MARX ON NATURAL SCIENCE

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ABSTRACT

This thesis begins with biographical details of Marx's studies of natural science and, before looking at Marx's theorisation of the latter, reconstructs the theorisation of natural science within the Marxist tradition. Marx's own theorisation of natural science is placed within the context of his materialist conception of history which states the thesis that "social being determines consciousness". Consciousness, including natural science, is located within specific social relations of production. The thesis concentrates on Marx's Critique of Political Economy by contextualising natural science within Marx's analysis of capitalist relations of production, the basis of which is, for Marx, the value-form, leading to the capital-form. The latter's development, capital accumulation, is dependent on the extraction of surplus-value through the "real subsumption of labour under capital". This is achieved via the practical application of natural science in the form of technology in the production process. Thus, the development of natural science is theorised in direct connection with the extraction of surplus-value. Given the direct link of natural science with the extraction of surplus- value, it is inferred that natural science has been, and continues to be, developed by and for the needs of capital. The thesis concludes: the capital-form stamps its mark on our knowledge of nature and production; thus, natural science cannot be viewed as an autonomous force independent of the social relations it finds itself in.

CONTENTS

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INTRODUCTION

One of the fundamental notions of Marx's thought is the thesis that social existence determines consciousness. However this thesis is not applied to natural science by most Marxists, science being implicitly taken as objectively given, and any critical evaluation being limited to the specific application of science. This position is most ardently reinforced by Engels, Lenin and Stalin via their "reflection theory" and "dialectical materialism". There have always been critics of this tradition, e.g. Georg Lukács, the Frankfurt School, Alfred Sohn-Rethel, and, more recently, the theoreticians of the Italian autonomist movement and in England some members of the Radical Science Movement, who have made attempts at an explanation as to the socio-historical determinants, as well as the practice, of science.

The following chapters systematise the above development and extend it by relating science as a social force to Marx's value theory and capital theory; thereby natural science is contextualised within Marx's analysis of capitalist relations of production, the basis of which is the value-form or the commodity-form. Marx's Critique of Political Economy throws light on a critique of natural science: for the classical economists the "characters that stamp products as commodities, and whose establishment is a necessary preliminary to the circulation of commodities, have already acquired the stability of natural, self-understood forms of social life, .."[1] Political economy conflates the conditions of the reproduction of forms of social life with their historical origin. Just as commodity production 'has

acquired the stability of natural, self-understood forms of social life', so are the conditions of the reproduction of natural science mistaken for its historical developments; science is de-historicised and takes on the character of a natural self-understood form of social life. Natural science, like political economy, sees itself as transhistorical. The connection between the specificity of capitalist social relations and the specificity of a particular knowledge of nature , once de-historicised, is obliterated. And yet, science, either as a knowledge of nature or as technology, the application of that knowledge to production, is a part of the totality of capitalist social relations which is reproduced in the value-form. Marx shows how the development of the value or commodity-form and the capital-form, the accumulation of capital, is dependent on the extraction of surplus-value through the "real subsumption of labour under capital", which is achieved via the practical application of natural science in the form of technology in the production process. Thus, the development of natural science is theorised in direct connection with the extraction of surplus-value. Given this link, it can be inferred that natural science has been, and continues to be, developed by and for the needs of capital.

We shall begin with some biographical details of Marx's studies of natural sciences and the enthusiasm he displayed at their development. Before we look at Marx's theorisation itself we shall reconstruct the theorisations of natural science within the Marxist tradition which often find their legitimate basis in Marx's ambiguous stance towards natural science.

CHAPTER 1

BIOGRAPHICAL NOTES

Marx's aim was to provide a revolutionary critique of capitalist social relations. This took the form predominantly of a critique of classical political economy, with only an implicit concern with issues which subsequent revolutionaries thought important to analyse. Critiques of racism, sexual relations, art, law, etc. have been developed (for better or worse) since the publication of Capital and are only to be found in embryonic form in Marx's theory of the production and reproduction of capitalist social relations. The same applies to natural science, in which Marx took a great interest but failed to integrate adequately within his theoretical framework. The reader is left with few statements, often not going beyond the status of an aphorism, and has to extract for her/himself a conceptualisation of natural science within the framework of a critique of capitalist relations. This task will take the reader through a combination of Marx's enthusiastic affirmation of new scientific developments, more thoughtful and historical hints as to the possible theorisation of natural science, and even condemning insights as to its social determinants.

We have reference to Marx's studies when still at University, reporting on his study of natural science (in relation to the Hegelian system) to his father, who urges him not to neglect this field[1]. Marx's doctoral dissertation concerns itself with natural philosophy, relating Epicurean and Democritian physics to their

respective philosophies. Marx's early works (1840-48) show a preoccupation with natural science in a philosophical and political sense, not a direct study of the subject matter and logic of science. The most famous statements regarding natural science are to be found in the Paris Manuscripts and in the German Ideology; the Holy Family includes a brief history of the philosophy of science, and implications can be drawn from the Contribution to a Critique of Hegel's Philosophy of Right, the "Thesis on Feuerbach" and the Communist Manifesto.

These texts also show, partly due to Marx's contact with Engels, a move from a concern with still abstract philosophical concepts to more directly political issues. In fact, the years during, before, and immediately after the 1848 revolutions kept Marx busy with political activity and journalism. Only in the late 1850's and 1860's did he take up again the study of natural science and mathematics, which he subsequently continued between 1873 and 1883. It is the latter period in which Marx applied himself to the most intensive study of natural science and mathematics, as the letters to and from Engels, and a large amount of excerpt notes evidence. Except for the Mathematical Manuscripts (a study of the differential calculus, which Marx tried to apply to problems of political economy), which have appeared in Russian, German and English, his studies have not yet been published, but will be included in the new Marx-Engels Gesamtausgabe.

1. Marx's Studies of Natural Science

Marx's efforts to keep up with scientific development made him study a great many works in detail. The recently published Marx-Engels correspondence on natural science in French[2] shows the diversity and depth of interest Marx displayed. His excerpt notes testify the same thoroughness, including, for example, a detailed picture of a steam engine drawn by Marx himself[3]. His major activity in the field of natural science was in the 1870's (most of his excerpt notes are from that period). This was the time when he should have been working very hard on the completion of volume II and III of Capital. There have been speculations as to why Marx never finished these works: ill health, poverty, lack of time due to his relatively early death, etc. Engaging himself with natural science at that crucial time might even have constituted a diversion from a task too difficult to accomplish. Many times before had he abandoned his major works, keeping himself busy with a study of natural science or mathematics. Expecting the proofs for A Contribution to a Critique of Political Economy, he writes to Engels: "Meanwhile, I am carrying on with algebra out of impatience"[4]. In 1864, when suffering from an attack of boils and therefore unfit for work, he informs his friend of having read up on physiology[5]. However, these pursuits were not just a way of occupying himself when either impatient or ill. Marx did take his studies seriously, as one letter to Engels amplifies: "You know that 1) Everything comes late with me, and 2) I always follow your footsteps. So definitely, that I shall now practice a lot of anatomy and physiology in my spare hours as well as visit lectures (where the stuff gets demonstrated and dissected ad oculos)"[6]. Marx held his friend's knowledge of natural science in high esteem, often consulting him on specific issues. When Marx was rather impressed by Trémaux,

considering his work a progress vis-à-vis Darwin, Engels disagreed and Marx soon dropped the matter. And, as early as 1851, Marx sent Engels an article about the application of electricity to agriculture, asking him to explain it and give an opinion[7].

In fact, agriculture was one of Marx's pet subjects, it provided the most direct link between his study of natural science and Capital. The extensive studies he undertook on agriculture, in particular in its relationship to geology and chemistry, were related directly to the subject of rent:

> The new agricultural chemistry in Germany, especially Liebig and Schönbein, which is more important for this subject than all economists put together, ... had to be ploughed through[8].

Marx studied in minute detail the chemical processes in agriculture, i.e. chemical composition of earth, plants, the effects of fertilizers, etc. Similar attention was given to the geological features of many parts of the world. Carl Schorlemmer, chemist and friend of Marx and Engels, had to help out:

> From Schorlemmer I would like to know which is the latest and best book (German) on agricultural chemistry? Furthermore, at what state is the controversy between the mineral-fertilizer and nitrogen-fertilizer-men? (Since I last occupied myself with it various new things have appeared in Germany). If he knows anything about the recent Germans, who have written against Liebig's ground exhaustion

> theory? If he is acquainted with the alluvion theory by the agronomist Fraas from Munich (professor at Munich University)? I have to be acquainted to at least some extent with the up to date question for the chapter on ground rent[9].

These studies provided an insight into the position of raw materials and suitable areas for specific food products, and must have given the knowledge about the value of land that was necessary for Marx's analysis of differential rent. His intended volume on world-trade would no doubt have benefitted greatly from his study of texts like Grant Allen, Geology and History (geological characteristics of England), J.F.W. Johnston, Elements of Agricultural Chemistry and Geology (relation of geology to agriculture), J. Yates, The Natural History of the Raw Material of Commerce (natural products all over the world: dairy, cereal, meat, coal, etc.)[10].

In addition to many excerpt-notes from books on agriculture, geology and chemistry, Marx's manuscripts include notes on physiology: J. Ranke, Grundzuege der Physiologie des Menschen, L. Hermann, Grundrisse der Physiologie des Menschen, and M. Schleiden, Die Physiologie der Pflanzen und der Tiere[11]. Given the date of these manuscripts (1876) it is conceivable that Marx's concern with physiology was at least partially a result of his own ill health. At that time Marx was suffering from a liver complaint which he was sent to cure at a health farm in Karlsruhe, and, as is well known, he had bad attacks of carbunkels (caused to a large extent by impurification of the blood). Marx is said to have had a taste for strongly spiced dishes, smoked fish, beer, wine and tobacco, the effects of which on various organs of the body he paid specific attention to in his

studies.

2. Marx's Enthusiasm

Marx seemed to have an almost childlike interest in the discoveries of natural science. Wilhelm Liebknecht, who was a frequent visitor to the Marx household, reports Marx to have talked excitedly about the progress of science and mechanics, and gives an insight as to the conversations of Marx's circles:

> Especially on the field of natural science - including physics and chemistry - and of history Marx closely followed every new appearance, verified every process, and Moleshott, Liebig, Huxley - whose 'Popular Lectures' we attended conscientiously - were names mentioned in our circle as often as Ricardo, Adam Smith, McCulloch and the Scotch and Irish economists[12].

When joining the Marx family for breakfast one morning, Liebknecht finds them having stayed up all night, still engrossed in the conversation about the natural sciences he had left them with the previous evening.

Marx was, of course, born into the "scientific age". Vast scientific inventions saw the day in the nineteenth century; immense progress was achieved in almost every aspect of the natural sciences and Marx eagerly followed the discoveries of men like Laplace, Kirkwood, Tyndall, Rebour, Darwin, etc. These were the men of secular science, effectively replacing religious explanations of the world

with a new scientific world-view. Marx, having spent quite some time attacking religion[13], welcomed these men with open arms. Having previously identified religion as the "opium of the people", he saw natural science as an ally of the oppressed, not realising that it could very soon be turned into a different opium which would lull the oppressed class into the dream of a modern, 'progressive', scientific world, clouding the reality of exploitation and commodity production. Even less could he forsee this dream turn into the nightmare of nuclear power stations, atomic bombs and ecological disasters.

But let us return to the more optimistic view of science in the nineteenth century. A letter by Jenny Marx vividly recaptures the atmosphere of her time:

> With regard to religion a significant movement is taking place now in gloomy England. The first men of science, Huxley (Darwin's school) at the front, with Charles Lyell, Bowring, Carpenter, etc. give the most enlightened, truly courageous, free spirited lectures for the people at St. Martin's Hall, indeed on Sunday evenings, exactly at that hour when otherwise the sheep make a pilgrimage to the pasture of the lord; the hall was abundantly full and the rejoicing of the people was so great that at the first Sunday evening, when I was present with my family, more than 2,000 people could not find entrance anymore into the room which was suffocatingly crowded. Three times did the priests allow this frightful event. Yesterday evening, however, it was announced to the meeting that no lectures

> were allowed to be given till the lawsuit of the pastors against the Sunday evenings for the people is finished. The anger of the meeting spoke decidedly and more than 100 pound sterling were collected for the proceedures of the trial. How stupid of the pastors to interfere. To the anger of this pious gang the evenings ended up with music. Chorus by Handel, Mozart, Beethoven, Mendelsohn and Gounod were sung and received with enthusiasm by the English, who till now were only allowed to bawl 'Jesus, Jesus, meek and mild' or to wonder to the ginpalace[14].

No doubt, Marx shared his wife's enthusiasm. After all, if the working class stopped believing all this religious nonsense and started to understand chemistry, physics, biology, etc., who would stop it taking over production altogether? And this, of course, was Marx's greatest concern. The body of knowledge contained within natural science was to aid the proletariat to revolutionise the mode of production: to transform it from an exploitative social organisation to one based on production for the benefit of all.

Marx was often called upon to address a working class audience. Invariably he includes a mention of the emancipatory effects of scientific development, were it not pressed into the service of capital. At the anniversary of the Chartist's People's Paper in 1856 he insists that the new forces of society have to be mastered by the working people, for "at the same pace that mankind masters nature, man seems to be enslaved to other men"[15]. Science is seen as liberating, but clutched in the claws of capitalism:

> Even the pure light of science seems unable to shine but on the dark background of ignorance. All our inventions and progress seems to result in endowing material forces with intellectual life, and in stultifying human life into a material force[16].

With the abolition of capitalism as a precondition, science is on our side. Remembering the experiences of 1848 Marx maintains that "Steam, electricity, and the self-acting mule were revolutionists of a rather more dangerous character than even citizens Barbes, Raspail and Blanqui"[17].

In his Inaugural Address to the First International, Marx asserts the necessity for the working class to conquer political power, for "no improvement of machinery, no appliance of science to production, no contrivances of communication, no new colonies, no emigration, no opening of markets, no free trade, nor all these things put together, will do away with the miseries of the industrious masses"[18]. Accordingly, the address to the Paris Commune is full of praise for the measures taken by the communards to ensure a democratic organisation. Marx emphasises the emancipatory effects the Commune had on science: "not only was education made accessible to all, but science itself freed from the fetters which class prejudice and governmental force had imposed upon it"[19]. In his draft for the address we read "science can only play its genuine part in the republic of labour"[20]. Science is an instrument of class rule which needs to be converted into a popular force while the men of science themselves are converted from the "panderers to class prejudice, place-hunting parasites, and allies of capital into free agents of

thought!"[21] Capital has outlived its progressive side by having created the material and intellectual elements for the collective form of ownership of the means of production[22].

On some of these occasions Marx contrasts natural science with ignorance. In his lecture on Wages, Price and Profit, where, for the first time, he publically explains his theory of surplus value, he takes recourse to natural science when making clear the seemingly paradox concept of profit: "Scientific truth is always paradox, if judged by everyday experience, which catches only the delusive appearance of things"[23]. (Like the paradoxes of the earth moving around the sun and the consistency of water being two inflammable gases). In his dispute with Bakunin the development of the international working class movement is compared to the development of natural science: sectarianism is considered reactionary, an evil in the infancy of the movement, just like astrology and alchemy were the infancy of science. But, the International oposes sectarianism, has a common programme, a common aim, although, historical errors appear: Bakunin's Alliance threatens to break up the movement. However, just as natural science rectifies its errors, so will the movement.

Marx could not have paid a greater compliment to natural science than comparing and identifying it with the working class movement. This faith in scientific thought makes him very typical of his time. No wonder subsequent Marxists have fallen into the trap of science idolatry. What makes Marx a-typical is his revolutionary and devastating critique of capitalism. It is the latter to which we have to turn for a more critical and historical perspective on natural

science. But, before we begin the task of elaborating the significance of Marx's critique of political economy for a critique of natural science we have to break the spell of scientism which the Marxist tradition itself has cast on Marxism and thereby undermined a critical perspective on natural science for a century.

CHAPTER 2

BREAKING THE SPELL OF SCIENTISM

One of the fundamental notions of Marx's thought is the thesis that social existence determines consciousness. Natural science, however, viewed by most Marxists as productive force rather than a form of thought, has escaped the critical edge of this thesis. As Ernst Bloch puts it:

> ... one relies indeed on bourgeois natural science, quasi natural science, to have recognised a part of nature, while everywhere else in bourgeois art and science only ideology comes to surface, ...[1]

Natural Science is rarely considered to pose a problem for Marxist theory. In the field of politics, economics, law, etc., such a perspective would be considered as heresy: here, as almost all currents of Marxism would concede, what is called for is a critique. But the idea of subjecting natural science to the same treatment appears so ludicrous that it need only be mentioned at all in the form of a violent repudiation of those who dare to take the idea seriously to begin with. Marxists and non-Marxists have entertained questions as to the organisation, financing and application of science, but have either failed, or even refused to subject science to a critique in the tradition of Marx's critique of political economy. The very proposal of such a critique calls forth vilification: "economic reductionism", "irrationalism", "fascism",

"libertarianism", "Lysenkoism", "Luddism", the list is endless. Hence, a lacuna (one of many) remains in the body of Marxist theory.

In an attempt to open up the prospect of a critique of natural science it is useful to recall what Marx meant by A Critique of Political Economy (the indicative subtitle of Capital): namely, to lay bare the categorial framework of political economy (value, equality, free exchange, revenues, etc.) as a bourgeois ideology. Whereas political economy explained capitalist society in terms of categories that supposedly expressed transhistorical 'natural laws', Marx's critique identifies those categories (starting with 'value') as the mystified expression of a specific, namely capitalist mode of production:

> The value-form of the product of labour is the most abstract, but also the most universal form of the bourgeois mode of production; by that fact it stamps the bourgeois mode of production as a particular kind of social production of a historical and transitory character. If then we make the mistake of treating it as the eternal natural form of social production, we necessarily overlook the specificity of the value-form, and consequently of the commodity-form together with its further developments, the money form, the capital form, etc.[2]

This mistake is not simply rooted in some 'conspiracy' to perpetuate bourgeois ideology, but is systematically reproduced by the objective appearance of capitalist production in as far as the latter is not subjected to a systematic critique. None of this is

particularly new, of course: indeed, the necessity for a critique of political economy is emphasised even by those Marxists whose subsequent theory and practice reveal a total oblivion to its fundamental significance. But when it comes to the question of natural science, even 'basic principles' usually regress to a pre-critical level: just as political economy exhausted itself with the insight that the content of the value-form is labour, so Marxism exhausts itself with the view that the content of natural science is knowledge of nature. Thus one can say of Marxism's perspective on natural science what Marx said of political economy's perspective on value: namely, that "it has never once asked the question why this content has assumed that particular form"[3]. Thereby, the dominant Marxist understanding of natural science remains at the level of immediate appearances, and the prospect of a critique is foreclosed.

In the absence of a critique, Marxism produces its own brand of bourgeois ideology under the grand title of the 'dialectic of history'. According to this evolutionist scheme, class societies 'develop' the means of production in the narrow interest of extracting maximum surplus labour from the immediate producers, but, so the account continues, this interest, far from determining the means of production, is (in a manner reminiscent of Hegel's 'Cunning of Reason') actually the unwitting carrier of the latter's transcendent goal, which is the perfection of people's scientific mastery over nature. This obviously involves social relations of production, but these are by way of 'attendant circumstance', mapped onto the autonomous scientific and technical processes that constitute the 'inner essence' of actual historical development. As a result, Marxist theorisation of the objective body of the immediate process

of capitalist production is usually restricted to a faith that the body in question constitutes the potential base of socialism. Thereby, a critical perspective is foreclosed by the overriding teleology of scientific rationality. It is for this reason that an understanding of Marx's position on natural science presupposes breaking the spell of an ideology that can justifiably be called scientism.

Scientism is an ideology which one can happily take for granted amongst 'bourgeois' philosophers and historians of science. for example, Cassirer, Wittgenstein, even the critical Russel can certainly not be expected to provide a historical materialist explanation of natural science. It is a matter of consistence for such thinkers (as it is not for Marxists) to view natural science in seperation from social relations. The latter are not seen as time-bound, therefore one cannot expect a different analysis of natural science. With the more modern developments in the history and philosophy of science even the more critical insights of the above named 'classics' have been lost.

For Karl Popper, one of the gurus of modern philosophy of science, science is supreme. His concern was to find a criterion of demarcation between science and non-science or 'pseudo-science'. This criterion lay in the refutability or falsifiability of a theoretical system. Only those assertions are elevated to the status of scientificity which may clash with observations. A theoretical system can only be classified as science if it can be tested by attempts to refute it. Non-testable theories are metaphysical or non-scientific. The methodology of science procedes on the basis of conjectures and refutations. Accordingly, Marx cannot be falsified while Einstein's theory of gravitation can be tested and therefore refuted. Thus physics is scientific, historical

materialism is not. Any theory which cannot be tested and refuted and thereby falsified cannot make claims to scientificity. It is the latter which gives a theoretical system its superior status - scientism par excellence.

Thomas Kuhn's sociological approach also remains scientistic. For Kuhn an understanding of scientific knowledge will involve sociological investigation of the scientific community. The members of this community share a paradigm which constitutes a scientific achievement including theory, method, application, observation, experiment, and defined problems. Science developes from paradigm to paradigm, the replacement of one by the other constituting a scientific revolution. Kuhn believes to escape the charge of relativism by upholding modern science as superior. This, in conjunction with his faith in scientific progress which develops within the scientific community and is not dependent on outside justification, constitutes a scientism which does not leave space for criticism.

However, this is not the place to provide a comprehensive survey of the works of philosphers of science. Hume, Locke, Descartes, Spinoza, Hegel, to mention just a few, as well as their modern successors, have argued about the methodology of natural science, but never questioned its social determinants. And there is no reason why they should. To question the social and economic determinants of any aspect of society has never been the prerogative of thinkers who eternalise a particular social relation. Thus, it is not surprising to find scientism in the non-Marxist camp of theoreticians of science. What is a little surprising and remains to be explained, is the scientism so prevalent in the Marxist tradition.

Marx and Engels had explained communist theory to be merely the theoretical expression of a movement going on before our very eyes. Marx never claimed to have invented a new politics, he merely had analysed the revolutionary actions and potential of the European working class. This analysis was subsequently imported into Russia for better or worse; Soviet Marxism being largely the creation of the intelligentsia, divorced from the working class. It was here where the intelligentsia promoted the industrialisation of a 'backward' country amidst the obstacles of civil war, foreign invasion, and a starving population, that scientism became most pronounced.

Not only the objective material conditions in the Soviet Union gave way to scientism. Soviet Marxists, in particular Lenin, had been watching European Social Democracy for quite some time and had grown rather impatient at the absence of any immediate possibility of a revolution. For them, the main obstacle to the removal of moribound capitalism was the reformism of a working class bribed by Imperialism. While Marx had seen the working class as the only revolutionary potential, Lenin, ironically in agreement with the 'renegade' Kautsky, believed the working class, left to its own, could only develop a trade union consciousness, that is, it was capable of fighting for better work and living conditions and higher wages, but not for revolution. A revolutionary consciousness would have to be transplanted into the working class from without. This was the role of the revolutionary party whose lead the working class would have to follow if it wanted to transform its reformist struggles into revolution.

Correct revolutionary theory and practice was seen to require a party of professional revolutionaries who would direct working class struggle towards socialism. Revolutionary intellectuals would infiltrate working class organs to gain leadership. As the professional vanguard they would have the correct understanding of 'scientific socialism', and from their scientific mastery over social relation it was not a big step to their scientific mastery over nature and production. This marked the substitution of the party for the class-struggle. The objectives of revolutionary working class action were no longer determined by the class-struggle, but by the party which had to organise and lead the proletariat. A vanguard of professional revolutionaries was substituted for the political action of organised labour at the point of production and elsewhere. Although the party was organised on the principle of democratic centralism the conditions of the Soviet Union dictated a centralised control which could not afford the luxury of democracy. Soon, the centralist principle won over the democratic one. The central committee became an authority not only on political organisation but also on production and technical know-how. 'All power to the Soviets' soon turned into 'all power to the party' and its hierarchial organisation lent itself to an acceptance of a scientific elite. The subsequent building of 'socialism in one country' made scientism an absolute imperative. On the international level the CPSU dictated not only political action to the Comintern, but also theoretical analysis which, of course, included scientism, thereby it contributed to a legacy which proved so fatal to a historical materialist critique of natural science.

PART 1: THE SCIENTISTIC LEGACY

1. The Foundations of Scientism: Engels and Kautsky

Despite his many positive contributions to Marxism and to Marx's own work[4], it was Engels who was the first to produce a scientistic version of Marxism. His ever increasing interest in the natural sciences, his obsession with the Hegelian dialectic, his reverence to Darwin, and his evolutionary conception of Social Democracy made scientism an inevitability in his conception of socialism. In Engels' 'scientific socialism' science was as important as socialism and therefore to be treated with deference. Paradoxically it was the well-intentioned concern to argue that Marx's thought was not just 'economic' which led Engels astray: rather than arguing that the natural sciences should, via a critique of their theoretical status, be incorporated into historical materialism, Engels took the opposite direction and reduced historical materialism to the status of an 'application' of a broader, metaphysical system which has become known as 'dialectical materialism'.

Dialectical materialism begins, in a manner almost identical to the Leviathan of Thomas Hobbes not with specific societies, nor with society in general, nor even with man in general, but with the most general laws of all motion, laws which must be "valid just as much for motion in nature and human history as for the motion of thought"[5]. According to this theory, matter, which is primary, moves by contradictions, and this movement is 'reflected' in the movement of mind, which is secondary. The Dialectics of Nature picked up the Hegel of the Science of Logic and Philosophy of Nature and tried to

'materialise' him: the result was that the dialectic, with its laws and aspects, was argued to be operative in nature, such that it could be appropriated by an equally dialectical thought. Scepticism about science was regarded as politically dangerous and wrong: in the test-tube, the scientist could make the 'thing-in-itself' (a total contradiction in terms that did not bother either Engels or Lenin). 'Absolute truth' is gradually approached via science. Within this metaphysical system, the scientific ensemble appears in the indeterminant form of an objective application of people's "rapidly growing knowledge of the laws of nature"; thus, "in the most advanced industrial countries we have subdued the forces of nature and pressed them into the service of mankind"[6]. All in all, the development of natural science is manifested in specific modes of production, but, far from carrying the marks of the latter in its objective structure, it ultimately transcends them. Such is the essence of scientism as bequeathed to Marxism by Engels.

However, even during Engels' life, but more so after his death, the role of 'executor' of Marx's theoretical legacy fell to Karl Kautsky. Far more explicitly and consistently than Engels, Kautsky 'extended' the 'materialist view of history' to the point where the 'history of humanity' became merely a 'special case of the history of living beings' in general; this 'special case' certainly had its 'specific laws', but it could ultimately be grasped only in conjunction with the 'general laws of animate nature'[7]. The class-struggle is simply a specific form of the general law of the development of nature[8]. Natural sciences and their practical application in the form of technology bring about freedom, for "there are no conflicting class interests within technology"[9]. Kautsky does relate mathematical and

abstract thought to trade, maintaining that trade "develops those mental faculties that lie at the basis of scientific study;"[10] however, this is only seen as an example whereby a 'progressive' economic process enables us to adjust our "thoughts to the facts of nature"[11]. Kautsky remains emphatic that the latter and our conception of nature are not socially constituted:

> Our conceptions of nature at any given time are, of course, always determined by the facts of nature which we know, not by the society in which we live[12].

Indicatively, Die Neue Zeit, the newspaper of the SPD, edited by Kautsky till 1917, did not go beyond its editor's position: natural sciences are revolutionary, they are the "ally of the proletariat"[13]. After all, the SPD's rival for working class support was the catholic Center Party, and secular natural science had to be used as a weapon against the religious explanations offered by the rival party. If natural science was convincing, Marxism also was to be convincing, given that its method was to follow the footsteps of natural science[14]. It was considered important that a working class newspaper would not just present articles on society and politics, but also on explanations of natural phenomena. So we have Pannekoek reporting on astronomy, Lipschüss on medicine, chemistry and biology, and Aveling on his pet subject - Darwin. Socialism would spring from the successful marriage between natural science and Marxism.

2. The Russian Connection: Soviet Marxism

Kautsky, and the Social Democrats generally, did not, of course, go unchallenged in their claim to be the apostles of Marx: Bolshevism was to a large extent constructed as an explicit repudiation of this claim. But whereas the split was quite radical on questions of party organisation, parliamentary democracy, state power and international war, the scientistic dimension of social democratic thought not only went unquestioned, but was explicitly affirmed and, if anything, deepened. The pivotal figure here was the 'Russian Kautsky', Georgi Plekhanov. As in the case of his German counterpart, Plekhanov's consternation at the suggestion that Marxism implied an 'economic determinism' was so great that he hastily conceded an absolute autonomy to (amongst other things) natural science, where "a genius discovers laws the operation of which does not, of course, depend upon social relations"[15]. The same holds, quite logically, for the means of production, which, though developed in and through specific social relations, have logical and historical priority over the latter; thus the reader is subjected to the simplistic generalisation that "on the basis of a particular state of the productive forces there come into existence certain relations of production"[16].

It was from Plekhanov that Lenin learned his Marxism, and although the pupil never hesitated to denounce his teacher's 'tactical opportunism', Lenin was anxious and emphatic that this should not be allowed to blur the fact that in the sphere of philosophy, Plekhanov was "the only Marxist in the international Social-Democratic movement to criticise the incredible platitudes of the revisionists from the standpoint of consistent dialectical materialism"[17]. That Lenin thereby

affirmed Social Democracy's scientism is clear from his restatement of 'consistent dialectical materialism' in Materialism and Empirio-Criticism[18] and his Philosophical Notebooks[19]. But, not surprisingly, though more importantly, this scientism is in the forefront of Lenin's conception of the transition to socialism. Full of praise for the scientific achievements of capitalism, the struggle to build the new party was based on a 'Marxism' understood as 'the ideology of the proletariat trained by capitalism'; to fully exploit this 'training', the Bolshevik must "distinguish between the factory as a means of exploitation (discipline based on a fear of starvation) and the factory as a means of organisation (discipline based on collective work united by the conditions of a technically highly developed form of production)". Having drawn this distinction, Lenin proceeds to commend its political significance: "the discipline and organisation which come so hard to the bourgeois intellectual are very easily acquired by the proletariat just because of this factory 'schooling'"[20]. His attack on the 'Proletkult'[21], which also applied to Bogdanov's 'proletarian science'[22] signifies his position on any real working class initiative; in fact, once the Bolsheviks were installed in power as the state organisers of work, Lenin began to express doubts about the rigour of the proletariat's former 'training': He bemoaned the fact that "obedience, and unquestioning obediance at that, during work ... is far, very far from being guaranteed as yet"[23]. However, Lenin took comfort in the fact that the 'dialectic of history' had produced a more effective 'training' in the form of Taylorism[24], to which he adopted his usual 'dialectical' attitude:

> The Taylor system, ... like all capitalist progress, is a combination of the refined brutality of bourgeois

> exploitation and a number of the greatest scientific achievements in the field of analysing mechanical motions during work, the elimination of superfluous and awkward motions, the elaboration of correct methods of work, the introduction of the best system of accounting and control, etc. ... We must organise in Russia the study and teaching of the Taylor system and systematically try it out and adapt it to our own ends[25].

This is no mere expedience dictated by the precarious military position of the new Soviet state, but a general theoretical and practical imperative in the Leninist conception of the transition to socialism. Crude materialism, reflection theory and the 'dialectic of history' fuse logically into a scientistic model which turns from a Social Democratic dream into the state workhouse of the USSR.

Lenin himself did not live to consolidate this dream, which was the work of Stalin. Along the way, the latter also produced a codification of Dialectical and Historical Materialism that is disarmingly simple: first, one needs to understand dialectical materialism in the manner of Engels; then, one applies dialectical materialism to the study of society in the form of historical materialism, which, true to the universal nature of dialectics, reveals that "the productive forces are not only the most mobile and revolutionary element in production, but are also the determining element in the development of production"[26]. Applied to contemporary capitalism, this world-view demonstrates that "capitalist relations of production have ceased to correspond to the state of productive forces of society and have come into irreconcilable contradictions

with them," revolutionaries thus learn that their 'mission' is "to replace the existing capitalist ownership of the means of production by socialist ownership"[27]. Once again, 'dialectics' performs the feat of purging science of any objective class structure and restricting the transformation of production to a simple question of property rights.

Stalin, as is well known, did not have an easy job in his attempt to formulate and embody the 'true' spirit of Marxism-Leninism. On the contrary, he was assailed and pilloried by Trotsky on a vast series of problems ranging from 'socialism in one country' to the struggle against fascism. But precisely because of this mutual animosity, the scientistic continuum in Social Democratic and Bolshevik theory and practice is revealed all the more strikingly when one realises that even in his attack on Stalin's break-neck, terroristic industrialisation programme, Trotsky never once entertained the thought that this programme might in fact be in perfect harmony with the objective structure of machine technology, electrical power, and Taylorism. As if sensing that he was on the threshold of heresy, Trotsky affirmed his own orthodoxy by stating that "Marxism sets out from the development of technique as the fundamental spring of progress, and constructs the communist programme upon the dynamic of the productive forces"[28]. And as if to prove that these were not empty words, Trotsky elsewhere extended Lenin's 'dialectical' appraisal of Taylorism to Henry Ford's work in constructing the first conveyor-belt production line: revolutionaries, according to Trotsky, should aim not to smash Fordism, but to "seperate Fordism from Ford and to socialise and purge it"[29]. Again, no mere expedient dictated by Russia's 'objective conditions'; but

capitalism's work ethic, taken to utmost extreme, becomes the sinequa non for socialism per se:

> The person who does not come to work on time, wastes time to no purpose in the workshop, busies himself in it with outside matters, or simply takes days off work, is the enemy of socialist Russia, and is undermining her future[30].

Freedom is only obtainable through mechanisation and automation; thus, a negative stance towards machinery is incompatible with socialism[31]. Technology and science escape the logic of capital, they have their own: a logic of cognition and mastery of nature. Socialist construction carefully utilises this logic, thereby natural science (dealing with matter) and Marxism (dealing with the social sphere) are linked, as well as maintaining autonomy[32].

We are thus dealing with a time-honoured tradition that takes in the otherwise un-unitable: Engels, Kautsky, Plekhanov, Lenin, and, as a mere footnote, Stalin and Trotsky. The list could be expanded ad infinitum (and ad nauseam); but to underscore the fundamental reformism of this tradition, one should perhaps close with Harold Wilson's vision of 'forging socialism in the white heat of the scientific-technological revolution'[33], and his Euro-Communist counterpart, Santiago Carillo, whose own brand of reformism quite legitimately establishes its 'orthodox' credentials by emphasising that "what can really be inferred from the development of the forces of production is that modern society is ripe for socialism"[34].

3. The China Syndrome: Mao

Chinese 'Communism', in particular the Cultural Revolution is often believed to be an anti-scientistic, anti-technicist version of working class power. Maoism, as a 'politics for the masses', did indeed seem to provide an alternative to the Soviet Union's state-centralised industrialisation programmes. A Critique of Soviet Economics is the basis for claims on behalf of Mao's status as an anti-technicist theoretician of the first order[35]. Here, it is true, Mao does criticise his idol, Stalin, for wanting "nothing but technology, nothing but cadre: no politics, no masses"[36]. But on the question of science, Mao still works with evolutionist categories like 'backward' and 'advanced', rather than dealing with specific relations of production; and his insertion of 'politics' and 'the masses' boils down to the hazy notion that mechanisation and automation must not be 'made too much of'. Instead, Mao counsels a 'sense of proportion'[37], the moralising substitute for a critique of science.

Mao's Where Do Correct Ideas Come From? paraphrases Marx to the effect that "it is man's social being that determines his thinking", but in Mao's hands, this is 'substantiated' by a puerile restatement of the crude materialism and reflection theory that render Marx's thesis meaningless. In the same manner, having tantalised the reader with the thesis that 'correct ideas' come from social practice and from it alone, Mao becomes more precise: "they come from three kinds of social practice, the struggle for production, the class struggle and scientific experiment"[38]. This scientistic perspective is present already before the Communist seizure of power: On Contradiction begins with the 'basic law of materialist dialectic', namely, the

'law of contradiction in things', and goes on to explain that when Marx 'applied' this law to the study of capitalist society, "he discovered that the basic contradiction of this society is the contradiction between the social character of production and the private character of ownership"[39]. Dialectics even affirms that "in the contradiction between the productive forces and the relations of production, the productive forces are the principal aspect"[40]. Admittedly, Mao contradicts himself (perhaps to prove the universality of the 'basic law of materialist dialectics' by stating, elsewhere in the same article, that "in capitalist society the two forces in contradiction, the proletariat and the bourgeoisie, form the principal contradiction"[41]. But throughout this equivocation, one thing remains quite clear: namely that Mao regards the productive forces as transcendent of specific social relations of production.

4. Critical Sparks: Luxemburg, Korsch and Gramsci

Turning now to those thinkers and doers who have managed, in varying degrees and forms, to extricate themselves from party politics and thereby from its accompaning scientism, one can usefully start with Rosa Luxemburg. Her unique contribution to Marxism lies in the fact that while repudiating both the overtly reformist as well as the sham-orthodox currents of the workers' party, she simultaneously took issue with the scientistic basis of Lenin's related broadside. Her rejection of the notion, common to both Kautsky and Lenin, of socialist consciousness being 'introduced into the proletarian class struggle from without'[42], took the form of a spontaneist prospect in which "the proletarian army is recruited and becomes aware of its objectives in the course of the struggle

itself". Indeed, these very objectives appear as the product of that struggle, such that there can be no pristine 'class consciousness from without': all that can be distilled are the general principles of the struggle itself[43].

These general principles can say little or nothing of a positive nature about socialist reconstruction, but they can and do deal mercilessly with residual capitalist values within the socialist movement. For example, Luxemburg pillories Lenin's hymn to factory discipline as evidence of his mechanistic conception of socialist organisation; for her part, she explicitly rejects the idea of a technocentric continuum in the transition to socialism (at that time still referred to as 'social democracy'):

> The self-discipline of the social democracy is not merely the replacement of the authority of the bourgeois rulers with the authority of a socialist central committee. The working class will acquire the sense of the new discipline, the freely assumed self-discipline of the social democracy, not as a result of the discipline imposed on it by the capitalist state, but by extirpating, to the last root, its old habits of obedience and servility[44].

In the wake of the Bolsheviks' actual seizure of power thirteen years later, Luxemburg's revolutionary imperative became, if anything, even more passionate[45].

"One's attitude to Rosa still strikes me as the best test of revolutionaries"[46], was the opinion of Karl Korschwhose break in the

1920's with the scientism common to both Social Democracy and Bolshevism grew out of a rejection of the crude materialism and reflection theory that form its metaphysical base. In 1923, he had not yet been faced with the transformation of Lenin's Materialism and Empirio-Criticism into a "bible", but, nonetheless, Korsch wrote even at this point: "the naively metaphysical standpoint of sound bourgeois common sense considers thought independent of being and defines truth as the correspondence of thought to an object that is external to it and 'mirrored' by it"[47]. This obviously came under attack by those codifying this very position. By the late 1920s, Korsch had been expelled and vilified. Openly confronted with the "diamat", he now swung into full attack: Lenin had merely "inverted" Hegel's idealist philosophy into a materialist philosophy, in which Matter replaces Spirit as the Absolute[48].

Whereas, ever since Engels, historical materialism had been reduced to an 'application' (one among many) of an overall metaphysical system, Korsch took the opposite direction: "the correct materialist conception of history ... is incompatible with seperate branches of knowledge that are isolated and autonomous"[49]. More specifically, Marx's critique of political economy "never ceases to be a critique of the whole of bourgeois society and so all its forms of consciousness"[50]. The failure of 'social democracy' to grasp this scarcely needed stating, but the Bolsheviks' parallel course needed to be exposed in full, with direct reference to its reformist consequences:

> The 'new materialism' of Lenin is the great instrument which is now used by the Communist parties in the attempt

> to separate an important section of the bourgeoisie from the traditional religion and idealistic philosophies upheld by the upper and hitherto ruling strata of the bourgeois class, and to win them over to that system of state capitalistic planning of industry which for the workers means just another form of slavery and exploitation[51].

This is the political backcloth to Korsch's opposition to Soviet Marxism. The Soviets' stress on the neutrality of science meant a defence of the split between mental and manual labour, both in terms of state power and the labour process. Korsch's move towards Council Communism (stressing workers' control of a syndicalist kind) went hand in hand with his critique of positivist Marxism. But it was Anton Pannekoek who best expressed this political dimension: critical of the idea of natural science and technology being under the direction of intellectuals, he maintained that capitalism will only be destroyed when the proletariat itself becomes the master of production[52]. In this way, Luxemburg's rejection of Lenin's 'factory discipline' is theoretically grounded in a repudiation of its idealistic base, and Korsch and Pannekoek thereby implicitly indict a time-honoured tradition stretching back to Engels.

If Korsch's immunity to a pre-critical, scientistic metaphysics of matter was in some sense due to his appreciation of Classical German Idealism, something similar happened in Italy in the case of Antonio Gramsci. While much of the Prison Notebooks is concerned to criticise the idealist tradition, particularly for its abstraction from class struggle, Gramsci felt that this tradition was perhaps closer to the critical spirit of historical materialism (dubbed the

'philosophy of praxis') than was the scientistic materialism popularised, for example, by Nikolai Bukharin in the early 1920s[53]. Gramsci asked:

> Might not the idealistic conception according to which nature is none other than the economic category be reduced, once cleansed of its speculative superstructures, into the terms of the philosophy of praxis and demonstrated to be historically linked to and a development of that philosophy? In reality the philosophy of praxis does not study a machine in order to know about and to establish the atomic structure of its materials or the physical, chemical and mechanical properties of its natural components ... but only in so far as it is a moment of the material forces of production, is an object of property of particular social forces, and expresses a social relation which in turn corresponds to a particular historical period[54].

This is clearly a historical conception of the machine which is linked to specific social relations. As well as being critical of the objective structure of technology Gramsci also points to a critique of natural science:

> Matter as such therefore is not our subject but how it is socially and historically organised for production, and natural science should be seen correspondingly as essentially an historical category, a human relation[55]. (my emphasis).

5. Historical Materialism, Commodity-Fetishism and The Critique of Scientism: Lukács

In anticipation of any misguided euphoria, however, it must be stated that Gramsci, Korsch and Luxemburg were complex, even contradictory thinkers, whose break with orthodoxy was far from definitive: numerous passages in their works reveal a residual scientism in one form or another. But, more importantly, even in their anti-scientistic moments, their theoretical frame of reference offers little in the way of constructing a critique of natural science in the spirit of Marx's critique of political economy. This is particularly true of Gramsci, whose enthusiastic 'revolution against Karl Marx's Capital'[56] was not merely a repudiation of social democracy's evolutionist determinism, but also testified to a life-long disregard of Marx's analysis of capitalist production as value-in-process.

By way of total contrast, Georg Lukács undertook a theoretical revolution on the basis of Marx's Capital. Lukács too is a complex figure, who went through many phases, and who actually produced one of the most cynical defences of Soviet Marxist scientism ever to appear[57]. But in the early 1920s, when serious theoretical work on revolutionary communism did not yet mean expulsion from the Communist Party, he proved himself a very gifted revolutionary thinker. Indicatively, Lukács' many achievements included an attack on scientism, as well as some serious progress in the direction of a critique of natural science. Not aware that Marx had written the Paris Manuscripts, Lukács studied Hegel's Phenomenology of Mind and saw Marx's debt to Hegel in a different light to the Soviets. According to Lukács, this

debt consisted in transcending the dualism of subject and object, not by a simplistic epistemology, but by transcending epistemology altogether, and, like Gramsci, stressing praxis.

As a first introduction to this dimension of his work, one should consult Lukács' attack on the scientism personified by Bukharin (an attack, incidentally, that is far superior to Gramsci's). Lukács' general point is that "this attempt to find the underlying determinants of society and its development in a principle other than that of the social relations between men in the process of production ... leads to fetishism". In particular, "it is altogether incorrect and unmarxist to seperate technique from the other ideological forms and to propose for it a self-sufficiency from the economic structure of society"[58]. Giving Bukharin a lesson in history which could long since have been learned from Capital, Lukács points out that the social preconditions of modern machinofacture predate the latter's technical realisation, which can only be theorised as "the consummation of modern capitalism, not its initial cause"[59].

The implications of this perspective are drawn out in Lukács' classical work, History and Class Consciousness. His fundamental principle is that Marx's theory of commodity-fetishism can be made to "yield a model of all the objective forms of bourgeois society together with all the subjective forms corresponding to them"[60]. Lukács applies this not merely to the subjective form of scientism, but to the factory system itself:

> Time sheds its qualitative, variable, flowing nature; it freezes into an exactly delimited, quantified continuum, filled with quantifiable things' ... In this enviroment

> where time is transformed into abstract, exactly measurable, physical space, an enviroment at once the cause and effect of the scientifically and mechanically fragmented and specialised production of the object of labour, the subjects of labour must likewise be mathematically dissected ... Mechanisation makes of them isolated abstract atoms whose work ... becomes mediated to an increasong extent exclusively by the abstract laws of the mechanism which imprisons them[61].

The factory could not possibly achieve this, Lukács adds, "were it not for the fact that it contains in concentrated form the whole structure of capitalist society". Lukács here clearly recognises the social relations of capitalism as the determinant of scientifically organised production in which the worker is imprisoned by the abstract laws of science. Laws which he sees as containing capitalist relations of exploitation. This reveals the difference between parroting isolated aphorisms on the 'dialectic of history' and actually basing oneself on the analysis contained in Capital[62].

6. Revisionist Ambivalence: Marcuse, Gorz and Braverman

With Lukács' kowtow to Soviet Marxism in the mid-1920s, the critique of scientism became increasingly divorced, at least temporarily, from the organised labour movement. This is illustrated by Korsch's increasing isolation after his break with Moscow, but it is even more marked in the case of the Frankfurt School, who, though never actively involved in working class politics, was nonetheless destined to keep alive something of Lukács' critical spirit. Common to the whole 'Frankfurt School' was a Lukácsian repudiation of crude

materialism, reflection theory, technocracy and scientism[63]. In an implicit critique of the Soviets[64], Max Horkheimer stressed that a qualitatively new form of society does not emerge simply by a change in property relations and increased productivity. In line with this, he rejects any a-historical approach to the scientific sphere, and instead, views methodological and categorial apparatus themselves as historically and socially determined. In their Dialectic of Enlightenment, Adorno and Horkheimer bemoan the Enlightenment's turn against itself: Reason, in the form of scientific - technological rationality, has moved from unity with nature to domination of nature and human beings[65]. In the same tradition, Alfred Schmidt's The Concept of Nature in Marx presents a Marx in total opposition to the scientism of orthodox Marxism[66]: nature is a social category, that is, nature can only be mediated through society, through practice.

It was Herbert Marcuse, who extended the Frankfurt School's philosophical critique of rationality to an attack on Taylorism as a 'streamlined autocracy' in which the laws of physical science and technological reason fused inextricably with the capitalist profit-motive[67]. In the early 1960s, Marcuse developed this into his famous thesis of one-dimensionality, within which the attack on technological rationality was absolutely central:

> Not only the application of technology but technology itself is domination (of nature and men) - methodical, scientific, calculated, calculating control. Specific purposes and interests of domination are not foisted upon technology 'subsequently' and from the outside; they enter the very construction of the technical apparatus[68].

As part of what he called the Great Refusal, Marcuse searched for signs of a working-class struggle against this technological monolith, and in the wake of 1968 he enthusiastically spoke of "a collapse of work discipline, slowdown, spread of disobedience to rules and regulations, wildcat strikes, boycotts, sabotage"[69]. And just to make quite explicit his rejection of Social Democratic and Bolshevik scientism both as a metaphysical system and as a political strategy, his last work identified elements of a revolutionary consciousness in "the struggle against the entire capitalist and state-socialist organization of work (the assembly line, Taylor system, hierarchy)"[70].

But despite this welcome break with the theory and practice of scientism, Marcuse's revisionism cannot be passed over in silence[71]. While not going as far as to repudiate Marx's analysis of value-in-process, Marcuse equally shies away from adopting the latter as his frame of reference. Instead, as in the case of his Frankfurt School colleagues[72], the full weight of the incipient critique is supposed to be borne by the elusive category of 'domination'. As a result, Marcuse's critical contribution is restricted to a number of stimulating, but diffusely scattered, semi-aphoristic insights, which, in the absence of a theoretical framework to sustain them, are precarious in the extreme, and have, in fact, been subject to various criticisms. For example, Marcuse's critical attitude towards machine technology is rejected by Jürgen Habermas, who, attributing secondary significance to the economic level, sees <u>zweckrationales Handeln</u> (purposive-rational action) as appropriate to material production, and is only critical of its extension beyond this realm, an extension which produces "systematically distorted communication"[73].

A similar revisionism to Marcuse's appears in the more substantial contributions of Andre Gorz. Gorz does argue that "organisation, production technology, division of labour form the matrix that invariably reproduces through inertia hierarchical work relations, the capitalist relations of production". As regards the latter, he emphasises, quite correctly, that "the goal of capitalist production can only be the growth of capital itself"[74], but Gorz traces this to an undifferentiated extortion of surplus labour[75], oblivious to the fact that for Marx capitalism is specifically characterised by the fact that surplus labour is extracted in the value-form. Thus, instead of viewing the immediate process of production in Marxian terms as the unity of labour process and valorisation process[76], Gorz, like Marcuse, abandons value-theory in favour of a unity of 'technique of production' and 'technique of dominating those who are producing'[77]. This revisionism explains the ease with which Gorz slips back into an objectivist perspective of science and technology being 'incorporated' from outside, explicitly granting them a 'degree of irreducible autonomy'.

The same ambivalence is found in Harry Braverman's widely read Labor and Monopoly Capital. On the one hand, Braverman stresses that only with the development of machinery is capitalism's goal of the domination of dead labour over living labour established as a physical fact[78]. On the other hand, theories which view machine technology as 'negative' in its objective structure are, in Braverman's estimation, "constructed on every level to exonerate capitalism"[79]. In this situation, there is no alternative (certainly no 'Marxist' alternative) but to return to a simple use/abuse model, garnished with some anthropological generalities: "it is not the productive

strength of machinery that weakens the human race, but the manner in which it is employed in capitalist social relations"[80]. If the ambivalence evident in Gorz is thereby resolved in favour of a scientistic dimension, the revisionism behind it is equally more explicit: abandoning Marx's surplus-value in favour of a generalised 'surplus', Braverman glibly outlines the 'major' thesis that "monopoly capitalism tends to generate a greater economic surplus than it can absorb"[81]. Thereby, he ditches value-theory, the basis upon which Marx structured Capital, and, as we have seen, Lukacs' point of departure for a repudiation of scientism and a critique of science.

7. The Revolutionary 'Anti-Marx': Castoriadis

If Marcuse, Gorz and Braverman reveal an ambivalence ultimately rooted in their revisionism, they do nonetheless acknowledge that their anti-scientistic moments are somehow indebted to Marx. This stands in total contrast to the Greek-cum-French ex-Trotskyist, Cornelius Castoriades, who argues that one can only develop an anti-scientistic, revolutionary theory and practice on condition that one breaks with Marx altogether. To this end, Castoriades does not simply attack the idea of productive forces being history's 'dynamic element'; rather, he challenges the whole notion of 'productive forces' to begin with. Writing in 1962, but drawing together ideas he has been developing since the 1950s, Castoriades writes:

> It is one thing to recognise the fundamental importance of Marx's insights on the connection that exist between production and other aspects of the life of a society ...

> But is is another thing to reduce production, work, and human activities mediated by instruments and objects to the level of 'productive forces' i.e. in the end to the level of technology. And it would be just as wrong to grant to technology an evolution which 'in the last instance' would be autonomous[82].

In reality, Castoriades argues, 'technological evolution', far from being an autonomous, homogeneous, teleological continuum, is determined "by the development of the proletariat and by the class struggle waged in the womb of capitalism"[83].

For Castoriades, the class struggle does not simply 'intervene' in the transition from one mode of production to another, but actually determines the development <u>within</u> the mode of production. Thus, if there is any sense at all in speaking of a 'contradiction' between productive forces and relations of production, it is <u>not</u> in the sense of a <u>transcendence</u> of capitalism:

> In the last 25 years the productive forces have undergone a development far in excess of anything previously imaginable ... but it has not altered or challenged the capitalist nature of the relations of production. What seemed to Marx and the marxists to be a 'contradiction' which would lead to the explosion of the system has been 'solved' from within the system itself[84].

As a result, the revolutionary assault on capitalism, far from 'taking over' an existing technological ensemble, must take the form of an

assault on that ensemble, along with its very canons of scientific and technological 'rationality', canons to which Marx himself, by and large, remained enslaved[85].

But while Castoriades thereby repudiates what scientism upholds, he nonetheless stands on common ground with them as regards the content and location of Marx's 'message'. While mocking the vulgarisers for ignoring the corner-stone of Marx's theory, namely, Capital, Castoriades himself shows a marked tendency to rely on the "1959 Preface" so popular with them[86]. When he does turn to Capital, it is to copy out passages reaffirming the 'dialectic of history', rather than to study Marx's analysis of "Machinery and Large-Scale Industry"; this failure too Castoriades shares with the 'orthodoxy' he so despises. And, last not least, Castoriades seems oblivious to the fact that his proposed critique of technology was pioneered long ago by Lukacs on the very basis of Capital, in particular its analysis of the value-form.

PART 2: THE DEPARTURE FROM SCIENTISM

1. Alfred Sohn-Rethel

One radical departure, by way of a sustained theorisation of science, can be found in the work of Alfred Sohn-Rethel, an obscure figure who began a prolonged study of Capital in the 1920s, and who finally achieved fame in Germany in 1970 with his opus magnum, Intellectual and Manual Labour: A Critique of Epistemology. Sohn-Rethel is of the same generation as the Frankfurt School of

which he sees himself as a disciple. In line with Horkheimer, Adorno and Marcuse he became very critical of Soviet Marxism, denouncing the technocratic, centralised, party-controlled construction of 'socialism' in the Soviet Union. His political conception which would like to place the democratic organisation of the working class back on the centre of the stage is accompanied by a more critical perspective on natural science. We discuss Alfred Sohn-Rethel at length as he is one of the few theoreticians to have attempted an analysis of natural science in the context of social relations. The (many) shortcomings of his theoretical production should not detract from his achievement to provide the beginnings for an understanding of forms of thought and thereby a critique of science.

Sohn-Rethel argues that there is a lacuna not only in Marxism but in Marx himself: there is no historical materialist analysis of the "conceptual foundations of the cognitive faculty vis-a-vis nature which in one form or another is characteristic of the ages of commodity production from their beginnings in Ancient Greece to the present day"[87]. Introducing the concept 'social synthesis' to designate the network of relations by which any one society forms a coherent whole, Sohn-Rethel states a major methodological premise: "The conceptual basis of cognition is logically and historically conditioned by the basic formation of the social synthesis of its epoch"[88]. By social synthesis Sohn-Rethel simply means the way individuals achieve a social nexus: while communism would be the conscious relationship of individuals, in capitalism the social synthesis is effected 'behind the backs' of individuals, through the mechanism of exchange. In fact, in all commodity producing societies the social synthesis is effected via exchange, and the "constituent

elements of the exchange abstraction unmistakably resemble the conceptual elements of the cognitive faculty emerging with the growth of commodity production"[89]. Although Sohn-Rethel seems to forget that commodity production (or exchange) was only marginal prior to capitalism and could therefore not have provided the basis for a social synthesis, his attempt to relate 'conceptual elements of the cognitive faculty' to the 'growth of commodity production' is promising.

Sohn-Rethel's critique of epistemology (bourgeois or marxist) takes its departure from Immanuel Kant. Kant's question concerning the possibility of 'synthetic judgement a priori' is a real question: namely, how does one explain the pre-given nature of the forms of intuition and categories of the understanding? Kant's own reply ('via the faculty of transcendental synthesis a priori') is a hypostatisation that merely restates the problem in the form of a self-assertive 'answer', but this should not prompt us to follow Hegel's 'sublation' (Aufhebung) of the Kantian problematic into absolute idealism, for such a course blots out a paradox which, for Sohn-Rethel, is objectively rooted in "the realities of capitalism"[90]. Rather than 'sublating' the problematic in the tradition of Hegel, and rather than discarding and vilifying it in the tradition of the Diamat, Sohn-Rethel asks: what is the historical origin of our ability to construct mathematical hypotheses and the elements contributing to them? What is needed, according to the author, is the demonstration that abstract thought, while having the form of thought, does not originate out of thought, but out of a socio-historical act which, though abstract, constitutes a real abstraction (Realabstraktion) by virtue of being a spatio-temporal occurence. For Sohn-Rethel, only one

person has ever affirmed the possibility of such a real abstraction, and this is Marx, to whose analysis of the commodity Sohn-Rethel turns his enquiry.

Whereas Marx, in his critique of political economy, begins with the two-fold nature of the commodity (use-value and exchange value), Sohn-Rethel, pursuing the critique of epistemology, concentrates on the corresponding polar activities: use and exchange. If the social synthesis of the commodity producing societies is carried by exchange, then exchange should, to satisfy Sohn-Rethel's methodological premise, also constitute the real abstraction sought after. This is indeed the case: the act of exchange, the abstraction from all use, provides a form of equation (Gleichung) that "abstracts quantity in a manner which constitutes the foundation of free mathematical reasoning"[91]. Paradoxically, however, this abstractness of the action is not reflected in the actor's minds, which, on the contrary, remain occupied with the use-value to be acquired: "the action is social, the minds are private"[92]. True, the abstraction does achieve 'representation' in coined money, but (in line with the fetishism of the value form as a whole) this 'representation' is 'disguised as a thing' and is thus not recognisable in its 'true identity as abstract form'.

However, Sohn-Rethel argues that the abstraction operative in exchange does achieve an 'identical' expression, namely the so-called 'pure understanding', the cognitive source of scientific knowledge. To illustrate this 'identity', he turns to ancient Greece and Ionia, which, as is often forgotten in philosophical discussion (George Thompson being a notable exception), achieved a 'Greek miracle' in

the secular sense of creating coined money, thereby generating the violent class struggles that posed radically new problems for the human mind to ponder. The long line of philosophers from Thales to Aristotle applied their intellectual genius not least to these very problems, but the most dazzling results of their labour took a form no less fetishistic than the money form itself; for example, Parmenides' 'the One' can be regarded as the first concept "fitting the description of the abstract material of money, but without any idea of what this concept stood for and what had prompted him to conceive it"[93]. In fact, what came into being was "the capacity of conceptual reasoning in terms of abstract universals, a capacity which established full intellectual independence from manual labour"[94].

Not only does Sohn-Rethel attempt to show how abstract thought is founded, logically and historically, on exchange, he also aims to explain this in terms of economic exploitation: "intellectual in seperation from manual labour arises as a means of the appropriation of products of labour by non-labourers"[95]. It is not the place here to summarise Sohn-Rethel's account of the changing relation of head and hand from ancient Egypt to the present. However, for our purpose it is relevant to grasp his argument regarding the specific relation of head and hand requisite to the capitalist mode of production. Whereas in ancient Egypt exploitation meant the non-labourer's appropriation of the product of labour of direct producers who were often their own masters as regarded the precise structure of the labour process, the rationale of capital valorisation is incompatible with a labour process based on the labourer's 'know-how' and autonomous manual expertise, and must, on the contrary, establish an "unambiguous division of head and hand in the production processes"[96].

For Sohn-Rethel, this is the ultimate significance of the mathematico-experimential method of Galileo and Newton: while manual labour is necessary both to set up the experiment and to carry out in the production process the operations to which the results are applied, the actual experiment itself is "safeguarded from any touch by human hand and made to register specific measurements which are then read as indicated by the instruments," which is only possible if, in direct opposition to the craftsmen skill, the phenomenon under investigation can be "torn out of the context in which it occurs"[97]. The mathematico-experimental method thus secures to capital "the possibility of a knowledge of nature from sources other than manual labour"[98]. And thereby it also secures a knowledge of production. However, having pointed to the class nature of natural science Sohn-Rethel now asserts its objective validity: "theoretical knowledge, i.e. knowledge bases on intellectual labour, has a class nature, although this does not prejudice its objective validity, i.e. a validity unsullied by its class connections"[99]. Natural science only has to rid itself from its 'false consciousness', that is it has to grasp its own historical and social origins.

The same reformist perspective is repeated in Sohn-Rethel's detailed discussion of Taylorism, which however marks him off as one of the few Marxists to have attempted a serious analysis of the modern production process. The analysis focuses on the attempt to reduce the various operations of the 'collective labour' to a uniform measure of time, the establishment and implementation of which presuppose, to quote Taylor, "taking the control of the machine shop out of the hands of the many workmen, and placing it completely in the hands of management"[100]. From Taylor's 'unit times', via Frank Gilbreth's

'synthetic timing', to Ford's 'flow production' is a momentous, but quite logical development. Sohn-Rethel's analysis shows how knowledge of production now rests firmly with science.

Important as this analysis is for an understanding of the capitalist production process, it gives rise in Sohn-Rethel's account to a far from unproblematic theory of the 'dialectic' of late capitalism: namely, the thesis of 'dual economics'. The thesis begins by delimiting post-1896 capitalism from the 'periods' presented in Capital: according to Sohn-Rethel, Marx analysed the period of manufacture, where the transformation of the mode of production takes labour-power as its starting-point, as well as the period of large-scale industry, where the instruments of labour are the starting-point, but he did not live to see and analyse what Sohn-Rethel regards as the 'third period', namely, monopoly capitalist flow production where, the author argues, "it is labour itself that forms the starting point"[101]. Despite the remarkably advanced 'extrapolations', particularly in the Grundrisse, Marx did not, in Sohn-Rethel's eyes, show "the implications carried by the external necessity of the continuity of the production process"[102], implications which constitute the heart of the concept of 'dual economics'. In matter of fact, had Sohn-Rethel read these 'extrapolations' more thoroughly, in particular the section on machinery in Capital, he might have recognised that Marx, as we shall see below, anticipated Taylorism in his analysis of the labour process, and would have identified twentieth century production as capitalism pure and simple and not as constituting some 'duality'.

However, the theory of 'dual economics' runs as follows: whereas laissez-faire capitalism was a market economy, uniformly resting on a commensuration of dead labour, 'monopoly capitalist flow production' confounds this with a Taylorist-Fordist commensuration of living labour, of "labour in action", the logic of the latter, a logic of production rather than appropriation (Sohn-Rethel believes that all class societies have been based on a logic of appropriation, while a logic of production will form the social nexus in communism) is, of course, subordinated to, and deformed by the primacy of capital valorisation; nonetheless, the irregressible duality in the mode of commensuration of labour (hence, 'dual economics') means that the modern labour process might "harbour potentialities which could assume a vital significance if society were no longer subservient to capitalism"[103]. The critique of political economy thus leads into a critique of 'scientific management': what masquerades as an 'objective, neutral science' is, in reality, the translation of the principles of the resocietisation of labour into the one-dimensional, fetishistic language of capital valorisation. Just as this fetishism is "one of the particular ideological concerns, not only of the capitalist themselves but of the State"[104], so any adequate socialist strategy must include the transitional struggle of the resocietised labour force to itself become 'the societising force': only as such can it "bring about the unity of head and hand that will implement a classless society"[105]. Such a strategy, far from being an abstract demand 'from without', is in fact objectively prepared by the development of capitalist exploitation: the fetishism of capital has, at least according to Sohn-Rethel, "worn thin in a type of production where both labour and machinery assume compound structure"[106].

At the same time as giving him credit for his analysis of the modern labour process, the underlying reformism of his attitude to technology and natural science has not escaped Sohn-Rethel's critics. P.S. Taylor welcomes Sohn-Rethel's attempt at a critique of scientific management, but argues that Sohn-Rethel fails to carry out such a critique consistently: Sohn-Rethel identifies the establishment of unit times as the essential aspect of time and motion study, but views it as a scientific commensuration of labour not derived from the law of value, and thus carrying potentialities for socialism. Taylor, by contrast, argues that unit times do not surpass the law of value - labour time is the value standard of commodity exchange. The programme of a scientific measure of time and motion simply ends up in a vicious circle of empirical observations of workers, and management's attempt to replace worker's independent control of work speeded up by 'scientific' standards is an ideological cover for the attempt to intensify labour. Thus, Taylor argues, such 'work-study' is the principle of capitalist work organisation, and, cannot, as Sohn-Rethel would have it, be extended to the economy of human labour in general.

Another critic, Norbert Kapferer, also points to Sohn-Rethel's limitations: if workers take over science and technology for socialist purposes they simply take over their own oppression. To assume 'objective validity' for machine technology and natural science requires the a-historical perspective that Sohn-Rethel had aimed to challenge. A critique would not end up in affirmation were it based on Marx's critique of political economy; it would show how cognitive abstractions are translated into categories of social domination. The clearest illustration of natural scientific thought 'proving itself'

(as a 'real abstraction') under conditions of capitalist societation, is offered by the transcription of natural-scientific procedures into production technology, were 'pure scientific' understanding really comes into its own: the remote - control of nature (free from any interference by the human hand) as a self-activating process is the model of industrial production, as it is of the experimental method itself. Taylorism, for example, combines human material and technological construction by strictly scientific procedures, namely, by dissecting man into detailed mechanical parts so as to fit him into the machine system"[108]. Thus, with the 'transcription of natural-scientific procedures into production technology' science obtains the exclusive rights to the knowledge of production and thereby the knowledge of methods of exploitation and domination.

2. The Italian Enlightenment

The political break with scientism came in Italy. The official trade union and communist movement had been firmly integrated into the Italian state by the sixties and the revolutionary left moved onto struggles which defied any form of state socialism as well as factory production as forms of capitalism. Theoreticians like Raniero Panzieri, Mario Tronti and Toni Negri[109], influenced by this break from orthodoxy, read Capital and the Grundrisse in a new light. Volume II and III of Capital taught them the notion of social capital, and the part on machinery in Volume I was read not only in a historical, but also in a theoretical light, which illuminated that tendency which identifies machinery as capital rather than a neutral productive force.

Panzieri rejected the official labour movement's dichotomy between socialist planning and the anarchy of the market. Social capital, in Panzieri's understanding, is not anarchic, but planned at the social level as well as the plant level. Competition had only been a phase of capitalism; with credit as a mechanism of centralisation, capital had socialised itself. With capitalism's historical tendency to overcome competition we have experienced what Marx predicted long ago: "the abolition of capital as private property within the framework of capitalist production itself"[110].

The centralisation of capital is accompanied by the concentration of the means of production which requires an ever more sophisticated planning of production at the plant level:

> The capitalist objectivity of the productive mechanism with respect to the worker finds its optimal basis in the technical principle of the machine: the technically given speed, the coordination of the various phases and the uninterrupted flow of production are imposed on the will of the workers as a 'scientific' necessity, ...[111]

Scientific development is given its imperative by the rationalisation of the production process. Machinery is capital's ally in its dominance over labour power and the extraction of surplus-value. Capital's authority finds an accomplice in the process of industrialisation. Panzieri links the process of capitalist planning on the social level to the despotism of capitalist planning on the shop floor. Capital has to exercise absolute control over production which it achieves through scientific 'rationality'. The political

lesson seems obvious:

> Faced by capital's interweaving of technology and power, the prospect of an alternative (working class) use of machinery can clearly not be based on a pure and simple over-turning of the relations of production (of property), where these are understood as a sheathing that is destined to fall away at a certain level of productive expansion simply because it has become too small. The relation of production are within the productive forces, and these have been 'moulded' by capital[112].

Productive forces are not objective and neutral, they are shaped by capitalist social relations. In addition, capital's control grows with the development of scientific rationality. Reminiscent of Marcuse's 'one-dimensionality', Panzieri sees the technological apparatus as capitalist despotism, involving ever more sophisticated forms of integration:

> There exists no 'objective', occult factor, inherent in the characteristics of technological development or planning in the capitalist society of today, which can guarantee the 'automatic' transformation or 'necessary' overthrow of existing relations. The new 'technical bases' progressively attained in production provide capitalism with new possibilities for the consolidation of its power. This does not mean, of course, that the possibilities for overthrowing the system do not increase at the same time. But these possibilities coincide with the wholly

> subversive character which working-class 'insubordination' tends to assume in face of the increasingly independent 'objective framework' of the capitalist mechanism[113].

Thus, revolutionary working class action recognises the despotism of technological rationality and fights against it at all levels. It denounces a trade-unionistic collaboration with capital and fights against capitalist development.

It was Mario Tronti who further articulated this perspective, linking revolutionary action and the analysis of technology: for him factory production is the specific mode of production of social capital. Labour power is not only exploited via the extraction of surplus-value, it is fully integrated into capital. The working class is organised by capital, that is social, collective capital organises the total process of production. Hence, the resulting class-strategy takes the form of the fight against labour. In order to oppose capital fully, the working class has to understand itself as part of capital and fight against itself in as far as it is capital. The collective worker is not only opposed to machinery as constant capital, but against labour power as variable capital. Labour equals exploitation, thus the strategy becomes the refusal of labour, the refusal of labour power to labour, the fight of the worker against her/himself as a labourer. The working class undertakes an active, collective, political, organised refusal of labour, which, at the same time, will mean the destruction of capital. This refusal of the working class to reproduce itself in the value-form will put a stop to capital's valorisation process. Total capital, including labour power as variable capital, has to be opposed as the enemy; the reproduction

of labour power in the commodity form has to be resisted.

Working class opposition to capitalist production does not make redundant the revolutionary seizure of state power. However, any political struggle which only happens outside the factory gates, which only directs itself against the representatives of the bourgeois state without taking into account the relations of production, is doomed from the start[114]. Capital has to be dissolved within the production process as a prerequisite to the smashing of the state. The bourgeois state machine has to be destroyed within the factory as well as outside.

Toni Negri developed this analysis further in his article "Capitalist Domination and Working Class Sabotage"[115], stressing the need for working class autonomy. Autonomous struggles rather than the integration into institutionalised forms of the labour movement are on the agenda now. The needs and desires of workers, or working class self-valorisation (a somewhat unfortunate term) is the first and foremost aim of working class struggle - not the needs of capital, the nation, the development of growth, etc. The realisation of the needs of the working class requires first of all the de-structuration of capital, the sabotage of the total of the capitalist machine. The working class cannot become a reformist ally in the accumulation process of capital, its needs have to be asserted against capital, against the productive forces of capital which are designed to break working class resistance:

> Through the application of advanced automation and the control system that is made available, capital puts itself

> in a position where it was able to organise social labour power, to put into effect its project of command via its capacity to articulate, hierarchise, and by whatever means remove or obstruct the possibilities of a recomposition of the class as a base for revolutionary organisation[116].

Working class struggle has to direct itself against this. The refusal of work through sabotage, strikes, direct action meets capital's attempt to break working class opposition through the implementation of automation technology. The refusal of work becomes a moment of the process of self-valorisation. To refuse to be incorporated into the capitalist production process is a transition to self-valorisation, or self-realisation, which is:

> the complete liberation of living labour within production and reproduction; it is the total utilisation of wealth at the service of collective freedom[117].

Here, revolutionary politics and the analysis of science and technology are beginning to fuse.

3. The Radical Science Movement

The consensus on the question of natural science is gradually being broken. The Italians have produced promising analyses, and in Britain things have been moving too. Although the official labour movement and the sectarian left still pay lipservice to orthodoxy,

sparks of light can be seen, critical perspectives are emerging. The last 50 years has even seen a development in attitudes towards natural science amongst radical scientists. Like their Italian comrades, revolutionaries in Britain in the sixties and seventies broke away from orthodox political conceptions of party organisation and leadership and moved towards a rank and file politics, subjecting all aspects of life and work under capitalism to revolutionary critiques, and towards a concern with politicisation at all levels, amongst all sections in the work force including the scientific worker. With the move to a new political practice radical scientists have gradually moved away from scientism.

The year 1981 saw the 50th anniversary of 'Science at the Crossroads', an International Congress of the History of Science and Technology held in London by radical scientists who questioned the social implications of science. The conference boasted names like Bukharin, Hessen, Bernal, Needham, etc. These people formed the Social Relations of Science Movement[118]. They challenged the established scientific elite which conceived of science as a pure pursuit of intellect with no connection to social and economic phenomena. Science for the first time was linked to society, in particular capitalist society. Boris Hessen gave Newton's Principia social and economic roots, claiming that science had developed out of production[116]. Perhaps a platitude today, but a most radical perspective in 1931. However, although the capitalist use of science was challenged, science itself was sacred and the first command for a socialist scientist was to be a good scientist. Bernal's subsequent The Social Function of Science was totally affirmative of science and technology, the use of which, he claimed, was for the welfare of human

beings. Science was holding out possibilities which, however, would only be realised under communism. Full social use of science can only be achieved when the working class controls production. Science is seen as a progressive force, a chief agent of change in society. The most progressive of the scientists in the 1930s was probably Joseph Needham who has since been occupied with the history of science and technology in Chinese civilisation. Fifty years after the Congress he writes:

> ... it might well be that the understanding of why modern science developed only in the European context could be elucidated by a careful study of the Asian civilisation in which it did not arise. We see the European changes as a kind of package deal, in which the rise of modern science was associated also with the rise of capitalism, ...[120]

The scientists of the 1930s were, however, not so much concerned with the origins of natural science as with its abuse by capitalism. As a socialist one had to be a good scientist, but also a responsible one. This attitude was picked up again in 1969 when the British Society for the Social Responsibility of Science (BSSRS) was founded. As the name implies, it is an organisation concerned with the responsibility of scientists. The aim was, firstly, to question the activity of scientists and to awaken the consciousness of people practising science. Secondly, to question the nature of research and, thirdly, to provide information on questions of science and its application, in particular on the hazards of science. Members thought of themselves as scientists who had a responsibility to the public to counteract the abuses of science in deed and speech. The Society

publishes the journal Science For People, is linked to the Radical Statistics group, the Politics of Health group and the Radical Science Journal collective, and had prominent supporters such as Ayer, Bernal and Russell. Unlike the 1930s scientists who all saw themselves as Marxists (crude though they were), BSRS encompasses a variety of political tendencies - social democrats, Marxists, liberals, very much to the frustration of two of its founder members, Hilary and Steven Rose, who wanted to give it a much more Marxist orientation.

The Roses, however, although critical of the movement's a-political attitude, land up in a contradiction: on the one hand, they claim, human perception is not absolute, but socially modified, while, on the other hand, "neither under socialism nor under capitalism should the individual 'fact' accumulated by science be different"[121]. The halo of science is only fading, in their eyes, when science is infiltrated by 'pseudo-science'. Science is only questioned for possible non-scientific content, such as the racist IQism of Eysenck or Wilson's sociobiology. Revolutionary scientists have to counterpose and attack such theories as reactionary, as pseudo-science. Real science is counterposed to ideology, truth to falsity, objectivity to subjectivity. Scared to see their own scientific practice as a reflection of their politics they lay claims to objectivity and neutrality and see their tasks as revolutionaries to counterpose the infiltration of ideology into science. Anyone who dares to see science itself as ideological is classified as an enemy of radical science[122].

The Radical Science Journal collective is one such enemy. The collective was formed in 1971 and a later editorial explains their

intentions:

> We set out to examine critically the meaning, in the class struggle, of the status of scientific knowledge and the role of science, technology and medicine, their rationality and their experts[123].

Science is now seen as ideological, as a social relation, a specific social practice, and, lately, as a labour process. A perspective which, of course, soon came under attack by those who draw a distinction between science and ideology, who see ideology as distortion, untruth, and false consciousness. For them ideology is by definition bourgeois, i.e. a distorted account of reality which hides the exploitative class nature of capitalism. The RSJ collective, however, does not adhere to this view, but, following Marx's thesis that it is social being which determines consciousness, they dismiss the notions of neutrality, truth, objectivity and see science itself as ideological. Science is not objective, true, neutral; it is a social relation within the social relation of capitalism. Science is production and in this production process there is a social relation of hierarchies, structures, rules, practices which remind of the social relations of capitalism in general. Science is constituted by social relations, the social relations of capitalism. Understanding of nature, concepts, methods, choice of research, etc., is socially constructed by the class forces of capital:

> Truth, then, is a practical construct of human labour. The search for particular units of matter and the effort to build apparatuses whose movements of electrons make this or

> that current or this or that molecule is an effort to embody particular values in the service of particular social relations. Nature is framed: we have no access to it in a primordial state of innocence[124].

The political strategy following this analysis certainly proves more useful than orthodoxy's. The RSJ proposes intervention at the process of origination of scientific work, and in the social relations of science with all its hierarchical structures, inbuilt elitism, racism, sexism, etc., and thereby challenge capital's control over knowledge production:

> Contestation on the terrain of control over the labour process and the origination of new technologies becomes an urgent political priority. It is in the process of origination that capital's structuring of social relations gets built into the technology[125].

Science and technology have always been part of the restructuring of capital. Thus, intervention is required at the point of origination.

The RSJ collective has brought us back to Marx's thesis that it is social being that determines consciousness. As one member points out, the point in question is not peoples' place in nature, but nature's place in people[126]. This equally applies to natural science. However, the 'Marxist' theorisations which see natural science in a different light find some legitimation in Marx himself. Marx was sufficiently ambiguous on the subject to allow for scientism that has marked the Marxist (and labour) movement ever since his death. The

attempts by some theoreticians to break the chains of scientism were left in a rudimentary state or else, as with Lukacs, consciously cut short by subservience to Moscow. In line with Lukacs' analysis of natural science in relation to the value-form and the production process, the following chapters return to Marx himself, and, while first looking at his more philosophical notion of natural science, lay emphasis on the critical tendency in Capital and the Grundrisse, relating natural science to the concepts of value, the commodity-form, and, in particular, to capital.

CHAPTER 3

NATURAL SCIENCE AS A FORM OF CONSCIOUSNESS

In the Communist Manifesto Marx and Engels identify the bourgeoisie as a class which aims to create a world after its own image and which compels all nations to adopt the bourgeois mode of production. This includes, of course, its mode of thought and conceptualisation. Science and technology is implanted into the 'Third World' (irrespective of the country's own culture) with the claim to absolute proprietorship to objective truth and know-how. The social forms springing from the capitalist mode of production and form of property are universalised and transformed into eternal laws of nature and reason. Marx and Engels call this the 'illusions of an epoch': "Whilst in ordinary life every shopkeeper is very well able to distinguish between what someone professes to be and what he really is, our historiography has not yet won this trivial insight. It takes every epoch at its word and believes that everything it says and imagines about itself is true"[1]. Natural science is no exception. Rather than seeing natural science as bound to a particular epoch the illusion is created that 'everything it says and imagines about itself is true'.

For Marx, the ideas of the ruling class are in every epoch the ruling ideas, i.e. the class which is the ruling material force of society is at the same time its ruling intellectual force. The class which has the means of material production at its disposal, has control at the same time over the means of mental production. The ruling class

is the producer of the ideas of its age. In order to ensure the continuation of its existence as a ruling class it has to give its ideas the form of universality, and represents them on the only rational and valid ones. Natural science does not escape this process; it is but one of the 'illusions of an epoch'. The illusion is created that natural science is uncontaminated by particular interests, detached from the ruling force of society and can thus appear as a neutral, productive force working to the benefit of society as a whole. While in reality the ruling class controls the intellectual production as a result of their control and ownership over the means of material production. In order to maintain this ownership and control the ruling class can only allow the production of ideas which do not provide a challenge to their position; ideas which are then passed on as universally valid and devoid of sectional interests. Natural science, working in the interest of the ruling class, is given universal validity and is thus turned into an 'illusion of an epoch'. What Marx says about human nature can equally be applied to natural science:

> Smith and Ricardo still stand with both feet on the shoulders of the eighteenth-century prophets, in whose imaginations this eighteenth-century individual - the product on one side of the dissolution of the feudal forms of society, on the other side of the new forces of production developed since the sixteenth century - appears as an ideal, whose existence they project into the past. Not as a historic result but as a history's point of departure. As the Natural Individual appropriate to their notion of human nature, not arising historically, but

> posited by nature. This illusion has been common to each new epoch to this day.

Recourse to nature to prove the validity of any theory has been the habit of most spokespeople of a particular ruling class since the inception of history, be it economist proving the economic system to be universally true or natural scientists eternalising their understanding of nature.

In the Communist Manifesto, the bourgeoisie is identified as the class which owns the means of social production. The latter are developed by and for the bourgeoisie as a means for the exploitation of wage-labour. An oppressed class under the domination of the feudal nobility the bourgeoisie succeeded to put an end to all feudal relations and with it religious explanations of natural phenomena, replacing the latter with secular natural science.

> When Christian ideas succumbed in the 18th Century to rationalist ideas, feudal society fought its death battle with the then revolutionary bourgeoisie. The ideas of religious liberty and freedom of conscience merely gave expression to the sway of free competition within the domain of knowledge[3].

In its struggle against the feudal lords, and for the subjection of the working class under its domination, the bourgeoisie has revolutionised the instruments of production. Unlike the feudal organisation, which has developed production very slowly, the bourgeoisie has created a 'colossal productive force': "Subjection of

Nature's forces to man, machinery, application of chemistry to industry and agriculture, steam navigation, railways, electric telegraphs, ..."[4] The feudal system foundered on all these inventions, and developments in natural science undermined and dissolved the old feudal communities. The bourgeoisie had created a new social relation, "for exploitation, veiled by religious and political illusions, it has substituted naked, shameless, direct, brutal exploitation"[5]. In feudal times illusions of a religious and political nature were created by the class in power to justify their rule and to provide a veil for exploitation. The 'naked, shameless, direct, brutal exploitation' which followed soon found its ideologists. Exploitation now was undertaken in the name of progress. Developments in production required the development of science and technology, and its progress, seemingly benefitting society as a whole, veiled the reality of the exploitation of the working class. Natural science was made to look like a neutral productive force uncontaminated by vulgar interests. The 'competition within the domain of knowledge' also took place within natural science. Different 'scientific' explanations of the natural world were advanced and those which were useful to the class in power were maintained and accepted as universal truths. Thus, natural science developed as an 'illusion of an epoch' created by class interests.

A communistically organised society will, of course, call forth knowledge not marked by class-interest. The social relations of communism will still determine peoples' consciousness, concepts, ideas, etc. However, this would be a conscious process, one of which the individual is aware; not an unconscious one as in precommunist societies where the determining processes happen 'behind the backs'

of individuals and thereby one which creates 'illusions':

> The reality which communism creates is precisely the true basis for rendering it impossible that anything should exist independently of individuals, insofar as reality is nevertheless only a product of the preceeding intercourse of individuals[6]. (my emphasis)

Natural science posits laws of nature as existing independently of us, while for Marx nature is always socially mediated. A fetishistic conception of nature, which treats natural science as a thing rather than as part of a social relation, will not be possible in communism:

> Communism differs from all previous movements in that it overturns the basis of all earlier relations of production and intercourse, and for the first time consciously treats all naturally evolved premises as the creation of hitherto existing men[7].

This, of course, includes our knowledge of nature, which like every knowledge, will be treated as a creation of people and will thereby lose its illusory character. Associated producers will consciously organise their lives; socialised people will regulate their social relations as well as their relation to nature in a transparent manner. Communism will be the "genuine resolution of the conflict between man and nature and between man and man"[8].

Marx's most famous statements on natural science are to be found in the Paris Manuscripts and the German Ideology. In both texts he

advocates the inseparability of nature and people:

> Natural science will in time incorporate into itself the science of man, just as the science of man will incorporate into itself natural science: there will be one science ... Man is the immediate object of natural science ... But nature is the immediate object of the science of man ... The social reality of nature and human natural science, or the natural science of man, are identical terms[9].

Thus, nature cannot be separated from human beings. When explaining their materialist conception of history Marx and Engels repeat the same point:

> We know only a single science, the science of history. One can look at history from two sides and divide it into the history of nature and the history of men. The two sides are, however, inseparable; the history of nature and the history of men are dependent on each other so long as men exist[10].

To look at nature in isolation from human beings and their social and historical relations is meaningless. That is not to say that nature does not exist independently of people and their social relations; however, our knowledge of it is always socially mediated.

Attacking the notion of pure science, Marx claims that natural science receives its aim through trade and industry and can therefore not lay claims to neutrality. In the 1844 Manuscripts he had already

pointed to the link between natural science and industry: "Industry is the actual, historical relationship of nature, and therefore of natural science, to man"[11]. Here, Marx's enthusiasm for natural science turns into ambivalence:

> ... natural science has invaded and transformed human life all the more practically through the medium of industry; and has prepared human emancipation, although its immediate effect had to be the furthering of the dehumanisation of man[12].

Large-scale industry has made 'natural science subservient to capital' and in Capital Marx is to go to great pains to describe this dehumanising effect of the application of natural science in industry. In 1844 however, he is still positive: "The natural sciences have developed an enormous activity and have accumulated an ever-growing mass of material"[13]. This development is welcomed by Marx given a certain proviso:

> ... natural science will lose its abstractly material - or rather, its idealistic - tendency, and will become the basis of human science, as it has already become - albeit in an estranged form - the basis of actual human life, and to assume one basis for life and a different basis for science is as a matter of course a lie[14].

Here, we can see a move towards a position subsequently to be developed in the German Ideology (and later in Capital): the inseparability of human life and science. Human life, for Marx, is confined to specific, historical social relations, which, given the inseparability of the

two, applies also to science. Marx's materialist conception of history locates his object of analysis within specific relations of production:

> ... the real process of production - starting from the material production of life itself - and comprehending the form of intercourse connected with and created by this mode of production, i.e., civil society in its various stages, as the basis of all history; describing it in its action as the state, and also explaining how all the different theoretical products and forms of consciousness, religion, philosophy, morality, etc., etc., arise from it, and tracing the process of their formation from that basis ...[15]

The German Ideology contains the materialist conception of history with the basic premise 'social being determines consciousness'. In this text Marx and Engels explain how knowledge is produced, an explanation which can also be applied to the production of our knowledge of nature.

1. The Production of Knowledge

Marx sees the formation of ideas, including any form of knowledge as a result of material practice. Practice forms the basis of all cognition. Human beings create all forms of thought on the basis of their material practice, although as we explained above, they are

often not conscious of this.

> They, the creators, have bowed down before their creations. Let us liberate them from the chimeras, the ideas, dogmas, imaginary beings under the yoke of which they are pining away.[16]

Natural science can also be seen as such a creation, created by people who have turned it into a dogma, a truth independent of them. The task is to see natural science as a creation of people rather than an objective truth. Any critique has to be constructed in this light, including a critique of science. Such a critique will identify the specific historical and material conditions in which natural science has developed, that is, the conditions of capitalist social relations. This, of course, is not to deny the existence of natural phenomena, but our knowledge of natural phenomena has to be seen as socially mediated. Marx's analysis of the production of knowledge can equally be applied to the production of our knowledge of nature which is thereby placed within specific social relations.

The premises from which Marx begins are "real individuals, their activity and the material conditions of their life, both those which they find already existing and those produced by their activity"[17]. Existing material conditions are worked upon and changed by people, who, at the same time as they are reproducing and producing their material conditions, produce a knowledge of those conditions:

> The production of ideas, of conceptions, of consciousness is at first directly interwoven with the material activity

> and the material intercourse of men - the language of real life[18].

Thus ideas, conceptions have a material basis. Mental production like monolity, religion, philosophy, or natural science is firmly rooted within real life:

> Morality, religion, metaphysics, and all the rest of ideology as well as the forms of consciousness corresponding to these, thus no longer retain the semblance of independence. They have no history, no development; but men, developing their material production and their material intercourse, alter, along with this their actual world, also their thinking and the products of their thinking. It is not consciousness that determines life, but life that determines consciousness[19].

Ideas have no independent development, no existence in isolation, but their actual development is bound up with the material intercourse of people.

Already in the Introduction to a Contribution to a Critique of Hegel's Philosophy of Right Marx stresses that legal and political forms are not based on the human mind, but like religion, are a result of material conditions. Like legal and political institutions, all institutions are the creation of people, but people living under specific material conditions: "man is no abstract being encamped outside the world. Man is the world of man, the state, society"[20]. Just as religion, the state, etc., are the result of a specific social formation, so is people's consciousness, including their consciousness

of the world around them. In this text we find Marx's famous remark on religion: "It is the opium of the people"[22]. Influenced by Bauer and Feuerbach, Marx saw the need to criticise religion, but went beyond this influence in his critique of the specific conditions and social relations which gave rise to and maintain the need for religion. Not only religion, but all theory, forms of consciousness, philosophy, etc., are traced to their origin within specific social relations:

> ... from the specific form of material production arises in the first place a specific structure of society, in the second place a specific relation of men to nature. Their State and their spiritual outlook is determined by both. Therefore also the kind of their spiritual production[23].

Production of material life is at the same time production of ideas, conceptions, politics, law, morality, religion, metaphysics. In the famous section in the German Ideology, "The Materialist Conception of History", natural science is not mentioned. However, it is cited under the heading "Forms of Social Consciousness"[24] which shows that Marx conceives of natural science as a social phenomenon: a specific form of consciousness related to a specific social reality. Natural science is inextricably bound up with the social relations which gave rise to it. Forms of consciousness, categories of thought, etc., are not autonomous[25], but are dependent on social and material conditions. Natural science is not independent from these conditions, but is closely linked to the material life process. Thus, Marx explains the formation of ideas from material, that is social practice. We find the centrality and importance of the concept practice expressively stated in the "Theses on Feuerbach", where Marx

criticises the static materialism of Feuerbach which does not include "practical-critical activity"[26]. Feuerbach's materialism is merely contemplative. Philosophers, Marx complains, only interpret, they do not see the active element in human beings who create, not contemplate, the world they live in: "The philosophers have only interpreted the world in various ways; the point is to change it"[27].

Feuerbach abstracts from the historical process and thereby is able to posit an abstract, a-historical 'essence' of people, while for Marx, the 'essence' of people is directly linked to history. Feuerbach analyses not the social, but the 'abstract individual'; Marx locates individuals as well as their spiritual production within particular forms of society:

> In order to examine the connection between spiritual production and material production it is above all necessary to grasp the latter itself not as a general category but in definite historical form ... If material production itself is not conceived in its specific historical form, it is impossible to understand what is specific in the spiritual production corresponding to it and the reciprocal influence of one on the other[28].

All forms of spiritual and intellectual production, be it religion, philosophy, 'scientific' conepts, etc., find their point of origin within a specific historical set-up. Marx refers to 'religious sentiment' as a social product; the same goes for natural science, it is a result of social practice:

> The question whether objective truth can be attributed to human thinking is not a question of theory but is a practical question. Man must prove the truth, i.e. the reality and power, the this-worldliness of his thinking in practice. The dispute over the reality or non-reality of thinking which is isolated from practice is a purely scholastic question[29].

Objectivity is not seen as an absolute, but as a result of social practice. This applies also to the 'objectivity' of natural science: it does not relate to some 'eternal truth', but to its position within social practice. The practice of natural science is real, that is 'objective', but it is not objective in the sense of being neutral, given for all times. Natural science, arising from a social relation is itself a social and historical practice. A communist social practice would obviously differ from a social practice within capitalist relations.

Marx's criticism of Feuerbach, for whom materialism and history diverge, can still be applied today to a materialism that does not see conceptual thought as historical, but claims the objectivity of scientific method whereby the 'real' world and nature can be appropriated. Marx objects to the claims of a theory which offers to explain nature or the material world independently of social relations. He believes the question about analysis and investigation of 'being' independent and outside human beings to be the same as the question concerning the existence of god and the creation of men and nature. Marx considers the question itself a product of abstraction: "Ask yourself whether your question is not posed from a standpoint to

which I cannot reply, because it is wrongly put ... When you ask about the creation of nature and man, you are abstracting, in so doing, from man and nature"[30]. A concern with the study of an independently existing nature abstracts from the interplay between human beings and nature, it abstracts from history, it abstracts from specific social relations. If one does not abstract from these conditions the question does not arise as "for the socialist man the entire so-called history of the world is nothing but the creation of man"[31].

When placed within a reality created by human beings "a self-sufficient philosophy (die selbstständige Philosophie) loses its medium of existence"[32]. Any notion of philosophy, or natural science, independent from the real process of material life is made redundant. Abstractions "divorced from real history, have no value whatsoever"[33]. Attacking Feuerbach, Marx claims that even 'sensuous certainty' has a historical dimension:

> He does not see that the sensuous world around him is not a thing given direct from all eternity, remaining ever the same, but the product of industry and of the state of society; and, indeed (a product) in the sense that it is an historical product, ...[34]

Marx points out that a cherry-tree (like almost all fruit-trees), which is a 'sensuous certainty' for Feuerbach, has only become such by being transplanted into the northern zone through commerce a few centuries ago. So what becomes 'natural' is a result of the actions of a specific society in a specific age. (Perhaps Newton's law of

gravity only exists as a result of the plantation of the apple-tree, although, no doubt, fruit has fallen off trees long before Newton's mythical ponderation under the apple-tree!). For Marx, nature that preceded human history no longer exists. People have changed nature through their interaction. Nature is not in pristine condition but is tampered with by people engaging in their material intercourse. Therefore, our 'sensuous certainty' as well as our 'intellectual certainty' of nature changes with the changes taking place in everyday life processes. Marx, although considering Feuerbach a cut above other materialists, complains that he "conceives of men not in their given social connection, not under their existing conditions of life, which have made them what they are". Feuerbach's abstract conception of 'man' in isolation from history and social relations is counterposed with people within social relations whose knowledge of nature is dependent precisely on those relations.

The materialist conception of history has as its starting point 'definite social and political relations'. Thereby Marx diverges from idealism as well as all other forms of materialism. Feuerbach's 'naive' materialism is challenged as well as the mechanical materialism of the French Enlightenment and the crude materialism of Vogt, Büchner and Moleschott in which natural necessity is all-determinant for human behaviour. Marx's central thesis, 'social being determines consciousness', anticipates a critique of Lenin's materialism in which matter becomes the central category. For Marx, however, as Mike Hales puts it, "the material is the social"[36], and the 'social' takes on specific forms:

> ... the capitalist process of production proceeds under definite material conditions, which are, however, simultaneously the bearers of definite social relations entered into by individuals in the process of reproducing their life[37].

Natural science is not exempt from this, it is part of a definite social relation which posits a specific relation to nature:

> ... the aggregate of these relations, in which the agents of this production stand with respect to Nature and to one another, and in which they produce, is precisely society, ...[38]

The 'aggregate of these relations' is not static; it is changed by revolutionary practice. As Marx claims again in the Eighteenth Brumaire, people are born into given circumstances, but these in turn can be changed. Material production and intercourse are altered by people and along with their material and social existence they alter their thinking and the products of their thinking. According to the 'historical materialist conception' it is the social relations which determine consciousness, modes of thought and the manner whereby knowledge of nature is obtained. Marx warns that:

> if material production itself is not conceived in its specific historical form, it is impossible to understand what is specific in the spiritual production corresponding to it and the reciprocal influence of one on the other[39].

Intellectual production is always specific, corresponding to material production and in turn having an influence on it. Knowledge is produced by material relations but will in turn have an influence on the latter. Accordingly, a particular knowledge of nature relates to a particular social relation, but will also have an effect on the latter as we shall see in the following chapters.

2. The Class-Interest of Knowledge Production

If material production is not conceived historically, as by Classical Political Economy, the intellectual production of a social formation cannot be grasped in its definite historical form, and nor can the basis be understood on which class ideology rests. And Marx infatically points to the class interest of intellectual production:

> The ideas of the ruling class are in every epoch the ruling ideas, i.e. the class which is the ruling material force of society is at the same time its ruling intellectual force. The class which has the means of material production at its disposal, consequently also controls the means of mental production, so that the ideas of those who lack the means of mental production are on the whole subject to it[40].

The ideas of the ruling class become the ruling ideas, expressing the dominant material relations of a time, The ruling class does not only rule materially but becomes producer of ideas and their ideas

become the ruling ideas of their epoch. As a class the rulers rule also as thinkers, regulating "the production and distribution of the ideas of their age"[41]. These dominant ideas, however, are not presented as ideas possessing a class-character, but as eternal laws, referred to above as the 'illusion of an epoch'. This includes the 'eternal laws' of natural science. Laws which are identified as natural while in reality they are the result of the material relations of production of a specific historical period, and therefore have a class-character.

No independent existence can be attributed to the ideas of the ruling class, they cannot be seperated from that class. One cannot even confine oneself to an understanding of these ideas as dominant at a given time, but has to take into account the specific conditions of production as well as the producers of the dominant ideas. Otherwise the dangers of universality will blur the class-character of those ideas:

> For each new class which puts itself in the place of one ruling before it is compelled, merely in order to carry through its aims, to present its interest as the common interest of all the members of society, that is, expressed in ideal form: it has to give its ideas the form of universality, and presentthem as the only rational, universally valid ones[42].

Only by presenting ideas as rational and universally valid will they obtain any credibility and become a 'knowledge' which is presented as generally accepted and not as pertaining to a particular class.

Thereby the class who generated that particular knowledge validates itself and shades the class-nature of its social formation:

> Once the ruling ideas have been separated from the ruling individuals and, above all, from the relations which result from a given stage of the mode of production, and in the way the conclusion has been reached that history is always under the sway of ideas, it is very easy to abstract from these various ideas "the Idea", the thought, etc., as the dominant force in history ...[43]

Marx, in this implicit attack on Hegel who thought the "Idea" to be the driving force in history rather than the struggle between classes, posits ideas as the result of this struggle and the material relations the opposing classes in a social formation inter into. This situation where class-rule appears as the rule of ideas while in reality these ideas embody a class-character will only be superseded when class-society itself will have disappeared:

> This whole appearance, that the rule of a certain class is only the rule of certain ideas, comes to a natural end, of course, as soon as class rule in general ceases to be the form in which society is organised, that is to say, as soon as it is no longer necessary to represent a particular interest as general or the 'general interest' as ruling[44].

But as long as class-rule persists will the class-structure of society influence the formation of consciousness, the dominating

consciousness will remain the consciousness of the ruling class. And the ideas of the spokespersons of the ruling class are of course readily accepted by those who are in support of the class system: in capitalism

> ... it is a matter of course, that Political Economy, acting in the interst of the capitalist class, has not failed to exploit the doctrine of Adam Smith, viz., that the whole of that part of the surplus-product which is converted into capital, is consumed by the working-class[45].

Adam Smith was clearly a spokesperson of the capitalist class, his economic theory clearly represented the ruling interests. However, his appeal to scientificity for economic analysis was to give his findings general acceptance. Smith believed the science of economics was to discover universally valid laws of human conduct, including economic conduct. Just as he believed in universally valid laws governing the universe so did he believe in universally valid laws governing economic behaviour. All the 'scientist' had to do was to discover precisely those laws. Smith went as far as justifying the market system by a 'scientific' analysis of human nature. The triad self-love and sympathy for others, the desire to be free and a sense of property, to produce and the natural propensity to truck, barter and exchange, shows an unchanging human nature on which rests the inevitable capitalist economy in which the market, acting like an invisible hand, coordinates the self- interested actions of individuals to the benefit of the common good. In this way, by his appeal to natural, unchanging laws, Smith has provided a 'scientific' explanation of capitalism, which, being based on human nature, is here to stay.

As the above quote indicates, Adam Smith also suffered from another scientific 'illusion', namely that all of the surplus product is converted into wages which, of course, clouds the reality of exploitation. Classical Political Economy dutifully protecting ruling class interests inherited from him the dogma that the price of commodities resolves itself into wages, profit and rent, thus providing a justification for the latter two revenues and their recipients. The whole 'abstinence theory', which holds that the capitalist class receives a revenue as a reward for abstaining from immediate consumption, serves as a justification for bourgeois rule. The bourgeoisie had to abstain from consumption so that capital, and thereby the wealth of society, could accumulate:

> Accumulation for accumulation's sake, production for production's sake: by this formula classical economy expressed the historical mission of the bourgeiosie ...[46]

Although the proletarian was seen to produce, it was the capitalist who had the important mission to reinvest and thus accumulate capital. The capitalist was torn between the desire to be rich and immediate enjoyment: "Two souls, alas, do dwell within his breast. The one is ever parting from the other"[47].

This conflict, according to Marx, was resolved by the parson Malthus by advocating "a division of labour, which assigns to the capitalist actually engaged in production, the business of accumulating, and to the other shares in surplus-value, to the landlords, the

place-men, the beneficed clergy, &c., the business of spending"[48]. Hereby Marx shows how within the spokespeople of the ruling class different ideas emerge according to their own economic position. Ricardo, spokesperson for productive capital, sees the landowners as a parasitic lot and emphasises the importance of the capitalist class who, through new investment will expand industry and capital. Invoking Say's law of 'supply creates its own demand' he claims that if a supply of a particular good should not be matched by sufficient demand, production will be shifted to other types of goods which will then be consumed, and the expanding industry will absorb the ever increasing population which will in turn consume the new products. In this way, capital accumulation is yet again given a 'scientific basis'. Not so for Malthus, who, coming from a different faction of the ruling class, fears that a glut of commodities will swamp the markets if the balance tips in favour of the industrialist class, and it has only been thanks to the non-producing landowning class that this glut of commodities has been prevented, thanks to their consumption.

> But Malthus! This wretch only draws such conclusions from the given scientific premises (which he invariably steals), as will be 'agreeable' (useful) to the aristocracy against the bourgeoisie and to both against the proletariat[49].

Knowledge production is not unanimous even within one particular class. Opposing interests within this class will lead to the production of different kinds of knowledge. Marx's comments on Malthus show how he views theory as connected to sectional class-interests:

> Already in his first work, one of the most remarkable literary examples of the successes of plagiarism at the cost of original work, had the practical purpose to provide 'economic' proof, in the interest of the existing English government and the landed aristocracy, that the tendency of the French Revolution and its adherents in England to perfect matters was utopian. In other words, it was a panegyric pamphlet for the existing conditions, against historical development and, furthermore, a justification of the war against revolutionary France[50].

Malthus tried very hard to protect the interest of the landowning class against the industrial bourgeoisie by advocating protective tariffs, rent and retrogressive steps in English legislation. His Principles of Political Economy were predominantly directed against Ricardo's defence of the industrialist class and had

> essentially the purpose of reducing the absolute demands of 'industrial capital' and the laws under which its productivity develops, to the 'desirable limits' 'favourable' to the existing interests of the landed aristocracy, the 'Established Church' (to which Malthus belonged), government pensioners and consumers of taxes[51].

Malthus is the classic example of the way theoretical production stems from and serves a particular class interest. He positions himself firmly within the ruling class vis-à-vis the working class, but when it comes to defend his personal interest as a parson he sides with the more reactionary elements of the ruling class:

> The parson Malthus ... reduces the worker to a beast of burden for the sake of production and even condemns him to death from starvation and to celibacy. But when these same demands of production curtail the landlord's 'rent' or threaten to encroach on the 'tithes' of the Establishment Church, or on the interests of the 'consumer of taxes', and also when that part of the industrial bourgeoisie whose interest stand in the way of progress is being sacrificed to that part which represents the advance of production - and therefore whenever it is a question of the interest of the aristocracy against the bourgeoisie or of the conservative and stagnant bourgeoisie against the progressive - in all these instances 'parson' Malthus does not sacrifice the particular interests to production but seeks, as far as he can, to sacrifice the demands of production to the particular interests of existing ruling classes or sections of classes[52].

Clearly, Malthus' theoretical production is marked by his alliance with the ruling class, in particular the most reactionary elements of this class of which he is a member, and by a condemnation of the oppressed. The poor are blamed for their poverty and are preached sexual constraint to solve the problem of a surplus labour force. Poverty, for him, exists as a result of a high level of breeding amongst the lower classes which leads to an overpopulation which in turn depresses wage-levels. Malthus' law of population appeals, yet again, to nature:

> It was, of course, far more convenient, and much more in conformity with the interests of the ruling classes, whom Malthus adored like a true priest, to explain this 'overpopulation' by the eternal laws of nature, rather than by the historical laws of capitalist production.

Rather than seeing 'over-population' as a result of the lengthening of the working day, the employment of women and children and the introduction of better and faster machinery, Malthus invents a natural law of over-population whereby the population would grow by geometrical progression while production would only grow by arithmetical progression. This could only be counteracted by a sexual constraint on the part of the lower classes who would only be induced to this constraint by lower wages, for higher wages lead to idleness and therefore to sexual indulgence.

The vulgarity of Malthus' arguments shows to what depth 'science' can sink when the defence of class-interest is on the agenda. Malthus' sole interest is to serve the interests of the ruling class, but he also acts as an example which shows that bourgeois interest acts as an unanimous monolith vis-à-vis proletarian interest, while it is not monolithic when it comes to fighting sectional interest. "On the one hand, if all members of the modern bourgeoisie have the same interests inasmuch as they form a class as against another class, they have opposite, antagonistic interests inasmuch as they stand face to face with one another"[54]. This opposition of interests arises from the very nature of capitalist production; the creation of bourgeois wealth takes place at the expense not only of the working class but also at individual members of the bourgeoisie whose wealth

is annihilated and who as a result are pushed into the ranks of the working class.

> The more the antagonistic character comes to light, the more the economists, the scientific representatives of bourgeois production, find themselves in conflict with their own theory; and different schools arise[55].

One of this school is the 'fatalist' school, including Smith and Ricardo. They worship the shrine of the accumulation of wealth on which the lives of the poor are sacrificed. The classics represent a bourgeoisie which struggles for industrial expansion, against all feudal vestiges. The proletarian, meanwhile, is given the consolation that any sufferings are only temporary. Economists like Adam Smith and David Ricardo, who

> are the historians of this epoch, have no other mission than that of showing how wealth is acquired in bourgeois production relations, of formulating these relations into categories, into laws, and of showing how superior these laws, these categories, are for the production of wealth to the laws and categories of feudal society. Poverty is in their eyes merely the pang which accompanies every childbirth, in nature as in industry[56].

Similarly, scientific advance is made at the expense of the poor, and scientists have the mission of formulating categories and laws, and of showing how superior these laws are to pre-scientific explanations of nature. Conflicting schools also arise within natural

science. Einstein replaced Newton, just like Marshall replaced Ricardo. Today, within bourgeois economics, neo-classisists, Keynesians and Moneterists fight their battle, while, as we have seen in Chapter 2, bourgeois theoreticians of natural science battle for the 'correct' interpretation of the methodology and nature of science.

Returning to the Eighteenth Century, Marx contrasts the 'fatalist' with the 'humanitarian' school

> which takes to heart the bad side of present-day production relations. It seeks, by way of easing its conscience, to palliate even if slightly the real contrast, it sincerely deplores the distress of the proletariat, the unbridled competition of the bourgeois among themselves, it councils the workers to be sober, to work hard and to have few children, it advices the bourgeois to put a judicious ardour into production[57].

This sounds like the use/abuse model. Capitalist production is alright as long as there is no abuse. Exactly as some radical scientists would argue for natural science, linking it to social relations only when 'abused' while otherwise attributing the status of neutrality.

3. The Metaphysics of Natural Science

It always has been the prerogative of the ruling-class aligned scientist to turn into eternal laws phenomena which are clearly a result of a particular social relation. Scientists "express the relations of bourgeois production, the division of labour, credit, money, etc., as fixed, immutable, eternal categories"[58]. The same applies to scientists who express their own understanding of nature as 'fixed, immutable, eternal categories'. What Marx describes as 'the metaphysics of Political Economy' can equally be said of 'the metaphysics of natural science':

> Economists explain how production takes place ..., but what they do not explain is how these relations themselves are produced, that is, the historical moment which gave them birth[59].

Marx criticises Proudhon for seeing these relations as mere principles, categories. "But the moment we cease to pursue the historical movement of production relations, of which the categories are but the theoretical expression, the moment we want to see in these categories no more than ideas, spontaneous thoughts, independent of real relations, we are forced to attribute the origin of these thoughts to the movement of pure reason"[60]. The metaphysics of natural science does exactly that. It views its categories as ideas, independent of social relations, as products of pure reason. Classical Political Economy assumed the economic organisation of capitalism to be eternal, immutable and intransient in the same way as Natural Science sees its practice as given, natural and unalterable. Marx's

comments on Hegel and Proudhon could equally be applied to natural science:

> All things being reduced to a logical category, and every moment, every act of production, to method, it follows naturally that every aggregate of products and production, of objects and of movements, can be reduced to applied metaphysics. What Hegel has done for religion, law, etc., M. Proudhon seeks to do for political economy[61].

Marx could have added: and the natural scientist seeks to do for natural science.

As we have shown above, for Marx knowledge is produced by people entering into definite social relation and forming ideas about these relations. If these relations are class relations than the produced knowledge will also have a class character, and the dominant knowledge will be that which favours the class in power. It is the ideological spokespersons of that class who face the task of hiding this class character by presenting any form of knowledge as universally valid, Proudhon being no exception:

> Economic categories are only the theoretical expressions, the abstractions of the social relations of production. M. Proudhon, holding things upside down like a true philosopher, sees in actual relations nothing but the incarnation of these principles, of these categories, which were slumbering - so M. Proudhon the philosopher tells us - in the bosom of the 'impersonal reason of humanity'[62].

Like a true philosopher, Proudhon gives priority to principles and categories over actual relation, although, Marx points out, he "understands very well that men make cloth, linen or silk materials in definite relations of production. But what he has not understood is that these definite social relations are just as much produced by men as linen, flax, etc."[63] And so are the categories which express those social relations:

> The same men who establish their social relations in conformity with their material productivity, produce also principles, ideas and categories, in conformity with their social relations. Thus these ideas, these categories, are as little eternal as the relations they express. They are historical and transitory products[64].

The principles, ideas and categories of natural science are no exception. It is not ideas which make history, but history makes ideas; it is not the law of gravity which made history, it is history which made the law of gravity. When we look at this particular law, or any other idea or principle and ask why they were prominent at a particular time, we have to take a close look at what people at that particular point in history were like, what type of social relations were prevalent, that is, people have to be seen as 'authors' and 'actors' of their own history. Doing this any 'eternal' principles will disappear and reappear as person-made. "But the moment you present men as the actors and authors of their own history, you arrive - by a detour - at the real starting point, because you have abandoned these eternal principles of which you spoke at the outset"[65]. There is no such thing as immutable laws,

eternal principles, ideal categories which have existed before the existence of acting people engaging in the making of history. Marx is being ironical when he 'concedes' to Proudhon "that these laws, principles and categories had, since the beginning of time, slumbered 'in the impersonal reason of humanity'"[66].

While economists like to take praise for the discovery of these laws which had, before their intellectual production, slumbered in this impersonal reason, they take all theories but their own as artificial:

> Economists have a singular method of procedure. There are only two kinds of institutions for them, artificial and natural. The institutions of feudalism are artificial institutions, those of the bourgeoisie are natural institutions. In this they resemble the theologians, who likewise establish two kinds of religion. Every religion which is not theirs is an invention of men, while their own is an emanation from God, when the economists say that present-day relations - the relations of bourgeois production - are natural, they imply that these are the relations in which wealth is created and productive forces developed in conformity with the laws of nature. These relations therefore are themselves natural laws independent of the influence of time. They are eternal laws which must always govern society[67].

Thus, to follow the logical conclusion, history no longer exists. The productive relations of capitalism are now seen as natural and

eternal, while history is banished to pre-capitalist formations like feudalism, the institutions of which are not seen as natural and eternal but as historical phenomena. The same argument can be adopted for natural scientists; they too have 'a singular method of procedure'. For them there are also artificial and natural institutions: the institutions of natural science is natural, while pre-scientific institutions or explanations of nature are artificial. Every explanation of nature which is not theirs is an invention of people, while their own emanates from nature. Their activity, their scientific practice is in conformity with the laws of nature while any pre-scientific understanding of nature is not. Accordingly natural science is seen to be based on 'natural laws independent of the influence of time'.

This eternalisation of categories is indicative of all metaphysics, and the metaphysician Proudhon who mascarades as a critique of bourgeois society "borrows from the economists the necessity of eternal relations"[68]. For example, he views the division of labour as an abstract, eternal category not taking into account the definite character of the division of labour in each historical epoch.

> Labour is organised, is divided differently according to the instruments it has at it's disposal. The hand-mill presupposes a different division of labour from the steam-mill. Thus it is slapping history in the face to want to begin with the division of labour in general, in order to arrive subsequently at a specific instrument of production, machinery[69].

The division of labour is "born of the conditions of material production"[70], not of an eternal category. The same applies to competition, which again, is eternalised by Proudhon who "makes of competition a necessity of the human soul"[71], not seeing it as a necessity dictated by capital accumulation. The same fallacy prevents Proudhon from understanding the economic origin of rent and property in general, seeing it as something 'mysterious'; thereby he makes "a mystery of the relation between production itself and the distribution of the instruments of production"[72]. In this way, Proudhon does not differ much from the classics: Ricardo who, "after postulating bourgeois production as necessary for determining rent, applies the conception of rent, nevertheless, to the landed property of all ages and all countries"[73]. Marx, in contrast, for whom "land as capital is no more eternal than any other capital"[74], rejects the conception of rent as a property of the soil:

> Rent results from the social relations in which the exploitation of the land takes place. It cannot be a result of the more or less solid, more or less durable nature of the soil. Rent is a product of society and not of the soil.

Ricardo, as well as his pseudo critic Proudhon falls into an "error common to all the economists, who represents the bourgeois relations of production as eternal categories"[76]. Once eternalised those categories cannot be subjected to a critique; once hypostatised into categories capitalist social relations cannot be altered. This, of course, provides the justification for the economists' opposition to working class action: "it is an effort as ridiculous as it is

dangerous for you to revolt against the eternal laws of political economy"[78].

These eternal laws of political economy include the social form of labour:

> This definite, specific historical form of social labour which is exemplified in capitalist production is proclaimed by these economists as the general, eternal form, as a natural phenomenon, and these relations of production as the absolutely (not historically) necessary, natural and reasonable relations of social labour[78].

Political economy provides no explanation as to the genesis of the social form of labour under capitalism, but accepts it as a given premise. Thereby the appropriation of other people's labour is validated by science:

> Classical economy is not interested in elaborating how the various forms come into being, but seeks to reduce them to their unity by means of analysis, because it starts from them as given premises. But analysis is the necessary prerequisite of genetical presentation, and of the understanding of the real, formative process in its different phases. Finally a failure, a deficiency of classical political economy is the fact that it does not conceive the basic form of capital, i.e., production designed to appropriate other people's labour, as a historical form but as a natural form of social production[79].

A definite, specific, historical form of social labour is seen as a natural phenomenon, and political economy proclaims this specific form of social labour as necessary, natural and rational. The social form of labour, that is value production and exploitation, is taken as natural while only distribution can be altered. With this Proudhon and many present-day socialists fall into the same trap as Ricardo:

> Ricardo never concerns himself about the origin of surplus-value. He treats it as a thing inherent in the capitalist mode of production, which mode, in his eyes, is the natural form of social production[80].

In this way classical political economy sets the stage for political action, portraying "production as an eternal truth while banishing history to the realm of distribution"[81]. As a result any possible change is limited to the sphere of distribution, leaving the relations of production unaltered.

The best way of seeing a particular relation as static, as unchangeable, is to reify this relation. This is precisely what economists do to capital:

> The economists do not conceive capital as a relation. They cannot do so without at the same time conceiving it as a historically transitory, i.e., a relative - not an absolute - form of production[82].

Capital, by them, is viewed as a thing not as a particular relation with a particular form of social production. Production, of course, is connected to nature, and by natural science providing a knowledge of nature it also provides knowledge of production. If production is then seen as static, as unchangeable, so must any knowledge of it.

4. Natural Science as Knowledge of Production

Science embodies a knowledge of production which is separated from labour. Through the separation of the intellectual potencies of the material processes of production science now 'knows' what previously would have been in the minds of the producer. Knowledge of production is taken away from the worker and concentrated into a body of thought called science. Knowledge of mechanical, biological, chemical and physiological processes rests with the scientist, not the labourer. The division of labour between mental and manual activities means that the knowledge of the production process does not lie with those who carry out the manual operations in production. Natural Science thus is not only knowledge of nature, but also knowledge of production. The natural scientist has a knowledge of the laws of motion, mechanical, chemical, biological and physiological processes required for production.

Marx, in fact, thought the scientist to be more knowledgeable about production than the economist; he refered in particular to Justus von Liebig whose work he had studied in detail. This was no

accident. Liebig's knowledge of organic chemistry lead him to the invention of the synthetic fertiliser and thereby to the application of scientific principles to technology. Liebig knew the effects of geology and chemistry on physiology and agriculture, and how methods in those could increase the fertility of the soil. The chemical and mechanical level of agriculture is dependent on the knowledge of the scientist and Liebig's knowledge of chemistry and geology could directly be applied to agricultural production. James Joule's application of thermodynamics to production is another example of the marriage of natural science and technology. The scientist has a precise knowledge of the operations required in production. The construction and operation of machines, transportation, telecommunication, computerised office work and automation is all but the technological application of science to production.

During production, in particular during that period of production which Marx refers to as 'functioning time' (in which natural processes operate) products undergo physical, chemical and physiological changes. Natural science has a knowledge of these processes and is able to interfere with them. For example, the knowledge of the effects of chemicals on biological processes has led to the use of preservatives, flavouring, colouring and the invention of synthetic products. In addition, the knowledge of these natural processes can speed up production. Marx gives the examples of chemical bleaching, dying, tanning, iron manufacture and the interference in biological processes like selective breeding for meat production.

Natural science thus is knowledge of production, technology the

application of this knowledge in the production process. The scientific principles embodied in machinery, computers and automation are the direct outcome of the practice of the natural sciences. Marx sees technology as the "conscious and systematic applications of natural science"[83] to the labour process. Technology uses the mechanical, physical and chemical laws arising directly out of science and can accordingly be seen as the "application of mechanics, of chemistry, and of the whole range of the natural sciences"[84]. Natural science has the knowledge of natural forces which are then pressed into the service of production. Production is thereby separated from the knowledge of production, marking an extreme form of the division of labour.

5. Natural Science and the Division of Labour

Marx sees the abolition of the division of labour as a pre-requisite for communism. The famous passage in the German Ideology explains that there will not be a fisher, a hunter, a critic; but that there will be people who fish, hunt, criticise. That is, the social channelling of an individual's abilities into a one-sided profession will be replaced by a variety of activities available to the individual. Marx's contention that people made clothes long before there were tailors also holds for natural science: people studied nature long before the existence of the natural scientist. The natural scientist as a professional has, in fact, only emerged in the nineteenth century; and with the abolition of the division of labour under communism the role of the expert natural scientist will have

become redundant. Knowledge of nature and production will be socialised.

As is well known the division of labour has not just brought about efficiency and increased productivity, but more so stultification of mind and body, one-sidedness and ignorance. The "division of labour only becomes truly such from the moment when a division of material and mental labour appears"[85]. Marx sees the priest, the first ideologist, as one of the first examples of this division of mental and manual labour. The practice of natural science is a more modern phenomenon of this division. The division between town and country proved a stepping stone into this division. In the Communist Manifesto Marx refers to country life being characterised by "rural idiocy", implying not a condescending attitude towards peasants, but his condemnation of the concentration of education and knowledge in the towns where new production processes, which require this concentration of mental activities, take place. The application of scientific methods in production concentrates people in industrial towns, creating an ever increasing split between town and country life. Thereby the capitalist production "destroys at the same time the health of the town labourer and the intellectual life of the rural labourer"[86].

The division of labour has become most extreme when mental labour separates from material labour:

> From this moment onwards consciousness can really flatter itself that it is something other than consciousness of existing practice, that is really represents something

> without representing something real; from now on consciousness is in a position to emancipate itself from the world and proceed to the formation of 'pure' theory, theology, philosophy, morality, etc, ...[87]

One could, of course, add natural science. With the split from manual labour natural science at the same time splits itself from its determining force, social practice, and is thereby able to advocate theoretical autonomy and neutrality. To obtain unity with social practice the appropriation and intercourse with nature will have to be based on an activity which reunites mental and manual labour. Revolutionising social relations will mean revolutionising theory whose claim to autonomy will be dissolved "only by the practical overthrow of the actual social relations which gave rise to this idealistic humbug"[88]. The production of knowledge via the 'pure' intellect is a direct outcome of the property relations of capitalism: "The various stages of development in the division of labour are just so many different forms of property"[89]. When the property relations of capitalism set natural science to their aid the division of labour lost "the last semblance of its natural character"[90]. With the development of 'pure' natural science capital was able to obtain knowledge of nature from sources other than manual labour. Only the abolition of capitalist relations will reunite intellectual and material activity.

Marx is ambiguous as to the abolition of labour. His early works would like to see labour abolished altogether, while his later writings are less drastic. In the German Ideology Marx views labour as a specific mode of activity and he advocates the abolition of this

mode. Similarly, in his polemic against Friedrick List he sees labour as an unfree, inhuman activity, determined by private property and creating private property. Thus, he concludes, the abolition of labour is the precondition for the abolition of private property. Labour, identified as a specific mode of activity, an activity inseparable from private property, has to be abolished if communism is to be realised:

> It is one of the greatest missapprehensions to speak of free, human, social labour, of labour without private property. 'Labour' by its very nature is unfree, unhuman, unsocial activity, determined by private property and creating private property. Hence the abolition of private property will become a reality only when it is conceived as the abolition of 'labour' ...[91]

However, the story soon takes on a different slant. In Capital Marx distinguishes between the realm of necessity and the realm of freedom. The latter lies beyond the sphere of material production. In all social formations people have to "wrestle with Nature" to satisfy their wants, and without labour "there can be no material exchanges between man and Nature, and therefore no life"[92]. This is the realm of necessity:

> Freedom in this field can only consist in socialised man, the associated producers, rationally regulating their interchange with Nature, bringing it under their common control, instead of being ruled by it as by the blind forces of Nature; and achieving this with the last

> expenditure of energy and under conditions most favourable to, and worthy of, their human nature. But it nonetheless still remains a realm of necessity. Beyond it begins that development of human energy which is an end in itself, the true realm of freedom, which, however, can blossom forth only with this realm of necessity as its basis. The shortening of the working day is its basic prerequisite[93].

The concluding sentence might well be an indication that Marx was caught up in working class propaganda which, at that time, advocated a reduction in the working day from 12 to 10 hours. He had already supported this demand in the Grundrisse: "Truly wealthy a nation, where the working day is 6 rather than 12 hours"[94]. In the Critique of the Gotha Programme the story changes yet again: "emancipated labour" now becomes life's "prime want". Labour in communism "is no longer just a means of keeping alive but has itself become a vital need"[95]. Indeed, in the Grundrisse labour "appears no longer as labour, but as the full development of activity itself, in which natural necessity in its direct form has disappeared"[96]. Whatever it may be, the abolition of labour, labour as life's prime want, or the continuation of labour as the realm of necessity, present day natural science, being based on the split between mental and manual activities, will have no place in communism where these activities will be united.

However, in spite of his criticism of the division of labour so characteristic of the practice of natural science, and of his insistence that the production of knowledge is linked to a specific set of social relations, Marx himself often falls into the trap of

scientism. Although his critique of value relations in Capital, provides an excellent basis for a critique of science and though he sees machinery as a means of labour adequate to capital, developed by and for capital, passages in Capital, in the Grundrisse and in the critique of Proudhon see machinery as possessing some transcendental use-value and will have to be subjected to the critical perspective outlined in this chapter. In Capital II, when analysing the circulation process of capital, Marx could perhaps be charged with scientism as he details the effects of science on production and circulation without analysing the reverse. However, Marx preempts this criticism by his contention that "the relation between capital and wage-labour determines the entire character of the mode of production"[97]. This entire character, of course, does not exclude natural science (although admittedly Marx does not provide a sufficient analysis of the latter) which does not escape "the regulation of the total production by value"[98]. It is to this determination of production by value-relation which the following chapters will turn.

CHAPTER 4

NATURAL SCIENCE AND THE VALUE-FORM

The point of departure for a serious analysis of natural science is not the explicit statements made on the subject in Marx's early works, but his analysis of the commodity in *Capital*. A commodity, for Marx, is a social relation, a relation which permeates all spheres of society, and an analysis of which has to be taken as the *sine qua non* of an analysis of any aspect of capitalism, be it money, the state, world trade or natural science. Science is part and parcel of commodity relations and any possible analysis or critique has to set out from an analysis of commodity relations, or, in Marx's terminology, value relations.

Marx's critique of classical political economy shows the historical character of commodity production, that is, labour producing in the value-form:

> The value-form of the product of labour is the most abstract, but also the most universal form of the bourgeois mode of production; by that fact it stamps the bourgeois mode of production as a particular kind of social production of a historical and transitory character. If then we make the mistake of treating it as the eternal form of social production, we necessarily overlook the specificity of the value-form, and consequently of the commodity-form together with its further developments, the money form, the capital form, etc.[1]

Marx praises the classical political economists for understanding that labour appears in the value-form, but criticises them for never asking the question "why this content has assumed that particular form".[2] Thus, Marx sets out to show not <u>that</u> labour is the source of value, but <u>why</u> the products of labour take on the value-form. The answer shows capitalism as a mode of production based on exchange - as opposed to collective production. Products produced for exchange, i.e. commodities, become the elementary form of wealth:

> The wealth of those societies in which the capitalist mode of production prevails, presents itself as 'an immense accumulation of commodities', ... Our investigation must therefore begin with the analysis of a commodity.[3]

Commodity relations (or value relations) is a synonym for exchange relations. That is, when products are bought and sold (i.e. exchanged) they become commodities:

> ... the concept 'value' presupposes 'exchanges' of the products. Where labour is communal, the relations of men in their social production do not manifest themselves as 'values of things'.[4]

Teaching the German state socialists a lesson in communism, Marx writes in the <u>Critique of the Gotha Programme</u>:

> Within the cooperative society based on common ownership of the means of production the producers do not exchange their products; similarly, the labour spent on the products no

longer appears <u>as</u> <u>the</u> <u>value</u> of these products, ...[5]

In capitalism, however, objects appear in the value-form. Thereby relations between people appear as relations between things. This is the basis of Marx's famous concept of 'commodity fetishism':

> ... the mutual relations of the producers, within which the social character of their labour affirms itself, take the form of a social relation between the products. A commodity is therefore a mysterious thing, simply because in it the social character of men's labour appears to them as an objective character stamped upon the product of that labour; because the relation of the producers to the sum total of their own labour is presented to them as a social relation, existing not between themselves, but between the products of their labour ... There it is a definite social relation between men, that assumes, in their eyes, the fantastic form of a relation between things.[6]

The world has become de-humanized. Qualities are attributed to objects which they do not possess. Marx polemicises against the conception which holds value not as a social relation, but as an attribute of an object: "So far no chemist has ever discovered exchange-value either in a pearl or a diamond".[7] Value is a relation imposed onto objects by a specific social relation which is based on the 'equalisation' of labour through the mechanism of exchange. Unlike a communal set up in which individual labour is <u>directly</u> a part of total social labour, in capitalism individual

parts of labour only become indirectly a part of total labour through their equalisation by the exchange mechanism. Thus, Marx sees exchange as an equalisation of labour, i.e. a social relationship, and not as an equalisation of properties inherent in the object: "No scientist to date has yet discovered what natural qualities make definite **proportions** of snuff tobacco and paintings 'equivalents' for one another".[8] In this world turned topsy turvy

> ... the relations connecting the labour of one individual with that of the rest appear, not as direct social relations between individuals at work, but as what they really are, material relations between persons and social relations between things.[9]

Natural science is fetishised in the same way.[10] What is really a social relationship is presented as objective laws of nature. Already when writing his doctoral dissertation Marx objected to Democritus' 'positive knowledge' and sided with Epicurus who did not aim at knowledge of nature in and for itself, but at 'the ataraxy of self-consciousness'. Epicurus was not interested in the object which is explained, but in the subject which does the explaining. His interest did not extend to the object as object. While discussing Epicurus' philosophy Marx develops his theory of commodity fetishism:

> Bring paper money into a country where this use of paper is unknown, and everyone will laugh at your subjective imagination. Come with your gods into a country where other gods are worshipped, and you will be shown to suffer from fantasies and abstractions. And justly so.[11]

Gods and paper money have to be explained as a social creation. Similarly, the categories specific to the capitalist mode of production, be it capital or natural science, have to be explained in social and historical terms:

> To develop the concept of capital it is necessary to begin not with labour but with value, and, precisely, with exchange value in an already developed movement of circulation. It is just as impossible to make the transition directly from labour to capital as it is to go from the different human races directly to the banker, or from nature to the steam engine.[12]

1. The Form of Value

Marx explains the economic basis for the concept of fetishism by an analysis of the commodity. A commodity, as well as being a use-value, an object of utility, has value in as far as it is a product of abstract human labour. However, labour or value in a commodity isolated from other commodities has no form of appearance. Value only acquires a form of appearance in another commodity through the act of exchange, its final form of appearance being money. The social nature of labour appears in a fetishistic form: a commodity acting as an equivalent seems to have the quality of being the form of value by nature. Social relations between people appear as thing-like relations or social relations between things. What appears as inherent qualities of things is really a social relationship.

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Marx begins his analysis of the commodity showing its internal contradiction of having an exchange value and being a use-value. A commodity has many exchange values. Hence, it must express something equal to those exchange values. It must be reducible to a third thing: value. A commodity has value by virtue of being a product of abstract, general, social labour. But, the commodity does not reveal this by itself. Marx has gone from exchange value to value, thereby abstracting from the mode in which value appears. He now turns to that mode:money is the final mysterious, completely fetishistic form of value. To get at this Marx does not just look at money, but abstracts to the elementary form of value, which contains the secret of money.

The elementary form of value contains two poles, mutually exclusive, but complementary: relative and equivalent.

20 yards of linen = 1 coat

Linen is in the relative value form, while coat is in the equivalent value form, i.e. the value of linen is being expressed while coat is the medium in which value is expressed. The value of the linen is expressed as something different and apart from the linen, that is, the use-value coat becomes the phenomenal form of the value of the linen.

The limits of the elementary form lie in that it only expresses the value of one single commodity in one other single commodity; like 20 yards = 1 coat, 2 lbs of tea = 1 lb of coffee, 1 lb of butter = $\frac{1}{2}$ lb of sugar. However, it already contains the germ of the total

or expanded form. Writing a string of equations like:

20 yards of linen = 1 coat

20 yards of linen = 2 lbs of tea

etc.

we get:

20 yards of linen = 1 coat or 2 lbs of tea or... etc.

This chain can be extended to include all commodities. What we have here is one commodity in the expanded relative form, i.e. expressing its value in all other commodities which figure in this form as particular equivalents. The advance of this value from the previous one is that the value of one commodity (which is a social thing) is now expressing itself socially, i.e. in all commodities. The limits of this expanded form of value are two-fold: any one commodity can stand in the relative position at any one time, and the value of any one commodity can only be expressed by an encyclopaedic list of all other commodities. Thus, there is no simple, unitary equivalent form of value. Value has not yet achieved a truly social form.

However, the total or expanded form already implies the general form, the next stage in the development of the value-form. If linen is in the expanded relative form this implies that in the world of exchange all commodities in turn express their value in linen. Thus we can reverse the equation and we get:

1 coat = 20 yards of linen

2 lbs of tea = 20 yards of linen

or more simply:

1 coat
2 lbs of tea } = 20 yards of linen
etc.

What we have here is a form in which the value of any commodity can be expressed simply and in a unitary manner. All commodities stand in the relative form with the exception of that simple commodity which stands in the equivalent form and which thereby constitutes the universal equivalent.

From this form of value to the money form is a self-explanatory development:

1 coat
2 lbs of tea } = 2 ounces of gold or £2 (if 2 ounces of gold when coined are called £2)
etc.

Marx has elucidated the form of value in terms of two poles. As we have seen, the relative and equivalent form undergo changes. Thereby the relationship between the two poles itself changes and the polarity of the value-form also undergoes a development. In the elementary form the polarity is contained but not fixed. One can reverse the equation without departing from the elementary form

itself. In the total or expanded form however, reversal of the form produces a different form, namely the general form. Equally, when one reverses the general form one gets the total or expanded form, i.e. within the more advanced form the polarity is fixed. The development of the relative and equivalent polarity in the form of value has socio-historical implications: isolated commodity production and exchange to fully developed commodity production and exchange. However, it is the political implication which concerns Marx the most. The analysis of the elementary form of value has shown that already in its simplest form the commodity contains the seeds of its universal equivalent, money, and in that the further development from money to capital. Thus, the abolition of capitalism necessitates the abolition of commodity production and exchange. For, the value-form stamps its fetishistic character on all aspects of the social relations of capitalism and puts its mark on all aspects of life and production, not least on science production.

2. Manufacture

Although commodity production is the sine qua non for capitalism, it is only with the emergence of a particular commodity, the commodity labour power, that we can speak of capitalism. Labour power becomes a commodity once the worker has ceased to be part of the conditions of production as s/he was in slavery and serfdom, but has become "free". Free in a double sense: free in that s/he belongs to no one, and free in that s/he is free from any means of production. Being free or deprived from any means of production s/he cannot produce, but is 'free' to sell his/her capacity to labour to any one

of those who own the means of labour. Thus, capitalism as a social relation emerges when the universalisation of the commodity form, or the value form includes the capacity to work, i.e. the commodity labour power.

When capitalism first emerged it inherited a labour process based on craft labour. The 'manufacturing period' took over the handicraft production of the guilds. Capitalism did not revolutionise the mode of production immediately:

> At first, capital subordinates labour on the basis of the technical conditions in which it historically finds it. It does not, therefore, change immediately the mode of production.[13]

Nevertheless, capitalism had introduced some changes, it had extended the scale of production. Considerably more labourers were employed than had been under the guild system (in fact, the legal requirements of the guild system, i.e. the specification of numbers of journeymen a master was allowed to employ proved a fetter to the development of capitalist production). In the manufacturing period a larger number of labourers were working together in one workshop on a cooperative basis. This cooperation, Marx tells us, is the logical and historical starting point of the capitalist mode of production (it underlies all succeeding stages of capitalism, but on an ever extending scale). Cooperation made possible the economising in the consumption of such means of production as building, furnaces and some tools. It also called for a progressive specialisation of

tools: the detail labourer was allotted a tool specific to his task. However, capitalist production at this stage still operated on the basis of handicraft. Any further development in the division of labour in the workshop as well as the refinement of the instruments of production and the 'scientification' of the labour process as a whole necessitated the transcendence of manufacture and handicraft production as its characteristic technical basis. Manufacture developed the basis for machine production by specialising tools and giving impetus to the study of the laws of mechanics. But machine production itself only erupted on the destruction of the handicraft basis of manufacture.

> This narrow technical basis excludes a really scientific analysis of any definite process of industrial production, since it is still a condition that each detail process gone through by the product must be capable of being done by hand and of forming, in its way, a separate handicraft.[14]

Manufacture was incapable of revolutionising the production process fully. However, the workshop produced, thanks to ever increasing cooperation and division of labour, a revolution in the means of production: machines. These were only used in isolated cases to begin with, but were of great significance for the development into machine production proper:

> The sporadic use of machinery in the 17th century was of the greatest importance, because it supplied the great mathematicians of that time with a practical basis and

stimulant to the creation of the science of mechanics.[15]

In addition, the compass, gunpowder, type-printing and the automatic clock were inventions of the handicraft period. Manufacture provided the basis for the development of the scientification of production. Once the stone started rolling there was no stopping. One scientific invention followed another: the hydraulic press, mechanical and chemical revolutions in bleaching, printing, dyeing, the cotton gin, etc. In addition the means of communication and transport were revolutionised which in turn demanded cyclopean machines. Soon machines were constructed by machines, and the process of production was transformed into a technological application of science. Huge natural forces were now pressed into the service of production and the productiveness of labour developed continually with the uninterrupted advance of science and technology. However, the separation of the intellectual 'potencies of the material process of production' from the labourer which had began in the manufacturing period with its ever-increasing division of labour is now "completed in modern industry, which makes science a productive potency distinct from labour and presses it into the service of capital".[16] Significantly, Marx inserts an extra page entitled "Capitalist Production" into volume I of Capital before his detailed discussion of "Machinery and Modern Industry". This indicates that the capitalist mode of production proper begins with the revolutionisation of the instruments of labour which marks the beginning of the "real subsumption" of labour under capital and thereby the production of "relative surplus value".

3. The Production of Relative Surplus-Value

Capitalist production is based on the extraction of surplus value, the production of which is dependent on the universalisation of the commodity-form for all products, including the commodity labour power. The specific use-value of labour power lies in it being "a source not only of value, but of more value that it has itself".[17] The value of labour power equals the values of the commodities the worker requires to reproduce him/herself (and family) which in turn equals the wage s/he receives (unless labour power is sold above or below its value). In other words, the worker receives a sum of money from the buyer of his/her commodity which s/he converts into food, clothing, housing, etc. During the labour process the worker reproduces this value. Not only does s/he reproduce the value equivalent to their wage, but s/he produces an additional value, a surplus value. This surplus value is pocketed by the buyer of the commodity labour power which becomes capital as soon as it is integrated into the production process. That is, once the commodity labour power belongs to the buyer it becomes part of capital: variable capital. Unlike constant capital (machinery, raw material), the value of which is of fixed nature, the part of capital represented by labour power is of a variable magnitude. It undergoes an alteration of value by producing an equivalent of its own value plus a surplus value. These different values are produced in what Marx calls necessary labour time and surplus labour time. Necessary labour time is that time of production needed to reproduce the value of the labour power - to reproduce the value of the wage. Surplus labour time refers to the time required for the production

of surplus value. Indicatively,

> The direct motive, the end and aim of capitalist production, is to extract the greatest possible amount of surplus value, and consequently to exploit labour power to the greatest possible extent.[18]

Capital can do this in two ways. It can increase surplus-value by lengthening the working day. This form of surplus-value Marx calls absolute surplus-value. But the working day has natural limits; it also has limits determined by political struggle. Thus, when the absolute extent of the working day is given, surplus value can only be increased by shortening necessary labour time. Marx refers to this form of surplus value as relative surplus value.[19]

> The production of absolute surplus-value turns exclusively upon the length of the working day; the production of relative surplus value, revolutionises out and out the technical process of labour...[20]

The production of relative surplus value coincides with what Marx calls the 'real subsumption' of labour under capital: machine production based on the technological application of natural science. Hence, the development of machine production is not due to any supposedly autonomous Industrial Revolution, nor is the development of natural science due to any autonomous scientific revolution or the result of some ingenious brain. Natural science and its technological application are the direct result of the need of

capital to extract relative surplus value:

> ... when surplus value has to be produced by the conversion of necessary labour into surplus-labour, it by no means suffices for capital to take over the labour-process in the form in which it has been historically handed down, and then simply to prolong the duration of that process. The technical and social conditions of the process, and consequently the very mode of production must be revolutionised.[21]

This revolutionisation of the technical and social conditions of production by means of science and technology makes the transition from the 'formal subsumption' of labour under capital to its 'real subsumption':

> If the production of absolute surplus-value was the material expression of the formal subsumption of labour under capital, then the production of relative surplus-value may be viewed as real subsumption.[22]

The difference between formal and real subsumption is identical to the one between manufacture and machinofacture. The insertion of the labour process into capitalist relations in the manufacturing period is referred to as the formal subsumption of labour under capital. The labourer has to enter into a contract whereby s/he sells his/her labour power and becomes 'a factor in the production process'. Formal subsumption entails a pure money relationship whereby the buyer of labour power is the owner of the conditions

of labour. These objective conditions of labour (the means of production) and the subjective conditions of labour (the means of subsistance) confront the worker as capital. The more the conditions of labour are alienated from the worker and confront him/her as alien property, that is, the more the formal relationship between wage labour and capital is established, the more is the basis laid for the real subsumption of labour under capital. The general features of the formal subsumption remain alongside the specifically capitalist mode of production which effects changes in the labour process whereby machinery becomes 'the real master of living labour'. With this real subsumption of labour a revolution takes place in the mode of production which now entails the direct application of natural science and technology: " Capitalist production leads to separation of science from labour and at the same time to the use of science in material production".[23]

4. Machinery

Marx was well-acquainted with machine technology. As we have seen in chapter I, he made a point of keeping up with technological and scientific development. In Capital Marx provides us with a description of a machine: "All fully developed machinery consists of three essentially different parts, the motor mechanism, the transmitting mechanism, and finally the tool or working machine".[24] The machine is put in motion by the motor mechanism, its power being derived either from a natural force like water or wind or from its own motive power like steam or electromagnetism. The

transmitting mechanism regulates this power by directing its motion. The tool or working machine is the most important defining part of a machine. It is that part of the machine with which the Industrial Revolution started, and which replaced the tools used by the craftsman. The human implement has been replaced by a mechanical implement: "The machine proper is therefore a mechanism that, after being set in motion, performs with its tools the same operations that were formerly done by the workman with similar tools".[25]

With the replacement of tools by machinery we can talk about the capitalist mode of production proper:

> In the machine, and even more in machinery as an automatic system, the use value, i.e. the material quality of the means of labour, is transformed into an existence adequate to fixed capital and to capital as such; and the form in which it was adopted into the production process of capital, the direct means of labour, is superseded by a form posited by capital itself and corresponding to it.[26]

Thus, the development of machinery is not accidental, the invention of machines is not the random construct of some scientist or the neutral product of an 'Industrial Revolution'. Nor did capital come across machinery by pure chance:

> The development of the means of labour into machinery is not an accidental moment of capital, but is rather the historical re-shaping of the traditional, inherited means of labour into a form adequate to capital.[27]

Hans-Dieter Bahr relates machinery and natural science to the value-form and thereby to capital via the concept of 'measure'. A concept borrowed from Hegel who uses it as an expression of 'determinate being': "Measure is the qualitative quantum, ... a quantum, to which a determinate being or quality is attached".[28] Bahr explains: "Measures constitute the quantitatively distinguishable qualities of objects as sheer amounts: number, length, area, space and weight".[29] Marx himself referred to measures in the "Results of the Immediate Process of Production":

> The majority of commodities, however, are discrete in nature... viewed as quantities of a given article, they are divisible in terms of measures traditionally appropriate to them as use-values. Thus we deal with a) wheat by the quarter, b) coffee by the hundredweight, c) linen by the ell, d)knives by the dozen - and in all these cases the single commodity is a unit of the measure, etc.[30]

Bahr, however, maintains that these 'traditional' measures arise in the value relation:

> It is only the determination of value which requires already existing characteristics to become the quality of specific quantitative forms, i.e.to become measures. Weights, spatial areas, and numbers, which through unit measures become a definite measure - magnitude, first arise, as intelligible forms of commodity objects, in the value-relation itself ...[31]

With machine production these definite measure magnitudes become inbuilt into production:

> Commodities are produced in definite amounts, in the form of a quantitative determinacy which makes it possible to exchange and buy commodities as 'measured' amounts. In the conscious production of values characteristic of capitalism, these intelligible forms of the commodity ('intelligible' because these forms like the price form, only exist through the 'understanding' of symbols, not through the sensuous perception of qualities) become forms of the commodity object 'within' production.[32]

Only with the advent of machinery can 'measures' be determined precisely already within the production process. Exact measurement of length, width, volume, etc, is only possible with 'uni-form' machine production in which the value-form finds its adequate expression. Bahr concludes that "These measures are now basic to all technical and scientific research activities and theoretical constructions".[33] Together with machinery, they cannot be part and parcel of a liberated society, Otto Ullrich claims, for such a society will experience a change in the 'measure system' "when 'essential dimensions' do not continue to be speed, size, productivity and efficiency, but e.g. life enrichment, health, beauty, tranquillity and leisure".[34] Ullrich mentions another concept: time. Economy of time is an important feature of capitalist social relations. The concepts of time and space have gone through various philosophical under-pinnings. David Hume confined space and time to our experience and Isaac Newton turned them into ontological realities.

Immanuel Kant identified these as forms of intuition (Anschauungsformen) rooted in the subject, and, more recently, Alfred Sohn-Rethel historicised Kant's forms of intuition by making these specific to social relations. E. Evans-Pritchards finds a social setting where the concept of time does not exist, be it ontological, intuitive or historical:

> ... the Nuer have no expression equivalent to 'time' in our language, and they cannot, therefore, as we can, speak of time as though it were something actual, which passes, can be wasted, can be saved, and so forth. I do not think that they ever experience the same feeling of fighting against time or of having to co-ordinate activities with an abstract passage of time because their points of reference are mainly the activities themselves, which are generally of a leisurely character. Events follow a logical order, but they are not controlled by an abstract system, there being no autonomous points of reference to which activities have to conform with precision. Nuer are fortunate.[35]

Time in capitalism, however, is fundamental. In Capital III, Marx refers to the economisation of time in the form of the 'economy in the employment of constant capital'. In order to maximise profits, machinery has to be speeded up and kept in constant use:

> Since the labourer passes the greater portion of his life in the process of production, the conditions of the production process are largely the conditions of his active living

> process, or his living conditions, and economy in these living conditions is a method of raising the rate of profit.[36]

The economisation of time within the production process has a most terrible effect on the workers' living conditions. Marx quotes Engels who bemoans the fact that "the workman must be in the factory at half past five. If he comes a few minutes late, he is punished; if he comes 10 minutes late, he is not allowed to enter until after breakfast, and thus loses a quarter of a day's wage. He must eat, drink and sleep at word of command".[37] And not only that. The speeding up of machines leads to fatigue and loss of attention and results in high accident rates. The factory reports Marx cites clearly indicate the importance of time for the capitalist economy:

> Every minute's stoppage is not only loss of power, but of production, and the workpeople are urged by the overlookers, who are interested in the quantity of work turned off, to keep the machinery in motion; and it is no less important to those of the operatives who are paid by the weight or piece, that the machines should be kept in motion. Consequently, although it is strictly forbidden in many, nay in most factories, that machinery should be cleaned while in motion, it is neverthelesss the constant practice in most, if not in all, that the work-people do, unreproved, pick out waste, wipe rollers and wheels, etc, while their frames are in motion. Thus from this cause only, 906 accidents have occurred during the six month...[38]

Thus, time is imposed at the expense of the workers' life and health. The capitalist economy, based on the maximisation of profit and a disregard of any human activity now teaches the working class that 'time is money'. As E.P. Thompson observes, within the capitalist economy time must not be wasted. "Time is now currency: it is not passed but spent".[39] In his article "Time, Work-Discipline, and Industrial Capitalism", Thompson describes the internalisation and external imposition of 'time'. Like technology and industrialisation, 'time' is not neutral but directly linked with exploitation. Thompson sees 'time-sense' in its technological conditioning, and time-measurement as a means of labour exploitation. He contrasts industrial with pre-industrial society:

> The work pattern was one of alternate bouts of intense labour and of idleness, wherever men were in control of their own working lives. (The pattern persists among some self-employed - artists, writers, small farmers, and perhaps also with students - today, and provokes the question whether it is not a 'natural' human work-rhythm.)[40]

The majority of workers in disciplined industrial capitalism however suffer an imposition of time-discipline by means of external pressures like the time-sheet, the time-keeper, informers and fines:

> In all these ways - by the division of labour; the supervision of labour; fines; bells and clocks; money incentives; preachings and schoolings; the suppression of fairs and sports - new labour habits were formed, and a new time-

discipline was imposed.[41]

Later, this new time-discipline was also imposed on leisure activities, in particular in the form of sport. Jean-Marie Brohm calls sport 'a prison of measured time'. Physical activities are subjected (just like factory work) to the stop watch, mechanisation, the productivity principle, 'taylorisation', etc. Time, through its external imposition, is internalised by those who are subjected to the economy of time, necessitated by the production of relative surplus value and aided by the application of natural science to production.

5. The Application of Natural Science to Production

Capital only develops fully when "the entire production process appears as not subsumed under the direct skillfulness of the worker, but rather as the technological application of science".[42] We have seen that in the manufacturing period a revolution took place in the use of labour power; in modern industry a revolution takes place in respect to the means of labour. Craft labour had to give way to the "conscious and systematic applications of natural science"[43] to the labour process:

> It is, firstly, the analysis and application of mechanical and chemical laws, arising directly out of science, which enables the machine to perform the same labour as that previously performed by the worker.[44]

In order to fully develop machine production, to develop means of production adequate to capital, natural science has to be developed to its highest point and new inventions have to be solicited. This process had already started with the division of labour in the manufacturing period where every aspect of the cooperative labour process had to be resolved into various constituent moments to be carried out by the detail labourer. This principle led to the creation of the 'new modern science of technology':

> The principle, carried out in the factory system, of analysing the process of production into its constituent phases, and of solving the problems thus proposed by the application of mechanics, of chemistry, and of the whole range of the natural sciences, becomes the determining principle everywhere.[45]

The development of machine production becomes thoroughly dependent on the sciences: "The implements of labour, in the form of machinery, necessitate the substitution of natural forces for human force, and the conscious application of science, instead of the rule of thumb".[46] This is a clear anticipation of Taylorism.

Taylor was to analyse and break down the constituent parts of the labour process and allot detailed fucntions to each labourer who, from now on, was to carry out these functions precisely as s/he was told, the knowledge of the total labour process resting with management. Marx clearly points to the development of 'scientific management' when he sees the workpeople divided into "operatives and

overlookers, into private soldiers and sergeants of an industrial army".[47] This technical subordination of the workers compels them to the most authoritarian discipline:

> ... on the basis of capitalist production, the mass of direct producers is confronted by the social character of their production in the form of strictly regulating authority and a social mechanism of the labour-process organised as a complete hierarchy - this authority reaching its bearers, however, only as the personification of the conditions of labour in contrast to labour, and not as political or theocratic rulers as under earlier modes of production...[48]

The technical basis of the labour process replaces slave-drivers and political coercion. Knowledge of the labour process is now separated from the labourer and the means of labour confront and dominate the worker as soon as the "accumulation of knowledge and of skill, of the general productive forces of the social brain, is thus absorbed into capital".[49] Thereby the split between mental and manual labour is completed. For Marx, the unification of intellect and body is one of the major prerequisites for communism; capitalist production is based on the separation of the two.

> The separation of the intellectual powers of production from the manual labour, and the conversion of those powers into the might of capital over labour, is, as we have already shown, finally completed by modern industry erected on the foundation of machinery.[50]

The employment of the machines is regulated by scientific laws and the cooperation originated in the manufacturing period is now a "technical necessity dictated by the instrument of labour itself",[51] that is, the machines require the subordination of the workers to the instrument of production:

> ... the use of the forces of nature and the sciences, of the products of labour, as machinery, all these confront the individual worker as something alien, objective, ready made, existing without their intervention, and frequently even hostile to them ... As objects they are independent of the workers whom they dominate.[52]

At the same time as science is developed for material production, it is separated from labour. Knowledge of production is concentrated in a body of thought called science. The activities of production are pre-conceptualised in the brain of a scientist,[53] the application follows in the form of machine technology which dictates to the worker the actual movements to be carried out. The labourer, with the advent of 'scientific production' undergoes a process of 'de-skilling' whereby the "special skill of each individual insignificant factory operative vanishes as an infinitesimal quantity before the science, the gigantic physical forces, and the mass of labour that are embodied in the factory mechanism".[54] The worker does not possess any know-how, any skill; all knowledge is concentrated in the machine which appears to them as an alien, external force:

> But the science realised in the machine becomes manifest

> to the workers in the form of capital. And in fact every such application of social labour to science, the forces of nature and the products of labour on a large scale, appears as no more than the means for the exploitation of labour, as the means of appropriating surplus labour, and hence it seems to deploy forces distinct from labour and integral to capital.[55]

We can, therefore, speak of the progression and development of natural science at the expense of the working class. The separation of all knowledge from the worker serves the exploitation of labour by capital. The production of relative surplus value requires that

> ... all means for the development of production transform themselves into means of domination over, and exploitation of, the producers; they mutilate the labourer into a fragment of a man, degrade him to the level of an appendage of a machine, destroy every remnant of charm in his work and turn it into a hated toil; they estrange from him the intellectual potentialities of the labour process in the same proportion .. as science is incorporated in it as an independent power.[56]

Intellect and manual activity are split and become diametrically opposed to each other.

With Taylorism and Fordism in the twentieth century this split is abolutised and justified; Ford explains:

> Repetitive labour - the doing of one thing over and over again and always in the same way - is a terrifying prospect to a certain kind of mind. It is terrifying to me. I would not possibly do the same thing day in and day out, but to other minds, perhaps I might say to the majority of minds, repetitive operations hold no terrors.[57]

Marx disagrees, identifying machinery with capital he sets out to show the effects of this specific form of capital on the worker. He compares the 'miserable routine of endless drudgery' which is imposed on the worker with the labour of Sisyphus: repetitive, tortuous work from which there is no escape and which leads to physical and mental retardedness: "factory work exhausts the nervous system to the uttermost, it does away with the many-sided play of the muscles, and confiscates every atom of freedom, both in bodily and intellectual activity".[58] The capitalist mode of production is more wasteful of human lives than any other mode of production:

> Every organ of sense is injured in an equal degree by artificial elevation of the temperature, by the dust-laden atmosphere, by the deafening noise, not to mention danger to life and limb among the sickly crowded machinery, which, with the regularity of the seasons, issues its list of the killed and wounded in the industrial battle.[59]

Marx uses factory inspectors' reports to describe the horrific accidents and dehumanising conditions the workers, including women and children, had to suffer as a result of machine production. People

had to work in insanitary premises, without breaks (food eaten amongst dirt, if at all), operating machines without safety devices and thereby risking loss of fingers, hands and other limbs. Marx had already utilised factory inspectors' reports in his capacity as a journalist. In the New York Daily Tribune he gives an account of "The Conditions in British Industry" and "The Position of Factory Workers":[60] accidents due to machinery, and, in particular, speed of machinery had led to horrific injuries and even death, not sparing women and children. Factory legislation was, of course, opposed; and in court cases instigated by factory inspectors it was a matter of proving that killing was not murder when it occurred for the sake of profit. Loss of a finger was considered a "trifling matter".[61] Today one only needs to point to industrial deafness, asbestosis and cancer as examples of the effects of modern industrial production on the body.

After subjecting the working class to the most gruesome sufferings - cutting of limbs, spoiling eye-sight, etc, capital invented jobs for precisely such cripples. Henry Ford had a use for everyone:

> The lighter jobs were again classified to discover how many of them required the use of full faculties, and we found that 670 could be filled by legless men, 2,637 by one-legged men, 2 by armless men, 715 by one-armed men, and 10 by blind men.[62]

Thus, Fordism introduced more 'human production methods', together

with higher wages (at least in the capitalist west - and mostly at the expense of the 'underdeveloped' countries). Should anyone point to an 'affluent' working class with 'improved working conditions', one only needs to look at capital's expansion into the 'third world'. For example, microelectronic companies found cheap labour power in South East Asia: 300,000 women workers, non-unionised work for wages between £ 0.80 and £ 5.00 per day. The average working lives of these women is four years after which they have to leave with ruined eyesight (due to looking through a microscope all day), to join the increasing number of prostitutes in South East Asian towns.[63]

Not only does machine technology attack the workers' mental and physical powers, it also makes them superfluous, threatens them with redundancy:

> The instrument of labour, when it takes the form of a machine, immediately becomes a competitor of the workman himself. The self-expansion of capital by means of machinery is thenceforward directly proportional to the number of workpeople, whose means of livelihood have been destroyed by that machinery.[64]

As soon as the tool, which was originally used by the skilled labourer, is handled by a machine, the value of the labour power of the labourer vanishes together with its use. The labourer has to put his/her labour power on the market for other sections of industry, thereby competes with other labourers already in the

market, which has the effect of a general reduction in the value of labour power. Marx gives the example of the gradual extinction of the English hand-loom weavers due to the introduction of power-weaving. Today we can easily point to the connection of technology and unemployment figures exceeding four millions. The consolation given to workers today does not differ from the one advanced in the nineteenth century: the sufferings caused by the introduction of new machinery and technology are only 'temporary'.

In addition to throwing the labourer out of work - to become a competitor, the machine is used as a powerful weapon for repressing strikes:

> It would be possible to write quite a history of the inventions, made since 1830, for the sole purpose of supplying capital with weapons against the revolts of the working class. At the head of these in importance, stands the self-acting mule, because it opened up a new epoch in the automatic system.[65]

Thus, having to endure the tortuous horrors of machinery, as well as being deprived of their livelihood by them, the workers revolt violently against the instruments of labour. The struggle between wage-labour and capital goes back as far as the beginnings of capitalism, but the instruments of labour only have become a target of attack for the worker since the introduction of machinery. It is only "with the advent of machinery, that the workman for the first time brutally revolts against the instruments of labour".[66] The

core of the Luddite movement was the breaking of threshing machines (complemented by riots and arson) as a reaction against their implementation which threatened redundancy. The basic aim was to attain a minimum living wage and end rural unemployment.[67] Unfortunately they did not have Marx's approval:

> It took both time and experience before the workpeople learnt to distinguish between machinery and its employment by capital, and to direct their attacks, not against the material instruments of production, but against the mode in which they are used.[68]

Having described the nature of machinery, specifying its existence as <u>adequate to capital</u>, and detailing the horrifying effects machine production has on the worker, Marx goes back on his own analysis and adopts the uncritical use/abuse model: machinery is put to a wrong use. The following passages are the ones which provide the 'dialectics of history school' with nourishment:

> While machinery is the most appropriate form of the use-value of fixed capital, it does not at all follow that therefore subsumption under the social relation of capital is the most appropriate and ultimate social relation of production for the application of machinery.[69]

Machinery is a result of capitalist social relations as well as part and parcel of its reproduction; now we get the advocation of its communist use: "it is just as easy to perceive that machines will

not cease to be agencies of social production when they become e.g. property of the associated workers".[70] Natural science, in its application in the form of machine technology, is no more considered as a 'form of consciousness', but as a productive force, developed by capital.

6. Natural Science as a Productive Force

Marx reacted against a political economy which saw all means of production as capital, all land as landed property and all labour as wage-labour. The "Trinity formula" eternalises and justifies the capitalist mode of production by seeing capital as the source of profit and land as the source of rent, obliterating the fact that profit (and interest) and rent are just a subdivision of surplus value. In addition, bourgeois economists have transformed the means of production into capital, just like land is transformed into landed property and labour into wage-labour. That is, for those economists, all labour is wage-labour, all land is landed property and all means of production are capital. Just as wage-labour appears as the eternal form of labour, so capital appears as an eternal form of the means of production, as the natural form of the means of labour. The specificity of the social relation within which capital and wage-labour can exist, is overlooked: "capital, like land and labour, is simply considered as a material substance, that is, simply as a produced means of production, and thus is abstracted both as a relation to the labourer and as value".[71] Classical political economy does not realise that the means of production only take on

the form of capital in a specific historical period:

> If, then, labour coincides with wage-labour, so does the particular social form in which the conditions of labour confront labour coincide with their material existence. The means of labour as such are then capital, and the land as such is landed property.[72]

Marx explains that labour and means of production become capital only once inserted into the capitalist production process:

> The means of production do not become the material forms of productive capital, or productive capital, until labour power, the personal form of existence of productive capital, is capable of being embodied in them. Human labour power is by nature no more capital than are the means of production. They acquire this specific social character only under definite, historically developed conditions,...[73]

As soon as commodity production is universalised and even labour power appears in the value form, both, means of production and labour power are inserted into the capitalist production process and thereby become capital. Means of production have to be seen in this social form and not only in their physical form.

> The way of conceiving capital in its physical attribute only, as instrument of production, while entirely ignoring the economic form which makes the instrument of production into

> capital, entangles the economists in all manner of difficulties.[74]

Marx had gone to great efforts in Capital I to show that capital is not a thing, not an instrument, but a specific social relation. He repeats this when discussing the Trinity formula:

> capital is not a thing, but rather a definite social production relation, belonging to a definite historical formation of society, which is manifested in a thing and lends this thing a specific social character. Capital is not the sum of the material and produced means of production. Capital is rather the means of production transformed into capital, which in themselves are no more capital than gold or silver in itself is money.[75]

Capital lends the means of production 'a specific social character', it transforms them into capital. By doing so it gives them a specific form and content. The means of production are transformed into a form adequate to capital's needs, adequate to the extraction of surplus-value. As we have seen above the form of the means of production adequte to capital is machinery. Machinery is a necessity dictated by the social relations of capital. Marx adheres to this position already in 1847 when formulating his critique of Proudhon: "Since 1825, the invention and application of machinery has been simply the result of the war between workers and employers".[76]

However, in the same letter Marx still talks about the capitalist

use of machinery:

> Machinery is no more an economic category than the ox which draws the plough. The application of machinery in the present day is one of the relations of our present economic system, but the way in which machinery is utilised is totally distinct from the machinery itself.[77]

Proudhon, like the bourgeois economists, saw all instruments of production as capital. Therefore Marx was eager to show that capital was not a 'thing', i.e. a machine, but a specific social relation and organisation of production. Means of production, Marx believed, only took on the form of capital under capitalism. By seeing all means of production, including machinery, as capital, Proudhon de-historicised the capitalist mode of production. Marx gives a historical explanation of capitalism but then falls into the trap of de-historicising the means of production by seeing machinery as a non-capitalist category which can be inserted into any mode of production. Instead, as well as specifying the historical nature of capitalism, he needs to show more consistency in his analysis of the historical nature of the means of production; which he did indeed a few years later in Capital.

In his critique of Proudhon,[78] however, Marx unwittingly treads into Proudhon's footsteps. Proudhon deifies the categories of bourgeois relations; Marx, in spite of his critique of Proudhon, is guilty of the same crime. He deifies 'productive forces', not seeing that the existing 'productive forces' are inextricably linked to

bourgeois relations. Marx argues that a particular social relation corresponds to a particular state of development of the productive forces. Those productive forces will outgrow the relations of production, new relations of production emerge. At a certain stage of development the social relations of feudalism were replaced by the social relations of capitalism. For the production process this meant a replacement of craft labour by natural science and its technological application. Here comes the point where Marx's argument fails to be carried to its logical conclusion, for, just as the development of social relations will not come to a halt (i.e. capitalism will be superceeded by a new social relation), so will the development of the productiveforces not come to a halt. At a certain stage of development natural science and technology replaced craft labour. Similarly, at a certain stage of development, technology, machinery and natural science will be replaced. Natural science and technology, far from being in contradiction with capitalism, are capital's most adequate form of production. A 'productive force' in contradiction with capital would have to be radically different.

Proudhon is criticised for eternalising commodity production and exchange while wanting to get rid of capitalism. For Marx, however, commodity production carries within itself the seed for the development of money and capital. Therefore, not only capitalism has to abolished, but commodity production in general. Marx does not draw the consequences from his critique of Proudhon: while realising the need for the overthrow of capital and commodity relations, i.e.value relations, he insists on taking over productive forces developed by

value relations and therefore adequate to capital and not to socialism, let alone communism. Capital is contained in the commodity and in productive forces.

A year after his critique of Proudhon the Communist Manifesto gives a warning to the proletarian: "Law, morality, religion, are to him so many bourgeois prejudices, behind which lurk in ambush just as many bourgeois interests".[79] There is no reason to assume that natural science is exempt from this interest. It came easy to Marx to identify law, morality and religion as bourgeois, but he had difficulties at this stage to apply the same identification with 'productive forces' developed in, by and for bourgeois society.[80] Nevertheless, Marx's and Engels' attack on bourgeois 'ideas' can easily be applied to natural science:

> Your very ideas are but the outgrowth of the conditions of your bourgeois production and bourgeois property, just as your jurisprudence is but the will of your class made into a law for all, a will, whose essential character and direction are determined by the economical conditions of existence of your class... The selfish misconception that induces you to transform into eternal laws of nature and of reason, the social forms springing from your present mode of production and form of property - historical relations that rise and disappear in the progress of production - this misconception you share with every ruling class that has preceded you.[81]

Marx had called this insistence of a historical period to eternalise its ideas and social forms the "illusions of an epoch". It is equally illusory to eternalise natural science, be it as a form of thought or as a 'productive force'.

People are born into specific circumstances, they are not free to choose their productive forces. Nevertheless, productive forces are a result of human practice, they are shaped by human activity. In fact, Marx claims in Capital, human history is as much a history of the productive forces:

> Technology discloses man's mode of dealing with Nature, the process of production by which he sustains his life, and thereby also lays bare the mode of formation of his social relations, and of the mental conceptions that flow from them.[82]

Thus, a study of the productive forces of a specific historical epoch will act as an indicator of the social relations of that time:

> It is not the articles made, but how they are made, and by what instruments, that enables us to distinguish different economic epochs. Instruments of labour not only supply a standard of the degree of development to which human labour has attained, but they are also indicators of the social conditions under which that labour is carried on.[83]

Future archaeologists will certainly identify the instruments of

technology and natural science with capitalism and not with communism!

It is, of course, the 1859 Preface, which is Marx's most famous work on the productive forces - social relations problematic. Friend and foe alike quote extensively from this text without taking into account that it is precisely the preface to a critique of political economy. And as we have seen in chapter II, the lengthy quotations from this preface are in inverse proportion to an actual reading of the text which outlines the essential nature of capitalist social relations, i.e. value relations. Without an understanding of the latter it is easy to interpret Marx in a scientistic, mechanistic manner. The law of value mechanically rules the "economic conditions of production", which appear as a mechanical structure governed by natural laws which can be studied with the "precision of natural science".[84] Patrick Murray points to the irony with which Marx compares his critique of the 'conditions of production' with the natural sciences: the 'precision of natural science' can only be applied because the economic conditions are governed by the same fetishistic laws as natural science.[85]

7. Natural Science and the Falling Rate of Profit

As the previous sections explained, the sole purpose of the development of natural science and its technological application through machine production was the extraction of surplus value. But Marx shows how the very mechanism which increases the mass of surplus value and thereby the mass of profit, brings capital into contradictions.

Capital is divided into machinery and labour power. The money laid out for machinery is constant capital (C), the money paid for labour power in the form of wages is variable capital (V). The value of those constituents of capital will reappear in the final product, the value of which is the sum of constant and variable capital as well as surplus value (S). While the value of constant capital which is merely transferred to the product, the value of variable capital is not only replaced during the process of production but an extra value, a surplus value, is added. Leaving aside constant capital for the moment, the increase of the variable capital is expressed by the ratio of surplus value to variable capital, i.e $\frac{S}{V}$. For example, should variable capital be 100 and surplus value 100, the increase would be $\frac{100}{100}$ or 100%. This 'rate of surplus value' is identical to the rate of exploitation, or the degree of exploitation of labour by capital.

But, of course, the capitalist does not only have to pay for labour power, he also has to lay out money for the means of production, i.e. constant capital. Thereby the proportion of the surplus value extracted from the work force to total capital becomes smaller. This proportion is represented by $\frac{S}{C + V}$, expressing the 'rate of profit'. If we assume the constant capital transferred to the product to equal 100, we arrive at a rate of profit of $\frac{100}{100 + 100}$ = 50%, much less than the rate of surplus value. Marx distinguishes the two:

> The rate of surplus-value measured against the variable capital is called rate of surplus-value. The rate of surplus-value measured against the total capital is called rate of profit.[86]

The rate of surplus value will determine the rate of profit. A high rate of surplus value, given other factors remaining the same, will mean a high rate of profit. However, the rate of profit is not only dependent on the rate of surplus value, but also on the 'organic composition of capital', that is, the ratio of constant to variable capital ($\frac{C}{V}$). With a high organic composition of capital, where the employment of constant capital is high in relation to variable capital, the rate of profit will be low. A capital with a low organic composition of capital where constant capital is low in relation to variable capital will yield a high rate of profit. For example, if we assume surplus value to be 100 and variable capital to be 100, a capital with a constant capital of 100 will generate a rate of profit of 50%, while a capital with a constant capital of 200 will produce a rate of profit of 33⅓%. Thus, if the rate of exploitation remains the same but the ratio of constant to variable capital increases, the rate of profit will fall. Marx considers it a law of capitalist production that variable capital will decrease in relation to constant capital, which will result in the 'tendency of the rate of profit to fall'. Constant capital will grow ever more and thereby the organic composition of capital will continuously rise. Thus, a rising rate of exploitation can be accompanied by a falling rate of profit:

> The progressive tendency of the general rate of profit to fall is, therefore, just an expression peculiar to the capitalist mode of production of the progressive development of the social productivity of labour.[87]

The decrease of variable capital in relation to constant capital, due to the social productiveness of labour, commands an increase in the means of production to employ the same amount of labour power and extract the same quantity of surplus value.

The introduction of machinery increases relative surplus value, but, at the same time, depresses the rate of profit. As the organic composition of total social capital goes up the general rate of profit will fall. However, Marx is quite clear that "this fall does not manifest itself in an absolute form, but rather as a tendency toward a progressive fall".[88] There are enough counter-acting influences at work which offset the fall in the rate of profit and give it the character of a mere tendency.

The development in the social productiveness of labour thanks to the introduction of machinery has resulted in the massive accumulation of capital. The increasing costs of fixed capital would have brought about a drastic fall in the rate of profit, had not counter-balancing forces been at work.

The application of machinery to the production process, which results in a fall of the rate of profit, also increases the productiveness of labour. Necessary labour time is curtailed which leads to a higher degree of exploitation. Thus, the same factor which presses down the rate of profit intensifies exploitation and thereby offsets this fall. A form of intensifying exploitation through machinery without depressing the rate of profit at the same time, is the increase in the velocity of machinery. Machines are

speeded up, the worker has to work faster and thereby reproduces the value of his/her labour power in a much shorter time. It does not cost the capitalist anything, he merely pockets an increase in surplus-value and ends up with a higher rate of profit. The same happens through the lengthening of the working day either in absolute terms or by the reduction of breaks or time set aside for the maintenance and cleaning of machinery. Another factor which offsets the falling rate of profit is the depression of wages below the value of labour power. Again, this means a curtailment of necessary labour time and an increase in the production of surplus value.

An important counter-balancing tendency to the falling rate of profit is the cheapening of the elements of constant capital. The mass of the elements of constant capital is increased in relation to variable capital while the value of the elements is reduced thanks to the increased productivity of labour. The latter being a result of the application of science and technology to the production process. Another counter-factor would be the relative over-population in a country which enables new lines of production, mostly starting out with a low organic composition of capital and wages below the value of labour power.

Foreign trade is another check on the falling rate of profit. It cheapens the necessities of life which decreases the outlay in variable capital, that is, lower wages can be paid in order to reproduce the value of labour power. Thereby surplus-value automatically increases, for, the labour time necessary for the

production of value which reproduces the value of the wage is curtailed and surplus labour time is prolonged. In addition, foreign trade cheapens the elements of constant capital, in particular raw materials which can be found abroad much more cheaply than in the home country. The general rate of profit is also raised by a high rate of profit being produced by capital invested in colonies (today neo-colonies) where a cheap labour force is found. Low wages, often below the subsistance level, and labour intensive rather than capital intensive production push up the rate of profit.

The above examples point to the paradox whereby the falling rate of profit actually keeps the rate of profit up by forcing capital to take recourse to the above named measures which invariably imply the increased productivity of labour:

> The rate of profit does not fall because labour becomes less productive, but because it becomes more productive. Both the rise in the rate of surplus-value and the fall in the rate of profit are but specific forms through which growing productivity of labour is expressed under capitalism.[89]

The tendency of the rate of profit to fall is bound up with labour productivity which in turn is linked closely to the development of machinery, automation and the technological application of natural science to the labour process. Thus natural science is an ally to the contradictory nature of capitalist production; on the one hand it increases the organic composition of capital causing a fall in

the rate of profit, on the other it forces the rate of surplus-value or the rate of labour exploitation to rise. This process enables capital to expand on an ever increasing scale, that is, more and more capital is accumulated at the expense of the working population.

8. Natural Science and the Accumulation of Capital

The first part of the circuit of capital was the conversion of money into means of production and labour power, the second step was the production of commodities which contain a value equal to the original sum plus a surplus value. These commodities must now be sold for their value to be realised. This "valorisation process" is the first condition of capitalist accumulation: "Employing surplus-value as capital, reconverting it into capital, is called accumulation of capital".[90] In order for capital to accumulate, at least a part of surplus value will have to be converted into capital. If a capitalist consumed the whole part of surplus value only simple reproduction would take place, not production on an expanding scale. Accordingly, only a part of surplus value is used up as revenue by the capitalist while the rest is reconverted into capital.

The accumulation of capital inevitably results in the 'concentration' of capital. The social means of production, the instruments of labour, the total social intellect, concentrate in the hands of the capitalist class, of social capital. That is, Marx regrets, the capitalist class has become communist, but it has

left out the working class.

At the same time as capital accumulates, or concentrates the means of production into the hands of a few, it goes through the process of centralisation. Centralisation differs from concentration in that it does not depend on a growth in the magnitude of capital, but is merely a regrouping of existing parts of total social capital. Capitalist expropriates capitalist and thereby many small capitals are transformed into a few large ones. Two important levers of the centralisation of capital are competition and credit:

> ... the development of capitalist production makes it constantly necessary to keep increasing the amount of the capital laid out in a given industrial undertaking, and competition makes the immanent laws of capitalist production to be felt by each individual capitalist, as external coercive laws. It compels him to keep constantly extending his capital, in order to preserve it, but extend it he cannot, except by means of progressive accumulation.[91]

Accumulation is a law of the capitalised mode of production, capital is forced to expand, and credit and competition are but facilitators of the process of centralisation. The latter in turn speeds up the process of concentration in that it revolutionises the composition of capital by diminishing the relative need for labour and increasing the requirements for a relative enlargement of constant capital. Thus the process of centralisation, although different from accumulation or concentration, speeds up the progress of accumulation.

New capitals are formed which give the impetus to new inventions and discoveries, at the same time as the new composition of old capital requires the most perfected technical form. The result of the latter will be that a much smaller number of labourers will set in motion an ever increasing quantity of the means of production. The more advanced the centralisation process of capital the more will the labour force be reduced:

> The accumulation of capital, though originally appearing as its quantitative extension only, is effected, as we have seen, under a progressive qualitative change in its composition, under a constant increase of its constant, at the expense of its variable constituent.[92]

The labour force is thus turned into a relative surplus-population. Accumulation of wealth in the form of capital produces an 'industrial reserve army':

> The greater the social wealth, the functioning of capital, the extent and energy of its growth, and, therefore, also the absolute mass of the proletariat and the productiveness of its labour, the greater is the industrial reserve army.[93]

The social productiveness of labour increases at the expense of the labouring class. New discoveries and inventions, the application of the 'scientific intellect' to production, developments in natural science, all lead to the relative immiseration of the working class:

> ... all means for the development of production transform themselves into means of domination over, and exploitation of, the producers; they mutilate the labourer into a fragment of a man, degrade him to the level of an appendage of a machine, destroy every remnant of charm in his work and turn it into hated toil; they estrange from him the intellectual potentialities of the labour-process in the same proportion as science is incorporated in it as an independent power,...[94]

Value expansion, the augmentation of exchange-value becomes the imperative for human behaviour. The pursuit of mere quantity at the expense of quality, in particular quality of human life, also becomes the determinant for the production of knowledge of nature. Nature ceases to be respected, beautiful, in harmony with human beings,[95] and is pressed into the service of capital. Production for production's sake, the guiding force of capital, is aided by natural science. As capital accumulates with the aid of more and more sophisticated scientific methods, the lot of the worker, including his/her intellectual powers, deteriorates:

> Accumulation of wealth at one pole is, therefore, at the same time accumulation of misery, agony of toil, slavery, ignorance, brutality, mental degradation, at the opposite pole, i.e. on the side of the class that produces its own product in the form of capital.[96]

We have seen how the accumulation of capital leads to concentration and centralisation. Social capital replaces the

individual capitalist; the socialisation of labour replaces individual production. Social labour comes about "through co-operation, division of labour, and the uniting of labour with the natural sciences".[97] Scientific labour becomes all-important for the capitalist mode of production. Scientific discoveries and inventions are universalised and profit is thereby drawn "out of all new development of the universal labour of the human spirit and their social application through combined labour".[98] Labour becomes universal. The capitalist mode of production abolishes private labour and socialises labour on an ever increasing scale. That is the reason why Marx considers the technical basis of capitalist production to be revolutionary:

> By means of machinery, chemical processes and other methods, it is continually causing changes not only in the technical basis of production, but also in the functions of the labourer, and in the social combinations of the labour-process.[99]

Albeit in a contradictory form. The rigid division of labour, the creation of an industrial reserve army thanks to the introduction of machinery, the monotony of production, create a stifled and crippled labour force. The revolutionisation of the technical and social conditions of production meant the separation of mental from manual labour; it meant the development of a knowledge of production divorced from the producers themselves; it meant the development of the role of the scientist, divorced from production; and it applied natural science in the form of machine technology which rationalised,

intensified and stultified the labour process and reduced the machine operator to a mere appendage of the machine. Thus, the capitalist mode of production cannot be seen as a formal property relationship. The production of relative surplus value is not just based on the formal buying and selling of labour power and the quantitative extraction of surplus value. It is a qualitative relationship in which the necessity to produce everything in the value-form, the necessity of exchange-value to determine and mediate use-value creates a labour process not fit for human prupose. Only the abolition of capitalism will

> replace the detail worker of today, crippled by life-long repetition of one and the same trivial operation, and thus reduced to the mere fragment of a man, by the fully developed individual, fit for a variety of labours, ready to face any change of production, and to whom the different social functions he performs, are but so many modes of giving free scope to his own natural and acquired power.[100]

But the abolition of the capitalist mode of production is not just a change in the ownership of the conditions of labour; it requires a qualitative transformation of the total social relation.

9. Notes on Agriculture

Marx read and made notes from numerous amounts of literature on agriculture.[101] His manuscripts show a concern with the effects of

geology and chemistry on agriculture. In Capital III we find the reasons for this concern.

> If the composition of capital in agriculture proper is lower than that of the average social capital, then, prima facie, this expresses the fact that in countries with developed production agriculture has not progressed to the same extent as the processing industries. Such a fact would be explained - aside from all other circumstances, including in part decisive economic ones - by the earlier and more rapid development of the mechanical sciences, and in particular their application compared with the later and in part quite recent development of chemistry, geology and physiology, and again, in particular, their application to agriculture.[102]

The application of mechanical sciences in industry generally preceeded the application of chemistry, geology and physiology to agriculture. This has left agriculture more labour intensive than the processing industries; a negative state of affairs for capital to be overcome by the intervention of natural science. A high composition of capital will increase the production of surplus value in agriculture and thereby will raise the rent of land.

Marx's analysis of rent was one of the objectives of his study of agriculture. Rent is, just like interest, a deduction of surplus value. The rentable value of land depends on the amount of surplus value produced and realised, which in turn depends at least partially on labour and the movement of market prices.

However, other factors enter the determination of rent. Marx explains that 'differential rent', in distinction from 'absolute rent', arises either from unequal capital investment or from differences in fertility of the land:

> So far as the difference in rent is concerned, provided equal capital is invested in land areas of equal size, it is due to the difference in natural fertility, in the first place, specifically with regard to those products which supply bread, the chief nutriment; provided the land is of equal size and fertility, differences in rent arise from unequal capital investment.[103]

Leaving aside capital investment and location (e.g. land situated near commercial centres), which Marx also considers important for the determination of rent, differential rent depends on fertility. That is, not rent itself is determined by varying fertility of land, but only differences in rent. This difference in natural soil fertility in turn depends on different stages of agricultural development. In other words, fertility of soil changes with the development of natural science:

> Fertility, although an objective property of soil, always implies an economic relation, a relation to the existing chemical and mechanical level of development in agriculture,...[104]

That is exactly the reason why Marx thought it so important to study

agriculture in all its aspects (chemical, geological, mechanical, etc). A study which would provide more understanding of rent than economists writing on the subject would provide:

> ... the real natural causes leading to an exhaustion of the soil ... were unknown to all economists writing on differential rent owing to the level of agricultural chemistry in their day,...[105]

The 'economic relation' is the 'progressive' application of natural science to agriculture, that is, the development of methods in chemistry, physiology, geology to increase the fertility of the soil whereby the "irrational, old fashioned methods of agriculture are replaced by scientific ones".[106] Apart from replacing the peasant by the wage labourer in the sphere of agriculture, an important effect of the capitalist mode of production is that "it transforms agriculture from a mere empirical and mechanical self-perpetuating process employed by the least developed part of society into the conscious scientific application of agronomy, in so far as this is at all feasible under conditions of private property".[107]

Here we are in full swing of the 'dialectic': development of science for profitability; yet it is precisely the latter which holds back the 'proper' application of science. Marx finds even bourgeois scientists to have pointed this out. The agriculturalists had a good understanding of the 'economic relation' of soil fertility, realising that relation to serve particular interests:

> To have developed from the point of view of natural science, the negative, i.e. destructive side of modern agriculture, is one of Liebig's immortal merits.[108a] - Very conservative agricultural chemists, such as Johnston, admit that a really rational agriculture is confronted everywhere with insurmoutable barriers stemming from private property.[108b]

Capitalist production, yet again, undermines any proper and beneficial agricultural activities, for "the whole spirit of capitalist production, which is directed toward the immediate gain of money - are in contradiction to agriculture, which has to minister to the entire range of permanent necessities of life required by the chain of successive generations".[109] It is in the interest of capital to exploit the soil for immediate, short-term gains, which means the soil, rather than being enriched through agricultural methods, is rendered useless for long-term purpose:

> ... all progress in capitalistic agriculture is a progress in the art, not only of robbing the labourer, but of robbing the soil; all progress in increasing the fertility of the soil for a given time, is a progress towards ruining the lasting sources of that fertility.[110]

Thereby, for generations to come, the soil will have been deprived of its nutrient assets. Natural science has to consist of methods which exploit nature for short-term profitability rather than provide for the need of humanity. Not only does capitalist production impoverish the soil, but also the labourer:

> In agriculture, as in manufacture, the transformation of production under the sway of capital, means, at the same time, the martyrdom of the producer; the instrument of labour becomes the means of enslaving, exploiting, and impoverishing the labourer, the social combination and organisation of labour processes is turned into an organised mode of crushing out the workman's individual vitality, freedom, and independence.[111]

In addition, the separation between town and country, necessary for capitalist production, prevents the recycling of matter necessary for the soil and destroys "the health of the town labourer and the intellectual life of the rural labourer".[112] Marx here repeats what he had already analysed in the German Ideology. The division of rural and urban life, the destruction of the soil and the poor health of the working population is a result of capitalist relations. His analysis in Capital shows how this process is aided by natural science.

CHAPTER 5

NATURAL SCIENCE AND VALUE-IN-PROCESS

So far we have looked at the capitalist production process, that is, the production of value. Marx now moves from his analysis of value production to an analysis of value-in-process; and volume II of Capital is indicatively subtitled The Process of Circulation of Capital. The question of circulation and the circuits of capital had been discussed in volume I only to the extent that they were directly linked to the analysis of the production process. The object of analysis was the commodity, i.e. products produced in the value-form, and the production of surplus-value. However, the circulation of capital, the realisation and distribution of surplus value (Trinity formula), far from being ignored by Marx, were precisely the object of his critique, but from the perspective of the production process. Now he turns to a serious analysis of circulation. Value has to be sold as well as being produced; and it has to reenter the production process in order to ensure the continuation of the total process of capitalist production. The quicker this process the better for capital accumulation. Therefore, capital is constantly trying to speed up circulation (as well as production), and, as we shall see, natural science plays a major part in this process.

1. The Circuits of Capital

The circuits of industrial capital comprise the circuit of money capital, the circuit of productive capital and the circuit of commodity capital. However, those circuits cannot be taken in isolation from each other but have to be seen together in order to provide a complete picture of the capitalist process: "The actual circuit of industrial capital in its continuity is ... not alone the unity of the process of circulation and production but also the units of all its three circuits".[1] It is only for purpose of analysis that Marx explains the three circuits in separation. He first introduces the circuit he had already analysed in volume I, the circuit of money capital: $M - C \begin{matrix} L \\ MP \end{matrix} \ldots P \ldots C' - M'$. This explains his theoretical procedure:

> The first and third stages were discussed in Book I only in so far as this was necessary for an understanding of the second stage, the process of production of capital. For this reason, the various forms which capital takes on in its different stages, and which it now assumes and now strips off in the repetition of its circuit, were not considered. These forms are now the direct object of our study.[2]

The circuit of money capital immediately reveals the class relations of the capitalist mode of production, i.e. it presupposes money sufficient to purchase means of production and labour power. It presupposes means of production separated from the labourer and

thus capable of purchase by the non-labourer and it presupposes, because of the spearation of the labourer from the means of production, the need for the labourer to sell their labour power to the capitalist. It thus shows that the combination of the factors of production in the actual process of production is a function of and subservient to capital. The remainder of the formula stresses what was already contained in Capital I, i.e. the production of surplus value for the capitalist; the fact that profit is generated in the production process and thus that profit is not to be explained as a surcharge.

Taken in isolation, this circuit is inadequate. But apart from pinpointing the class character in its first phase, i.e. $M - C \begin{matrix} L \\ MP \end{matrix}$, it has the merit of corresponding to Marx's historical statement in Capital I that all capital and all new capital emerge in the form of money. Thus, this formula, while presupposing the separation of the labourer from his means of production, does not presuppose that the means of production are produced by the capitalist mode of production. Nor does it introduce the reproduction of capitalism. Thus, it could be taken in a historical sense as the starting point of the capitalist mode of production.

The continuation of the circuit brings us to the circuit of productive capital, $P \ldots C' - M' \; . \; M - C \ldots P$. This, with its emphasis on production, is the dominant circuit of classical political economy. It reveals the origin of surplus value in production. But, just as $M \ldots M'$ seemed to be a function of money as such, $P \ldots P$ seems to be a function of production as such. And like the circuit of money capital it does not presuppose capitalism.

While introducing the reproduction of capitalism, it does not do so with reference to total social capital.

Continuing, we get the third and final circuit: commodity-capital, $C' - M' \ . \ M - C \ ... \ P \ ... \ C'$. This circuit presupposes capitalism in that it stresses the fact of the continued capitalist nature of production in as far as the commodities (C') themselves are seen as being produced by the capitalist mode of production. Thereby it provides the key to total social capital and its reproduction. As Marx explains at length in Capital III, capitalism

> produces its products as commodities ... being a commodity is the dominant and determining characteristic of its products. This implies, first and foremost, that the labourer himself comes forward merely as a seller of commodities, and thus as a free wage-labourer so that labour appears in general as wage-labour ... the relation between capital and wage-labour determines the entire character of the mode of production ... The characteristic 1) of the product as a commodity, and 2) of the commodity as a product of capital already implies all circulation relations, i.e. a definite social process through which the products must pass and in which they assume definite social characteristics; it likewise implies definite relations of the production agents, by which the value-expansion of their product and its reconversion, either into means of subsistance or into means of production, are determined. But even apart from this the entire determination of value and the regulation of the total production by value

> results from the above two characteristics of the product as a commodity, or of the commodity as a capitalistically produced commodity... Furthermore, already implicit in the commodity, and even more so in the commodity as a product of capital, is the materialisation of the social features of production and the personification of the material foundations of production, which characterise the entire capitalist mode of production.[3] (my emphasis)

As explained in chapter IV the production and circulation of commodities, including the commodity labour power, is the differencia specifica (together with the production of surplus value) of the capitalist mode of production. Marx again emphasises that "the production of commodities does not become the normal, dominant type of production until capitalist production serves as its basis".[4] But as soon as the formal characteristics of capitalism are established "use-value is universally mediated by exchange-value".[5] The totality of capitalist social relations, including natural science, is reproduced in the value-form. The conditions of production, i.e. labour power and means of production leave circulation and enter production as commodities.

2. The Reproduction of Capital

These three circuits (money-capital, productive-capital, commodity-capital), that is, this constant movement of value through production and circulation are part of the reproduction process of capital. Whereby Marx does not just mean the reproduction of

commodities and capital but also the reproduction of the total social relation, that is the reproduction of the working class and the capitalist class, i.e. the class character of the capitalist mode of production:

> It is not just the objective conditions of the process of production that appear as its result. The same thing is true also of its specific social character. The social relations and therefore the social position of the agents of production in relation to each other, i.e. the relations of production, are themselves produced: they are also the constantly renewed result of the process.[6]

In order to explain the concrete reproduction of capitalism, hence the reproduction of the class relationship, Marx introduces the 'reproduction scheme'. Capitalism produces means of production (department I) and consumer goods (department II). Value has to be replaced in the material form of means of production for department I and II, and the value of labour power of the working class in both departments has to be replaced by consumer goods produced in department II. The products produced in the two departments have to reenter the production process either in the form of 'productive consumption' or 'individual consumption':

> The annual product includes those portions of the social product which replace capital, namely social reproduction, as well as those which go to the consumption-fund, those which are consumed by labourers and by capitalists, hence both productive and individual

> consumption. It comprises also the reproduction (i.e. maintenance) of the capitalist class and the working class, and thus the reproduction of the capitalist character of the entire process of production.[7] (my emphasis)

The social relations of capitalism reappear in the social relations of natural science; and the reproduction of the class relation of capitalism concerns every aspect of this relation: the reproduction of the split between mental and manual labour, the reproduction of a scientific, intellectual elite (albeit subjected to capital), and the reproduction of an intellectually and physically impoverished class of manual workers.

The specifically capitalist nature of production, i.e. universal commodity production requires scientific production to appear in the value-form. The specific use-values natural science creates are determined by value relations. In Capital I Marx explained that for a commodity to have an exchange value it first has to be an object of utility, it has to be a use-value. Now the story is reversed. In capitalism exchange-value posits use-value. In as far as the products of individual and productive consumption are consumed as use-values (e.g. cloth, food, machinery, etc) the material form of these products become very important. The reproduction of the social relation in the value-form (commodities, money, capital) requires the production of specific use-values:

> So long as we looked upon the production of value and the value of the product of capital individually, the bodily

> form of the commodities produced was wholly immaterial for the analysis, whether it was machines, for instance, corn, or looking glasses. It was always but a matter of illustration, and any branch of production could have served that purpose equally well. What we dealt with was the immediate process of production itself, which presents itself at every point as the process of some individual capital. So far as the reproduction of capital was concerned, it was sufficient to assume that that portion of the product in commodities which represents capital-value finds an opportunity in the sphere of circulation to reconvert itself into its elements of production and thus into its form of productive capital; just as it sufficed to assume that both the labourer and the capitalist find in the market those commodities on which they spend their wages and the surplus-value. This merely formal manner of presentation is no longer adequate in the study of the total social capital and of the value of its products. The reconversion of one portion of the value of the product into capital and the passing of another portion into the individual consumption of the capitalist as well as the working-class form a movement within the value of the product itself in which the result of the aggregate capital finds expression; and this movement is not only a replacement of value, but also a replacement in material and is therefore as much bound up with the relative proportions of the value-components of the total social product as with their use-value, their material shape.[8]

Value, including the exchange-values of the products of natural

science, has to be replaced in a material shape which will perpetuate the social character of capitalism.

Capitalist production, however, "is not merely the reproduction of the relationship: it is its reproduction on a steadily increasing scale".[9] Not only does it comprise the reproduction of the total social capital, but in order to accumulate, to reproduce itself on an ever increasing scale, capital has to expand. Value expansion requires an accompanying expansion of use-values: existing consumption has to be increased, new needs have to be created, new use-values have to be discovered. Capitalism now becomes dependent on the

> ... exploration of all nature in order to discover new, useful qualities in things; universal exchange of the products of all alien climates and lands; new (artificial) preparation of natural objects, by which they are given new use-values. The exploration of the earth in all directions, to discover new things of use as well as new useful qualities of the old; such as new qualities of them as raw materials, etc; the development, hence, of the natural sciences to their highest point...[10]

Natural science becomes essential for capital reproduction on an extending scale. New machinery has to be invented to speed up production and thereby the circulation of capital. New consumer goods have to be created for working class consumption. Capitalism finds an ally in natural science for its need to accumulate, i.e. to reproduce on an ever extending scale. Science makes possible the

supply of new use-values and thereby increases value production. 'Production for production's sake' requires the invention of more and more consumer goods: synthetic products (a cheap replacement for natural ones), electric goods, new food products, etc. Capitalism creates new needs; natural science helps to invent products for the satisfaction of those needs.

3. The Turnover of Capital

Capital going through a whole circuit $M - C \ldots P \ldots C' - M'$, reproducing itself on an extending scale, Marx names the 'turnover of capital'. For capital to realise itself (including the newly produced surplus value) it has to go through one turnover period. This period includes production time (P) and circulation time (sale: $C' - M'$, and purchase of new machinery and labour power: $M - C^{LP}_{M}$). The faster capital can turn over the faster can it accumulate. Natural science helps to do precisely that. It helps to speed up the labour process (as we have already seen in chapter IV), as well as the buying and selling process. We shall look at the two periods (production and circulation) of the turnover of capital in relation to natural science.

Let us first consider production time which includes working time (the actual labouring of the worker), functioning time (operation of natural processes), and non-functioning time (that time in which the means of production lie idle, e.g. at night). Thus, apart from the non-use of the means of production and the actual labour process

of the worker, capital is engaged in a period in "which its form of existence - that of an unfinished product - is abandoned to the sway of natural processes".[11] Examples of these are the fermentation of grapes, drying processes in potteries, exposure for bleaching, maturing process of winter grain, the growth of timber, chemical processes in tanneries. In this period

> We are dealing ... with interruptions ... brought about by the very nature of the product and its fabrication, during which the subject of labour is for a longer or shorter time subjected to natural processes, must undergo physical, chemical and physiological changes,...[12]

Natural science is used to artificially reduce these natural processes and thereby reduce the functioning process of production time.

> Such instances are the introduction of chemical bleaching instead of bleaching on the green and more efficient drying apparatus. Or, in tanning, where the penetration of the tannic acid into the skins, by the old methods, took from six to eighteen months, while the new method, by means of an air-pump, does it in only one and a half to two months... The most magnificent illustration of an artificial abbreviation of the time of production taken up exclusively with natural processes is furnished by the history of iron manufacture, more especially the conversion of pig iron into steel during the last 100 years, from the puddling process discovered about 1780 to the modern Bessemer process and the latest method introduced since.[13]

The scientists' knowledge of physical, chemical and physiological processes, applied to production, will help reduce the functioning time of production which will speed up the turnover period of capital and thereby the accumulation process. Even the non-functioning time of production time can be reduced thanks to automation and the use of robots which require a low level of human attendance and can therefore be set to work at night when previously the means of production have lain idle.

In chapter four we have already discussed how working time is reduced by the introduction of new technology. The working period is cut drastically by the application of scientific principles to the production process, effecting an increase in the accumulation of capital by shortening the turnover period. This can also be achieved by the speeding up of machinery which will force the labourer to work faster and therby reduce the working period. As another example of a scientific attempt to reduce the working period, Marx discusses Bakewell's system of sheep production. By careful selection the skeleton of sheep is reduced to a minimum required for existence. The sheep is fattened when only one year old and reaches full growth before the end of the second year with most of its weight being pure meat. Thereby science achieved in under two years what nature could only deliver in five. Such methods have since been introduced to the production of other meats and food products.

We have shown how actual working time is reduced through the technological application of the sciences in the form of new machinery, new inventions. We have also explained how production time is significantly curtailed by the reduction of functioning time

and the working period thanks to the help of natural science. What remains to be seen is its role in the curtailment of circulation time.

In order to speed up the turnover of total social capital it is not enough to reduce the time of production; circulation time (C′- M′, M - C) and costs have to be reduced to a minimum. The turnover time of total social capital "is equal to the sum of its production time plus its circulation, or rotation, time. It is therefore a matter of course that a difference in the time of circulation causes a difference in the time of turnover and hence in length of the period of turnover".[14] Circulation includes buying, selling, book-keeping, storage and transportation, time and cost of which will have to be cut. The role of science is to do precisely that.

Book-keeping and office work in general increases with the development of capital (in particular in the form of banking). Office work however is cheapened "because the necessary training, knowledge of commercial practices, languages, etc, is more and more rapidly, easily, universally and cheaply reproduced with the progress of science..."[15] Today one can add the use of computers and micro-processors which make office work more productive[16] and therefore less time and cost consuming.

Credit facilities have speeded up the transition from C′ to M′ and from M to C, i.e. the selling process of the newly produced commodities as well as new purchase of machinery and labour power, and have thereby reduced turnover periods. As Marx states in

Capital III: "credit effects and thereby increases the velocity of circulation".[17] And credit facilities, like the circulation of money in general, are increased by improved means of communication like penny postage, telegraphy and railways.

Storage is another important factor in circulation: "The form in which a commodity exists, its existence as a use-value, sets definite limits to the circulation of commodity-capital $C' - M'$".[18] In other words, use-values are perishable and can therefore only be stored for a certain amount of time. Refridgeration is an important invention, supplied by science, which alleviates this problem. So is the preservation of spoilage by chemistry's use of preservatives and pasteurisation. Synthetically produced commodities which can be stored for long periods, replace natural ones for "the more perishable a commodity is and the greater the absolute restriction of its time of circulation as commodity on account of its physical properties, the less is it suited to be an object of capitalist production".[19]

One of the most effective and important means to speed up the ciruclation and thereby the turnover of capital is transportation. Improvement of transport cuts down drastically the circulation time of commodities. The steam engine worked wonders for capital, and improved and extended transportation networks enlarged national and international markets (e.g. shipping, air transportation, rail networks). In fact, as Gareth Stedman Jones upholds, it was precisely through development of transport facilities that capital got out of its crisis in the early nineteenth century: "railway-

building is what, more than anything else, resolved the capitalist crisis of the thirties and early forties. It lessened the impact of cyclical crisis, stimulated coal, iron, steel and machine production and resolved the crisis of profitability".[20]

In addition, improved means of communication have helped to cut down on the circulation time of capital. Thanks to the telephone and telegraph buyer and seller do not need to meet on the market and the stages C - M and M - C^{LP}_{M} can be reduced drastically, as well as markets enlarged:

> Whereas on the one hand the improvement of the means of transportation and communication brought about by the process of capitalist production reduces the time of circulation of particular quantities of commodities, the same progress and the opportunities created by the development of transport and communication facilities make it imperative, conversely, to work for ever more remote markets, in a word - for the world-market.[21]

In this instance the technological application of science helps capitalism to impose its system onto the world at large, as well as to increase its home markets by the introduction of foreign commodities.

However, increased transport networks, improved means of communication and chemical preservation of perishable goods do not eliminate the vicissitudes of the market. Again natural science

steps in, replacing natural products by synthetic ones. Natural products can severely limit the realisation of the circuit of capital. For example, Marx explains, the wool market in London was controlled by auction sales of wool taking place every three months. The production and sale of synthetic clothes is not handicapped in this way. Similarly the natural limitations imposed on agricultural goods are combatted by agricultural techniques like crop rotation, fertilisers and selective breeding.

We can conclude that natural science plays a very significant part in the turnover period of capital. Means of communication like telephone, telegraph, postage, help the circulation of money and credit facilities, and together with improving transportation speed up the buying/selling process and help to create the world market. The use of science in decreasing spoilage in perishable goods or replacing them with synthetic products altogether has helped capital accumulation, as has the invention of more and more consumer goods. The productivity of accounting, banking, clerical work has greatly increased through sophisticated computing methods. The functioning time of the production period has been reduced by speeding up biological, chemical and physiological processes. Last, but not least, the industrial labour process is a direct outcome of the technological application of natural science. Capital accumulation, i.e.value in process, requires scientific production for the perpetuation of its <u>differencia specifica</u>: commodity production and the exploitation of the working class.

CONCLUSION

In spite of his enthusiastic stance towards the developments in the natural sciences, Marx has provided the most devastating critique of the latter in the context of his analysis of capitalist social relations, which shows how the capital-form stamps its mark on the appropriation of knowledge of nature; thus, natural science cannot be viewed as an autonomous force independent of the social relations it finds itself in. However, this does not imply an apocalyptic attitude towards natural science, not a destruction of all its results (although of some!), but a differentiated view, in particular as to its social determinants and its practice. Both, the practice and products of natural science are determined by capital; as Marx explains, within the social relations of capital the use-value of commodities is universally mediated by exchange-value, that is, exchange-value posits use-values:

> ... the production in enormous mass quantities which is posited with machinery destroys every connection of the product with the direct need of the producers, and hence with the direct use value; it is already posited in the form of the product's production and in the relations in which it is produced that <u>it is produced only as a conveyor of value</u>,

and its use value only as a condition to that end.[1]

(my emphasis)

Exchange-value determines the production of specific use-values. Profitable use-values take predominance: weapons rather than socially useful products, private car production rather than improvements in public transport, drugs rahter than healthy food products, etc. Not only are the products of natural science posited by exchange-value, natural science itself appears in the value-form, is a commodity: a practice, or a knowledge which is bought and sold; determined and mediated by exchange-value. The scientific expert who sells his/her knowledge to capital, or whose labour power has the use of producing scientific knowledge is framen by capital. S/he is forced to produce a knowledge which is profitable, its use is subjected to that principle. Thus, knowledge production is not consciously regulated, but determined by value relations which necessitate a production process characterised by expertism, elitism, a divorce from manual production, and an exclusion of the majority of poeple. Even science's "application to the material process of production takes place in isolation from the knowledge and abilities of the individual worker".[2]

At the same time as capital obtains knowledge independently from manual labour, it creates a division between the manual and the scientific worker. Capital is, of course, dependent on a divided working class; divisions on tne basis of sex, race, income, education, ect, help to create hostilities amongst the working

people, which diverts the concentration on the real enemy: capital. All the more pressing is the task of the radicalisation of the scientific worker who has to question the practice s/he is engaged in and recognise its social determinants. Political practice within and outside science has to aim at the abolition of value relations and the transformation of a production process characterised by an extreme split between stultifying manual work and the scientific expert. Revolutionary struggle has to oppose the current practice of natural science, attacking it and changing it at all levels, including its concepts, designs and criteria. In the light of the arms race, nuclear power stations, ecological disaster (e.g.acid rain killing forests and lakes, chemical and nuclear waste polluting the sea and rivers, etc.) the most conservative of Marxists will have to give up asserting science's objectivity and neutrality, extending a critical attitude beyond the capitalist misuse of science, and question the social determinants as well as the practice of science itself.

APPENDIX 1

Marx and Darwin

Marx and Darwin have been closely linked in the history of Marxism. The topic has been written on exhaustively ever since Engels linked the two men at his graveside speech: "Just as Darwin discovered the law of development of organic nature, so Marx discovered the law of development of human history".[1] He repeats this claim in his preface to the English edition of the Communist Manifesto.[2] Engels himself, as we have seen in chapter II, follows an evolutionist method; this form of Marxism is continued in the German Social Democratic Party where Darwinism and Socialism are inextricably linked in articles in the Neue Zeit. In particular, Kautsky and Aveling are clear advocators of the Marx-Darwin marriage.[3] And, of course, in spite of revolutionary rhetoric, an evolutionary politics is finally adopted by the SPD. Lenin, quite in line with his inability to break with SPD reformism (see chapter II) is taken in by Darwinist Marxism.[4]

The final endorsement of the affinity between Marx and Darwin appears with the publication of two letters apparently written by Darwin to Marx (we now know that only one of these letters was addressed to Marx). The first was published by Edward Aveling

in his Charles Darwin and Karl Marx in 1897, the second by Ernst Kolman in Under the Banner of Marxism in 1931.[5] Aveling, an ardent admirer of Darwin, writes:

> Many of our opponents hold that the teachings of Darwin and that of Marx are antagonistic; that the theory of Natural Selection especially is in opposition to our opposition to Capitalism. I cannot here analyse this statement which appears to me entirely inaccurate ... but I should like to quote a letter from Darwin to Marx, which appears to me very characteristic and very beautiful.[6]

The letter, however, far from being 'very beautiful', is simply polite with Darwin distinctly distancing himself from Marx:

> Oct. 1, 1873
>
> Dear Sir
>
> I thank you for the honour which you have done me by sending me your great work on Capital; & I heartily wish that I was more worthy to receive it, by understanding more of the deep & important subject of political Economy. Though our studies have been so different, I believe that we both Earnestly desire the extension of knowledge, & that this in the long run is sure to add to the happiness of Mankind.
>
> I remain Dear Sir
>
> Yours faithfully
>
> Charles Darwin[7]

Marx, being very concerned about the scientific recognition of his work had indeed sent a copy of volume I of Capital to Darwin (as well as to Herbert Spencer!).[8] No accompanying letter has been found, but Marx inscribed the copy as follows:

> Mr Charles Darwin / On the part of his sincere admirer / Karl Marx / London 16 June 1873 / Modena Villas / Maitland Park.[9]

The copy survived and is kept in Darwin's Down House home. It is clear that Darwin never read it. According to Howard Gruber "his copy of Das Kapital has none of the pencil annotations which he made in books he owned and read, and its pages are cut as far as page 105, but uncut from there to the end page 822".[10] The references to Darwin are on pages 352 and 385-6 (323 and 352 English edition).

It was Ernst Kolman who, in 1931, first spread the famous myth that Marx wanted to dedicate volume II of Capital to Darwin.[11] A myth which has been repeated ever since by Marx's biographers and commentators[12] in spite of sufficient evidence pointing to the contrary: e.g. Engels' statement that Marx wanted to dedicate volume II to his wife, the fact that in 1880 the manuscript for volume II was still in a shamble and nowhere near ready, let alone the 'proofs' (referred to by Darwin), and Marx's sceptical remarks about Darwin. The only evidence in favour of this myth was a letter by Darwin (October 13, 1880), which we now know was in fact sent to Aveling:

> Dear Sir
>
> I am much obliged by your kind letter & the Enclosure. - the

publication in any form of your remarks on my writings really requires no consent on my part, & it would be ridiculous in me to give consent to what requires none. - I sh^{d}. prefer the Part or Volume not be dedicated to me (though I thank you for the intended honour) as this implies to a certain extent my approval of the general publication, about which I know nothing. -Moreover though I am a strong advocate for free thought on all subjects, yet it appears to me (whether rightly or wrongly) that direct arguments against christianity & theism produce hardly any effecton the public; & freedom of thought is best promoted by the ("gradual" added) illumination of ("the" deleted, "men's" added) minds; which follow from the advance of science. It has, therefore, been always my object to avoid writing on religion, & I have confimed myself to science. I may, however, have been unduly biased by the pain which it would give some members of my family, if I aided in any way direct attacks on religion. - I am sorry to refuse you any request, but I am old & have very little strength, & looking over proof-sheets (as I know by present experience) fatigues me much. - I remain Dear Sir / yours faithfully / Ch. Darwin[13]

This letter is quite clearly the answer to a letter sent by Aveling to Darwin the previous day:

Royal Polytechnic.

W.

12.10.80

Dear Sir

Many months ago I ventured to send to you the earlier numbers

of a series of articles on your works. To these you were good enough to express your approval. The Magazine wherein they appeared came to an untimely end and I have since its decease rewritten the articles & published them together with many others, their successors in the National Reformer. The works hitherto dealt with are the Voyage, Volcanic Islands, Geology of S. America, Orchids, Climbing Plants, Insectivorous Plants. I purpose after a study of the Forms of Flowers & Cross & self-fert^{n}. dealing with the Cirripedia & finally with the series commencing with the Origin & ending at present with the Emotions.

My friends Mrs Annie Besant and Charles Bradlaugh, MP contemplate publishing under the title of the International Library of Science & Freethought a series of works either by great scientific and freethinking men or upon their labors. The first of the series will be a translation of Dr L. Büchner's "An dem Geistes leben der Thiere" by Mrs Besant. To this translat^{n}. Dr Büchner has given full assent. A translat^{n}. of some work from the pen of Enrst Häckel by myself is also designed and other arrangements in regard to French & Italian works are pending. We desire to make the second volume of the series my work upon your writings and teachings. To you, Sir, therefore I again write to know if such a plan will meet with your approval and have the distinct advantage of your personal sanction. We desire from you as from Dr Büchner and Professor Häckel the illustrious support of your consent. As it is long since I last wrote, I remind you that the volume we desire to produce is designed 1 to give students of your writings a condensed analysis thereof 2 to give those

who have not time to read your productions a brief account of your discoveries and ideas.

Further I purpose, again subject to your approval, to honor my work and myself by dedicating the former to you. If you approve of this my wish & of the general plan of our second publicat^{n}., I need hardly say to you how honoured we should be were you to see fit to give us the immense support of a few words stating that approval. This would without doubt aid us very greatly in our endeavor to reach large numbers of those whoare yet but little acquainted with the thought-work of the 19th century, work with which your name must be for ever associated so closely. I forward herewith a litle (sic) pamphlet of Dr Büchner's already translated into English by Mrs Besant & if it will not be troubling you too greatly I should be very glad to send to you the proof-sheets of my work as they are issued. With the hope that the help of your approval may be ours

I am
yours faithfully
Edward B. Aveling (signed)
D.Sc.Lond.[14]

How then did Darwin's letter of 1880 get into Marx's literary remains? As is well known, Edward Aveling was Eleanor Marx's 'common-law husband' and an admirer not only of Darwin but also of Marx. After Engels' death Marx's personal correspondence went to Eleanor Marx who wanted to write a biography of her father. Aveling

helped her sorting and after writing his Charles Darwin and Karl Marx Darwin's letter could easily have slipped into the Marx - Nachlass. After Eleanor's death the latter was taken over by Karl Kautsky, then by the archives of the Social Democratic Party in Berlin, and later, due to German fascism, transferred to Amsterdam's Institute for Social History where most of Marx's manuscripts are still kept today. Copies had also been sent to Moscow from Berlin, probably including Darwin's letter to Aveling, which was published in Russian translation in 1931 by Ernst Kolman who was convinced that Marx had been the addressee.

This should be enough evidence to dispense with the myth that Marx wanted to dedicate volume II of Capital to Darwin. What remains to be seen is what Marx did think of the scientist. As we know, Marx was very keen on following the developments in natural science, not least in biology. Marx refers indeed to the Origin of Species as an "epoch-making work",[15] and after attending, together with Wilhelm Liebknecht, a series of six lectures in which Thomas Huxley popularised and explained Darwin's ideas to an audience of English workers, Liebknecht reports: "We spoke of nothing else for months but Darwin and the enormous significance of his scientific discoveries..."[1] But Marx's enthusiasm certainly seems to disappear after his two readings (1860 and 1862) of the Origin of the Species. Darwin only gets two mentions in Capital and one in the Ethnological Notebooks.[17]

In 1860, having just read Darwin, Marx writes to Engels: "Although crudely developed in the English manner, this book contains the natural-historical basis of our outlook."[18] Lasalle receives a similar letter in 1861:

> Darwin's book is very important and it suits me well that it supports the class struggle in history from the point of view of the natural science. One has, of course, to put up with the crude English method of discourse. Despite all deficiencies, it not only deals the death blow to 'teleology' in the natural sciences for the first time but also sets forth the rational meaning in an empirical way...[19]

The second letter to Engels in 1862 is already much more sceptical:

> Darwin, whom I have looked up again, amuses me when he says he is applying the 'Malthusian' theory also to plants and animals, as if with Mr Malthus the whole point were not that he does not apply the theory of plants and animals but only to human beings - and with geometrical progression - as opposed to plants and animals. It is remarkable how Darwin recognises 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 Phänomenologie, where civil society is described as a 'spiritual animal kingdom', while in Darwin the animal kingdom figures as civil society...[20]

This should suffice for a clear indication as to Marx's distance to any biological explanation of either history or society. Darwin transcribes nineteenth century laissez-faire market economy into nature, (just as Hobbes had imposed capitalist characteristics on

his 'state of nature'), which is, of course, unacceptable to Marx whose point against classical political economy was to 'denaturalise' capitalism, i.e.to show it up as a specific historical form of a social formation. Complaining about Darwinism Marx writes to his daughter and son-in-law, Laura and Paul Lafargue:

> Darwin was induced by the struggle for existence in English society - the war of all against all, bellum omnium contra omnes - to discover the struggle for existence as the ruling law of 'beast' and plant life. Darwinism to the contrary looks upon this as the decisive reason for human society to never emancipate itself from its bestial being.[21]

After this Darwinists fare rather badly in Marx's evaluation. Lange and Büchner are frowned upon, in particular their attempt to marry Darwinism and Socialism, which in Büchner's case is dismissed as "superficial rigmarole".[22] Lange gets the stick even worse:

> Mr Lange has made a great discovery. The whole of history can be brought under a single great natural law. This natural law is the phrase (in this application Darwin's expression becomes nothing but a phrase) 'struggle for life', and the content of this phrase is the Malthusian law of population or, rather, overpopulation. Thus, instead of analysing the 'struggle for life' as represented historically in various definite forms of society, all that has to be done is to translate every concrete struggle into the phrase 'struggle for life', and this phrase itself into the Malthusian

'population fantasy'. One must admit that this is a very impressive method - for swaggering, sham-scientific, bombastic ignorance and intellectual laziness.[23]

These lengthy quotations should dispense with any future attempt to pair off Marx and Darwin, or worse still, Marx and Darwinism.

APPENDIX 2

Marx and the Dialectic of Nature

Having dispensed with Darwin a few comments are required as to the "dialectic of nature", a philosophy often attributed to Marx,[1] but, as we have seen in chapter II, first initiated by Engels. We followed the development of this philosophy within Marxism and we disclosed Marx's analyses to be in contradiction to such ontological and epistemological claims. What remains to be shown is if Marx had anything to say on the matter at all. He did not.

In his correspondence with Marx, Engels did indeed air his thoughts on the dialective of nature. But Marx, who had something to say on almost every subject, did not comment. A letter of Engels to Marx links the cell (works on which Marx himself showed an interest[2]) to the Hegelian being-in-itself, and the fully developed organism to the Idea.[3] Marx follows Engels' request to send him Hegel's Philosophy of Nature, but his reply does not deal with Engels' speculations. When Engels further elaborates his thoughts on dialectical nature, Marx simply replies: "Just received your letter which has quite edified me. However, I shall not risk judgement, till I have had time to think the matter over, as well as to consult the 'authorities'".[4] These authorities are Carl Schorlemmer, a chemist,

and Samuel Moore, a physician, both lifelong friends of Marx and Engels. But, while Schorlemmer's agreeing comments are to be found in Engels' letter, Marx does not take up the matter.

However, Marx was familiar with Engels' Anti-Dühring in which Engels already expressed the same ideas later to be found in the Dialectics of Nature. Marx considered it to be an important text for a correct evaluation of German socialism.[5] He also, of course, knew Engels to be working on the Dialectics of Nature: referring to it in 1876, he tells Liebknecht that Engels, in order to write the critique of Dühring, had to give up writing an 'important work'.[6] But the nearest Marx himself got to any statement about Hegel's dialectical laws being operative in nature is his comparative remark to history in volume 1 of Capital. Pointing to the necessity of a certain amount of money having to be amassed for it to be turned into capital, he adds a commonplace: "Here as in natural science, is shown the correctness of the law discovered by Hegel (in his 'Logic'), that merely quantitative differences beyond a certain point pass into qualitative changes".[7]

Nevertheless, it has long since been shown convincingly that Marx did not uphold such a general a-historical view of the world as the philosophy of 'dialectical materialism' represents.[8] Our findings too have shown such a philosophy to be in contradiction with Marx's historical analysis of the social relations of capitalism.

NOTES

Introduction

1. Karl Marx, Capital I, London: Lawrence & Wishart, 1974, p.80.

Chapter I

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2. Karl Marx and Friedrich Engels, Lettres Sur Les Sciences De La Nature (et les mathématiques), Paris: Editions Sociales, 1973.
3. Marx-Engels Archive, Amsterdam, B 51, p. 40.
4. Marx to Engels, 6.5.1859, Karl Marx and Friedrich Engels, Werke 29, Berlin: Dietz Verlag, 1956-68, p. 429. (Hereafter referred to as MEW).
5. Marx read Carpenter, Lord, Kölliker, Spurzheim, Schwann, Schleiden, MEW 30, p. 418.
6. Marx to Engels, 4.7.1864, MEW 30, p. 418.
7. Marx to Engels, 5.5.1851, MEW 27, p. 245.
8. Marx to Engels, 13.2.1866, MEW 31, p. 178.
9. Marx to Engels, 3.1.1868, MEW 32, p. 5.
10. Marx-Engels Archive, Amsterdam, B 49, pp. 34-46; B 50, pp. 20-27; B 59, pp. 1-7, 34-35; B 106, pp. 29-135, 281-264; B 107, pp. 53-

75; B 112, pp. 3-9, 48-59, 89-103; B 138, pp. 56-95; B 143, pp. 2, 23-24; B 144, pp. 3-10; B 145, pp. 3-110, 133-333; B 161.

11. Marx-Engels Archive, Amsterdam, B 131, pp. 3-82; B 130, pp. 4-29, 38-54, 61-82, 29-37, 55-59, 64-82, 59-60.
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14. Jenny Marx to Johann Philipp Becker, 29.1.1866, printed in Der Vorbote, 2 (1966).
15. Karl Marx, "Speech at the Anniversary of the Peoples Paper", Surveys from Exile, Harmondsworth: Penguin, 1973, p. 299.
16. Ibid. p. 299f.
17. Ibid. p. 299.
18. Karl Marx, "Inaugural Address of the International Working Men's Association", The First International and After, Harmondsworth: Penguin, 1974, p. 77.
19. Karl Marx, "The Civil War in France", ibid. p. 209f
20. Karl Marx, "First Draft of 'The Civil War in France'", ibid. p. 259.
21. Ibid. p. 259.
22. Karl Marx, "Introduction to the Programme of the French Workers Party", MEW 19, p.238.
23. Karl Marx, "Wages, Price and Profit", Karl Marx and Frederick Engels, Selected Works, London: Lawrence & Wishart, 1968, p. 207. (Hereafter referred to as MESW).

Chapter II

1. Ernst Bloch, Erbschaft dieser Zeit, Fankfurt am Main: Suhrkamp, 1973, p. 291.
2. Karl Marx, Capital I, Harmondsworth: Penguin, 1976, p. 174.
3. Ibid., p. 174.
4. In fact, it was Engels who first conceived of the revolutionary analysis of capitalism as a critique of political economy, see "Outlines of a Critique of Political Economy", MECW 3.
5. Friedrich Engels, Dialectics of Nature, London: Lawrence & Wishart, 1954, p. 267; this is an explicit summary of the metaphysics propounded in Engels' more popular work, Anti-Dühring.
6. Ibid. p. 34f.
7. Karl Kautsky, Die Materialistische Geschichtsauffassung II, Berlin: Dietz Verlag, 1927, p. 630.
8. Karl Kautsky, "Die Zusammenfassung von Natur und Gesellschafts-wissenschaft", Die Historische Leistung von Karl Marx, Berlin: Buchhandlung Vorwärts, 1908.
9. Karl Kautsky, Die Materialistische Geschichtsauffasung I, Berlin: Dietz Verlag, 1927, p. 727.
10. Karl Kautsky, Foundations of Christianity: A Study in Christian Origins, London: Orbach and Chambers, 1925, p. 206.
11. Karl Kautsky, Die Materialistische Geschichtsauffassung II, p. 867.
12. Karl Kautsky, Die Materialistische Geschichtsauffasung I, p. 873.
13. M. Schön, "Naturwissenschaft und Arbeiterschaft", Die Neue Zeit 41 (1923), p.61.
14. See, for example: A. Bogdanov, "Ernst Mach und die Revolution", Die Neue Zeit 26 (1907-08); S. Eckstein, "Zur Methode der Politischen Oekonomie", Die Neue Zeit 28 (1909-10); P. Lafargue, "Oekonomie, Naturwissenschaft und Mathematik", Die Neue Zeit 24 (1905-6).
15. Georgi Plekhanov, The Development of the Monist View of History, Moscow: Progress Publishers, 1972, p. 192.
16. Ibid. p. 157.

17. V.I. Lenin, Collected Works 15, Moscow: Progress Publishers, 1960-70, p.33f. (Hereafter referred to as CW).
18. V.I. Lenin, CW 14; see, for example, p. 190.
19. The philosophical impotence of Materialism and Empirio-Criticism admitted, Lenin's philosophical genius is often attributed to his Philosphical Notebooks in which he points to the connection of Hegel's Logic and the deduction of value categories in Capital. This may well be ingenious, but has nothing to do with his epistemological claims which reproduce the reflection theory of Materialism and Empirio-Criticism. See, for example, Lenin, CW 38, p. 361f.
20. V.I. Lenin, CW 7, p. 389.
21. V.I. Lenin, CW 31, p. 316f.
22. By which, however, Bogdanov only meant a socialist, proletarian organisation of science.
23. V.I. Lenin, CW 27, p. 316.
24. On his admission, Frederick Winslow Taylor (1856-1915) was a management agent who fought to wrest all understanding of, and thus all control over production from the workers, as a prelude to an increase in output; for details, see Harry Braverman, Labour and Monopoly Capital, New York and London: Monthly Review Press, 1974, pp. 85ff. Braverman's own significance for a critique of technicism is discussed below.
25. V.I. Lenin, CW 27, p. 259.
26. The Essential Stalin, London: Croom Helm, 1973, p. 322.
27. Ibid. p. 326.
28. Leon Trotsky, The Revolution Betrayed, New York: Path Press, 1974 p. 45.

29. Leon Trotsky, Problems of Everyday Life, New York: Monad Press, 1977, p. 243.
30. Ibid. p. 269.
31. Ibid. p. 244.
32. Leon Trotsky, "Dialectical Materialism & Science", ibid.
33. This famous slogan summed up a central theme of Wilson's speeches from the Labour Party Conference of 1963 to the General Election of the folowing year; see, for example, Harold Wilson, Purpose in Politics: Selected Speeches, London: Weidenfeld and Nicolson, 1964, pp. 14ff.
34. Santiago Carrillo, 'Eurocommunism' and the State, London: Lawrence & Wishart, 1977, p. 23.
35. See, for example, Derek Sayer's review-article in Capital and Class 8 (1979).
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37. Ibid. p. 91.
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40. Ibid. p. 58.
41. Ibid. p. 51.
42. See Lenin, CW 5, p. 383f, where Kautsky's formulation is quoted at length and described as "profoundly true and important".
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47. Karl Korsch, Marxism and Philosophy, London: NLB, 1970, p. 83.
48. Ibid. p. 115.
49. Ibid. p. 54.
50. Ibid. p. 75.
51. Karl Korsch, "Lenin's Philosophy", printed as an appendix (and wrongly attributed to Paul Mattick) in Anton Pannekoek, Lenin as Philosopher, London: Merlin Press, 1975, p. 119.
52. Anton Pannekoek, ibid.
53. Nicolai Bukharin, Historical Materialism: A System of Sociology, London: Allen & Unwin, 1926.
54. Selections from the Prison Notebooks of Antonio Gramsci, London: Lawrence & Wishart, 1976, p. 466.
55. Ibid. p. 466.
56. Antonio Gramsci, Selections from Political Writings (1910-1920), London: Lawrence & Wishart, 1977, p. 34.
57. Georg Lukács, The Destruction of Reason, London: Merlin Press, 1980.
58. Georg Lukács, "Technology and Social Relations", New Left Review 39 (1966), p. 29f.
59. Ibid. p. 31.
60. Georg Lukács, History and Class Consciousness, London: Merlin Press, 1971, p. 83.
61. Ibid. p. 90 - modified.
62. In contrast, the Belgian Trotskyist Ernest Mandel uses the occasion of his Introduction to the otherwise impeccable edition of volume one of Capital in the Pelican Marx Library to reduce the 'contradictory' nature of the machine to a simplistic 'contradiction between use-value and exchange-value' (p. 37).

63. The 'Frankfurt School' position on this score is presented at its most elaborate in Alfred Schmidt, The Concept of Nature in Marx, London: NLB, 1971.

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77. André Gorz, ed., p. viii; in a later work Gorz abandons Marx altogether: Farewell to the Working Class: An Essay on Post - Industrial Socialism, London: Pluto, 1982.

78. Harry Braverman, p. 228.

79. Ibid. p. 229.

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81. Ibid. p. 285. Laying his revisionist cards on the table, Braverman adds: "I recommend to the reader the excellent exposition in Baren and Sweezy, Monopoly Capital."

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83. Ibid. p. 8.

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85. This is elaborated at its fullest and most provocative in Cornelius Castoriades, Les carrefours du labyrinth, Paris 1978, pp. 221ff.

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87. Alfred Sohn-Rethel, Intellectual and Manual Labour: A Critique of Epistemology, London: Macmillan, 1978, p. 5.

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100. Alfred Sohn-Rethel, p. 152.

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105. Ibid. p. 140.

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107. P.S. Taylor, "Labour Time, Work Measurement and the Commensuration of Labour", Capital and Class 9 (1979).

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109. Raniero Panzieri was chief editor of Quaderni Rossi; his ideas lived on (after his sudden death in 1964) in Potere Operaio (Workers Party) which dissolved itself into the area of workers' autonomy of which Toni Negri became the intellectual spokesperson. Negri has been hunted by the Italian state ever since the Moro

kidnap, of which he was wrongly accused in 1979. Mario Tronti, since his publication of Operai e Capitale (Workers and Capital) which followed Panzieri's analyses, has retreated into the PCI which has become a staunch supporterof the Italian state.

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111. Raniero Panzieri, "Surplus Value and Planning: Notes on the Reading of 'Capital'", The Labour Process & Class Strategies, London: CSE/Stage 1, 1976.

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113. Raniero Panzieri, "The Capitalist Use of Machineri: Marx Versus the 'Objectivists'", in Phil Slater, ed., p. 49.

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115. Toni Negri, "Capitalist Domination & Working Class Sabotage", Working Class Autonomy and the Crisis: Italian Marxist Texts of the Theory and Practice of a Classs Movement: 1964-79, London: Red Notes, 1979.

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126. Robert Young, "The Historiographic and Ideological Context of the Nineteenth Century Debate on Man's Place in Nature", in M. Teich and R. Young, ed., Changing Perspective in the History of Science: Essays in Honour of Joseph Needham, London: Heineman, 1973.

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3. Karl Marx and Fredeirick Engels, "Manifesto of the Communist Party", MECW 6, p. 503.

4. Ibid. p. 489.

5. Ibid. p. 487.

6. Karl Marx and Frederick Engels, "The German Ideology", p. 81.

7. Ibid. p. 81.

8. Karl Marx, "Economic and Philosophic Manuscripts of 1844", MECW 3, p. 296.
9. Ibid. p. 304.
10. Karl Marx and Frederick Engels, "The German Ideology", p. 28.
11. Karl Marx, "Economic and Philosophic Manuscripts of 1844", p. 303.
12. Ibid. p. 303.
13. Ibid. p. 303.
14. Ibid. p. 303.
15. Karl Marx and Frederick Engels, "The German Ideology", p. 53.
16. Ibid. p. 23.
17. Ibid. p. 31.
18. Ibid. p. 36.
19. Ibid. p. 36f.
20. Karl Marx, "Contribution to the Critique of Hegel's Philosophy of Law. Introduction", MECW 3, p. 175.
21. Ibid. p. 175.
22. Ibid. p. 175.
23. Karl Marx, Theories of Surplus-Value I, London: Lawrence & Wishart, 1969, p. 285.
24. Karl Marx and Frederick Engels, "The German Ideology", p. 92, notes, written by Marx, intended for further elaboration.
25. As for example Althusserians would have it. Even in Althusser is a contradiction: theory on the one hand is autonomous, on the other, Marx's 'scientific analysis' is due to a proletarian, -- communist position. See Louis Althusser, Lenin and Philosophy and other Essays, London: NLB, 1971.
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64. Ibid. p. 166.

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97. Karl Marx, Capital III, p. 880.

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4. Karl Marx, Theories of Surplus-Value III, p. 129.

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11. Karl Marx, "Difference between the Democrition and Epicurean Philosophy of Nature", MECW 1, p. 104. See also Marx to Lion Philips, 14.4.1864, MEW 30, p. 653.
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43. Karl Marx, Capital I, p. 457.

44. Karl Marx, Grundrisse, p. 704.

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50. Karl Marx, Capital I, p. 399.

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53. For a discussion of this process of 'preconceptualisation' see

Mike Hales.

54. Karl Marx, Capital I, p. 399.

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61. Quoted in Karl Marx, Capital I, p. 402.

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75. Karl Marx, Capital III, p. 814f.

76. Marx to Annenkov, 28.12.1846, MESW; p. 662f.

77. Ibid. p. 663.

78. Karl Marx, "The Poverty of Philosophy", MECW 6.

79. Karl Marx and Frederick Engels, "Manifesto of the Communist Party", p. 494f.

80. Even Gerry Cohen, who provides the best modern defence of the productive forces/production relation dialectic, claims that capitalist productive forces were developed by, and not prior to, capitalism. See his Karl Marx's Theory of History: A Defence, Oxford: Clarendon Press, 1978.

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86. Karl Marx, Capital III, p. 43.

87. Ibid. p. 213.

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89. Ibid. p. 240.

90. Karl Marx, Capital I, p. 543.

91. Ibid. p. 555.

92. Ibid. p. 589.

93. Ibid. p. 603.

94. Ibid. p. 604.

95. This is a conception of nature prior to capitalism. The channel four programme "Crucible" showed how the conception of nature changed through history. The 'modern' conception is illustrated by William Blake's drawing of Isaac Newton: Newton turns his back to nature, drawing a mathematical model of it. Marx: "nature fixed in isolation from man - is nothing for man", MECW 3, p. 345.

96. Karl Marx, Capital I, p. 604.

97. Karl Marx, Capital III, p. 266.

98. Ibid. p 104.

99. Karl Marx, Capital I, p. 457.

100. Ibid. p. 458.

101. See chapter I, note 10.

102. Karl Marx, Capital III, p. 759f.

103. Karl Marx, Theories of Surplus-Value II, p. 95.

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105. Ibid. p. 780.

106. Karl Marx, Capital I, p. 474.

107. Karl Marx, Capital III, p. 617.

108. a) Karl Marx, Capital I, p. 475; b) Karl Marx, Capital III, p. 617.

109. Ibid. p. 617.

110. Karl Marx, Capital I, p. 474f.

111. Ibid. p. 474.

112. Ibid. p. 474.

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2. Ibid. p. 25.
3. Karl Marx, Capital III, p. 879f.
4. Karl Marx, Capital II, p. 33.
5. Karl Marx, "Results of the Immediate Process of Production", p. 951.
6. Ibid. p. 1065.
7. Karl Marx, Capital II, p. 396.
8. Ibid. p. 398.
9. Karl Marx, "Results of the Immediate Process of Production", p. 1062.
10. Karl Marx, Grundrisse, p. 409.
11. Karl Marx, Capital II, p. 243.
12. Ibid. p. 242.
13. Ibid. p. 243.
14. Ibid. p. 252.
15. Karl Marx, Capital III, p. 300.
16. By productive I simply mean the cutting of labour time which is not to be conflated with an increased production in value and therefore surplus-value. Unlike transportation which adds to the value of a product, office work is not considered to be value producing by Marx, and therefore not productive. It is

merely a cost which shares in surplus value produced elsewhere.

17. Karl Marx, Capital III, p. 521.
18. Karl Marx, Capital II, p. 130.
19. Ibid, p. 131.
20. Gareth Stedman Jones, "Class Struggle and the Industrial Revolution", NLR 90 (1974).
21. Karl Marx, Capital II, p. 255.

Conclusion

1. Karl Marx, Grundrisse, p. 694.
2. Karl Marx, "Results of the Immediate Process of Production", p. 1053.

Appendix I

1. Frederick Engels, "Speech at the Graveside of Karl Marx", MESW, p. 429.
2. Frederick Engels, "Preface to the English Edition of 1888", Karl Marx and Frederick Engels, Manifesto of the Communist Party, Moscow: Progress Publishers, 1952, p. 21.
3. Karl Kautsky, "Darwinismus und Marxismus", Die Neue Zeit 13 (1894-95); Edward Aveling, "Cahrles Darwin und Karl Marx - Eine Parellele", Die Neue Zeit 15 (1896-97).

4. V.I. Lenin, "What the 'Friends of the People' are and how they Fight the Social Democrats", Selected Works XI, London: Lawrence & Wishart, 1939, p. 421f.
5. Edward Aveling, "Charles Darwin and Karl Marx: A Comparison", The New Century Review (1897); Ernst Kolman, Under the Banner of Marxism (1931).
6. Edward Aveling, "Charles Darwin and Karl Marx: A Comparison", p. 11.
7. Ibid. p. 11.
8. See Maximilien Rubel and Margaret Manale, Marx without Myth, Oxford: Blackwell, 1975, p. 291.
9. Howard Gruber, "Darwin and Das Kapital", Isis 52 (1961), p. 582.
10. Ibid. p. 582.
11. Ernst Kolman.
12. For the latest perpetuation of that myth see Steven Rose, "Survival of the fittest philosophy", New Socialist 6 (1982), p. 47.
13. Darwin to Aveling, 13.10.1880, quoted in Ralph Colp, "The Contacts Between Karl Marx and Charles Darwin", Journal of the History of Ideas 35 (1974), p. 335.
14. Aveling to Darwin, 12.10.1880, quoted in P. Thomas Carroll and Lewis S. Feuer, "Further evidence that Karl Marx was not the recipient of Charles Darwin's letter dated 13 October 1880", Annals of Science 33 (1976), p. 386f. The titles mentioned in the first paragraph are Darwin's books.
15. Karl Marx, Capital I, p. 323.
16. Quoted in Ralph Colp Jr., "The Contacts Between Karl Marx and Charles Darwin", Journal of the History of Ideas 35 (1974).

17. Between 1880 and 1882 Marx compiled excerpts and commentaries on ethnological writings, now known as The Ethnological Notebooks. In these notebooks Marx comments on the 'primitive' conditions of humankind, 'civilisation', the origin of class society and the emergence of the state. Marx's excerpts from Morgan have long been known through Engels' Origin of the Family, Private Property and the State. However, Engels' text is more akin to Morgan's, thereby giving Marx's comments on ethnological material an evolutionist interpretation based on biological factors. Marx himself went to great efforts to stress the social and political content of ethnology, thereby undermining biology's claim to provide an understanding of cultural behaviour. For a recent (epigone) adherence to 'ethnobiology' see E.O. Wilson's Sociobiology and On Human Nature.
18. Marx to Engels, 19.12.1860, MEW 30, p. 131.
19. Marx to Lassalle. 1.1.1861, Karl Marx and Frederick Engels, Selected Correspondence, Moscow: Progress Publishers, 1975, p.115. (Hereafter referred to as MESC).
20. Marx to Engels, 18.6.1862, MESC, p. 120.
see also Karl Marx, Theories of Surplus-Value II, p. 121.
21. Marx to Laura and Paul Lafargue, 15.2.1869, MEW 32, p. 592.
22. Marx to Kugelmann, 5.12.1868, MEW 32, p. 579.
23. Marx to Kugelmann, 27.6.1870, MESC, p. 225.

Appendix II

1. See, for example, V.I. Lenin, CW 38.

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