The Ecological Forces of Production: Reconciling Environmental and Class Based Politics

by
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B.A.,Simon Fraser University, 2009

A Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of

MASTERS OF ARTS

in the Department of Sociology, with a concentration in cultural, social, and political thought

Supervisory Committee

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Abstract

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This thesis centres on Karl Marx's conceptualization of the forces of production, which I argue has received poor treatment in contemporary Marxist literature and is in need of reconstruction. Narrow and 'lifeless' understandings of the concept serve to drag Marx into a modernist 'march of progress,' which is at odds with the deep ecological basis of his arguments and hold back current attempts to bring 'nature back in' to historical materialism. Conceptualizing forces of production broadly to look at *that dimension of human existence through which humanity is purposefully linked to the rest of nature,* brings out that ecological content and provides a foundation upon which we can shed light on contemporary environmental crises. More specifically, I argue that this allows us to reframe the classical Marxist notion of a contradiction between the forces and relations of production—by seeing ecological thinking itself (i.e. recognition of the need to maintain and restore the indispensible 'metabolism between humanity and nature') and associated action, as an advancement in the productive forces, which is however being subordinated and colonized by the imperatives of capital accumulation.

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Acknowledgments

I cannot account for the many peers and excellent teachers who have marked my thinking and contributed to this work, but I want to begin by thanking Gary Teeple, whose lectures on *Capital* along with our many informal meetings, brought me into the terrain of Marxist thought and surely influenced the project, without bearing responsibility for its outcome. My mom, Trish, for her ongoing support in my studies and the many hours she put in editing my early and often not so coherent work. My supervisor, Bill Carroll, who was so integral in helping me focus my thoughts for this project, as well as my committee member, Steve Garlick, for providing guidance at numerous points along the way. Finally, I want to thank my partner, Claire, for her patience, reassurance and insight during the whole process.

Dedication

To my niece, Isabelle

Chapter 1

Introduction:

Orthodox Marxism…does not imply the uncritical acceptance of the results of Marx's investigations. It is not the 'belief' in this or that thesis, nor the exegesis of a 'sacred' book… [it] refers almost exclusively to method.

George Lukács

In the *Grundrisse*, Karl Marx's most explicitly methodological text, he makes much of the need for basic and simple concepts and abstractions through which we begin to understand the complex interrelations and processes that are at work in the world and which come to bear on everyday life.[1] For Marx, these abstractions act as a foundation upon which we can build more complex conceptualizations, so as to approach step by step the concrete activities, elements and 'permanencies' that appear on the surface of societies. Yet our concepts, he warns, must not simply consist of a gathering of things, parts and elements that combine to form an abstraction, but also must include the world of relations, processes and flows that give rise to, sustain and undermine those various elements.

In taking this basic methodological insight seriously, this thesis is driven by the belief that Marx's conceptualization of the forces of production has received poor treatment in contemporary Marxist literature and is in need of re-construction. The concept of the forces of production, I suggest, has commonly suffered from either overly narrow or 'lifeless' definitions. In the first instance, certain elements are not included: for example, ignoring scientific knowledge as a productive force can cause us to overlook

[1] Marx, *Grundrisse*, pp. 100-07.

contemporary connections that are integral to capitalist accumulation or reproduction. In the second instance, and perhaps more importantly, treating the forces of production as a collection of inert elements and factors that together add up to or constitute a 'force,' fails to consider the wider relations and processes these elements are involved in and which make them up.

The latter mistake, in particular, has given rise to closed and narrow interpretations of Marx that see him as a causal and mechanistic thinker, wielding formulas and truisms that can be used to reveal something essential about social formations. With respect to the forces of production, narrow and mechanistic interpretations have allowed for the reduction of the concept to the point where 'technological hardware' replaces and sits in for what is in fact a far broader, more complex and embedded abstraction, and which simultaneously allows for the assertion of the primacy of the technological as the leading agent or executioner of social change. I argue that this understanding serves to drag Marx into a modernist/technological "march of progress," which is at odds with the deep ecological basis of his arguments and holds back contemporary attempts to reconcile class politics with ecology.

Against this narrow conceptualization and understanding, I suggest that Marx uses the forces of production far more broadly to look at *that dimension of human existence through which we are purposefully linked to the rest of nature.* This expanded definition brings out the deep ecological content of Marx's thought, and helps us to re-visit and reframe the classical Marxist notion that humanity's forces of production 'outgrow' or are fettered by relations of production. More specifically, this conceptualization helps us to recognize that ecological thinking itself (i.e. recognition of

the need to restore the indispensable 'metabolism between humanity and nature' and related practices of sustainability) should be read as an advancement of the productive forces, which is however being subordinated and colonized by the imperatives of endless capital accumulation.

The first chapter is devoted to late 20th century engagements with Marx on the forces of production, which I then proceed to critique. Of specific focus will be Gerald Cohen's classic, *Marx's Theory of History: a Defense* and Ernest Mandel's *Late Capitalism*. I argue that these technologically deterministic readings of Marx (which still have a large degree of purchase within the Marxist tradition) severely narrow and weaken our understanding of the antagonisms and contradictions facing contemporary capitalism. Furthermore, they have little to offer in terms of understanding the contemporary forces, forms and sites of resistance that emerge from the contradictory processes of capitalist development.

The second chapter provides a close textual analysis of Marx's various writings on the forces of production. The challenge is that while the basic principles of historical materialism can be easily read as an ecologically 'grounded' approach to human history and subjectivity, Marx's later and more economic formulations of the labour process often seem to be removed from ecological considerations and concerns. I will argue that an expanded understanding of the productive forces, along with a more dialectical understanding of Marx's method (which shows how processes of production spin out, re-enforce and modify other processes), shows continuity in his thought, particularly in reference to his ecological commitments. While emphasis will be placed on the ecologically embedded nature of that concept, Marx's understanding of co-operation and

socialization, the role of the body, of technology and science, and the complex interconnections and relationships therein, will be theorized and worked through. Remaining faithful to Marx's notion that the movement towards socialism or communism should not be thought of as an ideal, but as a movement that reacts to set of concrete social antagonisms, this conceptual re-casting and re-reading helps us to formulate antagonisms that continue to generate the communist "Idea."[2]

The third and final chapter is devoted to contemporary Marxists who have been working to bring out the full ecological potential of Marx's thought. The chapter begins with an analysis and critique of James O'Connor's theorization of a "second contradiction" to capitalist reproduction, which revolves around natural barriers to accumulation. While his work is an important contemporary effort to renew Marxist ecology, I take issue with his desire to feed Marx's ecological reflections into an economic crisis theory, and suggest that his work ultimately fails to overcome a dualistic conception of nature and society. This analysis is followed by an overview of Neil Smith and David Harvey's 'produced nature' thesis, which sees nature as a dialectical and historically produced category, and which they develop from Marx's scattered engagements with the concept of nature. I approach their work enthusiastically (particularly with respect to their analysis of how capital circulation produces nature in distinct ways and gives shape to specific and uneven geographies), but also use it to expose the limitations and potential pitfalls of a strong social constructionist approach to both nature and science. I then turn to the work of John Bellamy Foster, who has extended Marx's understanding of the 'ecological rift' and worked to uncover the deep

[2] See Zizek, 'How to Begin From The Beginning,' *The Idea of Communism* (London, 2010).

incompatibility of ecology and capitalism. Finally, I revisit the work of Herbert Marcuse, which helps us re-interpret the contradictions that emerge between the forces and relations of production and provides more concrete grounds for envisioning the important ecological dimensions of any future socialism.

Chapter One:

From the Politics of Production to an Ecological Critique of the Determinists

Marx is often understood by both supporters and critics as a technological determinist, who argued that changes in the forces of production (understood narrowly as technological 'hardware'), dictate the course of human history, including the evolution of our social relations, our mental conceptions of the world and our relation to nature. Despite longstanding attempts to undo this interpretation, influential late 20th century engagements with Marx on the productive forces, such as Gerald Cohen's *Marx's Theory of History: a Defense* and Ernest Mandel's *Late Capitalism*, provided powerful instances of this position. While these interpretations have been criticized for their anti-humanist implications and latent teleology,[3] I aim to develop a further critique on ecological grounds. More specifically, I will argue that the technologically deterministic reading of Marx (which often stems from a narrow and 'lifeless' understanding of the forces of production), drag him into a modernist 'march of progress,' and hold back current attempts to rejuvenate Marxist political economy along environmental lines.

In the context of current economic and ecological crises, capitalism has once again become a common subject of contention, but the equation between Marxism and anti-capitalism is no longer as straightforward as it was in the 1970s, when Cohen and Mandel's books were published. While Marxism has certainly survived all late attempts to bury it historically, contemporary revivals and renditions of Marx often take highly abstract, eccentric and eclectic forms. In the work of many key Marxist figures today like

[3] See Dyer-Witheford, *Cyber Marx* (Chicago, 2000), for a discussion of the anti-humanism inhering in this position. In opposition to this, Dyer-Witheford and other *autonomous* Marxists have sought to replace the traditional Marxist focus on the logic of capitalist development with one that centres on workers' struggles within the labour process.

Alain Badiou, we find proposed theoretical systems that altogether reject or eclipse the key tenets of classical Marxism.[4] By contrast, both Cohen and Mandel remind us of Marx's claim to offer a general interpretation of the forces governing the trajectory of human history (revolving around the contradiction(s) that emerge between the forces and relations of production); yet how that theory is to be interpreted, how it might mesh or contrast with other understandings of Marx seeking to understand the antagonisms of today's global capitalism, bears critical examination.

The most forceful and influential technologically deterministic reading of Marx is likely Gerald Cohen's classic, *Karl Marx's Theory of History: A Defense (KMTH hereafter)*. Cohen's work represents an attempt to apply the rigors of analytic philosophy to Marx's various statements on historical change, in an overall effort to pinpoint and tie down the specific causal mechanism(s) in Marx's interpretation of history and then to test that theory across historical epochs. This method is clearly pitted against a dialectical thinking that posits a relational, interdependent and more contingent understanding of change, and which for Cohen, "thrives only in an atmosphere of unclear thought."[5] In contrast to dialectical approaches, he argues that Marxists need to provide rigorous analyses and explanations of the specific micro-mechanisms through which epiphenomenal events emerge, rather than enlist teleological reasons or enter into the morass and push and pull of theories of 'co-constitution.'

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[4] See Badiou, *Metapolitics* (London, 2006) who while advocating dialectical materialism as a mode of inquiry, goes some way toward removing the historical basis of Marxist materialism by suggesting that there is nothing internal to capitalist development that can be seen to push us towards an alternative social order.

[5] Cohen, *Karl Marx's Theory of History* (Oxford, 1978), p. xxiii.

Cohen employs "the standards of clarity and rigour which distinguish twentieth century analytic philosophy."[6] He asserts the functional primacy of the forces of production over the relations of production. The former include for him labour power, defined as the capacity to work embodied in human beings, and the means of production. The means of production are defined as instruments of production, including the productively relevant parts of science, raw materials and geographical spaces. The relations of production, or productive relations, are then defined as the ownership and control over both those means and labour power. Cohen argues that Marx was committed to the belief that history is based on the growth of human productive powers and that the economic structures that come to determine the form of society rise and fall according to how they enable or impede that growth. In this vein, the historical modes of production or the different economic epochs identified by Marx, such as slavery, feudalism and capitalism, are distinguished and determined by the material instruments of labour they involve.

To defend this reading of Marx in KMTH, Cohen relies on the Preface to the *Critique of Political Economy*, which allegedly encapsulated Marx's 'mature' understanding of the development of social, political and economic systems and from which a basic law of historical periods could be extrapolated. A short extract from the preface will be instructive*:*

> In the social production of their existence, men inevitably enter into definite relations, which are independent of their will, namely relations appropriate to a given stage of development of their material forces of production. The totality of these relations of production constitutes the economic structure of society, the real foundation, on

[6] Ibid., p. ix.

> which arises a legal and political superstructure and to which correspond definite forms of social consciousness.[7]

In using this passage as his foundation, Cohen goes on to expose the reader to a range of Marx's other statements and theses on the forces and relations of production and proceeds to show analytically, that while there are numerous passages where Marx asserts that productive forces produce changes in social relations and mental conceptions of the world, arguments suggesting a reverse 'dialectical' movement are nowhere to be found in Marx's corpus and simply did not hold. While Cohen admits some difficulty in reconciling his primacy thesis in KMTH, with his recognition that capitalist property relations provide a clear stimulus to the development of the forces of production, he is able to side step this argument and re-assert primacy, by means of a functional explanation through which phenomena are explained by their *tendency* to bring about certain effects. For Cohen, the fact that property relations underpinning capital clearly spur on the productive forces does not contradict the primacy thesis, in so far as relations of ownership and control *function* to develop the forces and exist given their capacity to do so. Put differently, the forces of production are understood to choose social relations and political/ideational structures and arrangements according to their capacity to promote further development.

To further defend the claim that the development of the productive forces was primary, Cohen needed to rely on a motor force of development that was outside the forces and relations of production and ultimately served to act on the former. For Cohen, this exogenous force was human rationality and the basic impulse of human beings to better their life situation: to overcome scarcity by further developing the forces of

[7] Marx, *A Contribution to The Critique of Political Economy* (New York, 1976), pp. 20-21.

production. Thus, the drive to overcome material want served to fill out his functional argument and allowed Cohen to construct rigid conceptual and theoretical distinctions between the material forces of production, the social relations of production and the legal and ideological 'superstructure,' which were apparently grounded in the "distinction between the form and content of a society…[whereby] people and productive forces comprise its *material content*, a content endowed by production relations with *social form."*[8]

While numerous authors have challenged the adequacy of functional explanations on Cohen's own analytical terms,[9] I argue here that his strict insistence on the separation between the material and the social, on which his thesis rests, is at clear odds with Marx's emphasis on processes over things, and cannot hold. While Cohen's initial definition of productive forces is not incorrect in my view, his analysis falters in so far as the elements in his material list are completely inert and lifeless and do not seem to be involved in any kind of connections, relations or processes. As Alex Callinicos has pointed out,[10] if we look at how the means of production and labour power become combined within a labour process, it becomes clear that these elements are also a 'relation of production.' That is, in examining Marx's understanding of the process of production, we see that the way in which the means of production (including technology, scientific knowledge and understandings, natural materials) and the capacity for labour, are fitted together and modified in an actual process, is dependent upon the complex interconnections, forms of

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[8] *KMTH*, p. 89.
[9] For an analytical critique of functional explanation see Elster, *Explaining Technical Change* (Great Britain, 1983), pp. 57-66. From a critical realist perspective see Agar, 'G.A. Cohen's Functional Explanation: A Critical Realist Analysis,' *Philosophy of the Social Sciences*, 33 (2002), pp. 291-310.
[10] See Callinicos 'G.A. Cohen And The Critique Of Political Economy,' *Science and Society, 70 (2006).*

co-operation and other social relationships that preside at that moment history. The concept of the productive forces therefore does not simply or even primarily refer to productivity or growth in the surplus they make possible, but rather to the qualitative and socially variable ways in which productivity is *ensured* and historical needs met.[11]

In this regard, Cohen's insistence that methods of labour or material relations of production be excluded from what counts as a productive force (based on an earlier distinction between the material and the social, nature and society), glosses over Marx's recognition that labour is a social activity that necessarily involves relationships and forms of cooperation between actors. As Marx understood, 'instruments of labour' should be understood to function through and within a particular technical division of labour, (which involves occupational specializations, including divisions among skilled and unskilled labour, mental and physical, agricultural/ manufacturing, levels of co-operation, methods of co-ordination and control representing divisions between classes), thereby making us incapable of creating sharp social/material dichotomies or marking the primacy of the material over the social.[12] Indeed, the recognition that the forces and relations of production are distinct, yet overlap and interpenetrate in the process of production, led Marx to suggest in the *German Ideology*, that "a certain mode of production or industrial stage is always combined with a certain mode of cooperation, or social stage and this mode of cooperation is itself a 'productive force.'[13]

It is only by interpreting the forces of production narrowly and lifelessly that Cohen is able to boil down his concept to the point where he understands technological

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[11] Callinicos, *Making History* (Chicago, 2009).

[12] For a particularly clear presentation of this point see Radar, *Marx's Interpretation of History* (New York, 1979), ch.1.

[13] Marx and Engels, *The German Ideology* (New York, 1976), p. 43.

development as an autonomous historical force that continually smashes through anachronistic forms of property ownership leading a clear path towards socialism. Following this line of thought, Cohen declares that the key contradiction of advanced capitalism revolved around the priority given to the creation of exchange value over use-value, so that 'the structure of the economy mitigates against the optimal use of its productive capacity and functions to the detriment of general human welfare.'[14]

Although rather general, his argument continues to have relevance today where capital investment is increasingly directed towards asset and derivative markets, rather than the production of material goods[15] and where we are confronted by the irrationality (made increasingly apparent in times of economic crisis), of having unmet need and human suffering laying next to huge productive surpluses. However, this argument is only one piece of our critical understanding of contemporary capitalism, and the fierce separation of the social and material, of society and nature, upon which the thesis rests has insidious implications that I address later on in the chapter.

Ernest Mandel's book, *Late Capitalism,* is more nuanced than KMTH in marking the dialectical interrelations and contradictions between productive forces and social relations, but it shares with that work a particular view of productive forces, as the central agent or executioner of an almost inevitable socialist transformation. Further, while KMTH is a broad and sweeping historical analysis that attempts to find consistency across historical epochs or modes of production, *Late Capitalism* attempts to mark the development of the forces of production specifically *within* the stages of development or modes of production in the history of capitalism. Mandel argues that there have been

[14] Ibid., p. 310.
[15] For a discussion and current figures on increasing investment in asset values see Harvey, *The Enigma Of Capital* (London, 2010), ch. 1.

three distinct yet successive modes of capitalist development (market capitalism, monopoly capitalism and late capitalism), each of which emerged out of the contradictions of the previous stage and propelled industry forward along a narrowly defined and linear path. Again for Mandel, these three stages of development have direct correspondence to technological developments or revolutions. The steam engine enabled the inauguration of the capitalist mode in the 1840s, the electric and combustion motors in the late nineteenth century led to the era of monopoly capital and finally the computerization of production beginning in the 1950s, signalled the inauguration of our current era, late capitalism.

For Mandel, each of these technological developments spurred structural changes in the economy and allowed for the re-configuration of the forces of production within the labour process, which was ultimately required for the maintenance of capital accumulation. Therefore, rather than treating technology as an external and autonomous social force (as Cohen did), the forces of production are understood to develop and advance in accordance with capitalism's attempts to stabilize the perpetually unstable conditions of class reproduction. It is important therefore that Mandel not be understood as technological determinist in the straightforward sense of the term; for him, the forces of production are intertwined with relations of ownership and control, as the growth of those forces are understood to be driven by the inner dynamics of capital accumulation (by the law of the falling rate of profit). While I do not want to enter too far into Marxist economic and crisis theory, a brief technical summary is required.

According to Mandel's version of this classical Marxist theory, the attempts of individual capitalists to produce relative surplus value[16] by increasing the intensity and efficiency of production through speed-ups and investment in new productive systems, create perpetual revolutions in the forces of production, as other firms are forced to follow suit through the 'whip of competition.' In simplified terms, this level of coercive competition among manufacturers obliges the rational capitalist to invest in more 'constant capital' (new plants, equipment, machinery and hardware) and therefore proportionately less in 'variable capital' (labour power and wages), in order to catch up to the original innovator, who is once again encouraged to increase the productivity of social labour by pushing production forward, in order to restore the gains in relative surplus value that were previously afforded through competitive advantage. While this process of technological innovation and eventual 'leap-frogging' may begin in one industry, it is understood to spill over and have multiplying effects that reverberate across increasingly integrated spheres of economic activity.[17]

However, the Marxian theory of value holds that the source of surplus value is the exploitation of living labour. The theory of value is represented in the formula C+V+S. The value of constant capital-'C'-is not increased in the production process but merely preserved by it. 'V' or variable capital is the part used by the capitalist to increase the value of capital. 'S' represents surplus value, or the portion of new value appropriated by the capitalist. The ratio between constant and variable capital is referred to as the 'organic

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[16] In relation to the accumulation strategies of individual capitalists, relative surplus value refers again to the excess profits that can be achieved by selling at a price set at a social average when production costs are well below those prices, due to superior production techniques.

[17] While Mandel spends some time trying to track this interdependence, for a discussion that focuses on uneven geographical development, see Harvey, *Limits to Capital* (London, 2006), pp. 120-126.

composition of capital.' Thus, if constant capital 'C' increases over variable capital 'V' the margin of surplus labour time relative to the total production of capital invested is reduced, causing the rate of profit to decline.

Based on this inner tendency of capital accumulation, Mandel reconstructed the last two centuries of Western history in an attempt to show that they had been driven, at the most fundamental level, by long-waves of economic growth based on the perpetual advancement and re-organization of the forces of production in search of relative surplus value, but this process inevitably gave way to stagnation and faltering rates of profit (given the rising organic composition of capital), that could only be temporary stabilized *through* crises. Accordingly, Mandel understands crises as the means through which the forces of production are re-configured and revolutionized, so that the conditions of accumulation could be restored; however, this temporary route of escape could only serve to push capital into further and deepening crises, as progressive mechanization expelled the worker from the production process and the rate of profit (and eventually the mass of surplus value) diminished.

For Mandel our current phase of late capitalism, which was signalled by the rapid computerization of production that began in the 1950s (and was really beginning to be pushed forward in the late 1960s), is again understood to be brought about by the drive to replace wage labour with systems of automated production, in an effort to produce short-term economic gains and temporarily restore rates of profitability in the face of creeping stagnation. Corresponding to this shift, Mandel predicts that we will see widespread changes to the economy, including the rise of supervisory roles (machine minding), the increasing unification of scientific research and development, constant investments in

technology applied to the mode of production, continual speed-ups, hyper-specialization, growing unemployment, repression or stagnation in wages, the ascending importance of market research and the rise of 'unproductive' and non-value added forms of labour (such as the service economy). For Mandel, in this last, late phase of capitalist development, the relentless drive to expand the forces of production and eliminate living labour from the production process, deepens the structural antagonism that underlies the capitalist mode and pushes it towards its interior limits.

There are of course, as Mandel recognizes, various countertendencies through which the 'law' can be circumvented: through 'primitive accumulation' and forced opening of new markets with low organic composition, thereby 'rejigging' the capital-labour ratio,[18] by increasing the efficiency of machine manufacturing and lowering the costs of the means of production, by speeding circulation by advertising, marketing and innovation, and even by creating vast tracks of unemployment and using this structural antagonism to suppress wages and force longer work hours in order to extract the maximum labour-surplus. [19] However, these were all taken by Mandel as subsidiary diversions that can temporarily offset but not eradicate the law of the falling rate of profit, which along with the irrepressible logic of capitalism (accumulate, expand or perish), become the instruments of its imminent demise.

Few today (even in the context of the current economic crisis) will be convinced of the imminent and automatic collapse of the system, given that capital has continually

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[18] According to recent estimates (Freeman, 2010), the proletarianization of huge expanses of Eastern Europe and Asia, has had the effect of reducing current global capital/labour ratio by 60 percent.

[19] See Balakrishnan, 'The Coming Contradiction,' *New Left Review*, 66 (2010), for recent discussions on the global shaping and function of the 'reserve army of labour.'

been able to circumvent this type of crisis by ongoing technical or geographical re-structuring.[20] In the end, it seems that there are too many contingencies and aforementioned counter tendencies to slavishly follow the law of falling profit. Mandel's analysis is too hasty and simplistic, and capital more dynamic and adaptable than he had supposed**.** Yet, there are undeniable insights in Mandel's position. Written in the late 1960s, it was a powerful challenge to the common contention at the time that the new 'post-industrial' economy no longer obeyed the laws of classical capitalism and had all but banished crises, depressions, mass unemployment and poverty.[21] Mandel categorically rejects the idea that the growth of technical and administrative experts (reflecting the requirements of a regime of 'post-industrial' accumulation emerging in the late 1960s that was increasingly premised on scientific and technological knowledge and innovation) marked a new and unprecedented era or epoch of development, and instead he situates theses changes within the framework of historical materialism, arguing that late capitalism " appears as the period in which the branches of the economy are fully industrialized for the first time."[22] Mandel argues that what was being witnessed was the inauguration of the purest stage of capitalism yet, where the activities pertaining to the economic realm were increasingly integrated. He goes on to anticipate, with remarkable accuracy, our current conditions of increasingly unemployment, the stagnation of wages, the casual nature of the work force and the ascendency of part time and temporary

[20] See Harvey, *The Limits to Capital* (London, 2006), ch. 12 and13 for an excellent analysis of the geographical mobility of capital and of the geographical movement (or circumvention) of crisis and contradictions.
[21] For earlier renditions of this argument, see Bell, *The Coming of Post- Industrial Society* (New York, 1973) and Toffler, *The Third Wave* (New York, 1980).
[22] Mandel, *Late Capitalism* (London, 1975), p. 191.

contracts.[23] It should therefore be as clear today as it was for Mandel that while productivity gains can increase the material living standards of workers even as wages stagnate, the modernist promise of increasing free time for all cannot be abided within the confines of private property, and that advancements in technical efficiency will not be directed towards reducing working hours across the labour spectrum.

While Mandel's political economic critique provides a powerful understanding of the contradictions and instabilities that compel capitalists to continually search for new technological and organizational 'fixes' which lead to re-occurring crises, and while it encourages a recognition of the contingency of science and technology on capitalist relations, the closed, narrow and deterministic understanding of the forces of socio-historical change has deeper implications that need to be challenged.

Marxist critiques of Mandel have often focused on the profound absence of human agency and class struggle in his highly economistic account of development and historical change. In attempting to account for the specific internal mechanism or logic that had pushed capital into recurring and deepening crisis, critics argued that *Late Capitalism* continually glossed over the complex social determinations of production and accumulation and made no attempt to systematically link class structure, class struggle and profits.[24] Therefore, even with respect to the tendency of the rate of profit to fall, Marxist critics have pointed out that Mandel provides almost no discussion of the distinctive social processes (labouring conditions, the social organization of production, the institutional conditions and limits on scientific and technological knowledge, class

[23] For a more contemporary look at some of these changes to the structure of advanced capitalist economies see Teeple, *Globalization and the Decline of Social Reform* (Aurora, 2000), pp. 51-80.
[24] See Callinicos, *Making History* (Chicago, 2009), ch. 2.

struggle within the labour process and so on) which clearly influence the amount of surplus labour performed, the rate of exploitation or profit, the pace and direction of technical change and the crisis tendencies of capital.[25]

The inadequate analysis of class relations and lack of social critique in this account of productive growth led researchers following Mandel in the 1970s to take up a more systematic analysis of how the class relations that prevail in capitalist societies enter *into* the labour process and are exercised through the systematic re-organization of the forces of production. In particular, Harry Braverman's classic book, *Labour and Monopoly Capital,* renews the Marxist critique of social rationality through an analysis of deskilling. Braverman, in an effort to bring Marx's analysis of the processes of deskilling that befell craft workers in the nineteenth century into his own era of monopoly capital, reminds us of the fragmentation of work tasks, and the ongoing attempts by management to control labour. As such, they are in fact highly socially contingent and born out of capitalists' systematic attempts to gain increasing control of the labour process and enhance profitability by subdividing the work of each productive specialty into limited operations. On this point Braverman writes:

> The capitalist mode of production systematically destroys all-around skills where they exist and brings into being skills and occupations that correspond to its needs. Technical capacities are henceforth distributed on a strict "need to know" basis. The generalized distribution of knowledge of the productive process among all its participants becomes from this point on, not merely "unnecessary," but a positive barrier to the functioning of the capitalist mode of production (56).[26]

Braverman points out that because the prevalence of all-around skills acts as a barrier to the penetration of capitalist social relations in the labour process, the expansion

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[25] For a nuanced discussion of these factors see Harvey, *Limits to Capital* (London, 2006), ch. 4.
[26] Braverman, *Labour and Monopoly Capital* (New York, 1978), p. 56.

of surplus value depends on the progressive erosion of the majority of workers' control over work processes. Potentially 'monopolizable' scientific and technical knowledge is brought under control and progressively eroded or broken apart**.** For Braverman**,** this technical and organizational re-structuring of the productive process requires the service of sophisticated managerial and technical (engineering) understandings and skills. These processes are mobilized by capital and in turn give rise to a new social-hierarchical ordering and to a particular 'advanced mode of co-operation,' which speaks to the structure and shape of the working class *as a whole,* under conditions of monopoly capital. Given the prevalence of these new productive (class) relations, Braverman argues that there are ongoing attempts on the part of the technocratic/managerial class (functioning as new sub-stratum of the bourgeoisie[27]), to continually expropriate knowledge and skills from workers before then parceling, simplifying and fragmenting work tasks so that they can be planned, paced and technologically routinized. Braverman states that this form of systematic and scientific (Taylorist) control over the conditions of production, ensures that "as craft declined the worker would sink to the level of general and undifferentiated labour power, adaptable to a wide range of tasks, while as science grew it would be concentrated in the hands of management."[28]

Thus, whereas Mandel (largely through a narrow understanding of the forces of production that ignored the nature of their transformation within the labour process), has a great deal of difficulty explaining how capital can continually find the appropriate

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[27] See Van der Pijl, *Transnational Classes and International Relations* (London, 1998), ch. 5, for an interesting and provocative discussion of ongoing attempts to incorporate this technocratic/managerial/administrative group into the ruling class, yet the class affiliations of this 'cadre group' remain in question, as does the prospect of their incorporation as part of an anti-capitalist labour movement.

[28] Ibid., pp. 120-121.

technological mix required to continually renew the conditions of accumulation, Braverman's detailing of the level of managerial control over the production process and his account of the ability of a particular class to direct and mobilize science and technology, shows that in the monopoly era capital has gained the organizational capacity to revolutionize the forces of production almost at will.[29]

By showing that labour discipline and control is continually enforced through the re-organization of the productive forces at the point of production, Braverman's analysis presents a deep challenge to the tacit understanding of progress that animates the work of both Cohen and Mandel. While Cohen and Mandel effectively ask us to accept continual technical and scientific growth, in so far as it carries an underlying movement towards a higher social order and while they thereby consider the advancement of the forces of production to be an unqualified boon for civilization in the long run, Braverman reminds us that the assembly line and the fragmentation and division of work upon which the growth of those forces is premised, appears as progress only within a specific social context. Accordingly, if production takes place at the community level and is under control of associated producers, we will likely find a different interpretation of work, accompanied by different technical choices.

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[29] It is important to note here that rather than understanding that process as a once and for all move pertaining only to industrial labour, Braverman recognizes it as an incomplete and ongoing, occurring when new regimes or modes of capital accumulation and production bring to life new skills and competencies**.** For example**,** while there was an initial proliferation of well paying technocratic and computer based administrative positions (which were required for the establishment of a computer based economy emerging in the 1970s), the same processes of technological deskilling and regulation can be seen at work in the 'post-industrial' era, as countless technocrats and experts have increasingly lost their jobs as their bodies of knowledge have been stored, computerized and made obsolete. For more on that process see Menzies, *Whose Brave New World?* (Toronto, 1996).

The groundwork for Braverman's position can be found in the work of Marx, but the tacit suggestion that science and technology may actually function to tie us to the status quo was first elaborated on by the Marxist philosophers of the Frankfurt School. In works like Adorno and Horkheimer's *Dialectic of Enlightenment (1947)* and Herbert Marcuse's *One Dimensional Man (1964),* Critical Theorists argue that Enlightenment reason and the scientific and technological developments that once held the promise of liberation from basic want and religious superstition were high-jacked and usurped by the immediate interests of the system.[30] Here, they argued that while pre-modern technical activity was guided by culturally secured values that were incorporated in the practice of craft, the removal of substantive goals from the structure of reason and its reduction to a mere instrument for arbitrary ends under conditions of advanced industrial capitalism, led itself to takeover by powerful social interests and oriented scientific and technological development almost exclusively towards profit.

After challenging the hegemony of instrumental rationality, one of the key tasks put forward by the Frankfurt School and Marcuse in particular, was the development of an alternative rationality that would ensure the incorporation of life affirming standards and values into technical rationality and the technological base. While most members of the Frankfurt School went on to apply that critique to media and other forms of mass communication that they saw as highly repressive, several Marxist sociologists and social historians working after the Frankfurt School (including Braverman), provided historical

[30] While I present this interpretation here, as we will see in Chapter 3, the reason Adorno and Horkeimer called it the 'dialectic of the enlightenment' is that the problem of reason was inherent in the concept. That is, reason was the tool that people used to exercise dominion over nature, but that meant that it was also a tool that would be used to exercise control over men and women [who were themselves natural beings] and over nature as 'being'. Thus reason becomes both a cause of enlightenment and a source of instrumental oppression. So for them, it is not merely a question of being hijacked, but a problem inherent in the concept of enlightenment.

reconstructions of the process of technical development, confirming the suggestion that technical specifications were highly socially contextual, and demonstrated that the 'markings' of class relations could be traced onto the very design and structure of machines.

In particular, David Noble's inquiry into the social evolution of automatically controlled machine tools in his book *Forces of Production: A Social History of Industrial Automation*, presents a further challenge to the idea that technologies represent the pure application of knowledge of nature. Noble's work here provides a particularly clear case study of the way in which the design, development and diffusion of techno-science is deeply caught up with social and political criteria. While Noble analyzes the complex social determinations of technology from many angles and levels (which I cannot adequately summarize here), perhaps the most provocative part of his analysis is to show how the concepts of 'economic and technical viability' that are continually cited as the generic criteria for technological development and advancing automation are, upon close historical inspection, inherently political and deeply intertwined with social relations of production. By carefully reconstructing the historical genesis and design of 'numerical controls' (NMC's) which were widely used for automating machinery beginning in the post-war period, Noble argues that a cheaper and simpler variant for automation called 'record playback,' was sacrificed and never developed in the early stages of automating industrial production. According to Noble, echoing Braverman, "management was willing to sacrifice economy and cost in order to retain control over production."[31] Noble argues that record playback, which necessitated shop floor participation and programming, and which emphasized workers' skill and creativity in the labour process,

[31] Noble, *The Forces of Production*, (New York, 1984), p. 185.

was abandoned for more expensive and potentially less efficient numerical controls. These offered management a means of breaking down the power of skilled unionized machinists by eliminating the human element and shifting programming to a separate and centralized office. According to Noble, taking up Marx's remarkable suggestion that "it would be possible to write a whole history of the inventions made since 1830 for the sole purpose of providing capital with weapons against working-class revolt,"[32] capitalists are seen to be consciously constructing new technologies as weapons of class-struggle.

Again, the underlying suggestion that technology might function to reinforce relations of subordination rather than to subvert them, presented a serious challenge to the determinism and developmental *telos* found in the work of Cohen and Mandel. Therefore, while these scientific socialists maintained that technologies were neutral and could act as a foundation for a future socialism or communism, Noble understands these techno-scientific changes to be inextricably caught up with the increasing subordination of knowledge, skill and labour power to capital, and are thereby distinctive or appropriate only to the capitalist mode of production. For Noble, theories suggesting that the sheer force of new technologies will usher in a new social era (be they in the form of post-industrial modernization theories or in technological deterministic readings of Marx), represent a deep-seated linear progressivist ideology that glosses over the extent to which powerful social interests preside over the earliest stages of scientific and technical research. These include university education in science and technology,[33]which when combined with corporate patenting laws, direct development in ways that reinforce

[32] Marx, *Capital, I* (New York, 1976), pp. 562-63.
[33] For a further discussion on how university education in the sciences has been progressively subordinated to corporate demands see Noble, 'Selling Academe to the Technology Industry,' *The Nea Higher Education Journal* (1998).

servility and exploitation. Based on the framing of his argument and his suggestion that techno-scientific growth and increases in productivity have repeatedly generated unemployment and job insecurity and is fundamentally premised on a model of "progress without people,"[34] Noble calls for the revival of a neo-Luddism for the information age – a revival that should be aimed at directly halting further technical advance.

While I think that Noble, as well as the aforementioned members of the Frankfurt School, painted an overly dystopian view of modern technological and scientific development, which again placed severe limits on the potential for agency and movements of political resistance within rational systems[35] and went too far in closing off the progressive *potentiality* of the productive forces, the recognition that technologies are socially constructed and reflect class relations presents an important challenge to narrow and deterministic readings of Marx. It also has implications that extend to our concept and understanding of socialism. For, as Nick Dyer-Witheford has argued, if socialism is seen as an almost pre-destined result of the continuous advancement of neutral industry, and property relations are read simplistically as an obstacle or fetter to their further advancement (as they ultimately are in Cohen and Mandel's work), then the subsequent task of social transformation easily becomes defined as the speeding up of technology and science at all costs, even if resistance to that process or alternatives are presented by

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[34] See Noble, *Progress Without People* (Toronto,1995).

[35] See Burawoy, 'Towards a Marxist Theory of the Labour Process: Braverman and Beyond,' *Politics and Society*, 8 (1978), pp. 246-314, who argued that both Marx and Braverman had reduced the worker to a passive object of development and thereby ignored the subjective experience of worker's dealings with systems of scientific management and further ignored movements of resistance to that process. With respect to the Frankfurt School, see Feenberg, *Between Reason and Experience* (Cambridge, 2010), for an excellent discussion of contemporary democratic interventions into technological and scientific developments, which avoids the dystopian conclusions of Adorno and Horkheimer, while still attending to the limitations of attempting to shape development within the confines of a market society.

those in whose name the revolution is enacted. As Dyer-Witheford suggests, "where the consequences of this concept appeared in truly grotesque form was of course in the late Soviet regime—in which the objectivism of scientific Marxism combined with the logic of vanguardism, substitutionalism, and technocratic expertise in a fatal mix."[36]

By examining a deeper level of the co-constitution of the forces and relations of production, we not only cast serious doubt on analyses that would have us sit on our hands and wait until 'all possibilities for development within the system have been exhausted,' but we also recognize that machinery is only a 'moment' in the forces of production, which is itself a question of social power. It becomes clear that any socialistic transformation will have to go well outside of the market/plan dichotomy and enter deep into the technical 'base' of the forces of production: efforts will need to be directed towards discovering and creating an alternative technical/organizational basis to society and ensuring that the views and interest of community members and actors guide our technical relation to the world.

While these are important considerations and reconstructions, we still find in Braverman and Noble, like Cohen and Mandel, a narrow understanding of the forces of production that fails to mark the deep ecological content of Marx's conceptualizations and critiques. I suggest that Marx used the forces of production as a way of analyzing *the dimension of human existence through which we are purposefully linked to the rest of nature* and that his reflections on scientific knowledge, technology and organization forms always contained that deep ecological dimension. Here, while Braverman and Noble's reconstructions are important in attempting to pull Marx out of a linear and

[36] Ibid., p. 47.

technologically deterministic reading, their analyses continually bracket-out our relationship to nature and categorically ignore the environmental implications (or contradictions) of continuously developing and advancing the productive forces in capitalist societies. Therefore these accounts seem to once again carry the implicit modernist assumption that we stand outside of the natural world and that the ecosystems that support life can absorb any and all costs of growth.

Yet today, given that several areas of the world's oceans have been badly contaminated and fished out, fresh water sources poisoned, the air in urban and industrial areas polluted, huge forest expanses depleted, growing species extinction, massive desertification, and where countless ecosystems are plundered and incapable of short term regeneration, the natural basis of human life can no longer be taken for granted. The environmental consequences of decades of advancing production must move to the forefront in our critiques of political economy.

While Marx considered technologies to be expressive of underlying social relations and processes rather than socially determining, the centrality of technologies and technological choices in ecological transformations brings another dimension to our analyses. Recognition that the technologies inherited from capitalism must be transformed based on a concern for our relation to nature (and which appears to be completely lost in the deterministic framework) is critical for marking the importance of the Marxist critique of technology. Particularly in the contemporary period, where social struggles over scientific and technological developments are at the forefront of the more radical wings of the environmental movement.[37] The task for Marxists from this

[37] For a clear articulation of the enduring importance of the Marxist critique of technology and of the need to finding an alternative technological foundation for a future socialism, see Feenberg,

standpoint should be to continue to demonstrate the class basis of the relations and processes that drive the forces of production (and by extension our relation to the rest of nature), and which continue to subordinate and colonize attempts and initiatives seeking to define a future that is more socially just and ecologically sustainable.

Unfortunately, many contemporary Marxist attempts to bring ecological concerns back onto the terrain of historical materialism have often reproduced the deterministic frameworks seen in Cohen and Mandel. They have ignored the relations and processes that link us to the rest of nature. Initial concerns over the ongoing degradation of human and natural environments through corporate-led industrial processes and practices have often given way to 'objective' economic analyses that gauge the extent to which ecological destruction and depletion produces external and unforeseen costs, which then have a faltering effect on rates of productivity and profit.[38] This so-called "second contradiction" of capital is now widely perceived as integral to capitalism's new crisis. Such eco-Marxist analyses are often accompanied by scenarios of pending systemic break down, as the limits to economic growth in the depletion of natural resources coincide with already faltering economic activity, thereby producing a new fatal mix.

While the more nuanced versions are accompanied by a critique of the flagrant misappropriation of resources by corporate-led industrial processes and add to our understanding of the instability of the conditions of capitalist reproduction, approaches to natural barriers of economic expansion tend to move away from a critical account of the

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'Marxism and the Critique of Social Rationality: From Surplus Value to the Politics of Technology,' *Cambridge Journal of Economics*, 1-13 (2009).

[38] For one of the earliest Marxist articulations of this 'second contradiction' see O'Connor**,** 'Capitalism, Nature, Socialism: A Theoretical Introduction,' *Nature, Capitalism, Socialism*, 1, 1985.

dynamics that push us in environmentally perverse directions in the first place and replace history and politics with inevitability.

My recasting of Marx's concept of the forces of production is meant to shed light on the ecological dimension of human existence and intends to open up new terrain, allowing us to further politicize contemporary ecological concerns. I therefore turn in the next chapter for a close textual analysis of Marx's use and understanding of that concept, in hopes of recovering that ecological content.

Chapter 2:

Ecology as a Class Question

> The first premise of human history is naturally the existence of living human individuals. Thus the first fact to be established is the physical organization of these individuals and their consequent relation to the rest of nature…All historical writing must set out from these natural bases and their modification throughout the course of history through the action of men and women.
>
> -Marx/Engels, *The German Ideology*

Late twentieth century engagements with Marx on the forces of production have commonly ignored the ecological content of that important concept. While most scholars working with the productive forces have included natural conditions as a silent 'factor' of production, there has been a tendency to categorically ignore the relations linking us to the rest of nature and to view Marxism exclusively as a theory of society, or as a purely social philosophy. By contrast, in this chapter I will attempt to show that Marx used the concept as a way of interrogating the practices through which we are purposefully linked to the rest of nature, and as a critical tool for examining the social forces and class relations that continue to push us in environmentally perverse directions. Furthermore, I will argue that this expanded and open understanding of the concept allows us to bridge Marx's earlier and later works and provides a foundation upon which we can shed light on contemporary ecological degradation.

In the context of the current ecological crisis, certain classical eighteenth and nineteenth century philosophical and economic debates concerned with the character of our relation to nature in modernity and of the social and ecological ramifications of widespread industrial expansion have gained new credibility. Within many channels of ecological thought, critiques have once again been launched targeting the modern

humanist and Enlightenment traditions' tendency to reduce nature to a passive object of reason, which continues to shape attitudes toward the rest of nature and which purportedly allows us to assert our ongoing dominance over it.[39] Yet the romantic and sceptical empiricist critique of instrumental reason, which colours many of the deep ecological responses to present day concerns, and which seeks to assert the independence of the natural world from us, tends to 'elevate' nature to the point where it inevitably appears as an objective force that dominates over the subject.[40]

One of the main achievements of the ecological movement has been to break down philosophical dualisms between society and nature and force us to recognize that human history is part of natural history. What remains less understood, however, is that the relationship to nature emerges through social practices and is mediated by human labour, in all its forms and historical varieties. It was Marx who first argued effectively that human production was a metabolic exchange or interaction between society and nature without which history would not develop and human beings would cease to exist. I argue that his reciprocal or dialectical understanding is critical for marking the deep link between class-based politics and ecology/environmentalism that unfortunately still continues to contain a certain opposition to each other.

Furthermore, because contemporary ecological thought continues to be caught up in these 'old' philosophical questions and because there is often a perceived epistemic break between Marx's earlier philosophical work and his more 'mature' and economic

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[39] See Duguid, *Nature in Modernity,* (Toronto, 2009*)* for an account of the humanist and modern treatment of the concept of nature, including contemporary and classic critiques and defenses of that position.

[40] See Vogel, *Against Nature (New York, 1996),* for a critique of the Frankfurt Schools' reversion to romanticism and the difficulties in asserting a strong ontological separation between nature and society.

writings (which threatens to undermine his important treatment of the society/nature metabolism), I will provide a brief historical exegesis of his philosophical anthropology before showing its centrality in the formation of the later concept of the forces of production which runs through *Capital*.

Beginning in the 17th century, the project of the Enlightenment and the advancement of individualism and instrumental reason sought to impose an ethic of reason in the development towards progress and in the attempt to counter religious dogma, superstition, conflict and violence. The belief was that the freedom to make our own rational choices through the exercise of free will, guided by reason, would lead to a true moral order that was not falsely prescribed by the church**.** Within this development came the construction of numerous dichotomies, including the emergence of the disengaged individual, whose mind was understood to be abstracted from both the body and the material world. With the creation and insistence upon various dichotomies and separations, the view also led to an increasing belief in the disenchantment of the world, whereby our surroundings became reducible to scientific inquiry and law, and were seen to lose their sense of mystique and power. Simultaneously, the capacity to comprehend the laws of nature was driven by a sense of (and desire for) security; that is, science would make nature and natural events comprehensible and would mediate and level out religious conflict and violence by posing basic laws which can be agreed upon by all: "sufficient reason."[41]

From the beginning, the model of Enlightenment knowledge was founded upon contemplation: the world was understood to be fundamentally separate from the knower,

[41] Hyland, *The Enlightenment: Sourcebook and Reader (*New York, 2003).

and knowledge was a process whereby the real was passively received by the subject.[42] The task of critical inquiry was to uncover the universal laws and principles of human and external nature embedded in facts so that they could be used for human benefit. Yet the difficulty of this position arose in explaining how a world of knowledge achieved through observation and analysis (which is inherently social and subjective) could be shown to accurately and reliably portray the world as it exists. Without detailing the unfolding of this dilemma in modern philosophy, the impossibility of knowing the object in itself without the taint of subjective experience is grasped by Kant and then later radicalized by Hegel, who tried to solve the problem by suggesting that we do not in fact passively receive information from an independent source, but instead actively produce the world as we know it through thought. Hegel accepted that knowledge is active and world creating (the world as we know it is the only one that exists and is knowable only through our constitution of it) and turned around to ask why it was that the external world, which bore the mark of our thought, seemed separate from our making. By emphasizing the social, dynamic and historically changing character of our knowledge of the world, that which appeared to be static, fixed or 'natural,' had merely been forgotten or reified, and needed to be deconstructed in order to reveal its social character. For Hegel, it was only through a long and complex process of self-reflection that the subject could recognize that the world bears the traces of human actions.

For Marx, the concept of world-making activity presented by left Hegelians gave a false conception of history because it left no account of how we actively and physically *produce* (rather than just reflect upon) the world that surrounds us. For Hegel, meaning-making activity remained decisively outside of concrete historical acts and processes. His

[42] Vogel, Ibid.

ontology ultimately maintained a dualism between the social and natural world (or reduced our relationship to the rest of nature as that which occurs within the mind). In contrast, Marx insisted that embodied human beings (and not an abstract spirit) were the subjects of this process and that the world, along with our understanding of it, is made through concrete social practices. De-alienation and 'self recognition' were not to be achieved by coming to terms with the ways we actively create the world that surround us in our minds, but by first recognizing that people literally *produce* the world that surrounds them with their physical bodies and through socially organized practices.

Marx was aided in his conception of the material basis of history by the anthropological materialism presented by Feuerbach. In this regard, Feuerbach counterposed himself against Hegelian idealism by presenting the framework for a non-philosophical naturalism, where all reason and science would be founded in nature. In doing so, he conceived of humans as natural and sensuous (rather than ideal and spiritual) beings, and argued that our corporeal nature was the precondition of any theory of subjectivity.[43] However, Feuerbach's naturalism lapsed into naïve romanticism, as he saw unity with nature as a given, based merely on the physiological fact that we arose from it. In this regard, Feuerbach maintained Hegel's rational belief that humanity has a special power, but instead of seeing this power as the universal power of thought, he simply viewed it naturalistically. For Feuerbach, humanity is a 'generic-being' because it is a special type of natural being that takes the universal (and therefore its own species character), as the object of its thought and activity.[44]

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[43] For an excellent analysis of the philosophical backdrop of Marx's approach to nature see Schmidt, *The Concept of Nature in Marx* (London, 1965).
[44] See Osborne, *How to Read Marx* (London, 2005).

Early attempts to extend the materialist critique of idealism rallied against Feuerbach's romantic notion of unity of nature and people, and sought to express the final separation of natural science from philosophy. In this regard, the mechanical materialists of the mid-nineteenth century saw any attempts to theorize about a unity between nature and history as a form of idealism and continually sought to establish a rigid distinction between society and the natural, which was seen to have always existed 'in-itself' and without human mediation.[45] Here, because nature is understood to exist prior to social construction, it was thought that uncovering the laws of the environment through the natural sciences could reveal reality and meaning.

While Engels in *The Dialectic of Nature*, along with other early materialists, suggested that the laws of nature could be used to reveal something essential about the social world, this position failed to consider that natural science was itself a social practice, and that knowledge of the natural world came through socially mediated categories. As Marx argued, it was only possible to speak of natural history when one supposes human history made by conscious actors. Therefore, natural history was understood to involve human history's extension backward, and Marx was keenly aware that these views were always imprinted with social categories. As he wrote in a letter to Engels on this point:

> It is remarkable how Darwin recognizes among beasts and plants his English society with its division of labour, competition, opening up of new markets, 'inventions', and the Malthusian 'struggle for existence'. It is Hobbes' 'bellum omnium contra omnes,' and one is reminded of Hegel's *Phenomenology*, where civil society is described as a 'spiritual animal kingdom,' while in Darwin the animal kingdom figures as civil society…[46]

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[45] Schmidt, Ibid.
[46] Karl Marx and Friedrich Engels, *Collected Works* (New York, 1975), 45, 106-7.

By attempting to subsume social history into natural history, mechanical materialism failed to challenge the purported objectivity of positivist philosophy and acted to deny people access to the contents of their consciousness, which now appeared only as the product of evolution, and as a passive reflection of the unfolding of nature, but not as a productive force.

Marx went beyond Feuerbach and recovered dialectical materialism from the passive materialism presented above, by not only including sensuous intuition in his inversion of idealism, but also the whole of human practice. For Marx, the fact that we are embodied, sensuous and physiologically needy, means that we have an inescapable need for basic natural substances and social relationships that reside outside of ourselves and which are, "the everlasting nature imposed conditions for human life."[47] Therefore, rather than conceiving of people as purely mental beings or as determined fully by material conditions, it was the living, sentient and physiologically needy character of human beings that is understood to connect them to the environment and to the development and transformation of the social and natural world.[48] As Marx wrote in the first of his *Theses on Feuerbach:* "the chief defect of all hitherto existing materialisms (that of Feuerbach included) is that the thing, reality, sensuousness is conceived only in the form of the *object or of contemplation,* but not as sensuous human activity, practice, not subjectively." While Feuerbach succumbed to the naïve myth of pure nature and early materialists reverted to an absolute separation of nature and society through passive materialism, Marx accepted the idealist view that the world is mediated through the

[47] Marx, *Capital,* I, p. *493*.
[48] For a discussion of the importance of the body in Marx's work see Schilling, *The Body in Culture, Theory and Society* (London, 2005).

subject, but inverted idealism by substituting concrete, sensuous and practical human labour for the abstract activity of *Geist*.

This understanding of embodiment and sensuous human practice roots us firmly in the natural environment, and overcomes an ontological dualism between nature and society from the outset. However, Marx's focus shifted to the study of the separation within that unity, and the process whereby we 'oppose' ourselves to nature, "*as one of her own force*s, setting in motion arms, legs, head and hands, the natural forces of his body," in a form adapted to historical needs and productive powers.[49] Here, for Marx what distinguishes human productivity from that of other animals is the variety of ways we meet our bodily needs by virtue of our social and cognitive capacities. Thus, the ability to raise the structure of our activities in the imagination before acting on them, and our simultaneous capacity to produce according to changing forms of social organization and co-operation (made possible through human capacity for complex language), means that we have the power to modify and improve upon prevailing productive techniques, rather than being tied to a rather fixed repertoire of behaviour characteristic of other species.

While Marx's understanding of socio-ecological practice incorporated a hitherto ignored subjective and material element in his understanding of history, there was still no discussion of the social relations and processes linking us to the rest of nature. It was not until he began to critique the classical political economic heirs of enlightenment (particularly Locke, Hume and Smith), for their narrow and reified understanding of capitalist political economic organization, that he took up the importance of the economic dimension of existence (understood broadly as the production of use-values in order to

[49] *Capital*, I, 177.

satisfy basic needs), and gave concrete content to his materialist conception of history. For Marx, socio-natural praxis needed to be approached and understood through an analysis of a historically defined and conditioned labour process, which was to act as the fundamental point of departure for his new materialist mode of inquiry. As he wrote in *Capital*:

> The labour-process is purposeful activity aimed at production of use-values. It is an appropriation of what exists in nature for the requirements of man. It is the universal condition for the metabolic interaction between man and nature, the nature imposed condition of human existence, or rather it is common to all forms of society in which human beings live.[50]

While Marx speaks here of the natural fixity of the most basic human needs, the development of human needs and the powers for interacting with nature (including the instruments of labour involved in the production process, which reflect and are deeply caught up with social relationships, forms of co-operation and mental conceptions of the world), are profoundly historical and in a constant process of transformation. As Marx suggests, "Not only do the objective conditions change in the act of reproduction, e.g. the village becomes a town, the wilderness a cleared field etc., but the producers change too, in that they bring out new qualities in themselves, develop themselves in production, transform themselves, develop new powers and ideas, new modes of intercourse, new needs and new language."[51]

The metabolic relation to nature is therefore according to Marx constantly evolving, and the dependence of human beings on nature is an insurmountable material fact**.** Moreover, it is from this basis that we encounter the simplest and I think most helpful understanding of the forces of production, comprehended broadly as the

[50] Marx, *Capital*, I, p. 290.
[51] Marx, Grundrisse, p. 494.

dimension of human existence through which we are purposefully linked to the rest of nature.

From this foundational position, Marx interprets history, at the most basic level, as a process whereby in order to reproduce themselves people enter into social relationships and work to appropriate nature in a manner that is consistent with those relationships and forms of knowledge that are historically developed and available. Marx acknowledges that there are all sorts of social, cultural and spiritual 'checks' that can hold societies in relatively stationary states, but suggests that once this equilibrium is broken down, contradictory forces come into play and the ongoing struggle to balance the tensions and antagonisms between the productive forces, social relationships and mental conceptions of the world become a motor force of history.

This broad understanding of productive forces, along with Marx's general interpretation of the forces governing history, is put to work under the dynamics of capital accumulation, wherein the quest to appropriate surplus value gives form to the practices linking us to the rest of nature, and impels a constant revolutionizing of those practices, as their development is in contradiction with prevailing social relations. To make this rather abstract proposition more concrete, I turn to Marx's analysis of how the productive forces particular to large-scale 19th century industrial capitalism came into being, primarily through his analysis of the Industrial Revolution in Chapter's 15 and 16 of *Capital I*, which I support with other passages that complement the direction and intention of his arguments**.** We look here to his understanding of the development of the factory system and the rise of machine industries that was aided by the integration and instrumentalization of scientific knowledge in the labour process. Marx noted that the

quest for stable and balanced accumulation forces virtually all other forms of production to adopt the qualities of capitalist industrial production. Agriculture, mining, and even societies at large were pushed to adopt its regimes of mechanization, its discipline, its temporalities and rhythms.

The difficulty is that when we start to unravel and re-cast Marx's concepts we see how changes in the labour process spiral out, re-enforce and modify other processes, causing an argument to spin out in every direction thereby seeking to make connections across every aspect of the mode of production. Clearly, I cannot rigorously reconstruct Marx's corpus here; again, I revisit these passages to demonstrate that Marx is analyzing and critiquing capital as an organizational form through which we are linked to the rest of nature.

Chapters 15 and 16 of *Capital I,* entitled "Machinery and Large Scale Industry" and "Large Scale Industry and Agriculture" provide particularly fertile grounds for studying the role of science and technology in socio-ecological transformations and developments. However, it was Marx's complex analysis of the social relations and material processes that were driving the technical/organizational transformations, which made his analysis so unique and prescient. Here, in Marx's account of the Industrial Revolution, we find a simultaneous transformation of technologies (including organizational forms), knowledge systems/mental conceptions (as industry is increasingly separated from art and culturally secured values), relations of production and our relation to nature.[52]

[52] The expansive and dialectic nature of Marx's treatments in these chapters is inspired by David Harvey's online lectures of *Capital* available online at < http://davidharvey.org >.

Marx begins to piece this transformation together with a discussion of the transition from tools to machines:

> The machine which is the starting point of the industrial revolution, replaces the worker, who handles a single tool, by a mechanism operating with a number of similar tools and set in motion by a single motive power, whatever the form of that power. Here we have the machine but in its first role as a simple element in production by machinery. [53]

While Marx asserted the pre-eminence of the machine here as a point of departure, he noted that to have a mechanism that puts several tools together in motion, human sources of motive power needed to be replaced by natural forces, consciously harnessed and brought under the thumb of science (in particular made possible by Watt's invention of the steam engine that drew power from coal and water)**.** As Marx argued, these 19th century scientific developments allowed industry to be liberated from local and geographically embedded sources of power (waterwheels and biomass), and concentrated in urban centres, as the material elements and means of production could effectively be shipped anywhere. This process (as we will see again later) led to fierce separation of town and country and a veritable revolution in our relation to the rest of nature, as land could be increasingly used for food and raw material production to be shipped to cities. And so it is here, in nineteenth century industry, that we began to see the coalescing of science and technology as a means for transforming the natural world; however, as Marx suggested, 'the steam engine-itself…did not give rise to any industrial revolution. It was, on the contrary, the invention of machines that made a revolution in the form of steam-engines necessary."[54]

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[53] *Capital,* I, p. 497.

[54] *Capital*, I, p. 496.

While on first glance Marx seems to be asserting a particular form of technological determinism (similar to what we saw with Mandel earlier), he argues that the entire process was premised on the re-organization of the labour process in order to produce for exchange value, which simultaneously *oriented* machine design:

> In manufacture, it is the worker who, either singly or in groups, must carry on each particular process with their manual implements. The worker has been appropriated by the process; but the process has previously to be adapted to the worker. This subjective principle of the division of labour no longer exists in production by machinery. Here the total process is examined objectively, viewed in and for itself, and analyzed into its constituent phases. The problem of how to execute each particular process, and to bind different particular processes together into a whole, is solved by the aid of machines, chemistry, etc.[55]

We see here that the drive to create the foundational conditions for continuous capital augmentation and circulation required the wholesale re-organization of work (as craft labour is broken into constituent and scientifically assessed parts before being mechanized and routinized), as well as the conscious application of scientific knowledge to production, which becomes a 'material force' in so far as it is used to transform the natural materials of labour and again materialized in order to guide production. While a common understanding of technological development would have it that historically advancing knowledge generates technological innovation (i.e. advancing knowledge drags technology in its wake), Marx suggested that the knowledge that develops for production evolves under the impact of the prevailing system and is dependent upon class power. Here, while he recognized that scientific knowledge and ingenuity had a degree of its own momentum that could not be totally captured by capital, the relationship between technology and knowledge also reflected and was deeply caught up with the social relations and requirements of capitalist production, as inventions were made increasingly

[55] *Capital*, I, p. 501.

possible by having a mass of skilled mechanical workers placed at the disposal of industrial projects and as the scientific means of facilitating the natural materials of production were being harnessed, directed and consciously applied to technical systems.

Concomitant with the harnessing of science to the prerogatives of accumulation, the capitalist class was faced with the dilemma of how to best mobilize and organize the collective powers of labour as a productive force. While it is clear that the machine is used to increase the productivity of labour, it also allows the capitalist to control the rhythm and pace of work, and efficiency becomes as much a social as a technical question. As Marx noted,

> In handicraft and manufacturing, the worker makes use of a tool; in the factory, the machine makes use of him. There the movements of the instrument of labour follow him, here it is the movement of the machine that he must follow. In manufacturing the workers are part of a living mechanism. In the factory we have a lifeless mechanism which is independent of the workers, who are incorporated into it as its living appendages. … the separation of intellectual faculties into powers exercised by capital over labour, is, as we have already shown, finally completed by large scale industry erected on the foundation of machinery.[56]

We gain perspective here on the ongoing class based attempts to control the labour process from above by separating mental from manual labour, and parceling out work tasks so that production is no longer rooted in the community or family, and artisanal skill is replaced with the performance of generic, undifferentiated machine minding skill. Marx was perhaps at his most critical when speaking of the capitalist employment of machinery and the violence visited upon the worker in the attempts to extract and enhance surplus value. With the development of large-scale industry, people were becoming progressively alienated from social and cooperative relationships, from their senses (including their sensuous relation to the land) and from their bodies, which were

[56] *Capital*, I, p. 548.

being formed over in the image of a process over which they had no control. The degraded nature of work, the crippling of the senses, and harm done to the body, were, for Marx, bound to provoke a great deal of resistance and potentially as likely to cause revolutionary ferments, as were low wages and high rates of exploitation.[57]

While Marx noted that past bonds, relations, and ties are forcibly eroded as work is atomized and parceled out, and that labour has the appearance of being private and particular under capitalism, he recognized that the social nature of the labour process was in fact enhanced through largely invisible and concealed forms of mutual interdependence and routine organization. Here, as the division of labour proliferated, the drive to organize, plan, unify and control functionally divided social activities was argued to give rise to the particular (yet ongoing and geographically differentiated) process of socialization and standardization.[58] In this regard, along with this drive to co-ordinate and plan the relative availability of labour power across differentiated spheres, Marx noted that capitalism continually seeks to unify the natural sciences within the production process, as once the productive qualities of a chemical or material element became recognized they are quickly turned into standardized, stored knowledge to be directly and consciously applied to a functionally divided, but increasingly homogenized and routinized process of production. Again, cumulative standardization of knowledge mutually reinforces the division of labour as more complex productive tasks are accomplished with the aid of small stratum of skilled technocratic and managerial experts placed at the disposal of capital, alongside a mass of generic abstract labour. The advanced division of labour and standardization of knowledge leads in Marx's words to

[57] Again, see Schilling, *The Body in Culture, Theory and Society* (London, 2005).
[58] This understanding of socialization is developed by Van Der Pijl, *Transnational Classes and International Relations* (London, 1996), ch.1.

"the conscious technical utilization of science, the planned exploitation of the earth, the economization of all means of production by their use as means of production of combined, social labour…."[59]

While already evident in the 19th century, more can be said today than Marx could say about the importance of a class of managerial and technocratic workers that emerged through processes of de-skilling, and who are associated with the task of socialization and the reproduction of capitalist formations. Kees Van Der Pijl has argued,[60] that the task of maintaining social cohesion and stability under the conditions of an advanced division of labour (and where execution has been separated from design) brings forward a specific stratum of managerial functionaries, who act as administrative 'interfaces' between functionally divided productive spheres or social activities. As he writes:

> Under the discipline of capital and the commodity form, the real subjects cannot executive planning/normative function for themselves; alienation and exploitation imply the negation of autonomy to begin with. Therefore, planning and the propagation and monitoring of social norms have historically evolved into a special task of special category of functionaries subordinate to the ruling class—the cadres.[61]

Van Der Pijl suggests that this intermediate stratum of functionaries (composed of professionals, managers, technical experts, natural scientists and other intellectuals, administrators and elites) act to maintain social cohesion and the integrity of the social substratum exploited by capital. Based on the complexity of production and the growth of social organization under conditions of an advanced division of labour, the ruling class gives up or cedes aspects of its rule to a class of social engineers and technical experts who are assigned the task of planning, arbitration, mediation and techno-scientific design

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[59] *Capital*, III, p. 720.
[60] See *Transnational Classes and International Relations* (London, 1998).
[61] *Ibid., p.* 138.

and maintenance. Moreover, just as the capitalist class has to control the workings of the labour process, it is increasingly faced with the difficulty of disciplining the cadre class it relies on to retain that control.[62]

However, along with the reduction of specialized skill and control to a small substratum of workers, Marx perceived a potentially positive side to this process of progressive alienation for the common worker in the 19th century:

> Large Scale industry, through its very catastrophes, makes the recognition of a variation of labour and hence of the fitness of the worker for the maximum number of different kinds of labour into a question of life or death. The possibility of varying labour must become a general law of social production, and the existing relations must be adapted to permit its realization in practice. …the partially developed individual who is the bearer of one specialized function, must be replaced by the totally developed individual, for whom the different social functions are different modes of activity he takes up in turn.[63]

Here, Marx presciently notes that the mass of workers are paradoxically freed from being the bearers and possessors of a narrow specialization that previously characterized craft production and are instead increasingly able to perform a variety of social tasks, as perpetual innovation and development demands the prevalence of 'all around skill' and flexibility in adapting to differing modes of activity. Elsewhere, Marx argued that public education arose (and continues to adapt in part) out of the need to produce the literate, flexible and well trained labour force required for constantly changing conditions of

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[62] Van Der Pijl argues here that while there are ongoing attempts to incorporate this technocratic/managerial/administrative group into the ruling class, the class affiliations of this 'cadre group' remains in question, as does whether they can be drawn into an anti-capitalist labour movement. This is perhaps an important question for contemporary environmental movements, as we begin to see the emergence of 'scientist activists,' such as James Hansen, who have recognized the systemic nature of ecological degradation and have begun to move beyond the principles of private property, at times positioning themselves directly against capital and calling for drastic social transformation.

[63] *Capital*, I, p. 618.

production, and he was an enthusiast for the potential future development of an education that would emphasize the multifaceted potentiality of human beings and schools that would provide basic training in a variety of technical, agricultural and vocational matters, as opposed to specialized and private teachings, often required for past forms of production**.** However, for Marx, the goal of finding a form of production that would allow for the cultivation and realization of all the qualities of the human social being, was continually thwarted by the social relations and class power that configure our forms of labour and that employ people to perform narrow, monotonous and repetitive tasks.

Marx understood that it was through transformations in social relations, technologies (including organizational forms), and knowledge systems that the technical basis of manufacturing was overcome, and a truly capitalist mode of production came into existence. In other words, it was through these transformative processes that the practices through which we are purposefully linked to the rest of nature, took on a specifically capitalist character. However, while Marx was showing the deep class basis of transformations in the forces of production during the Industrial Revolution, this was not a once-and-for-all move pertaining to the inauguration of the mode of production. As I suggested Marx was concerned to show that the dominant class relations of capitalism enforce and ensure a perpetual transformation and re-organization of the labour process in the quest to create conditions for relative surplus value.

Marx argued that when capitalists re-invest for the purposes of making more money, they require an investment in the means of production that are available on the market. These investments take the form of intermediary products that will be applied to the production (such as metals, cloth, chemicals, lumber and so on), as well as machinery

and fixed capital such as factories and transportation systems. While at one point Marx noted that capital is compelled to innovate in part due to coercive laws of competition (noted by Mandel), as suggested in our earlier discussion of standardization and administrative coordination, he also perceived the development of a high degree of interdependence between industries and a strong tendency towards centralization and market monopolization,[64] which increased along with the proliferation of the division of labour:

> The transformation of the mode of production in one sphere of industry necessitates a similar change in all other spheres. This happens at first in such branches of industry which are connected together by separate phases of a process, and yet isolated by the social division of labour, in such as way that each of them produces an independent commodity. Thus machine spinning made weaving by machinery a necessity, and both together made the mechanical and chemical revolution that took place in bleaching, printing, and dyeing imperative. …but as well as this the revolution in modes of production of industry and agriculture made necessary a revolution in the general conditions of the social process of production, i.e. in the means of communication and transport. … (which) gradually adapted themselves to the modes of production in mechanical industry, by the creation of river steamers, railways, ocean steamers, and telegraphs.[65]

As Marx showed, technological innovations in one sphere of activity create mutually reinforcing and spiralling techno-scientific changes in other spheres which ensure the flow of capital inputs and outputs between industries (think only today of the number industries that parallel the automotive sector and we could surely extend this argument to our homes, where our appliances and devices must continually keep with the advancement of other industries or else become obsolete). Yet, he also noted that

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[64] While I emphasized the importance of the administrative coordination for purposes of socialization, we can also see the 'organizational revolution' and the tendency towards corporate forms of organization as a function of the expansion of the law of value. For this account see Harvey, *Limits to Capital* (London, 2006), pp.144-155.

[65] *Capital*, I, pp. 506-7.

advancements in industry impel concomitant transformations in physical infrastructures and transport systems, which are required for overcoming spatial isolation of different processes (now considered as appendages to the development of the means of production and described by Marx in the *Grundrisse* as "human organs in the will over nature or of the participation in nature"),[66] which forced the separation of town and country and produced drastic and irreparable transformations of the landscape.

Furthermore, by speaking of infrastructural innovations in transportation and communication (as well as the concomitant production of space that is 'pressed' into the service of capital), as extensions of the means of production, or as part of the relentless dynamic that allows value to become the universal form of abstract labour, Marx provides prophetic insight into capital's ongoing attempts to continually 'annihilate space by time' by creatively destroying all geographical/spatial barriers and fixities that inhibit the circulation of capital goods**.** [67] In this regard**,** the speed and scope to which capital has impelled transformations of the physical landscape in order to universalize the mode of production in less than two centuries is nothing short of staggering, and lends further credence to Marx's remarkable observation almost 150 years ago that "the nature that preceded human history today no longer exists anywhere (except perhaps on Australian Islands of recent origin)."[68] Today, of course, even those reefs have been altered by human practices, including anthropogenic global climate change.

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[66] *Grundrisse*, p. 703.
[67] While this is understanding is first put forward by Marx in his *Grundrisse*, and revisited in *Capital*, II, it is extended and revised by Harvey in *The Condition of Post-modernity* (Oxford, 1989).
[68] *The German Ideology*, p. 63.

The relation to nature, while providing foundation for Marx's arguments in this way, comes fully back into the analysis, as Marx suggested in the last section of chapter 16, that the growth of large scale industry and the outward expansionary logic of capital, "has [in the sphere of agriculture], a more revolutionary effect that elsewhere for the reason that it annihilates the bulwark of the old society, the 'peasant', and substitutes for him the wage-labourer."[69] In this process, we find the historical dissolution of peoples' prior and more communal relations to the land by capitalist relations of production and the basis for urbanization, as people were forced to seek an industrial wage in the city. While Marx is again a fierce critic of the violence stemming from this process of dispossession,[70] he was enthusiastic about the potential associated with the conscious application of science to agriculture (in his time the development of soil chemistry that was required to improve fertility undone by capitalist agricultural techniques), and its potential to produce "material conditions for a higher synthesis" between agriculture and industry, which he suggested could provide the basis for overcoming a state of perpetual material want and insecurity.

Yet he suggested that the potentially positive side to this advancement in the forces of production was again fettered by the drive for accumulation. For Marx, the development of conscious powers regulating our relation to the rest of nature were being used as a means of rationalizing a process of ecological destruction and occurring at the

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[69] *Capital*, I, p. 637.

[70] See *Capital*, I, Chapter 26 entitled "The Secret of Primitive Accumulation," which documents the historical rise of capitalism through enclosure and the solidification of private property in the countryside. Marx here critiques the foundational myths of liberal political economists by showing that the peasantry was by no means inclined to embrace the enclosure of lands, and were consequently violently and forcibly removed from the commons—coming into wage labour, not for security, but as Marx writes, "dripping from head to toe, from every pore, with blood and dirt" (p. 896).

expense of "disrupting the metabolic interaction between man and the earth, (i.e. it prevents the return of the soil to its constitute elements consumed by man in the form of food and clothing); thereby, hindering the operation of the eternal natural conditions for the lasting fertility of the soil."[71] Furthermore, growing urbanization and the antagonistic separation of town and country, which was forcing long-distance trade, exacerbates this problem, leading Marx to conclude that,

> ...all progress in capitalist agriculture is a progress in the art, not only of robbing the worker, but of robbing the soil; all progress in increasing the fertility of the soil for a given time is the progress towards ruining the more long lasting sources of that fertility. The more a country proceeds from large-scale industry as the background of its development, as in the case of the United States, the more rapid this process of destruction. Capitalist production, therefore, only develops the techniques and the degree of combination of the social process of production by simultaneously undermining the sources of all wealth—the soil and the worker.[72]

For Marx, the depletion of the soil was in no way undone by the development of scientific agricultural techniques, and soil sciences were incapable of being developed in a manner than would ensure the longevity of the natural basis of life, subservient as those techniques were to the needs and prerogatives of capital accumulation.

Far from being a linear thinker, Marx saw the development of the forces of production as always a contingent and contradictory process, producing negative and destructive turns (particularly in terms of the relations between technology, nature and everyday social life), while also continually opening up counter agencies and progressive potentialities.

Furthermore, despite Marx's clear distance from the Enlightenment, we can see in these and other passages that he remained broadly concerned with questions of human

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[71] *Capital*, I, p.637.

[72] *Capital*, I, p. 638.

emancipation and self realization and considered that some separation or estrangement from an immediate sensuous relation to nature was essential in terms of the formation of modern consciousness and critical for the development of emancipatory forms of knowledge.[73] Here, he fully resisted romantic theoretical backsliding and never abandoned the view that some combination of modern science, technology and industry can provide the basic means for overcoming material want and scarcity. Of course, the question of how the productive forces we have inherited can be transformed in an effort to create less alienated and more just relationships with fellow human beings, and also a creative, sensuously liberated and ecologically sustainable experience with nature, presents us with serious conundrums. Yet, rather than roundly rejecting the technological mixes that capitalism gives us (as many contemporary ecological discourses propose), the critical tasks for an eco-socialist project become those of gradually developing less punishing material practices and more transparent and meaningful labour processes and, in line with the members of the Frankfurt School, locating a 'higher' form of technical rationality that is not purely instrumental, and perhaps creating 'new' and more sensitive forms of science that bring us closer to a sensuous relation to the natural world.

In the chapter that follows I will address these difficult questions, by examining some contemporary writers who have attempted to push forward certain aspects of Marx's thought in an effort to not only develop a fuller understanding of the current ecological crisis, but also to deal with the often more pragmatic question of how best to develop an eco-socialist or communist politics for our times.

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[73] Harvey brings this point out in Chapter 6 of *Justice, Nature and the Geography of Difference* (Oxford, 1996).

Chapter 3:

Marxism and the Politics of Nature

While Marx's socio-ecological thought provides a foundation from which to approach contemporary environmental problems, his explicit eco-political engagements were scattered and his ontological approach to 'nature' remained partial and incomplete. The level of ecological degradation in the late 20th and early 21st centuries and the growing scientific consensus that we are facing a deepening ecological crisis have led to numerous attempts to bring out the full ecological potential and significance of his thought and build an eco-socialist politics for our times. In this chapter I suggest that three contemporary Marxist approaches or frameworks attempting to bring 'nature back in' to historical materialism have emerged and can be identified: (1) James O'Connor's early and ground breaking attempt to theorize a 'second contradiction' in capitalist reproduction, which involves natural and resource based limits to continuous accumulation; (2) Neil Smith and David Harvey's 'production of nature' thesis, which sees nature as being dialectically and historically produced; and (3) John Foster's eco-Marxist approach, which theorizes an 'ecological rift' in the society-nature 'metabolism' and attempts to show the deep incompatibility of ecology and capitalism. By juxtaposing the three approaches, I aim to highlight their strengths and weaknesses (both ontologically and as eco-political formulations) and ultimately argue that they all have difficulty articulating the ecological dimension of a future socialism or communism. To help fill that gap, I conclude by re-visiting the work of Herbert Marcuse, who called for a technical rationality that is of a higher order than any so far constructed.

Economist and founding editor of the leading eco-socialist journal, *Capitalism, Nature, Socialism*, James O'Connor began writing on ecological degradation in the early 1980s, in the context of growing awareness of resource scarcity, habitat destruction and air and water pollution, which contributed to the sense that we were approaching a deepening ecological crisis. Alongside the growing environmental movement, two mainstream eco-political approaches (which are still clearly with us) emerged in the literature.

The first approach, which is commonly understood as technocratic and managerial, suggested that ecological problems could be resolved by rather straightforward technological and scientific advancements, along with a fine-tuning of economic rationality. This discourse emerged in the context of wider 'post-industrial' theorizations, which along with promises of liberation from monotonous work, argued that the arrival of high technologies and the increasingly immaterial nature of information based labour, would do away with pollution and lead to a more ecologically sustainable future. The second approach, often termed 'neo-Malthusian' or eco-centric, converted Thomas Malthus' arguments into a conservationist ideology. Ecological problems were located in the basic human dependence on finite resources, which was argued to be exacerbated by population growth. This could only be resolved by population and birth control, and not by the application of science and technology.

For O'Connor, and other Marxists who were attempting to bring 'nature back in' to historical materialism in this period, both approaches were insufficient and thwarted a solution to on-going ecological degradation by largely ignoring the shifting history of social organization in relation to nature, and thereby effacing the social and political roots

of the problem. In the case of neo-Malthusian arguments, the ideological content was clear from the outset: contemporary ecological problems at the heart of bourgeois society were being placed on the shoulders of the poor and their perceived tendency to succumb to innate sexual desires and over-procreate.[74] The technocratic solution betrayed similar functionalist underpinnings because it tended to ignore the extent of the geographic re-location of industrial production in advanced capitalist countries. This was part of a wider tendency to expand production and consumption on a global scale, countering arguments that industrial forms of production no longer claim hegemony in the global economy. Furthermore, studies in this period revealed that the production of many so called 'clean technologies' such as computer chip manufacturing were in fact highly polluting, toxic and environmentally hazardous.[75]

In an effort to reframe the debate, O'Connor understands the ecological crisis by re-visiting Marx's argument that social transformation is driven by the contradiction between the forces and relations of production. He declares there is a largely ignored 'second contradiction' in Marx's analysis of capitalist reproduction, revolving around the natural limits or barriers to continued economic growth and accumulation.[76] O'Connor argues that while the 'first contradiction' of capitalism revolves around social control over the forces of production (machine technologies, scientific knowledge and skill, as well as labour power), capital accumulation and expansion is also premised on the use and transformation of largely ignored 'external natural conditions of production.' These

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[74] See Harvey, *Justice, Nature and the Geography of Difference* (Oxford, 1996).

[75] For a look at this process in the United States see Hayes, *Behind the Silicon Curtain* (New York, 1985).

[76] O'Connor, 'Capitalism, Nature, Socialism: A Theoretical Introduction,' *Capitalism, Nature, Socialism,* 1, 1985.

are in many cases non-renewable (such as water, ore and oil), and their diminishment and degradation were leading to a specific and new form of crisis for capitalism.

Therefore, based on the underlying argument that the economic system is incapable of preserving scarce natural resources due to its inherent need to expand the circle of accumulation, production and consumption, O'Connor argues that the degradation of these natural conditions of production (which is only exacerbated or sped up by the mobility of capital and the retrenchment of national forms of protection in the global era), not only constitutes a natural barrier to continued capitalist growth in the long run, but also involves a whole series of unanticipated costs for individual companies that limit accumulation in the interim. The reproduction of conditions of on-going growth and accumulation is understood to involve a whole host of unexpected "externalities" (such as replenishing trees, restoring soil-eroded land, cleaning up hazardous waste sites, fishing well off-shore as stocks run thin and inlets become more polluted, and having to drill for oil in evermore remote and precarious places) that both deepen and exacerbate ecological devastation and drive up the costs of production and depress profit.

By re-framing Marx's explicit ecological reflections in *Capital* (which O'Connor views as unsystematic and incomplete), he seeks to explain that 'the second contradiction' is contributing to and re-enforcing a wider crisis in accumulation. This has the associated effect of forcing companies to spend billions of dollars to hold down costs associated with production under conditions of scarcity and leads to corporations attempting to externalize the social and environmental costs of this process.

O'Connor's work was a landmark in critiquing both the flagrant misappropriation of resources by corporate-led industrial processes and the politics emerging from the

corporate drive to ensure that resources are available to capital on an ongoing and easy basis. As such, it is a significant contribution to an understanding of the instability of the conditions of capitalist reproduction. However, his desire to feed Marx's analysis into a theory of economic crisis seemed to limit some of the more radical components of Marx's reflections.[77] In many ways, O'Connor re-capitulates capitalist arguments that go back to classical economists such as John Stuart Mill or David Ricardo, who long ago theorized that an economy based on constant resource extraction could reach a 'stationary state.'[78] The fact that capitalism had successfully circumvented natural barriers to accumulation in the past[79] and has shown a capacity to accumulate in the midst of ecological destruction (indeed to actually profit from environmental degradation[80]) was glossed over by O'Connor. This should give us reason to doubt the inevitability of this kind of crisis in the near future.[81] Of course, it would be silly to suggest that these barriers will never translate into an accumulation crisis if present practices continue indefinitely. However, arguments borrowing from O'Connor's framework that focus on absolute and pure limits in nature distract from the dynamics and relations that actually

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[77] See Foster, 'Capitalism and Ecology,' *Monthly Review*, 54, 2002.

[78] The origins of this critique are noted by Kunkel in 'How Much is Too Much?' *London Review of Books, 33, 2011.*

[79] Marx already mapped radical shifts in the relations to nature and transformations in resource and energy production as we saw in Chapter 16 of *Capital, I.* For an elaboration and expansion of this argument see also chapter 2 of Harvey, *The Enigma of Capital* (Oxford, 2010).

[80] The contemporary proliferation of highly profitable waste management industries speaks to this process.

[81] There are parallels to be made here by comparing the shortfalls of O'Connor's theorizations to those of Mandel. As we saw, Mandel's tight focus on the 'law' of falling rate of profit forced him to bracket out various contingencies and features of Marx's thought that did not feed into a specific crisis theory.

force environmental changes, and subsequently inflect history and politics with a sense of inevitability and apocalyptic doom and gloom.

The limitations and shortfalls of O'Connor's approach perhaps stem from an under-theorization of the category of nature and an uncritical acceptance of nature's externality to production. For David Harvey and his colleague and interlocutor Neil Smith, who took up the political task of critiquing what they called 'bourgeois environmentalism' in this same period, arguments suggesting that 'pure' limits in nature were being undermined by the logic of capital accumulation were 'sad capitulations to capitalist arguments'. Such positions re-enforce a dualistic conception of society and nature and carry Malthusian undercurrents, in so far as they see scarcity as in some sense fixed, universal and inevitable and not socially, politically, culturally and economically situated and constituted. [82] Harvey and Smith see O'Connor's attempt to define resources or needs independently of the processes, relations and material practices that constitute them, and to thereby imagine a world of distinct and autonomous things, containing their own essences, to be a-historical and decidedly un-Marxist. What was needed was a reconstruction of Marx's ontological commitments, a fully-fledged and expanded historical and geographical materialism that understood nature itself as a materially and discursively constituted historical product.

In his classic *Uneven Development: Nature, Capital and the Production of Space,* Neil Smith argued that while Marx did not have a single coherently elaborated concept of nature and never explicitly spoke of nature's 'production,' there was an implied understanding in his work that leads us firmly in the direction of treating nature as a

[82] Harvey, *Justice Nature and The Geography of Difference*, p. 146.

socio-historical category. This understanding, which is shared by Harvey (and indeed reflected in my reading of Marx in the previous chapter), begins with Marx's recognition that the labour process and the appropriation and transformation of non-human labour is a quasi-transcendental condition of human existence. To recall, as Marx wrote in *Capital*:

> The labour-process is purposeful activity aimed at production of use-values. It is an appropriation of what exists in nature for the requirements of man. It is the universal condition for the metabolic interaction between man and nature, the nature imposed condition of human existence, or rather it is common to all forms of society in which human beings live.[83]

Central to Marx's analysis was a clear understanding that humanity has always existed as a part of nature and that people must work to appropriate material resources in order to survive. For Harvey and Smith, this recognition implies that there can be no prior ontological divide between society and nature (as bourgeois ideologies would have it), for humanity has never been separated from or outside of the natural environment. Human labour should not be thought of as external force imposed upon nature from outside (and which is in some way undermining nature's basic integrity), but rather recognized as one of its central and constituting parts. Thus, as Harvey and Smith maintain, nature is neither external nor asocial, but socially produced and understood as internal relation within a larger integrated totality.[84]

Accordingly, Harvey and Smith argue that there is nothing 'un-natural' about humans transforming the environment that surrounds them in ways that are conducive to

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[83] *Capital*, I , p. 290.

[84] This ontology of internal relations is most developed by Bertell Ollman in his *Dialectical Investigations* (New York, 1993), where again each component of a larger 'totality' is understood to internalize relations of the other parts, rather than containing its own essence or relating to itself. No element of a totality ever stands still but is constantly changing, moving and co-evolving in relation to other components of the whole.

their own reproduction (indeed Harvey has provocatively argued that New York should be thought of as a complex ecosystem that is no more 'un-natural' than an ant hill). There is little left on the surface of the planet that can be thought of as pure or pristine nature independent of human modification and therefore inherently in need of conservation (as environmentalists often imagine). Recognitions of this sort oblige us to see the environment as a category that includes fields that have been cleared, forests that have been cut down, estuaries that have been dredged, rivers that have been re-engineered and the roads, canals, ports, harbours, factories, schools, houses, apartments, sewer systems that have been constructed, and which support (but also threaten) human life and the life of countless species that have adapted to these conditions. In fact, so intricately are humans intertwined with the environment that our sudden removal from the planet would, as Harvey suggests, not save or preserve the planet as some ecologists have it, but would rather transform it in ways which would likely have disastrous effects "for all species and forms of life that have become dependent upon our presence."[85]

The refusal to posit non-human nature as being pristine and in need of preservation has not surprisingly angered many contemporary environmentalists. And while we might later find reasons to doubt some of Harvey and Smith's more forceful claims, I believe that their approach in many ways opens us to a richer form of ecological politics, which focuses on the practices and social forces behind the harmful and degraded 'natures,' environments and geographies that are currently being produced. These politics invite us to consider the environments we might or *ought* to produce in the future. Along these lines, the natural world does not come back into the analysis as an

[85] Harvey, *Justice Nature and The Geography of Difference,* p. 186.

external and irksome barrier that is in the way of further growth and development (as it often seems to in O'Connor's work), or merely in the form of national parks and wilderness areas to be protected from society, but as a socio-historical category to be shaped collectively and democratically.

Through analyzing the forces and practices producing spaces, places and environments, Harvey, more than Smith, has been willing to open up his study to consider the more heterogeneous processes and multiple forces that contribute to the production of nature outside of capital.[86] Yet he has remained deeply and I believe rightly suspicious of studies that focus solely on local ethnographies of difference, and that place what he sees as exaggerated emphasis on fluxes, flows and the transitory nature of forms of production and place making.[87] Here, despite his commitment to a relational and dialectical ontology of multiple social forces, Harvey maintains that we must focus our attention on the permanencies and constants that crystallize from underlying processes and which have real consequences and effects. On this question, both Harvey and Smith have, like other eco-Marxists, consistently argued that our attention needs to be focused on the relations and dynamics of capital accumulation,[88] which provide the historical

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[86] There has been a great deal of room in Harvey's work (see *Limits* Chapter 12 and *Enigma* Chapter 6), dedicated to showing that place making and territory formation take shape according to distinctive cultural histories, values and beliefs, which have real effects in the world and are crucial in understanding our relation to nature. Yet, Harvey has also attempted to combat the relativism in these accounts with a detailed analyses of the way in which territorial organization continues to tend towards an informal 'structured coherence' on a global scale and shown the way in which regional specializations and territorial divisions are actively produced, maintained and preyed upon by capital.

[87] In *Justice, Nature and Geography of Difference* this critique is aimed at the tradition of mechinic ecology, and thinkers such as Deleuze and Guatarri.

[88] Smith has been particularly emphatic on the importance of seeing exchange value as the driving force of nature's production on a global scale. Failure to recognize that Marx is working with exchange-value under capital as opposed to use-value when analyzing labour in general and as a 'quasi-transcendental human characteristic,' is at the root of the dubious claim that Marx's

form of the generative processes through which everyday environmental practices take shape, as well as the forces driving nature's production on a global scale. As Smith suggests:

> Under dictate with the accumulation process, capitalism as a mode of production must continually expand if it is to survive. The reproduction of material life is wholly dependent on the production and reproduction of surplus value. To this end capitalism stalks the earth in search of material resources; nature becomes a universal means of production in the sense that it not only provides the subjects, objects and instruments of production, but is also in its totality an appendage to the production process.[89]

Here, beyond serving as an ontological foundation, Marx's thought provides Harvey and Smith with a political economic basis through which they have worked to show that at the heart of environmental-ecological politics must be an analysis of capitalism and its spatial/geographical effects.

While Marx's analysis of the accumulation process is seen by Smith and Harvey to contain foundational gestures and references towards understanding the outer, physical and spatial manifestations of capitalist relations, his specific geographical arguments are seen to be under-theorized and his thought primarily spelled out in temporal terms. In an attempt to extend these arguments and add insight into the geographical dimensions of historical materialism, Harvey and Smith have both worked to demonstrate how the expanded reproduction of capital gives rise to particular although continually shifting sites, places and environments, or what Harvey refers to as 'spatial fixes.'[90]

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harboured a 'Promethean' attitude toward nature. For example, see Smith's critique of Alfred Schmidt's classic *The Concept of Nature In Marx,* (London 1971), in chapter one of *Uneven Development: Nature, Capital and the Production of Space* (Georgia, 1996).

[89] Smith, *Uneven Development*, p. 49.

[90] See Harvey, *Limits*, Chapter 12, where he follows the way in which social relations, productive systems, daily lifestyles, technologies and relations to nature are woven together and crystalize into material *permanencies*.

There are two interrelated forms of spatial fixes or outward manifestations of capital that Harvey in particular reflects upon. The first is the territorial logic that emerges from the imperative of market expansion, which pushes capital beyond the bounds of a particular geographical region. This is noted in Marx's argument (seen earlier) that the forces of production include investments in transportation and communication that are required to facilitate the outward mobility of capital. Harvey pushes Marx's reflection further here and works towards developing a fully developed historical geography of capitalist imperialism, by showing that the territorial logic of capitalism is intricately related to the inherent instability of the accumulation process and the internal crisis tendencies of the system. Harvey argues that when a crisis of over-accumulation occurs (when capital and labour can no longer be re-invested at an average rate of profit in their original territory/space), capital attempts to overcome this situation through geographical restructuring, territorial expansion and escape. These moves are not only facilitated by investment in physical infrastructures for expansion, but they lead to the forced opening and establishment of new, temporary and often precarious markets that provide a temporary restoration of the rate of accumulation. Aside from the insidious social and political ramifications of this movement, this process entails the commodification and often rapid exploitation and exhaustion of the ecological commons, and the ongoing production of particular yet unstable, shoddy, hazardous and often polluted local environments and spatial configurations.

While Marx analyzed 'primitive accumulation' as a once-and-for-all move, attempts on the part of transnational corporations to privatize common resources such as land, forests, water and minerals (as well as knowledge, public infrastructures and genetic

information), remain central to processes of valorization and private accumulation.[91] Neo-liberal policies and strategies have been defined by this battle between private and public property. Therefore, instead of profiting through the internal configuration of the productive forces in the labour process, as Harvey argues, accumulation and exploitation continue to take the form of the expropriation of the commons.

The second form of spatial fix revolves around the need for investment in relatively secure and durable physical infrastructures (considered here as investments in the forces of production), allowing for the circulation of capital, whether in the form of the workforce, commodities and speculative financial investments, within a given territory or relatively structurally coherent region. Therefore, despite the drive to continually overcome spatial barriers to commodity circulation, capital is compelled, as Harvey writes, "to create a landscape adequate to its own requirements- a second nature built in its own image as it were- at one point in time only to revolutionize that landscape at a later point in time in order to accommodate further accumulation at a compound rate."[92]

The physical manifestation of constant construction and renewal of the built environment in the image of capital can be seen on display by mapping wide-scale transformations of built environments that facilitated production in many North American and European cities. The steel plants, cargo docks and state-sponsored working class housing that facilitated industrial production, have in many cases been abandoned (think for example of the forced obsolescence of whole areas of the North Eastern United States, which now make up what is often referred to as the 'rust belt'), or radically

[91] See Harvey, *A Brief History of Neo-liberalism* (Oxford, 2005).

[92] *The Enigma of Capital*, (Oxford, 2010), p. 86.

transformed by introducing new infrastructures, spaces and places that are hoped to draw new investment and sow the seeds for future precarious regimes of economic growth.

Understanding innovation in physical infrastructure as an extension of practices emerging from 'first nature,' and intrinsic again to labour, opens up a broadened conception of the forces of production. The work that is done to construct and maintain highways, bridges, buildings, power grids, sewer systems and those doing landscaping, renovations, interior decorating or urban planning are central in understanding the practices linking us to the rest of nature.

Harvey and Smith's emphasis on the geographical effects of global capitalism also allows us to explore how social relations and physical forms are woven together and lead to distinctive politics and contested ways of life in different places.[93] As Harvey shows, this drive for development proceeds with callous indifference to the environmental problems (air and water pollution, inadequate housing and hazardous working conditions) most directly affecting the poor, working poor, and racialized communities. Marginalized social groups are subsequently displaced from their own communities. By seeing urban social questions as simultaneously ecological questions, Harvey and Smith open Marxist analyses to a whole host of social movements concerned broadly with regaining power over common, communal conditions of reproduction and constructing environments according to more democratically defined criteria of human (and non human) health, wellbeing and beauty. While these movements may be rooted in

[93] See *Limits*, especially chapter 12*,* where Harvey suggests that in the city there has always been a dual movement or struggle over place formation, as developers struggle to provide physical infrastructures for accumulation on the ground, in the face of people's attempts to forge the city on a more social and collective basis. This is a critical component of the contemporary battle to retain and renew the 'commons.'

different spaces and places, the sources of their struggles can be linked to wider logics, and local mobilizations can be linked to wider movements.

Harvey and Smith's production of nature thesis demonstrates that the environment is a historical category shaped by social and political struggle. More fundamentally they effectively argue that the drive for constant compound growth that characterizes capitalism is incompatible with a satisfactory and long-term resolution to ecological problems that occur at various different levels: including global questions of ozone depletion, global warming, biodiversity and forest depletion, and localized questions of water quality and breathable air.

However, as a specific eco-political formulation it suffers from some major difficulties. There is an anthropocentrism at work within their argument, given that labour and labouring processes are placed at the absolute centre of nature's dynamic history. While I agree with Harvey and Smith's suggestion that we will always need to have some sort of 'dominion' over nature, by showing that we must work to transform our environments in order to survive, they come dangerously close to reproducing the subject/object dichotomy of the Enlightenment by suggesting that we can produce any 'nature' we desire. In this sense they see the environment as consisting of a set of passive assets placed at human disposal.[94] What appears to be missing in Harvey and Smith approach is a recognition that nature has its own dynamic, turbulent and contingent evolutionary processes, which are outside of human production and which come to bear on the social.

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[94] This problem in noted by Bruce Baum in 'Towards a New Earth and a New Humanity,' *David Harvey a Critical Reader* (Oxford, 2009), pp. 191-221.

Harvey and Smith's refusal to posit limits and to entertain suggestions that we are approaching an absolute crisis in our relation to nature has put them at odds with one of the leading eco-Marxist theorists, John Bellamy Foster. While I agree with Harvey's suggestion that the apocalyptic tenor of much of Foster's writing (exact measures of pending climactic catastrophe and projections of rapidly approaching final tipping points), is both ontologically problematic and a poor basis for left politics,[95] Foster's work has been central in terms of attempting to renew and rehabilitate a dialectical materialist approach to ecology that recognizes that nature includes its own processes and operations that global 'societies' are dependent upon, while he also attends to the fact that human production involves a constant interaction with nature through which both nature and society are transformed.

Foster, like Smith and Harvey, recognizes that Marx's concept of nature is profoundly historical and that the environment that surrounds us is dependent to a large degree upon previous generations. However, consistent with his 'dialectical materialist' approach, Foster argues that Marx maintained that the natural world is ontologically prior to and independent of our actions and therefore Marx never abandoned some of the basic tenets of realism. Foster understood that Marx conceived of the society-nature relation as a co-evolutionary or co-dependent movement, containing ecological constraints to human development that deserve careful attention.

For Foster, this understanding was most explicitly expressed in Marx's use of the concept of social metabolism: the complex interchange between human beings and natural systems. By reconstructing the historical basis of Marx's arguments, Foster shows

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[95] See Harvey, 'Marxism, Metaphors and Ecological Crisis,' *Monthly Review,* 49, 1998.

that his analysis of capitalist agriculture was strongly influenced by the work of 19th century natural scientists, in particular that of German Chemist Justus von Liebig,[96] who had discovered that natural systems, like the nutrient cycle, had their own metabolism, which operated separately from the social and allowed for their longevity and re-generation.[97]

While Foster notes that Marx was first excited about the possibility for agricultural improvements he saw coming from the knowledge garnered from natural scientific analysis, his optimism for the potential future development of these productive powers gave way to a much more sophisticated critique of ecological degradation based on capitalist agricultural techniques, which came with a recognition that the conditions of nature were closely bound to the historical development of social relations and material practices.

From this historical basis, Foster suggests that Marx developed a materialist critique of modern agriculture, employing the concept of a 'metabolic rift,' to show that capitalist operations were undermining the regenerative capacities of ecosystems. He likened 19th century industrialized agriculture to a 'robbery system,' as the transportation of food and fibre over long distances between the country and the city meant that essential depleted the soil of essential and regenerative nutrients, which in turn, ended up

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[96] See Foster, *Marx's Ecology* (New York, 2000), ch. 2.

[97] For an in-depth account see Magdoff, "Ecological Civilization," *Monthly Review*, 62, 2011. As Maddoff explains, metabolism refers to the work done inside an organism or a cell as it goes about its normal operations. We find the building up of new organic chemicals and the breaking down of others, the recovering of energy from some compounds, and the use of energy to do work. However, a critical part of the metabolism of a cell or large organism is the exchange of materials with the environment and other organisms: obtaining energy-rich organic molecules and individual elements necessary to make all the stuff of life, including oxygen, carbon dioxide, nutrients (such as nitrogen, phosphorus, potassium, and calcium), and water.

contaminating open sewers and polluting rivers.[98]

As Foster notes, 19th century attempts to compensate for lack of soil fertility led to the creation of an international guano and nitrate market, and an imperialist scramble to claim islands off the coast of Peru and Bolivia with large bird populations and nitrate deposits, leading to the development of the vicious "guano wars." Despite importing vast quantities of these fertilizers to meet the demands of capitalist economies, depleted soil fertility continued to strain agriculture until the early 20th century, when another radical shift took place in agriculture with the development of synthetic soil fertilizers that could be produced in large quantities and used to sustain and increase production.[99]

Based on these and other historical case studies, Foster argues that every temporary 'technological fix' and chemical advance that compensates for the diminishment of natural conditions such as the loss of soil fertility has forced capital to shift its operations in order to continue the process of accumulation, creating new rifts and environmental problems (in this case, the seepage of fertilizers into bodies of water like the Gulf of Mexico and the creation of cancer epidemics due to the prevalence of pesticides) while not alleviating old ones. While soil erosion was a chief concern of environmental degradation in Marx's era, Foster argues that Marx's analysis of a rift or contradiction was not merely an incidental observation limited to agriculture, but rather a logical

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[98] As we saw in chapter 2, in the seventeenth century, the cities' reliance on the more immediate surrounding countryside prevented rapid and extensive urbanization. At this time, cities were more 'bioregionally' defined as solid and fluid excrements of animals and humans were collected and recycled back into surrounding areas, fertilizing them. Yet with the development of large-scale industry and the expansion of trade, food and fibre were shipped longer distances. The nutrients of the soil were sent long distances to cities in the form of agricultural produce, but these same nutrients, in the form of human and animal waste, were not returned to the land. Thus there was a one-way movement, a "robbing of the soil" in order to maintain the socio-economic reproduction of society.

[99] See Foster's, *The Ecological Rift (New York, 2010), ch. 2.*

extension of his analysis of the outward expansion of capitalist industry up to that point,[100] which located an inherently destructive tendency towards natural environments in the very inner logic of the system.

As Foster notes, Marx's analysis of an ecological rift in soil cycles led to his corresponding call for the conservation and, if need be, the 'restoration' of the metabolism between society and the rest of nature. In Marx's words, this is "the inalienable condition for the existence and reproduction of the chain of future generations."[101] Marx was developing a sophisticated understanding of environmental degradation and sustainability, which goes well beyond his era and directly addresses such contemporary issues as desertification, deforestation, flooding, climate change, biodiversity, recycling of industrial wastes, air and water pollution, and sanitation.[102]

Foster, like other ecological Marxists, has been emphatic on the point that these deepening issues are internal to the processes of capitalist expansion and development and cannot be solved within the confines of a system that is premised on 'accumulation for accumulation's sake.' As he writes: "It is an inner characteristic of the capitalist economy that it is essentially limitless in its expansion, It is a grow or die system. The 'drive to amass capital' recognizes no physical boundaries. All obstacles are treated as barriers to be surmounted in an infinite sequence. Capital is thus from a wider social and ecological standpoint, *a juggernaut*, an un-unstoppable crushing force."[103]

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[100] See Burkett's, 'On Some Common Misconceptions of Marx's Critique of Political Economy,' *Marxism and Ecology, 7,* 1996.

[101] Marx, *Capital*, III (Moscow, 1971), p. 948.

[102] Foster, *The Ecological Rift,* ch. 9.

[103] Foster, *The Ecological Rift*, p. 39.

Foster has consistently argued that the restoration of the metabolism between people and the rest of nature requires wide-scale social transformations. Such restoration can in Marx's own words "consist only in this, that socialized man, the associated producers, govern the metabolism with nature in a rational way, bringing it under collective control, instead of being dominated by it as a blind power, accomplishing it with the least expenditure of energy and in conditions most appropriate and worthy for their human nature."[104]

Clearly, part of the impetus behind Foster's historical re-construction and development of Marx's concept and analysis of social metabolism and ecological rifts, has been to place an emphasis on developing a historical materialist understanding of ecological degradation, and on the importance of natural scientific understandings. Leaving aside questions of the exact severity of the crisis and whether current practices might lead us to a 'final' tipping point, there is a clear enthusiasm in Foster's work for the development of ecological science and ecological thinking, which he sees as representing a movement towards more complex, holistic, historical and materialist forms of analyses.[105] Critically for Foster, ecological science is in itself an important historical development. It aims at the dialectical unification of social and natural phenomena and breaks down dualistic understandings by explaining the complex interdependencies of organisms in the environment and by bringing forward knowledge concerning the protection and well being of human beings and other species.

Behind this enthusiasm, Foster has expressed a serious concern with an anti-scientific tenor of many left and Marxist perspectives. This reflects his contention that the

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[104] *Capital*, III, chapter 48.
[105] See Foster, *The Ecological Rift*, An Introduction.

world's physical and natural scientists, who have done a great deal to alert us to the dangers facing humanity[106] and who have been central in terms of understanding the unintended consequences of our practices, should be joined by those providing an analysis of the dynamics of capital accumulation in order to understand the full extent of the ecological crisis. More plainly, it is Foster's contention here that scientific knowledge producing good quality, complex descriptions and understandings of anthropogenic climate change, human induced floods, soil erosion, ozone depletion and so on, should be one of the key sources contributing to an analysis of present ecological concerns and a critical source of information contributing to their eventual resolution under socialistic or communist conditions.

While I think that Foster is right to emphasize that the knowledge brought to us by natural science should be an integral source of information guiding the advancement of the forces of production under alternative property forms, there is a danger of being insufficiently critical in this call for a 'rational regulation' of the nature-society metabolism. In particular, his call could be read to suggest that property relations are all that is standing in the way of an otherwise benevolent scientific expertise and consensus that alone will guide or drive the forces of production. This runs the risk of losing the subversive edge of ecological politics and opening us to a concept of socialism wherein an expert class of administrators and technical experts could form a new ruling class in the place of a more egalitarian collective. The ecological antagonism at the heart of

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[106] For example, in 1992 there was the development of the "world scientists" group that is comprised of the world's most distinguished scientists, and who issued a 'warning to humanity' concerning the ecological direction we were heading in. More recent comprehensive scientific assessments include the Intergovernmental Panel on Climate Change available online at < http://www.ipcc.ch/ >, and The Millennium Ecosystem Assessment found online at < www.maweb.org/ >.

global capitalism could be resolved under an authoritarian 'socialism' presented in the guise of some sort of populism or communitarianism.[107] For this reason, we need to do more to articulate, in positive terms, that socialism can and must be seen as an opening for the radical democratization of technical relations based on new forms of popular participation and the further politicization of science based on our lived experiences with the rest of nature.

To bring out this point, I first take a detour through the work of the Frankfurt School with a focus on the work of Herbert Marcuse and his proposal that technology and technological rationality can be transformed under an alternative economic system to serve rather than dominate humanity and nature. I do not pretend to provide a full treatment or summary of this rich body of work, but wish to bring out certain components of their analysis that are integral for ecological-environmental politics.

Horkheimer and Adorno's *The Dialectic of Enlightenment,* was a foundational ecological text that placed the relation or struggle between human beings and nature at the centre of their analysis. Despite holding Enlightenment values of emancipation and self-realization, they argued that these objectives are negated by the very philosophical and political means that were meant to achieve them. The scientific and technological techniques that were meant to escape feudal superstitions, fears and the church-based ignorance of nature, became instruments of domination, to the point where "the fully enlightened earth radiates disaster triumphant."[108] While at times in the text they provided more social explanations for the disastrous effects of modern technology by critiquing the way capital channels scientific and technical development, their analysis

[107] See Zizek, 'How to Begin From the Beginning,' *The Idea of Communism* (London, 2010).

[108] Adorno, *Dialectic of Enlightenment* (New York, 1972), p. 3.

centred primarily on the perceived failures and shortcomings of instrumental reason. They chose therefore to see the proliferation of nuclear weapons and systems of Second World War mass destruction not as a mere betrayal or aberration of Enlightenment principles, but as a consequence of that philosophical traditions contradictory beliefs, thoughts and practices.

According to Horkheimer and Adorno, a central component of the original violence of the Enlightenment was the construction of the natural world as a purely external and lifeless other. The natural environment had been separated not only from the world of action and thought, but also totally disenchanted and deprived of its own life and force—rendering it a set of passive assets to be scientifically assessed and valued only in utilitarian—and under the conditions of capital accumulation-- monetary terms. Worse still, the unrestrained manipulation and domination of 'external' nature became a model for the domination of human beings, who are increasingly regarded as fungible cogs and inputs or means toward short term and arbitrary ends.

While they maintained that the natural world has an existence outside of social construction, similarly to eco-Marxists, Adorno and Horkheimer set as part of their task to show that nature and history are not independent of each other, but are rather part of an inseparable connection (or internal relation) that needs to be understood more in terms as a kind of mutual "participation." Part of this involved fighting against positivism and attempts to universally quantify nature, which they identified closely with the devaluation of the natural world. They held open the possibility of constructing an alternative science that could overcome the firm distinction between facts and values and suggested that an alternative technical rationality -- at once distinctly modern but also guided by life

affirming standards -- could recuperate a sensuous encounter between human beings and the rest of nature.

These rich questions were opened by Adorno and Horkheimer, but alternatives carrying conviction were never elaborated by them. Herbert Marcuse, focusing more on the extent to which the imperatives of the capitalist market underlie the stripping of values from technological rationality and orient development towards arbitrary ends and profit,[109] provided a more convincing understanding of how substantive goals could be incorporated into reason under socialism. Before exploring the positive alternatives opened by Marcuse, some further elaboration of his concerns is needed.

In his classic *One Dimensional Man*, Marcuse extended Marx's immanent critique of market rationality, and broadened it into a more radical analysis of scientific-technological rationality, which had become the dominant cultural form in the 'monopoly stage' of capital in the 1960s.[110] In late industrial societies, the daily material battle to meet basic needs by harnessing nature has largely been accomplished.[111] Yet this mastery comes at the cost of dominating nature and also thwarting the development of intellectual creativity and sensuous liberation. The scientific and technological rationality that has

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[109] See Marcuse, 'Industrialization and Capitalism in the Work of Max Weber,' *New Left Review*, 30, 1965.

[110] For background on Marcuse's relationship to Marx, see Aronowitz, 'The Unknown Herbert Marcuse,' *Social Text*, 17, 1999.

[111] While I argue that Marcuse's environmental project is critically important for our times, the component of Marcuse's analysis suggesting that the material needs of 'underlying populations' has been met in advanced capitalist societies is left wanting. Marcuse was reflecting on the so called 'golden age" of capitalist development in the 1960s, in the full height of the welfare state and social democratic movements. After three decades of welfare retrenchment and the corresponding dissolution of redistributive policies and programs, manufactured scarcity continues to be a serious problem in industrialized capitalist nations and the daily material needs of many are clearly not being met.

allowed us to move outside of the immediate 'oppression' of nature, is now so pervasive that it structures not only people's actions but also their thinking. Thus, the hegemony and insidious regularity of this rationality colonizes the capacity to think critically about human progress, continually foreclosing an imaginative relationship to the world and proposing technical solutions to any and all problems -- solutions available only on the terms of the present system.

Marcuse was concerned with a situation in which lived experience is critically devalued in contemporary societies and modern science supplies all of the knowledge and truth that human beings require. Rather than having human perception and practical sensuous experience guide the distinction between the desirable and undesirable, the management of life is increasingly driven by a division between the rational and irrational, with the rational associated with the production of facts --the success of science in harnessing nature-- and the irrational with the subjective experience of the lifeworld. Accordingly, reality is increasingly approached and understood only in terms of the empirical aspects that expose it to control. Reason is separated from art and aesthetics, bleached of values, and more and more tightly associated with science.

Like Adorno and Horkheimer, Marcuse here is concerned that substantive goals have been stripped from the structure of rationality so that reason becomes merely instrumental and contains no necessary preference for life over death. This separation of ethics from rationality allows science and technology to be wielded for arbitrary ends (such as short-term profits), biasing them as instruments of exploitation for the powerful. Accordingly, he argues that to escape one-dimensional thinking and to make a truly radical break from our current state of affairs, a life affirming ethos and 'non-rational'

criteria of peace, beauty and the common Good, need to be re-incorporated back into our concept of Reason. Here Marcuse argued for,

> …rupture with the continuum of domination, the qualitative difference of socialism as a new form and way of life, not only rational development of the forces of production, but also the redirection of progress towards ending the competitive struggle for existence, not only abolition of poverty and toil, but the reconstruction of the social and natural environment as a peaceful, beautiful universe: total transvaluation of values, transformation of needs and goals. This would mean not to regress in technical progress, but to reconstruct the technical apparatus in accordance with the needs of free men and women, guided by their own consciousness and sensibility, their own autonomy.[112]

While Marcuse's projection sounds utopian and was often denounced as such in a period where piecemeal change and social reform appeared possible within the framework of private property, some component of his call for a radically different understanding of development and progress, coupled with a recognition and respect for the forces of the natural world that support life and human happiness is required.

Perhaps more directly, the implications of this reading are once again that emphasis needs to be placed on the transformation and reconstruction of the technological base of the system, based on a respect for the natural world and human well being. While Marcuse made this argument in the late 1960s, as the counter-culture movement reached a high point in the United States, since that time a politics of science and technology has been slowly developing through the impact of the environmental movement, further refuting the belief that technological controversies can be solved by

[112] Quoted in Feenberg, *Heidegger and Marcuse (London,* 2005).

straightforward scientific consensus, and making Marcuse's call for a reformed science and value based technical rationality more conceivable and convincing.[113]

Along with the decline of positivism and growing contemporary challenges to technological determinism, the rationalist view of progress that sees knowledge acquisition as a purely technical exercise carried out by people in white coats, no longer carries conviction. Scientific agreement is no longer expected to be so simple and technical progress to be so straightforward. Yet, the need to re-valorize experience and overcome a strong dualism between facts and values when guiding development, does not just come from simple challenges to expert authority, but is also tied up with the inherent uncertainties, contradictions and negative consequences of capitalist industrialization, along with the complexity and scale of contemporary environmental problems.[114]

Here, as Katherine Farrell argues,[115] 'normal science' was traditionally understood as straight-forward puzzle solving. Now the demands that late industrial societies place on science range from weighing in on quality of life questions such as what constitutes acceptable levels of pollution, to determining the safety of genetic engineering, or to attempting to define 'sustainability' in a way that contains reference to

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[113] Ibid., ch. 3.

[114] Ulrich Beck, in *The Risk Society* (London, 1992) has proposed a theory of 'reflexive modernity" to suggest that first modernity created technologies that were both fragmented and powerful which created disastrous consequences in many places. As a result, we are increasingly wary of automatic modernization processes, leading to self reflection and political challenges aimed at transforming industrialism.

[115] Farrell, 'The Politics of Science and Sustainability,' *Capitalism, Nature, Socialism*, 19, 2008.

both the carrying capacities of ecosystems and the enhancement of quality of life.[116] This should force a far richer exchange between natural and earth scientists and the wider public when attempting to determine the direction and shape of development based on a common concern for the wellbeing of people and ecosystems that support life.[117] Instead of their providing complete faith in scientific consensus, scientific and technical experts are valued as individuals sharing and distributing knowledge and participating in a more common culture.[118] Extending and radicalizing these developments, Marcuse's conception of socialism entails the shift to more extensive developmental regulation based not only on scientific criteria, but on far more democratic and participatory procedures than we are currently witnessing, opening an imaginative understanding of what the world could or *ought* to look like.[119] While this does not directly correspond to Marcuse's calls for a 'new science,' it does argue for the critical revalorization of

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[116] World Wide Fund for Nature (2006, p. 19.), defines the criteria for sustainable development, as "improving the quality of life while living within the carrying capacity of supporting ecosystems."

[117] As Farrell shows, we are already beginning to witness this type of democratization of scientific knowledge. Here, under 'post-normal science' conditions, where the stakes of decisions are high and uncertainty great, the quality of scientific insights is no longer determined by scientific peer community but by an extended peer community including scientists from other disciplines and laypeople.

[118] See Richards, *Philosophy and The Sociology Sciences* (Oxford, 1987), pp. 200-205. It is worth providing a cautionary note here to the progressive potential I am attributing to critical challenges towards scientific consensus. While this contains the potential towards more radical forms of democratic and populist participation, it can also lead to a populist rejection of science more broadly and to the reduction of the scientific enterprise to more narrow political concerns. In this process, genuinely progressive aspects may be lost through a reactionary disdain for any form of expert based knowledge production. In fact, right wing lobby groups, as well as oil and coal companies, such as ExxonMobil, The American Petroleum Institute and Koch Industries have been very successful in their attempts to intentionally obfuscate the reality of global warming and to perpetuate this scepticism in order to justify and legitimate more established regimes of accumulation.

[119] For this articulation of Marcuse's understanding of Socialism, See Feenberg's, *Between Reason and Experience* (Cambridge, 2009).

lifeworld experience and concerns, claiming its own ontological significance and importance, shaping development alongside natural scientific knowledge.

As Andrew Feenberg argues, Marcuse's position can be extended and given more force in relation to technological rationality. Ecological values are already being translated into technical specifications that seek to protect the environment by enhancing efficiency in broad terms, thereby reducing costly side effects of technology.[120] The recognition that technological designs can and do incorporate values through choices made by competing alternatives confronting designers (indeed shown earlier by Braverman and Noble), further disputes the common notion that technology represents a purely rational means to efficient ends and shows the possibility of further opening technical disciplines and technologies to the incorporation of life affirming standards independent of the market.

While the contemporary incorporation of environmental values into technical designs should be seen as a positive development signalling the impact and potency of environmental movements, these types of specifications appear to be accommodated only in so far as they can be incorporated into the accumulation process.[121] It would be a mistake to see such small refinement as addressing the ecological crisis we face. Moreover, as I have argued throughout, the ability to have human and ecological needs

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[120] Feenberg, Ibid.

[121] The documentary film *Who Killed The Electric Car* was an excellent case study of the subordination of scientific and technological developments that could potentially challenge the profit making capacity of established and integrated automotive and oil industries. We should note, however, that the 'greening' of capitalism, from the creation of more environmentally conscious consumer products to the production of less polluting industrial technologies, also presents an opportunity for new investment and new 'regimes' of capital accumulation for a particular faction of the capitalist class. This signals again the remarkable flexibility of capital in terms of continually locating new sources for profit making and is perhaps another case of the famed power of capitalism for recycling everything aimed at its destruction.

recognized or prioritized by technical innovations and developments, or to have any wide measure of ‘sustainability’ considered as a factor in the advancement of the forces of production, is seriously contained in capitalist societies. The imperative of capital accumulation continues to expand the circle of production and consumption regardless of environmental costs, and does so on the basis of independent decisions that subordinate collective demands and defy common interests. Current movements pushing for a radical democratization of technologies (which intend to re-direct science and shape productive technologies at the level of their design, construction and use) are tantamount to a call for collective control over the means of production, which would negate the framework of private property.

Some of these considerations push us outside the ken of classical Marxism. Yet, from this position we can reframe a famous precept of historical materialism—that of a contradiction between the forces and relations of production—by seeing ecological thinking itself (i.e. recognition of the need to maintain and restore the indispensable ‘metabolism between humanity and nature’ and related practices that aim at ‘sustainability’) as an advancement of the productive forces, which is however being fettered and colonized by the imperatives of endless capital accumulation.

Conclusion:

Beginning with one of Marx's most foundational concepts and abstractions, I aimed to expand its meaning by providing a generous definition and re-casting it in contemporary contexts. I hope that this approach contributes in some small way to the perpetual creation of new openings and new terrain in his writings. More importantly, I hope that the expansive understanding of the forces of production contributes to an understanding of the global ecological crisis and elucidates social antagonisms that continue to generate the need for a socialist or communist alternative.

While many contemporary Marxists continue to bracket the relation to the rest of nature out of their analyses and have even regarded environmental issues as a distraction from the proper terrain of class politics, throughout Marx's work there is an understanding that societal development is deeply engraved by the way nature is appropriated and transformed and that human history is interconnected with the rest of nature. This ecologically embedded understanding allowed Marx to analyze the complex and historically shifting processes, class relations, forms of co-operation and other social relationships through which humanity is linked to the rest of nature. Part of this involved recognizing that although society and nature are deeply interconnected and involved in a dialectical relationship, they can also be in contradiction with each other. As Marx recognized, socioeconomic appropriation can contradict biophysical processes and undermine their ability to function. Such recognitions reverse the linear and deterministic reading of Marx and the corresponding preoccupation with the ways in which relations of production may fetter further technological development, growth and productivity.

As we know, Marx argued that the forces of production develop within property forms that are antagonistic to and come to fetter those forces. Adopting an expansive and dialectical conceptualization can help us reframe that antagonism and see the deepening ecological crises as an expression of that contradiction. Although, the science of ecology emerged in the nineteenth century through the transformation of natural systems, our understanding of the functioning of those systems and the complex interaction of organisms with the environment has since developed and deepened. This is not to assume that natural scientific results are immune from political struggles and power relations and that they represent a pure and 'true' account of nature. It is critical to remain attentive to how nature is constructed both practically and symbolically (in scientific and cultural terms).[122] Still, based on the methods and practices of natural and earth sciences, we are more than ever in a position to understand and control the environmental consequences and unintended effects of our actions and daily activities.[123] Ecological thinking, which emerges from the destructive consequences of capitalist industrial processes, should be read as an advancement of humanity's productive forces.[124]

This knowledge should be thought of as a 'common,' open to be shared and applied as a collective resource—helping guide the practices through which we are purposefully linked to the rest of nature. It should be distributed as part of a 'general intellect.' Yet such knowledge, thinking and associated action is indeed being fettered by

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[122] See Gorg, "Societal Relationships to Nature: A Dialectical Approach to Environmental Politics," *Critical Ecologies* (Toronto, 2011).

[123] See Magdoff, 'Ecological Civilization,' *Monthly Review,* 62, 2011.

[124] Despite my focus on a particular form of knowledge production, there is a good deal of room, I believe, for further fruitful engagement and overlap between Marxist ecology and Indigenous knowledge of the functioning of ecosystems.

the need to accumulate capital. We see it being privatized, subdued and appropriated for the purposes of profit and accommodated only in so far as it can be incorporated into the accumulation process. Where such knowledge poses a direct challenge to contemporary regimes of accumulation, we will find attempts on the part of ruling classes to delegitimize it.

Now global in its scope and reach, it should become increasingly apparent that capital is at its heart an ecologically destructive system that creates environmental havoc locally, regionally and globally. Although we have seen a number of local initiatives and international agreements that mitigate the impacts of environmental problems, it is increasingly clear that such reforms cannot resolve deepening problems. The compulsion for accumulation that characterizes capitalism continually negates the possibility of bringing the transformation of the rest nature under rational and collective control and governing it by considerations of beauty rather than profit. In so far as ecology emerges at the intersection of science and public concern and has as its public purpose the protection of ecosystems that support the well being of a variety of species and human beings,[125] it is in contradiction with an economic system predicated on limitless expansion and growth. This contradiction is perceived by many contemporary 'scientist activists,' who have recognized the systemic nature of ecological degradation and have begun to move beyond the principles of private property, at times positioning themselves directly against capital and calling for drastic social transformation.[126] The continued

[125] For this articulation see Feenberg, *Heidegger, Marcuse and the Critique of Technology.* Available online at < http://www.sfu.ca/~andrewf/selected_articles.html>.

[126] U.S. climatologist James Hansen is an excellent example. See his 'Carbon Tax & 100% Dividend vs. Tax & Trade,'(2008), which addresses present day environmental problems, as well

incorporation of this group as a component of an anti capitalist eco-political movement would represent a particularly deep fault-line for ongoing capitalist reproduction.

Moreover, as I have argued, the complexity of contemporary ecological problems, and the unification of social and natural phenomena that those problems force, require that we overcome disciplinary barriers between natural and social sciences and between experts and ordinary people. The knowledge brought to us by ecologists and earth sciences should become a key factor contributing to the eventual resolution of global ecological crises, but it is important to stress that this alone cannot and should not drive development. 'Sustainable development,' which contains reference to both the carrying capacity of ecosystems and quality of life questions, overcomes or at least forces a complex interplay between facts and values when deciding collectively on what constitutes the good life. Questions of what the environment (almost all of it now 'built') could or ought to look like should be driven by practical life-world concerns and an imaginative sensibility.

Marx argued in the 19th century that the separation of politics from the economy made property more effective and guaranteed its dominance.[127] The state becomes formally dominant while real levers of (economic) power lie in society. By framing struggle and social strife in terms of legal and individual remedies, deep antagonisms are concealed and we are left with small refinements and marginal re-arrangements of the social edifice. An adequate resolution to contemporary ecological crises requires the collective re-appropriation of these social processes. We are forced to consider how our

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as highlighting the need for radical measures to be taken in relation to carbon emissions. Available online at <www.columbia.edu/~jeh1/2009/WaysAndMeans_20090225.pd >.

[127] See Douzinas, 'Adikia: On Communism and Human rights,' *The Idea of Communism (*London, 2010*)*.

practices, relations, economies and technologies can be re-appropriated and re-configured in an attempt to define a future that is more socially just and ecologically sustainable. This requires that any socialistic transformation go well outside of the market/plan dichotomy and enter deep into the technical 'base' of the forces of production: efforts will need to be directed towards discovering and creating an alternative technical/organizational basis to society and ensuring that the views and interest of community members and actors guide our technical relation to the world.

Ecological questions are therefore simultaneously class questions because they centre on whether the forms of class power that shape and configure labour and development can be replaced and a new logic of democratic relations put in their place.[128] This would negate the framework of private property and the State itself would be radically transformed, relying on new forms organization and popular planning. This continues to be the precondition for freedom and the free development of human beings in history.

[128] See Aronowitz, 'Ecology and Class,' *How Class Works* (New Haven, 2003).

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