitalist system entails a corresponding technological revolution leading to a renovation of the means of production. Mandel (1975), especially in chapter 8 of his *Late Capitalism*, links his assessment of technological revolutions with Marx's theory of capitalist crisis. The permanent tendency of the rate of profit to fall accelerates the appearance of technological revolutions. The conflict between the means of production and the relations of production is overcome by a renovation of the means of production. So more technological revolutions,

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revolutionising the means of production, are necessary in order to compensate the falling rate of profit.

The development of machine learning and artificial intelligence is overwhelmingly directed towards automation, predictive analytics, and behavioural modification - objectives that serve to maximize profit, manage workforces, and create new markets (Zuboff, 2019). The directives selected are not neutral; they are those that promise to enhance capitalist control and productivity.

How Does AI Affect the Social Relations of knowledge Production?

The rise of the new technologies of AI and automation has driven the beginning of what has been termed as 'cognitive capitalism' which in my view is nothing more than a specific feature of Late Capitalism. This type of capitalism is characterized by the fact that the object of accumulation consists mainly of knowledge, which becomes the basic source of value and the principal location of the process of valorisation.

Like other historical phases of capitalism, its cognitive version carries inbuilt the source of its own instability, represented by the 'exploitation of the invention power' versus the 'traditional' exploitation of labour power of industrial capitalism. That means that the conditions of exploitation of intellectual labourers are the same as the conditions of exploitation of industrial workers.

The proliferation of precarious academic labour, the intense commodification of knowledge through patent regimes, the hegemony of corporate funding, and the metrics-driven "audit culture" have rendered the university and research laboratory clear sites of alienated labour and exploitation (Lave, Mirowski, & Randalls, 2010). Scientists often experience themselves not as disinterested seekers of truth but as "proletarianized" knowledge workers, compelled to compete for grants and publications within a hyper-competitive market. This has revitalized the relevance of a Marxist analysis of science *as labour* and also raises profound Zilselian questions concerning the class dynamics of knowledge production in the digital age.

How AI Affects the Social Division of Labour?

The answer resonates well with Zilsel's thesis. The knowledge - centered capitalist economy powered by AI profoundly introduces a new form of organization of labour and simultaneously new forms of exploitation of intellectual workers.

It reshapes the division of labour by favouring the emergence of a more horizontal structure, kept together by the existence of virtual networks and/or collective intelligence systems.

At the same time, a new synthesis of knowledge forms is underway. The "scholars" (computer scientists, engineers, etc.) are merging their expertise with the practical, often tacit, knowledge of domains once remote: the knowledge of drivers (for autonomous vehicles), radiologists (for medical AI), and factory workers (for industrial robotics). This synthesis, however, is not a democratic confluence of equals. It frequently constitutes a process of "expropriation," whereby the practical knowledge of workers is extracted, codified, and embedded in machines that may ultimately displace them (Bastani, 2019).

Thus, the famous "Machinery Question", concerning the deepening inequality between the specialized and unspecialized workers because of the advanced industrialization (Pasquinelli, 2023) reemerges in the relevant literature.

Is AI Ideologically Neutral?

The ideology of "AI neutrality" represents a contemporary conception of science's ideological function. The idea that algorithms are merely objective mathematical processes serves to obscure the human biases encoded in their design, the profit-driven purposes of their deployment, and the class interests they ultimately serve (Eubanks, 2018). When an AI system or a hiring algorithm discriminates against women (Voutyrakou, 2025a; 2025b) the typical developer response is a

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technocratic appeal to "fixing the error," thereby deflecting critique away from the fundamental social and economic choices embedded within the design technology itself.

The formulation of the answers given to the above questions has stimulated a scholarly rediscovery of Marxist classics. The republication and re-examination of the works of Hessen and Zilsel is not an antiquarian exercise but a search for robust theoretical instruments to analyse a world in which technology and capitalism are more deeply intertwined than ever before. Contemporary scholars are deploying this revived framework to analyse the political economy of Big Pharma (Mirowski, 2011), the commodification of academic publishing (Fyfe et al., 2017), and the rise of "surveillance capitalism" (Zuboff, 2019).

This constitutes not a simple return to a past but a sophisticated new historical materialism that incorporates the valid insights of the postmodern turn while re-embedding them within a broader analysis of power and political economy. It acknowledges the importance of the social relations within the laboratory while insisting on an inquiry into the economic and political forces that govern the laboratory itself and determine its purpose.

Conclusion: Towards a Critical and Materialist Social Study of Science

The intellectual trajectory of the Social Study of Science mirrors broader tides of philosophical and political change. From its radical, materialist origins in the works of Hessen and Zilsel, through its postmodern, micro-sociological phase, the field is presently experiencing a necessary and vital correction. The extreme constructivism of the late twentieth century, while performing an essential deconstructive task, ultimately encountered its limits. By focusing predominantly on the micro-politics of knowledge construction, it failed to furnish a critical language adequate to addressing the macro-politics of science as a major social institution embedded within global capitalism.

The new technological revolution has rendered the limitations of a post-political science studies acutely visible. The rise of AI, automation, and machine learning cannot be comprehended solely through laboratory ethnography or actor-network maps. It necessitates the posing of larger, Hessenian questions regarding the economic forces that set research agendas. It demands Zilselian questions about the class dynamics of knowledge production and extraction. It requires Marxist questions concerning alienation, ideology, and power.

The return to historical materialism is, therefore, not a nostalgic retreat but a forward-looking necessity. It provides the conceptual apparatus to connect the micro-world of scientific practice to the macro-world of capitalist production. It enables the recognition that an algorithm is not merely a technical object but a social relation crystallized in code. It facilitates a critique that is simultaneously epistemologically comprehensive and politically engaged.

The imperative for a renewed, critical SSS is to synthesize the strengths of both traditions: the empirical richness and sensitivity to practice derived from the micro-sociological turn, and the critical, political, and economic depth inherent in the materialist tradition. By placing Hessen and Zilsel back in the center of our analysis, a more robust and genuinely social study of science can be advanced, capable not only of interpreting the techno-scientific world but of critiquing it with the aim of transformative change.

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