

MARX AND SCIENCE

J. D. Bernal



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FOREWORD

By PROFESSOR BENJAMIN FARRINGTON

I do not think Bernal has ever written better than here. He first glances at the progress of Marx through the humanities, law, philosophy, political and economic theory to the formation of the world-view now described by his name. This more familiar portion of his theme, here enriched with much acute comment and with illustrative material from the less accessible writings of Marx, is the prelude to the special subject of this essay, a topic less familiar to the student, namely, the use Marx made in the elaboration of his views of his studies in mathematics, technology, and the natural sciences. It is the point where historical materialism broadens out and unfolds into the dialectics of nature. Bernal here is on ground where he has unrivaled competence. Following him we see that Marx should rank not only as the founder of the science of history but as founder also of the history of science, for in his immense perspective they appear as two aspects of one process. Marxism operates in the world today not only to shift the balance of political power, but to redraw the frontiers of knowledge. With a master's hand Bernal sketches for us, not only the outline of Marx's views, but the actual situation of science today in the capitalist and in the socialist world.

I. Introductory

A few weeks ago I was taking a distinguished poet from the west coast of Africa to see the grave of Marx in Highgate Cemetery. There as we stood alone by that simple monument I reflected how the man who was buried there was known and revered in every part of the world today. I thought of how he had affected every aspect and field of human thought, natural science as much as any of the economic and political fields that were his particular concern.

To talk of the contribution of Marx to science seems almost superfluous, for Marx himself was a scientist. Starting from the observation and practice of the most difficult of them—the science of human society in its historic development—he had come to comprehend the whole range of sciences. Nevertheless he might have remained a journalist, a historian, or an economist if he had done no more than analyze and contemplate these fields of human knowledge. He had seen beyond that; his thinking merged always into political action. It was through this combination of theory and practice that he was able to use the whole weight of his great intelligence to absorb, and in the process to change, the whole method of thought and action that we call the social and natural sciences.

What Marx did for science in his time and what the result of his work will do for science in the future is the subject of this lecture. His great contribution was that he brought out for the first time the basic social character of science and the corresponding necessity of science to society. To be able to do that at all meant the assimilation of the complete range of science as well as a deep knowledge of history and philosophy.

It is difficult for us now to grasp what a great feat it was, because the fundamentals of Marxist ideas are now common property even among the most embittered anti-Marxists. The great discovery of Marx was that the ultimate motive force of history, of human social development, was not to be found in abstract ideas or mystical intuition. It lay in the very process by which men made their living—the productive process by which they got food, clothing and shelter. Production, social from the outset, brought with it social productive relations leading to the appearance of rival classes. Their conflicts, which form the significant part of history, can be followed in unbroken sequence to the present day and beyond it, and are the

source of the intellectual productions of human culture. These ideas, which Marx was to spend so much of his life proving and amplifying, were already firmly grasped by him early in his life's work. Thus we find in the *Okonomisch-philosophische Manuskripte* (1844):

"This material, directly perceptible private property is the material perceptible expression of alienated* human life. Its movement—production and consumption—is the material manifestation of the movement of all previous production, that is to say realization or actuality of man. Religion, family, state, law, morality, science, art, etc., are only particular ways of production and fall under its general laws."¹

While a year later he was to write:

"History is nothing but the succession of the separate generations, each of which exploits the materials, the forms of capital, the productive forces handed down to it by all preceding ones, and thus on the one hand continues the traditional activity in completely changed circumstances and, on the other, modifies the old circumstances with a completely changed activity. . . .

"Thus, for instance, if in England a machine is invented, which in India or China deprives countless workers of bread, and overturns the whole form of existence of these empires, this invention becomes a world-historical fact."²

We owe to Marx this insight into the social and economic basis of history which in one form or another has penetrated all modern thought, even that of the most devout obscurantists or virulent anti-Marxists. Its present familiarity should not make us forget that for Marx to discover it when he did, in the face of all the thought of the time, was a vast intellectual achievement.

Marx's ideas are not exempt from the application of his own theory. It was by no means an accident that it was left to a man with his background and his experience to make this discovery. Although it was latent in the development of early nineteenth century thought and politics, there is a whole world of difference between the vague acceptance of the inter-relatedness of different parts of

* The word alienated (*entfremdet*) is used by Marx in a metaphorical sense. Material goods are the product of human labor: they take up a portion of the lives of the workers that produce them. By embodying that portion in *property*, it is, so to speak, taken out of life and set aside (alienated) as one alienates one's own property by selling it.

culture and the precise form of that relationship which Marx expounded with the aid of the new dialectical method which he developed.

This method cannot be understood without going right back to Marx's original writing. This is why I personally am so glad that I have had to give this lecture, because it has driven me back to the study of many familiar classics of Marxism as well as to some of his earlier and lesser known writings that I have now read for the first time. It is strange how the experience of the post-war world actually makes what was written more than one hundred years ago seem much clearer now than it did at first reading. As the examples of the economic and political events of the last few years add up, one begins to see more and more what it was that Marx was driving at. It seems more than ever astonishing that he was able to achieve the understanding he did without the range of economic and political events that has brought his ideas home to us in this century.

Though Marx had reached his main conclusions as early as 1843, when he was only twenty-five, they were by no means the result of intuition, however brilliant, but of intense study and acute observation of life and society. The actual transition by which, if we may say so, Marx became a Marxist is one of the most interesting examples of the development of human thought. It deserves a most elaborate and detailed study and anything I say about it now must be considered in the nature of a very amateur effort; but it is still one worth making, because these kinds of critical transformations of thought are the really revolutionary events that, much more than the steady accumulation of facts, mark the conquest of human intelligence over the human environment.

II. How Marx Became a Marxist. Philosophy and Religion

Karl Marx, the son of a well-to-do lawyer of Treves, was born in 1818 and had the upbringing of a typical liberal intellectual of the time. Trained for the law, he could not restrict his interest to it, but wandered, even in his schooldays, over many fields of culture. Although he produced a play and some satiric poetry, he found his first serious and absorbing interest in philosophy. Coming to Berlin

in 1837 he became almost inevitably a Hegelian, for at that time Hegel represented the most complete synthesis, however abstract and idealist, of the revolution in thought that in Germany had taken the place of the political and industrial revolutions of France and England.

The great contribution of Hegel's thought to that of Marx was his insistence on the development of *processes* rather than the existence of things. Yet Hegel's thorough idealism prevented his "process" having any concrete reality. The idea of evolution in nature was simply not conceivable; the natural world appeared all at once, as in the simplest of creation myths. But Hegel did propound evolution, and evolution by successive stages, in human history.* He coined the phrase, "All that is rational is real." This, however, did not imply fixity but change. As Engels explains:

"Now, according to Hegel, reality is, however, in no way an attribute of any given state of affairs, social or political, in all circumstances and for all time. On the contrary. The Roman Republic was real, but so was the Roman Empire which superseded it. In 1789 the French monarchy had become so unreal, that is to say, it had been so robbed of all necessity, so non-rational, that it had to be destroyed with the greatest enthusiasm. In this case the monarchy was the unreal and the revolution was the real. And so, in the course of development, all that was previously real becomes unreal, loses its necessity, its right of existence, its rationality. And in the place of moribund reality comes a new reality capable of living—peacefully if the old has enough intelligence to go to its death without a struggle; forcibly if it resists this necessity. Thus the Hegelian proposition turns into its opposite through Hegelian dialectics itself: All that is real in the sphere of human history becomes irrational in the process of time and is therefore irrational already by its destination, is tainted beforehand with irrationality, and everything which is rational in the minds of men is destined to become real,

* In his *Philosophy of History*, Hegel wrote: "The changes that take place in nature, how infinitely manifold soever they may be, exhibit only a perpetually repeating cycle; in nature there happens 'nothing new under the sun.' . . . Only in those changes which take place in the region of Spirit does anything new arise. This peculiarity in the world of mind has indicated in the case of man an altogether different destiny from that of merely natural objects—in which we always find one and the same stable character, to which all change reverts; namely, a real capacity for change, and that for the better—an impulse of perfectibility."

however much it may contradict the apparent reality of existing conditions. In accordance with all the rules of the Hegelian method of thought, the proposition of the rationality of everything which is real resolves itself into the other proposition: All that exists deserves to perish. But precisely here lay the true significance and the revolutionary character of the Hegelian philosophy."³

This was the lesson of the Hegelian dialectical philosophy that was to pass straight on to Marx. Following Engels again:

"Just as the bourgeoisie by large-scale industry, competition and the world market dissolves in practice all stable, time-honored institutions, so this dialectical philosophy dissolves all conceptions of final absolute truth and of a final absolute state of humanity corresponding to it. For it, nothing is final, absolute, sacred. It reveals the transitory character of everything and in everything; nothing can endure before it except the uninterrupted process of becoming and of passing away, of endless ascendancy from the lower to the higher. And dialectical philosophy itself is nothing more than the mere reflection of this process in the thinking brain. It has, of course, also a conservative side: it recognizes that definite stages of knowledge and society are justified for their time and circumstances; but only so far. The conservatism of this mode of outlook is relative; its revolutionary character is absolute—the only absolute it admits."⁴

Hegel himself certainly did not see this consequence, he was too concerned with elaborating a universal *system* which would show that the *Absolute*, first revealed by him, was embodied in the Prussian State of Frederick William III. But to quote Engels once more:

". . . the doctrine of Hegel, taken as a whole, left plenty of room for giving shelter to the most diverse practical party views. And in the theoretical Germany of that time two things above all were practical: religion and politics. Whoever placed the chief emphasis on the Hegelian *system* could be fairly conservative in both spheres; whoever regarded the dialectical *method* as the main thing could belong to the most extreme opposition, both in politics and religion."⁵

Marx belonged from the outset to the second group, the Left Hegelians, but his break with idealist philosophy did not come at once.

His first original work, his doctoral dissertation of 1841, showed that Hegel's own method was leading him away from his master's idealistic conclusions. Its title was "The difference between the Democritan and Epicurean Philosophy of Nature." Now these philosophers were the founders of materialist atomism, in contrast to the non-atomic materialism of the early Ionians or the idealist atomism of Pythagoras,* and in discussing them, although still in Hegelian terms, Marx was beginning his exploration of the social and political implications of materialism. Marx preferred Epicurus to Democritus because Democritus appeared to him as a merely naturalist-materialist philosopher, reducing everything to atoms and the void, whereas Epicurus wished to make this atomic philosophy, with certain variations, the basis of a moral and political theory. In his own words Marx concludes:

"... in Epicurus, atomistics with all its contradictions, as the natural science of the self-consciousness, which is an absolute principle under the form of abstract particularity, is carried through, and completed, up to its highest consequence, which is its dissolution and conscious contra-position to the General. For Democritus the atom is only the general objective expression of empirical natural inquiry. The atom thus remains for him a pure and abstract category, a hypothesis which is the result of experience, not its animating principle, and which thus remains without realization, just as it no longer determines real natural inquiry."⁶

Though expressed in language which must seem almost unintelligible to the reader of today, Marx's thesis contained nevertheless many penetrating observations. Among them are the recognition of the limited and unsatisfactory character of pure natural science, and of the importance of Epicurus' law of atomic deviation in which chance is introduced into the rigid atomism of Democritus. The purport of the thesis, however, was by no means academic. It was to set out the liberating role of Epicurean ideas, particularly in the struggle against state-supported religion. Recent researches have shown how far Epicureanism was considered a subversive philosophy

* The *numbers* of Pythagoras were conceived by him as actual little solids made up of piles of points, so that his philosophy might be called materialistic. Nevertheless his followers, and particularly Plato, took number in its abstract and even magical sense and made it the cornerstone of a thorough-going idealism.

in ancient Greece and Rome and how it had largely been destroyed by the efforts of the official Platonic and Stoic philosophies.

If Marx had been a conventional philosopher he might have continued from this very promising start and ended up as a most distinguished Geheimrat Professor at any German University. But he could not keep away from the events of the time. Hardly was his thesis finished—he never printed it—when he was involved, with other Left Hegelians, in journalism, first as contributor and then, in 1842, as editor of the *Rheinische Zeitung*, a new liberal paper. The link for him between philosophy and politics was furnished by the criticism of religion, itself a political question, since religion was the standby of the landed interests that controlled the Prussian State. As Marx himself put it:

"The criticism of heaven transforms itself into a criticism of earth, the criticism of religion turns into a criticism of law, the criticism of theology turns into a criticism of politics."⁷

The most powerful intellectual influence working on him at that time was that of Feuerbach, himself a very quiet and retiring philosopher but one who had the courage, that even Hegel lacked, to come out directly against the whole Christian dogma, in his *Essence of Christianity* (published in 1841). Marx and his circle studied Feuerbach, were inspired by him, and were immediately stimulated to go much beyond him. As Marx summed it up in one of his earliest and most trenchant essays, *A Criticism of the Hegelian Philosophy of Law*, published in 1843:

"As far as Germany is concerned the criticism of religion is practically completed and the criticism of religion is the basis of all criticism.

"The foundation of the criticism of religion is: man makes religion, religion does not make man. Religion, indeed, is the self-consciousness and self-estimation of man who has either not yet achieved his individuality or has lost it again. But 'man' is no abstract being, drifting about outside the world. 'Man' is the world of man, the state, society. This state, this society, produced religion, which is an upside-down world-consciousness, because they are an upside-down world. Religion is the general theory of this world, its encyclopedic compendium, its logic in popular form, its spiritual *point d'honneur*, its enthusiasm, its moral sanction, its solemn contemplation, its general source of consolation and justification. It is the

fantastic realization of the human being, inasmuch as the human being possesses no true reality. The struggle against religion is thus indirectly the struggle against the world whose spiritual aroma is religion.

"Religious suffering is at once the expression of real suffering and a protest against real suffering. Religion is the sigh of the oppressed creature, the sentiment of a heartless world, as it is the soul of soulless conditions. It is the opium of the people.

"The abolition of religion, as the illusory happiness of the people, is the demand for their real happiness. The demand that they abandon illusions about their condition is the demand to abandon a condition which requires the illusions. The criticism of religion is therefore potentially the criticism of the vale of tears whose halo is religion."⁸

This passage, which introduced the unforgettable phrase the "opium of the people," was pretty strong medicine for the clerical reactionary regimes of the day.

III. Journalism, Politics, and Exile

This intellectual advance, however, was not taking place in a vacuum. On the *Rheinische Zeitung* Marx was getting his first experience of political life. He held the job of editor for five months in a state of continual warfare against the authorities, till he was forced to resign by the Prussian censor. He experienced, as he never had before, the deadening hand of feudal restrictions in politics, law, and culture and began to glimpse at the economic realities behind them. His politics were still liberal and well suited the rising anti-aristocratic and anti-clerical manufacturers, who financed the paper. Under his editorship it became, indeed, a popular success, the number of subscribers rising from 885 in October 1841 to 3,400 in March 1842.

Marx rapidly became the leading spirit of the young liberals of the Rhineland. The following remarks in a letter from Moses Hess to Auerbach must have seemed most extravagant at the time—they now appear a remarkably accurate prophecy:

"You will enjoy meeting a man here, who also belongs to our friends, although he lives at Bonn, where he will soon be holding

lectures. He is a character who made an imposing impression on me, though I work in the same field; in short, you can be prepared to meet the greatest, perhaps the *only* living *real* philosopher; when he appears before the public (in his writings as well as lectures) he will draw the eyes of Germany upon him. Both in his general tendency and in the structure of his thought he goes not only beyond Strauss, but also beyond Feuerbach—and that is saying a lot. If I could be in Bonn when he is lecturing I should be his most zealous pupil. I've wanted just such a man as my philosophy teacher. Now I feel what a tyro I am in philosophy proper. But patience! I shall start learning something now! Dr. Marx (that's the name of my idol) is still a very young man (at most about twenty-four years old) who is going to give the death-blow to medieval religion and politics; he combines the profoundest philosophical seriousness with a cutting wit. Imagine Rousseau, Voltaire, Holbach, Lessing, Heine and Hegel united in one person: I say *united*, not muddled up—that is Dr. Marx."⁹

After the suppression of the *Rheinische Zeitung*, Marx felt he had no immediate future in Germany. He went with his young wife in 1843 to Switzerland and later to Paris as joint editor of the *Deutsche-Französische Jahrbücher*, of which only one number appeared. Here, however, it was not the censor but the quarrels between the refugees that brought it to an end. Marx's stay in Paris was to be little longer; he was expelled in 1845 at the request of the Prussian government for, among other similar crimes, writing in support of the strike of the Silesian weavers. He went to Brussels with Engels and other active socialists and immediately took a leading part in the movements which were to lead up to the great events of 1848.

Nevertheless, though his stay in Paris was short it was to be a decisive stage in his intellectual and political development. Thanks to his father he was already familiar from his boyhood with French literature, particularly with that of the great philosophers and materialists of the eighteenth century. Now he was to experience the living impact of French culture and the new ferment of ideas among the liberals, the utopian socialists of the schools of St. Simon and Fourier and the followers of Proudhon.

Marx was impressed, but he did not become a disciple. His sound German philosophic training and his greater learning and basic common sense made him instead an acute and constructive critic.

Already he saw that socialism was not something that came from above. In the very first article he published in Paris, *A Criticism of the Hegelian Philosophy of Law*, already cited, he recognizes that the moving force of the transformation of society is the new "proletariat" created by the rise of mechanical industry. The role of philosophy is to arm the proletariat with the knowledge of its own nature and possibilities. "Just as philosophy finds in the proletariat its material weapons, so the proletariat finds in philosophy its intellectual weapons. . . . Philosophy cannot be realized without the abolition of the proletariat, the proletariat cannot abolish itself without realizing philosophy."

IV. Frederick Engels

Another influence of even greater importance was to reach Marx in Paris. In 1844 Frederick Engels came to meet him there. They became fast friends from that time and began the intellectual cooperation which was to last until Marx's death. Engels brought with him experience and knowledge which were essential to the full building of Marxist thought—the experience of England and the knowledge of economics and of the natural sciences. Marx had only known the relatively primitive and undeveloped industry of the Rhineland. Engels had seen, and had engaged, as partner in a Manchester cotton firm, in industrial production at the highest point it had then reached.

Coming from abroad he had not taken British industry for granted: he saw it at the same time as a gigantic force for transforming man's material conditions and as a social pattern degrading the human beings, masters and men, who took part in it. Engels got to know the British working class, their life and their organized struggles in a way that he was to immortalize in his *Condition of the Working Class in England in 1844*. He was to introduce Marx to this direct experience and to bring to his knowledge the theories of the British economists, Adam Smith, Ricardo, and Malthus, which had been evolved in the atmosphere of the industrial revolution. He also brought a growing knowledge and interest in the natural sciences, which had been enhanced in the atmosphere of Manchester, where science and industry were more closely linked than anywhere else.

It was the combination of these influences that was to lead Marx, somewhere in 1844, to his philosophical and political synthesis, to his great turning of Hegel upside down and substituting a real material base for Hegel's ideal and spiritual base. As he explained it himself many years later:

"My dialectic method is not only different from the Hegelian, but is its direct opposite. To Hegel, the life-process of the human brain, *i.e.*, the process of thinking, which, under the name of 'the Idea,' he even transforms into an independent subject, is the demiurges of the real world, and the real world is only the external, phenomenal form of 'the Idea.' With me, on the contrary, the ideal is nothing else than the material world reflected by the human mind, and translated into forms of thought."¹⁰

The three principal elements in Marxist thought—materialism, economics, and dialectic—derived mainly from French, British, and German sources—all came together at this time in this great synthesis.

The materialism that Marx thus first promulgated was from the outset very different from that which had grown up in the tradition of 18th century France, that of Holbach and Lamettrie. It was at the same time more general, more logical and, for the first time, a historical materialism. Its following out led Marx himself, as well as Engels, into the fields of natural science. Marx was interested in natural science not, however, only for the philosophic reason that it provided a more accurate description of the real world, but also for an economic reason, because of the close connection of science with industry in the phase of rapidly developing capitalism.

While Marx and Engels were working over the material that was to shake the world in *The Communist Manifesto* of 1848 they had gone far to establish the general lines of the new dialectical materialism. Much, it is true, was to be added in *Capital* on the detailed economic workings of the capitalist system, but as far as natural science was concerned the principles are already clear by the time of writing *The German Ideology* in 1846.

V. Revolution and Evolution

Marx based himself solidly on the achievements of earlier thinkers: on the historical dialectical approach of Hegel; on the implicit

materialism of the natural scientists; on the economic analysis of the classical economists, Adam Smith and Ricardo. But he did far more than make a synthesis of their work, great as that achievement was. His contribution above all was to transform that mass of analysis, knowledge, and criticism from an object of contemplation to one of action. This radically new step he derived not from any system of philosophy or science, but from the experience of the revolutionary struggles of the people in which he was a participant as much as an observer.

This finds clear expression in a quotation drawn from Marx's polemical work, *The Poverty of Philosophy* (1846), which was the answer to Proudhon's *Philosophy of Poverty*. In it Marx drew a sharp distinction between the philosophy of well meaning *philanthropic* bourgeois doctrinaires and real practical socialism grown from the struggles of the proletariat:

"Just as the *economists* are the scientific representatives of the bourgeois class, so the *Socialists* and the *Communists* are the theoreticians of the proletarian class. So long as the proletariat is not yet sufficiently developed to constitute itself as a class, and consequently so long as the struggle itself of the proletariat with the bourgeoisie has not yet assumed a political character, and the productive forces are not yet sufficiently developed in the bosom of the bourgeoisie itself to enable us to catch a glimpse of the material conditions necessary for the emancipation of the proletariat and for the formation of a new society, these theoreticians are merely utopians who, to meet the wants of the oppressed classes, improvise systems and go in search of a regenerating science. But in the measure that history moves forward, and with it the struggle of the proletariat assumes clearer outlines, they no longer need to seek science in their minds; they have only to take note of what is happening before their eyes and to become the mouthpiece of this. So long as they look for science and merely make systems, so long as they are at the beginning of the struggle, they see in poverty nothing but poverty, without seeing in it the revolutionary, subversive side, which will overthrow the old society. From this moment, science, produced by the historical movement and associating itself with it in full recognition of its cause, has ceased to be doctrinaire and has become revolutionary."¹¹

Marx had drawn from Hegel the idea of human history as a series of developments, but having now become a materialist he saw those

developments no longer as those of an *idea*, but in terms of the development of productive forces and productive relationships in the real world. Further, with the experience of two revolutions in France behind him, he saw the significant and decisive changes of history, not as slow evolutionary transformations, but as changes occurring in rapid jumps, marking the successive advent to political power of classes more able to utilize the productive forces.

In studying human history, irreversible change cannot be missed, and the difficulty is to trace the existence of regular laws. These *laws of motion* of human history were first laid bare by Marx. Later he extended them to cover the world of nature as well as that of man. He created in the modern sense a *natural history*. He perceived that the static concepts of natural and invariable law and order that prevailed in the official science of his time were a compound of mental laziness and religious timidity. He was more inclined to accept the evolutionary ideas which, although then suspect, were, thanks to Darwin, to become dominant in the latter part of the nineteenth century. His appreciation of Darwin's *Origin of Species* was immediate though not uncritical; he was especially critical of the Malthusian aspect of the struggle for existence. He writes to Engels in December 1860, within four weeks of the publication:

"During my time of trial, these last four weeks [he had been nursing his wife through a severe illness] I have read all sorts of things. Among others Darwin's book on Natural Selection. Although it is developed in the crude English style, this is the book which contains the basis in natural history for our view."¹²

And he wrote to Lassalle in 1861:

"Darwin's book is very important and serves me as a basis in natural science for the class struggle in history. One has to put up with the crude English method of development, of course. Despite all deficiencies, not only is the deathblow dealt here for the first time to 'teleology' in the natural sciences but their rational meaning is empirically explained."¹³

Since that time the idea of evolution, with changes more sudden than Darwin imagined, has spread beyond the world of organism to the earth and the whole universe. In the light of recent discoveries scientists are now more willing to accept the phenomena of nature as *processes* not things, given or created. Intellectually, therefore, Marx, who saw it all over a hundred years ago, stands revealed

as a mind of the first caliber. Nevertheless if he had restricted himself to founding a materialist historical world view, humanity would have missed something much greater than any intellectual construction.

VI. The Philosophers Must Change the World

Marx's crowning contribution was in the linking of thought with action. This new dimension of philosophy came to him from the Hegelian dialectic, restored to its material basis, and from the direct experience of political struggle. Marx used the Hegelian idiom very freely and with great mastery. Indeed, he was so steeped in Hegel's method of thought and expression that a good deal of his early work must appear much more obscure to us now than it did to his contemporaries. Nevertheless on reading and rereading Marx one finds that those parts of his work which are sometimes referred to as pure jargon are often the most significant. It is mere mental laziness on the part of scientists, many of whom have never even read a line of Marx, to reject it because its philosophic expressions are foreign to the rather naïve levels of thought of natural scientists outside their own specific scientific fields. Many of the quotations used in this lecture are good examples of the conciseness of expression Marx achieved by using the Hegelian mode. Nevertheless he was always careful in his major works, such as *The Communist Manifesto* or *Capital*, to set out his argument without any Hegelian reference, even where he had used the dialectic in arriving at his results.

The dialectic is essentially a philosophy of change and action. Marx used it to show how the specific and rapid changes that actually occurred in the real and material world came about. In his view such changes did not just happen by chance or by the intervention of mysterious outside powers. They had to happen precisely because of the struggles and contradictions between elements which were themselves the products of changes at a previous stage.

Marx continued to be interested in the nature of change all his life. This is shown even in his work on mathematics,* where he tries to gain a deep insight into the differential calculus, that part of

* The 900 pages of his mathematical manuscripts have now been published, but so far only in Russian. A discussion of some of these is given by Professor D. J. Struik in "Marx and Mathematics," *Science and Society*, XII, No. 1, pp. 181-196 (Winter, 1948).

mathematics that studies how a function changes from one value to another and what its characters are at the point of change.

The working out of the major concepts of dialectical materialism belongs to the formative years before 1846. They were already expressed in his early essay on Feuerbach (not published in his lifetime but later published in *The German Ideology*) which contains his first formulation of the doctrine of historical materialism in the passage:

"... the first premise of all human existence, and therefore of all history, the premise namely that men must be in a position to live in order to be able to 'make history.' But life involves before everything else eating and drinking, a habitation, clothing and many other things. The first historical act is thus the production of the means to satisfy these needs, the production of material life itself. And indeed this is an historical act, a fundamental condition of all history, which today, as thousands of years ago, must daily and hourly be fulfilled merely in order to sustain human life."¹⁴

It was in meditating on Feuerbach that Marx saw the limitation which that philosopher had accepted in restricting the pursuit of knowledge to "the contemplation of truth."

It was at this point that he first stated clearly the principle of the unity of thought and action, of theory and practice, that was to guide him from the idealist abstractions of Hegel to the concrete and dynamic real world of dialectical materialism. These ideas have become known to millions in an aphoristic form in the *Theses on Feuerbach*. They provide his answer not only to Feuerbach's *Essence of Christianity* but also to his later work, *Provisional Theses Towards a Reform of Philosophy*, published in 1843. Marx intended them originally as notes for his own guidance, but they were published in a slightly modified form by Engels as an appendix to *Ludwig Feuerbach and the Outcome of Classical German Philosophy* in 1889. It is worth examining them more closely.

The first two theses deal with the question of the relations between theory and practice:

"I. The chief defect of all materialism up to now (including Feuerbach's) is, that the object, reality, what we apprehend through our senses, is understood only in the form of the *object* or *contemplation* (*Anschauung*); but not as *sensuous human activity*, as *practice*; not subjectively. Hence in opposition to materialism the *active* side was

developed abstractly by idealism—which of course does not know real sensuous activity as such. Feuerbach wants sensuous objects, really distinguished from the objects of thought: but he does not understand human activity itself as *objective* activity. . . .

"II. The question whether objective truth is an attribute of human thought—is not a theoretical but a *practical* question. Man must prove the truth, i.e., the reality and power, the 'this-sidedness' of his thinking in practice. The dispute over the reality or non-reality of thinking that is isolated from practice is a purely *scholastic* question."¹⁵

Here we see Marx's grasp of the essentially active character of the process of thought which applies with greatest force to the organized thinking we call science, natural as well as social. Science, he asserts, is always connected with the changing of nature for human use, and with the understanding of nature only in so far as it can be used to change it. This does not, of course, diminish in any way the speculative value of science, but only imposes the check of material test and utility to establish the position of science at any time. As we know, there have been and still are many pseudosciences, ranging from the *natur philosophie* and phrenology of Marx's day to the vitalism and parapsychology of our own. These systems of thought have a certain, if limited, value as artistic creations, but they fail to pass the test of practice and are relegated by Marx to the ideological superstructure doomed to pass away with the social system that gave them birth.

Marx realized fully that all ideas, including the theories of science, were the product of the social environment of the time, and that there was no question of any absolute or eternal truths, but a sequence of relative truths, each representing a greater and greater understanding and, what proves that understanding, an enhanced control of natural processes.

At the same time he had already passed beyond the naïve social determinism that sees man only as the product of circumstances over which he has no control. This appears clearly in the third thesis:

"III. The materialistic doctrine concerning the changing of circumstances and education forgets that circumstances are changed by men and that the educator himself must be educated. This doctrine has therefore to divide society into two parts, one of which is superior to society.

"The coincidence of the changing of circumstances and of human activity or self-changing can only be comprehended and rationally understood as *revolutionary practice*."¹⁶

This thesis with its emphasis on the process of "educating the educator" came close to the core of the understanding of the origin of humanity itself which was later to be developed so brilliantly by Engels in his *Origin of the Family*.

In the fourth thesis Marx explains how Feuerbach's liberating analysis, which shows the religious world as an imaginary reflex of the real social world, needs to be supplemented by practical activity which changes the real world. The fifth, sixth, and seventh theses deserve to be quoted in full:

"V. Feuerbach, not satisfied with *abstract thought*, wants contemplation: but he does not understand our sensuous nature as *practical*, human-sensuous activity.

"VI. Feuerbach resolves the essence of religion into the essence of *man*. But the essence of man is no abstraction inherent in each separate individual. In its reality it is the *ensemble* (aggregate) of social relations.

"Feuerbach, who does not enter more deeply into the criticism of this real essence, is therefore forced:

1. To abstract from the process of history and to establish the religious temperament as something independent, and to postulate an abstract—*isolated*—human individual.

2. The essence of man can therefore be understood only as 'genus,' the inward, dumb generality which *naturally* unites the many individuals.

"VII. Feuerbach therefore does not see that the 'religious temperament' itself is a social product and that the abstract individual whom he analyzes belongs to a particular form of society."¹⁷

Here we see emerging from the criticism of Feuerbach a new sociological principle, that of humanity, not as a sum of individuals, but as the "ensemble of social relations." This idea strikes at the root of the whole liberal individualist outlook which Marx had already shown was itself the expression of early *laissez-faire* capitalism. At the same time it is far from a denial of the value of the individual, as some shallow anti-Marxist critics maintain to this day. The recognition that the individual is not only formed by society but in turn creates society, makes him more and not less important

than the abstract creature or economic man of the Christian or liberal traditions.

In the eighth to the eleventh theses Marx drives the argument home to its logical conclusion:

"VIII. All social life is essentially *practical*. All the mysteries which urge theory into mysticism find their rational solution in human practice and in the comprehension of this practice.

"IX. The highest point to which contemplative materialism can attain, *i.e.*, that materialism which does not comprehend our sensuous nature as practical activity, is the contemplation of separate individuals and of civil society.

"X. The standpoint of the old type of materialism is civil society, the standpoint of the new materialism is human society or social humanity.

"XI. The philosophers have only *interpreted* the world differently, the point is, to *change* it."¹⁸

The last two theses, with the now classical concept of *socialized humanity* and the call to the philosophers to *change* the world, are the core of Marx's whole life-work. They are already being realized as he foresaw and strove for.

VII. The Place of Natural Science

At the same period of the development of his thought, Marx had reached that comprehensive understanding of the significance and place of natural science which characterized all his later work. This is already stated explicitly in one of his unpublished economic-philosophic manuscripts of 1844:

"Natural sciences have developed an enormous activity and appropriated to themselves a steadily increasing field. Philosophy however has remained as strange to them as they have remained to philosophy. Their momentary union was only a fantastic illusion. The will was there but the means were lacking. Even the writing of history only gives incidental attention to natural science as an element of enlightenment, utility arising from individual great discoveries. But the more science has practically intervened in human life and transformed it through industry, thereby preparing the way for human emancipation, the more it has been obliged to

complete a process of dehumanization. Industry is the real historical relation of nature, and therefore of natural science, to man. Hence if natural science is understood as an external revelation of human powers, the human essence of nature or the natural essence of man will be understood and hence natural science will lose its abstract material or rather idealistic tendency and will become the basis of human science as it has already become, although in alienated* form, the basis of actual human existence. One basis for life and another for science is *a priori* a lie. Nature as it develops through human history—in the genesis of human society—is the real nature (known to) of man, therefore nature as it develops through men's industry, even if in an alienated form, is the real nature of man.

"That which is perceptible to the senses [*Sinnlichkeit*] (see Feuerbach) must be the basis of all science, but only when it emerges in the double form of material consciousness as well as material need, *i.e.*, only if science starts from nature is it real science. All history is the prelude to 'man' becoming the object of material consciousness and the higher needs of 'man as man' will become real needs. History itself is a real part of natural history, of the development of nature into man. Later natural science will include the science of man in the same way as the science of man will include natural science. There will be only one science."¹⁹

In this intensely compressed statement is to be found the starting point of the Marxist analysis of the world of nature and man as exemplified in Engels' *Anti-Dühring*, *Origin of the Family*, and *Dialectics of Nature*, in Lenin's *Materialism and Empirio-Criticism*, and in Stalin's *Marxism and Linguistics*, as well as in many books that have still to be written. It is clear from the above passage that the importance which Marx gives to natural science is based on its relation to industry or to the expression of social productive forces. For, as we have seen, he already understood how it is that social productive relations—the institutions of property, of the market, of competitive or monopolistic industry—are linked with the state of the productive forces. But these in turn depend on the state of science and at the same time provide a major motive for its advance or stagnation.

The crucial importance of the development of productive forces is shown by Marx's insistence that the passage to a new type of

* See Footnote, p. 6.

civilization, particularly to socialism, is only possible if the productive forces have reached such a state of development as to provide the material possibilities, that is, the high productivity, which can make *socialism* work, and that only after this is achieved will *communism* be possible.

Much later, in the *Critique of the Gotha Programme* (1875), Marx criticizes sharply those who think it would be possible to achieve a state of ideal distributive justice in a socialist state which has just emerged from capitalism.

"But these defects are inevitable in the first phase of communist society as it is when it has just emerged after prolonged birth pangs from capitalist society. Right can never be higher than the economic structure of society and the cultural development thereby determined.

"In a higher phase of communist society, after the enslaving subordination of individuals under division of labor, and therewith also the antithesis between mental and physical labor, has vanished; after labor, from a mere means of life, has itself become the primary necessity of life; after the productive forces have also increased with the all-round development of the individual, and all the springs of co-operative wealth flow more abundantly—only then can the narrow horizon of bourgeois right be fully left behind and society inscribe on its banners: from each according to his ability, to each according to his needs."²⁰

This passage brings out more clearly almost than any other how well Marx understood the problems of the transition to communism. We may also reflect how well the actual builders of socialism, Lenin and Stalin, have carried out the program he then laid down, while all their "socialist" detractors, who have done nothing themselves to emancipate their own countries from capitalism, clamor that the Soviet rulers have abandoned true Marxism.

Marx fully recognized that the existence of modern science is a necessary precondition of large-scale mechanical industry and that many of the specific characters of that industry, notably prime movers such as steam engines, needed science for their invention as much as for their improvement. On the other hand, he is equally aware that science is no spontaneous creation of the human mind, nothing like Athene springing full-armed from the head of Zeus. He saw that science is itself a product of the social and industrial forces which it serves. As he wrote in *The German Ideology*:

"... the celebrated 'unity of man with nature' has always existed in industry and has existed in varying forms in every epoch according to the lesser or greater development of industry, just like the 'struggle' of man with nature, right up to the development of his productive powers on a corresponding basis.

"Industry and commerce, production and the exchange of the necessities of life, themselves determine distribution, the structure of the different social classes and are, in turn, determined by these as to the mode in which they are carried on; and so it happens that in Manchester, for instance, Feuerbach sees only factories and machines where a hundred years ago only spinning-wheels and weaving-loom were to be seen, or in the Campagna of Rome he finds only pasture lands and swamps, where in the time of Augustus he would have found nothing but the vineyards and villas of Roman capitalists. Feuerbach speaks in particular of the perception of natural science; he mentions secrets which are disclosed only to the eye of the physicist and chemist: but where would natural science be without industry and commerce? Even this pure natural science is provided with an aim, as with its material, only through trade and industry, through the sensuous activity of men. So much is this activity, this unceasing sensuous labor and creation, this production, the basis of the whole sensuous world as it now exists, that, were it interrupted only for a year, Feuerbach would not only find an enormous change in the natural world, but would very soon find that the whole world of men and his own perceptive faculty, nay his own existence, were missing."²¹

This two-way interrelationship between science and technique was well expressed later by Engels when he wrote:

"If, as you say, technique largely depends on the state of science, science depends far more still on the *state* and the *requirements* of technique. If society has a technical need, that helps science forward more than ten universities. The whole of hydrostatics (Torricelli, etc.) was called forth by the necessity for regulating the mountain streams of Italy in the sixteenth and seventeenth centuries. We have only known anything reasonable about electricity since its technical applicability was discovered. But unfortunately it has become the custom in Germany to write the history of the sciences as if they had fallen from the skies."²²

Further, Marx recognized that in every state of society up to his

own time the very theories of science are not absolute and eternal ideas. They are part and parcel of the ideology of the ruling class of the time of their origin, and they are maintained and developed to suit the interest of that ruling class:

"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, so that thereby, generally speaking, the ideas of those who lack the means of mental production are subject to it. The ruling ideas are nothing more than the ideal expression of the dominant material relationships, the dominant material relationships grasped as ideas; hence of the relationships which make the one class the ruling one, therefore the ideas of its dominance. The individuals composing the ruling class possess among other things consciousness, and therefore think. In so far, therefore, as they rule as a class and determine the extent and compass of an epoch, it is self-evident that they do this in their whole range, hence among other things rule also as thinkers, as producers of ideas, and regulate the production and distribution of the ideas of their age: thus their ideas are the ruling ideas of the epoch."²³

Thus in medieval times the idea of a static world order, familiar to us through Dante's *Divina Commedia*, with its heavenly spheres perpetually turned by angels and its circles of hell, was a reflection of the feudal order of pope, emperor, kings, and nobles all living on the labor of the villeins and serfs. Later when the social order changed and money was the measure of all things, when gunpowder and navigation had opened the world to trade and exploitation, a more dynamic physics and world picture was needed. A new impetus and direction was given to science resulting in the first place in the astronomy and gravitational theory of Copernicus, Galileo, and Newton.

VIII. *The Year of Revolutions and "The Communist Manifesto"*

So far I have dealt only with the achievement of the young Marx, before he had entered into the main part of his political

and economic life-work. Even in this little space it is possible to get some measure of the wealth and coherence of his ideas. Nevertheless they would certainly not have had the overwhelming influence they did if Marx had not had to leave his theoretical work for a while and plunge into the world of action in the stirring events of 1848.

There, a bourgeois revolution showed, in its early success and even more rapid failure and betrayal, how the capitalist class had passed from a progressive and liberating historical role in attacking the relics of feudalism, to one where it joined the reactionary forces to keep down the newly emerging industrial working class. It was to this class, the proletariat, whose role he had first clearly understood, that Marx gave his full allegiance. It was then, at the height of the revolutionary wave, that he and Engels launched *The Communist Manifesto*. Into this ever-living document they poured, in language that even their enemies understood too well, the fruit of all their theory and experience. It still remains the most concise and clear statement of the beliefs and program of Marxism, as from then on it was to be called.

In those days Marx and Engels went back to their native Rhineland to take their personal part in the struggle—Marx as editor of the fierce and, for a while, untrammelled *Neue Rheinische Zeitung*, Engels as an officer of the Republican volunteers. The episode was a short one, but it was a turning point in both their lives. It was to end in a permanent exile to England, to begin a heartbreaking and apparently hopeless struggle by the written and spoken word against a capitalist order triumphant and exuberant as never before.

Yet in the long run this struggle in exile was to be the most fruitful of all their enterprises. The very ineffectiveness of their position as exiles enabled them to concentrate, with a thoroughness for which they had never before had time, on the detailed analysis of capitalism in its most characteristic aspect—its economic structure.

IX. *Science and Industry in "Capital"*

Marx learned his economics at the center of the economic life of the world of his time, in England, and particularly in London and Manchester. As he acquired it, it gave him a greater grasp of all other aspects of culture. Marx's understanding of science and its

relation to economic and social change was to continue to deepen all through his life and was enriched by the new experience of practical science and technology which he acquired in England. Of the pair, it was Engels who was more closely attached to the techniques of the productive process and to the general field of natural science:

"Marx and I were pretty well the only people to rescue conscious dialectics from German idealist philosophy and apply it in the materialist conception of nature and history. But a knowledge of mathematics and natural science is essential to a conception of nature which is dialectical and at the same time materialist. Marx was well versed in mathematics, but we could only partially, intermittently and sporadically keep up with the natural sciences. For this reason, when I retired from business and transferred my home to London, thus enabling myself to give the necessary time to it, I went through as complete as possible a 'moulting,' as Liebig calls it, in mathematics and the natural sciences, and spent the best part of eight years on it."²⁴

Nevertheless Marx himself worked hard at acquiring the necessary basic and even practical knowledge. For example he wrote to Engels:

"I am adding something to the section on machinery.* There are some curious questions here which I ignored in my first treatment. In order to get clear about it I have read through all my notebooks (extracts) on technology again and am also attending a practical course (experimental only) for workers, by Professor Willis (at the Geological Institute in Jermyn Street, where Huxley also used to give his lectures). It is the same for me with mechanics as it is with languages. I understand the mathematical laws, but the simplest technical reality demanding perception is harder to me than to the biggest blockheads."²⁵

Marx never shone as a hand worker. At the depths of his financial difficulties he did get a job as a railway clerk, but was only able to keep it for a few days on account of his bad handwriting.

Through even closer association with Engels, Marx was able to see and analyze the actual processes of industry and to relate them in detail to their economic consequences. This is shown very clearly in his great work *Capital*, particularly in Chapter XV of the first volume, on "Machinery and Modern Industry," and in Chapter V

* In *Capital*, Vol. I, Chap. XV.

of the third volume, on "Economies in the Employment of Constant Capital." The opening passages of the former are astonishing to read even today in their clarity and penetration. Marx showed an understanding of the essence of mechanical production which was far ahead of that of anyone else of his time. One only has to read the ideas of a very intelligent and penetrating English scientist, Charles Babbage,* to see the enormous advantage which Marx drew from his more comprehensive, philosophic and economic approach. Where Babbage only saw individual examples of the use of machinery, Marx could see a single continuous transforming process. This process started with the handicraftsman with his tools, moved on to the period which he called that of manufacture, where a number of handicrafts are put together and where a division of labor results in lowered costs, to reach the position of modern industry where the machine enters the field.

Marx first analyzes the machinery of productive industry in a general way:

"All fully developed machinery consists of three essentially different parts, the motor mechanism, the transmitting mechanism, and finally the tool or working machine. The motor mechanism is that which puts the whole in motion. It either generates its own motive power, like the steam engine, the caloric engine, the electro-magnetic machine, etc., or it receives its impulse from some already existing natural force, like the water-wheel from a head of water, the wind-mill from wind, etc. The transmitting mechanism, composed of fly-wheels, shafting, toothed wheels, pulleys, straps, ropes, bands, pinions, and gearing of the most varied kinds, regulates the motion, changes its form where necessary, as for instance, from linear to circular, and divides and distributes it among the working machines. These two first parts of the whole mechanism are there, solely for putting the working machines in motion, by means of which motion the subject of labor is seized upon and modified as desired. The tool or working-machine is that part of the machinery with which the industrial revolution of the 18th century started. And to this day it constantly serves as such a starting point, whenever a handicraft, or a manufacture, is turned into an industry carried on by machinery."²⁶

* See C. Babbage, *On the Economy of Machinery and Manufactures*, London, 1832.

This leads him to consider the essential character of a machine to be the fact that it is a tool operated not by a man but by a mechanical contrivance:

"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. . . .

"The machine, which is the starting point of the industrial revolution, supersedes the workman, who handles a single tool, by a mechanism operating with a number of similar tools, and set in motion by a single motive power, whatever the form of that power may be. Here we have the machine, but only as an elementary factor of production by machinery.

"Increase in the size of the machine, and in the number of its working tools, calls for a more massive mechanism to drive it; and this mechanism requires, in order to overcome its resistance, a mightier moving power than that of man, apart from the fact that man is a very imperfect instrument for producing uniform continued motion. But assuming that he is acting simply as a motor, that a machine has taken the place of his tool, it is evident that he can be replaced by natural forces."²⁷

He saw the first phase of machine industry arising, not out of any radically new invention, but by the multiplication of simple handicraft operations, linked by such a mechanism as that of the spinning jenny or Crompton's mule. His analysis of the later stages of the development of industry was even more penetrating. He showed how it was changing: first, by the blending of different machines into each other to form more complex machines and leading the way towards the continuous flow, semi- or completely automatic process that we consider characteristic of twentieth-century industry; and secondly by the enlargement of mechanical means, so as to do things which were impossible by limited individual human strength, particularly in the heavy engineering and iron and steel industries:

"Modern Industry had therefore itself to take in hand the machine, its characteristic instrument of production, and to construct machines by machines. It was not till it did this, that it built up for itself a fitting technical foundation, and stood on its own feet. Machinery, simultaneously with the increasing use of it, in the first decades of this century, appropriated, by degrees, the fabrication of

machines proper. But it was only during the decade preceding 1866, that the construction of railways and ocean steamers on a stupendous scale called into existence the cyclopean machines now employed in the construction of prime movers."²⁸

He saw further that this development was linking science with industry and that it was to have far-reaching social consequences.

"The implements of labor, in the form of machinery, necessitate the substitution of natural forces for human force, and the conscious application of science, instead of rule of thumb. In Manufacture, the organization of the social labor-process is purely subjective; it is a combination of detail laborers; in its machinery system, Modern Industry has a productive organism that is purely objective, in which the laborer becomes a mere appendage to an already existing material condition of production. In simple co-operation, and even in that founded on division of labor, the suppression of the isolated, by the collective, workman still appears to be more or less accidental. Machinery, with a few exceptions to be mentioned later, operates only by means of associated labor, or labor in common. Hence the co-operative character of the labor-process is, in the latter case, a technical necessity dictated by the instrument of labor itself."²⁹

Marx was able to have this functional understanding of machinery because he linked it at every stage with its actual economic use. He demonstrated that the reason for John Stuart Mill's complaint that machinery had not "lightened the day's toil of any human being" was that this had never been the motive of invention under capitalism. That motive had been first and last that of profit. The function of technical improvement was primarily to increase the value of the product for the same labor force, and secondarily to increase the rate of profit by increasing the quantity of raw materials worked up in a given period of the employment of plant and machinery. (See the discussion in *Capital*, Vol. III, Chapter V.) He further showed that, paradoxically, the more labor-saving the machinery the more people could profitably be brought in to work on it. The development of industry towards mass-production is very clearly foreshadowed in this part of his work.

Marx also understood well what science had to do in the development of modern industry. The demand for ever greater speed and economy of operation was one that rule of thumb improvement could no longer satisfy.

“. . . co-operative and social production, a co-operation within the primary process of production. On the one hand, this is the indispensable requirement for the application of mechanical and chemical inventions without increasing the price of commodities, and this is always the first consideration. On the other hand, only production on a large scale permits those economies which are derived from co-operative productive consumption. Finally, it is only the experience of combined laborers which discovers the where and how of economies, the simplest methods of applying the experience gained, the way to overcome practical frictions in carrying out theories, etc.

“Incidentally it should be noted that there is a difference between universal labor and co-operative labor. Both kinds play their role in the process of production, both flow one into the other, but both are also differentiated. *Universal labor is scientific labor, such as discoveries and inventions.* This labor is conditioned on the co-operation of living fellow-beings and on the labors of those who have gone before; co-operative labor, on the other hand, is a direct co-operation of living individuals.

“The foregoing is corroborated by frequent observation, to-wit:

“(1) The great difference in the cost of the first building of a new machine and that of its reproduction, on which see Ure and Babbage.

“(2) The far greater cost of operating an establishment based on a new invention as compared to later establishments arising out of the ruins of the first one, as it were. This is carried to such an extent that the first leaders in a new enterprise are generally bankrupted, and only those who later buy the buildings, machinery, etc., cheaper, make money out of it. It is, therefore, generally the most worthless and miserable sort of money-capitalists who draw the greatest benefits out of the universal labor of the human mind and its co-operative application in society.”³⁰ [My italics—J.D.B.]

Thus he saw this universal labor, science, as a component of the productive force distinct from the older co-operative labor and, to a certain extent under capitalism, opposed to it. This is clearly stated in *Capital*:

“It is a result of the division of labor in manufactures, that the laborer is brought face to face with the intellectual potencies of the material process of production, as the property of another, and

as a ruling power. This separation begins in simple co-operation, where the capitalist represents to the single workman, the oneness and the will of the associated labor. It is developed in manufacture which cuts down the laborer into a detail laborer. It is completed in modern industry, which makes science a productive force distinct from labor and presses it into the service of capital.”³¹

X. *The Working Class as the Heirs of Science*

But if capitalism had built up science as a productive force, the very character of the new mode of production was serving to make capitalism itself unnecessary. Even while Marx was writing, in the very heyday of capitalism, he was able to see signs of its decay and the beginning of the process of monopolistic restriction that has grown so monstrously since his time. But Marx knew well enough that however superfluous and even disastrous capitalism was becoming, it would not vanish of itself. Nor would it merge imperceptibly into a better system, as well-meaning or cowardly liberals or socialists would have liked to think. He knew that the full social use of science could come only when the proletariat, the class that had been called into existence by industry, itself controlled the productive system that it was already maintaining by its own co-operative labor. Marx said this plainly in the speech which he gave at the anniversary dinner of the *People's Paper* in 1856:

“There is one great fact, characteristic of this, our nineteenth century, a fact which no party dares deny. On the one hand, there have started into life industrial and scientific forces, which no epoch of the former human history had ever suspected. On the other hand, there exist symptoms of decay, far surpassing the horrors recorded of the latter times of the Roman Empire. In our days everything seems pregnant with its contrary; machinery gifted with the wonderful power of shortening and fructifying human labor, we behold starving and overworking it. The new-fangled sources of wealth, by some strange weird spell, are turned into sources of want. The victories of art seem bought by the loss of character. At the same pace that mankind masters nature, man seems to become enslaved to other men or to his own infamy. Even the pure light of science seems unable to shine but on the dark background of ignorance.

All our invention and progress seem to result in endowing material forces with intellectual life, and in stultifying human life into a material force. This antagonism between modern industry and science on the one hand, modern misery and dissolution on the other hand; this antagonism between the productive powers and the social relations of our epoch is a fact, palpable, overwhelming, and not to be controverted. Some parties may wail over it; others may wish to get rid of modern arts in order to get rid of modern conflicts. Or they may imagine that so signal a progress in industry wants to be completed by as signal a regress in politics. On our part, we do not mistake the shape of the shrewd spirit that continues to mark all these contradictions. We know that to work well the new-fangled forces of society, they only want to be mastered by new-fangled men—and such are the working men. They are as much the invention of modern time as machinery itself. In the signs that bewilder the middle class, the aristocracy and the poor prophets of regression, we do recognize our brave friend, Robin Goodfellow, the old mole, that can work in the earth so fast, that worthy pioneer—the revolution. The English working men are the first born sons of modern industry. They will then, certainly, not be the last in aiding the social revolution produced by that industry, a revolution, which means the emancipation of their own class all over the world, which is as universal as capital-rule and wages-slavery.”³²

In this Marx brings out both the importance of science and the fact that it is only through the working class that it can effectively be used. The essential feature of modern industry as he saw it—the social production of value—cannot work effectively unless it is accompanied by the social utilization of the values produced. The only people who can ensure that social utilization are the people who suffer from the present system and who themselves are the major motive force of that system—the industrial workers.

Marx here clearly foreshadows a productive system which would be far more consciously controlled by the people than anything that capitalism could evolve. In this control he sees the possibility of achieving results which are impossible in the constant pursuit of profit, which warps all constructive enterprise, and in the anarchy of production imposed by the conditions of the market. That social control is, therefore, itself a condition of freedom. It was to this end that Marx called on the working class to take the matter into their own hands by overthrowing the bourgeois state. Then only would

the “one science,” comprising the science of nature and of humanity, be able to take form in practice as well as in theory. In this, as in everything else, in philosophy as well as politics, Marx throughout his whole life wove the future into the present. He both foresaw and ensured the realization of his prophecy.

XI. The Heritage of Marx

Looking back now over the years since Marx’s death we should be able to appreciate something of the importance of his understanding of the relations between science, production, and political forms. Yet how few intellectuals with their knowledge and the experience of the great and terrible events of our time have even begun to do so! Certainly the majority of intellectuals of his own time did not. Most of the “well-educated” scientists who were, whether they liked it or not, components of the productive mechanism, the economists and philosophers paid to provide the ideological background of the capitalist system, were incapable of refuting Marxism because they were incapable of looking at it at all, much less of understanding it. The Marxist ideas spread among the working class, which was the only class capable of appreciating from the experience of their own lives the essential features of this philosophy, and particularly the need to combine at every stage their understanding with their action.

Marx himself had been the first to set out the laws of transformation of human society. From the very moment he did so he became an active working-class leader. It was this aspect of his activity, transmitted through an increasing class-conscious proletariat, that was to prove the effective means of carrying out the task of “changing the world” which he himself had given to the philosophers. Lafargue indeed had written:

“Karl Marx was one of those rare men who are fitted for the front rank both in science and in public life. So intimately did he combine these two fields that we shall never understand him unless we regard him simultaneously as man of science and as socialist fighter. While he was of the opinion that every science must be cultivated for its own sake and that when we undertake scientific research we should not trouble ourselves about the possible consequences, never-

theless, he held that the man of learning, if he does not wish to degrade himself, must never cease to participate in public affairs—must not be content to shut himself up in his study or his laboratory, like a maggot in a cheese, and to shun the social and political struggles of his contemporaries. 'Science must not be a selfish pleasure. Those who are so lucky as to be able to devote themselves to scientific pursuits should be the first to put their knowledge at the service of mankind.' One of his favorite sayings was, 'Work for the world.'³³

Marx made no secret of his teaching, it was open to all, even the capitalists, to read and understand. Nevertheless his offered prophecies were disregarded even as, one after the other, they were realized. The ruling class could not understand them—because they could not face the logical picture they revealed. And yet they were obliged to execute them, even to their own destruction.

In the course of the century since Marx's first analysis of capitalism, and largely through the utilization of science, productive methods have enormously improved in efficiency. Yet this great increase in productive power has not diminished in any degree the difficulties and contradictions of capitalism. In fact, as we all know from our bitter experience, it has very much increased them. From 1850 to 1950 we have witnessed crises growing in depth and duration, and resolving themselves in wars and reactionary tyrannies worse than anything that could have been imagined by any mid-nineteenth century economist or historian. But we have also witnessed the practical realization of Marx's more positive prophecies in the establishment of the first socialist state, the Soviet Union, which has been able, in spite of every opposition and attack, to grow and prosper. And there are now growing round it, west and east, other states imbued with the same creative philosophy.

XII. Science Under Imperialism—Frustration and Militarization

In this period, too, science has undergone enormous and progressive changes. Our knowledge of the universe in 1950, inanimate and living, and with it our powers of control of nature, are almost

immeasurably larger than they were in 1850. Nevertheless it would be absurd to say that on that account everybody is more comfortable and free from anxiety now than they were then. All that has happened is that the gap between what is being done for humanity, and what could be done for it through science, is far wider. Science appears to the scientist, as well as to the ordinary member of the public, no longer as a hopeful and beneficent force, but as something which is willy-nilly being used for increasingly futile or destructive purposes. It becomes more and more difficult to think of science abstracted from society. The indirect control through benefactions and government grants, well-concealed by the doctrine of pure science, can no longer operate on the scale demanded. In capitalist countries the scientists are now directly controlled by governments or by monopolies, and often in a peculiarly unpleasant way. The process has indeed been so rapidly accelerated since the war that most scientists are still left completely bewildered.

With the increasing complexity of science, its costs have risen to such an extent as to make it almost completely dependent on either government or monopoly support. That support is now given increasingly for military purposes, directly or indirectly. Already over 80 per cent of government expenditures on science both in Britain and the United States is devoted to war purposes. The proportion is now going up so fast that research for purposes of human betterment in backward countries and even in advanced industrial countries is stagnating or is actually being cut down.

As galling to the individual scientist is the effect of secrecy—an inevitable concomitant of the use of science for military purposes. All the old commonplaces of science, the ideas of free research and free publication are gradually being eaten away,* and their place is being taken by a system of inspection and police supervision, with the sanctions of dismissal or imprisonment, which make the modern scientists hardly freer than the expensively trained cultured Greek slaves of Roman times.

* Here is a most politely phrased official estimation of what is in store:

... One of our difficulties in utilizing the Universities is that University professors and scientists broadly claim that they should be entitled to publish anything that they discover. A great deal of the work which we want them to undertake is so highly secret that we could not allow them to publish it, and that does to some extent cramp our style. It is a point which I am at present discussing with Sir John Lennard-Jones, who is Chairman of our Scientific Advisory Council, and I have been asking him if he could persuade

This control under cover of "security" does not stop at matters of research. It goes into matters of political opinion and even of those of scientific thought itself.* It is becoming increasingly difficult in the United States and in all the countries which it dominates for anyone who has not got the appropriate beliefs to do any scientific work at all. Loyalty oaths and political tests are rapidly becoming the requirements for the scientific research or teaching job.† The essential condition is that the recipient of

the Universities to undertake a little more 'aimed' research. He is hoping to be able to do something in that direction. It is a real point that the Universities could do more for us, but they are not prepared to accept the restrictions which we may impose in respect of particular projects." (Evidence given by Sir Archibald Rowlandson [Permanent Secretary Ministry of Supply] to *Select Committee on Estimates 17th Report [Sub-Committee B.]* "The Defense Estimates," HMSO, p. 7, para. 1311.)

Another more pointed reminder was given by Viscount Portal in a speech at the Royal Society Anniversary Dinner in November 1951:

"... There can be very few people with any spark of idealism in them who do not respect and admire the ideal of the freedom of science. But may I say with equal sincerity that there can be very few people with a spark of political sense in them who do not see that, for the present at any rate, this ideal cannot be allowed to hold full sway. . . .

"There is already a great body of scientists and technologists working for industry to whom the idea of secrecy has become familiar. These men have not found that loyalty to the scientific ideal is incompatible with loyalty to the firm that employs them. How much less should it be incompatible with loyalty to their own country?

"We must however recognize that there are some scientists who for conscientious reasons resent the need for restrictions and who, by propagating their rather one-sided views, may help to weaken the national loyalty of some of those, especially the young, on whom we have to rely."

* Dr. Du Bois, one of the most distinguished of American sociologists had, at the age of 82, to stand trial for the crime of being an unregistered foreign agent because of his advocacy of peace. That he was acquitted is a tribute to the world-wide protest his case excited. Professor Struik of the Massachusetts Institute of Technology is indicted for conspiring to overthrow the government of the United States of America by force and violence because he taught Marxist theory. Dr. Spitzer was dismissed from his post for writing in a scientific journal that it might be advisable to study Lysenko's theories before denouncing them. Nearer home there is the case of Joliot-Curie, who lost his post as Director of Atomic Energy in France because he declared that he would not be a party to using it for destructive ends.

† See G. R. Stewart, *The Year of the Oath; the fight for academic freedom at the University of California* (in collaboration with other professors of the University of California), New York, 1950.

scientific funds should not in any way criticize what is done with the result of his work and that he should have an absolute belief in the rightness of the actions of his government. The same kind of thing may well follow here, unless it meets the solid resistance of the scientists and people of Britain.

Of course, it is not very difficult for a number of people to submit to these conditions, but that submission is made at a very heavy cost.* It reinforces the already very strong sanction which has existed in capitalist society ever since its beginning against any kind of investigation which might criticize the bases of capitalist economy and the structure of society itself. This leads to a kind of inculcated and automatic stupidity.

There has never been a time, not even at the height of the reaction to the French Revolution, in which conventional thinking with a tendency towards mystical and religious belief has been more common in science. Such thinking is now becoming almost obligatory for "respectable" scientists, and those to whom it comes naturally are apt to be promoted to the highest posts.†

Just at a time when the internal developments of science itself are pointing more and more clearly to the unity of all the sciences and to the close relations between science and economic and historic processes, it becomes a matter of faith that science must be considered as perfectly free and independent from those processes.

* See W. Gellhorn, *Security, Loyalty and Science*, Cornell University Press, 1950, in which the ill effects of thought control in science are shown to be already evident.

† Sir Walter Moberly indicates how this can be done in the most gentlemanly and unobtrusive manner:

"With regard to honest heretics no doctrinaire rule can be laid down, but there are two guiding principles. First the university's fundamental orientation must be maintained. The admission to teaching posts of those who repudiate it in such quantities as to threaten it should be opposed. Secondly, as we have seen, heretics may have a genuine contribution to make, and subject to the above qualification should not only be tolerated but be made welcome.

"The practical application of these principles will vary with different offices and different subjects. When the appointment in question is that of Vice-Chancellor or Principal, 'Head of a House,' Warden of a Hall, or—more doubtfully—Dean of a Faculty, it is to be remembered that, in his own institution, he is the only one of his kind. As its official head, he should be the most influential person in it. He may belong to any one of a large variety of schools of thought; but his basic values and outlook should be congruous with those of the university." (*The Crisis in the University*, London, 1949, p. 159.)

Just at a time when science, from physics to biology, is deeply imbued with the essentially Marxist idea of historical and dialectical transformation, it becomes dangerous heresy to believe in any such changes at all.

In fact, the criterion for success in science is the admission of complete and blank ignorance, of which a magnificent example has been provided in a book by Dr. Vannevar Bush, the war-time director of military scientific research in the United States:

"Yet the whole affair is a ghastly fallacy. Science has been misread. Science does not exclude faith. And faith alone can meet the threat that now hangs over us.

"Science does not teach a harsh materialism. It does not teach anything at all beyond its boundaries, and those boundaries are severely limited by science itself.

"Science builds great telescopes to extend the power of man's vision. . . . But it does not examine how the cosmos first appeared to be reasoned about. Still more strongly, it is silent as to whether there was a great purpose in the creation of the cosmos beyond the grasp of the feeble mind of man. These things are forever beyond its ken.

"Science builds microscopes to delve into the inner recesses of matter.

"It speculates as to whether all is cause and effect, or whether there is an element of probability and chance, even in the interrelation of physical things. But when it comes to the reason why these forces exist, what their ultimate nature is, how they came to appear, it pauses. These things are beyond its ken.

"Science looks at life.

"It traces the evolution from a primordial cell under the sun to a system of organic life culminating in man, and it teaches man how best to cope with his environment. But it does not speculate as to how the materials and processes that were involved came ultimately to be present, or whether these were chance or were expressly designed to produce a man. These things are beyond its ken.

"Science probes into the mind of man itself. . . . But it does not define consciousness or tell us why there is a being on the earth who can reason as to why he is there. It does not speak with authority as to whether there is such a thing as free will, a choice of actions over and above that dictated by the operations of the

mechanism. It does not deal with faith. These things are beyond its ken."³⁴

The irony of the situation is that all this obscurantism and reaction is paraded as part of the "freedom of science" and of "Western Civilization." Even history can be perverted to such an extent that the Catholic Church is portrayed as a patron and promoter of scientific progress as part of Christian civilization. This is despite the fact that it did its best throughout most of its history to prevent science existing at all outside a fixed dogmatic scheme.

With this reaction goes a deep-seated pessimism as to the possibilities of the use of science for human betterment. There is a return to Malthusian ideas of overpopulation and the limited nature of the world's resources. Much of this agitation conceals rather badly the basic bourgeois fear that the people—the "inferior" masses, the Negroes, the Orientals—will push those above them out of their privileged places. It passes imperceptibly into the race theory of the fascists, and will lead again, unless it is checked, to war and mass destruction. The destructive elements in science are extolled, the creative disparaged.*

XIII. The New Socialist World—Science for the People

Fortunately, thanks to Marx, there is another side to the picture, first in theory, now in practice. Already by 1843 Engels had challenged the theory of the decreasing productivity of the soil:

"The extent of land is limited. Very well. The amount of labor power which has to be applied to this area increases with the population; let us even assume that the increase of the yield is not always proportionate to the increase of labor; yet there still remains a third factor—which never counts for anything with the economists, it is true—namely science, and the advance of science is as limitless and at least as rapid as that of population. How much of the progress of agriculture in this century is due to chemistry

* This finds practical expression in the relative sums of well under \$1,000,000,000 budgeted by the U.S. Government for assistance to the under-developed countries in which 1,100,000,000 people live (given under President Truman's celebrated "Point four" program) and over \$50,000,000,000 budgeted for military preparations (1952-53).

alone, and indeed to two men alone—Sir Humphrey Davy and Justus Liebig? But science multiplies itself at least as much as population: population increases in relation to the number of the last generation; science advances in relation to the total amount of knowledge bequeathed to it by the last generation, and therefore under the most ordinary conditions in geometrical progression too—and what is impossible for science? But it is ridiculous to talk about overpopulation while 'there is waste land enough in the valley of the Mississippi for the whole population of Europe to be transplanted upon,' and while in general only a third of the earth's surface can be regarded as cultivated and the production of this third part could itself be increased sixfold and more by the application even of the improved methods already known."³⁵

Today this is not just reasoned optimism, it is achieved fact. A new world has come into being. There are 800,000,000 people living under socialism. The ideas of Marx and Engels found worthy development in the thought and work of Lenin and Stalin. With the key of the dialectic and the experience of revolutionary struggle they made the first breach in the world domination of capitalism. They succeeded because, thanks to Marx, they understood the laws of action of the social forces and above all the role of the proletariat as the leading force of the revolution.

Now in our time, after another world catastrophe brought about by the insane greed and violence of decaying capitalism, the camp of socialism has grown still wider. In the People's Democracies in Europe the age-old rule of the landlords is over and the natural talents of the people can find expression for the first time. In China the change is no less significant. Under the leadership of Mao Tse-tung, this great people is leaping from the double oppression of foreign imperialism and local feudalism into the forefront of human social achievement. In all these lands, and in good accord with their local and national characteristics, Marx's original ideas of the relation of science to productive forces are being put into practice. The essential features of this program are, firstly, that science is given the task of helping to satisfy ascertainable human needs for food, for shelter, for means of production and transport; and secondly, that science is ceasing to be something separated from the rest of social activities and the preserve of an intellectual elite, and is becoming part of the everyday life and work of the great majority of the population.

This is very different from the position under capitalism. Under capitalism science is limited in academic circles to diluted and unco-ordinated contributions to the understanding of nature. In practice it is applied when it is profitable to do so or where it can produce lethal weapons. There is a violent refusal to treat science as a whole and to relate its various parts in any comprehensive plan of human betterment. Such a plan would in effect be completely nonsensical in a capitalist country, because it would be absurd even to think of planning science, when production itself remains subject to the whims of private property and monopoly which restricts it except for military ends. But in a socialist state this restriction is removed and science falls naturally into its place as the normal means of improving productivity in a continuous and progressive way.

Socialist planning of science is often distorted and caricatured as an attempt to plan thoughts and inventions in advance. No such attempt has ever been made, and if that had been the best use they could make of science, it would have been impossible for the Soviet Union to have achieved the results in peace and war that it has, in the face of enormous initial poverty and repeated foreign armed intervention. What really happens in the Soviet Union and the New Democracies is that science is applied to the solution of problems arising out of the general economic plan. For example, in the great combined schemes for the southeast of the Soviet Union, which are to change the whole face of nature and provide food for a hundred million people, some thousands of scientists of the most varied categories from mathematicians to archaeologists are studying, on the spot and in their laboratories, the multiplicity of problems that need to be formulated and solved.*

In the light of the knowledge of the needs of the country and with the experience of actually co-operating in constructional work, the scientists are able individually and collectively to determine which are likely to be the most fruitful lines of research and are enabled to direct their work along these lines.

This implies both a wider and a deeper use of science. The deeper understanding comes from surmounting the conventional barriers

* See J. D. Bernal, "The Developments of Soviet Science," *Anglo-Soviet Journal*, Vol. 12, No. 3, Autumn 1951; "Grand Construction Works of the Stalin Epoch," *New Times*, No. 39, Supplement, September 1950; and *Man Conquers Nature*, S.C.R. pamphlet, 1952.

to science set up in the seventeenth century in Europe, and staunchly maintained since by official science. These have barred the scientist in the past from considering the philosophic or social basis of his work. The value of Marxist theory to science is that it enables us to look beyond the results of existing theories to see the forces which molded those theories. Only on that condition is it possible to reconsider theories in the light both of the development of science and productive forces, and of the general theoretical understanding provided by Marxism itself.

Naturally the process is not a simple or an easy one. It involves very great struggles and contradictions, because the whole ideology of science itself, an ideology implicit in all scientific theory, is derived from that of capitalism.

Indeed, any serious study of the history of science shows that from the moment when, at the very beginning of civilization, science became separated from practical handicraft, it acquired the character and methods of thought of the upper classes of class-divided society. Such a cast of thought was hardly at all concerned with the material control of the environment; it was much more concerned with justifying the aloofness of the superior man of science, devoted to contemplation and by his very existence proclaiming the eternal nature of class society.

The arguments and struggles that are now going on in the Soviet Union in many fields of science—not only the famous case of genetics—are the expression of the great intellectual effort that is being made to break with the past and to raise science to a level of social and intellectual coherence which it has never had before. As early as 1844 Marx saw the need for this (see page 23). Those who today talk about, and in most cases hope for, the destruction of Soviet science under the influence of Marxism will suffer the same disappointment as Bertrand Russell did, when he announced that an atom bomb built on Marxist principles would never go off—just a week before Truman's announcement that one had gone off.

The other feature of science in the Soviet Union and the New Democracies is its co-operative and popular character. Marx's *Capital* contains an illuminating section (Vol. I, Ch. XV, 5) "on the strife between workman and machine" in the early days of capitalism. Indeed, the workers in capitalist countries still feel with some justice that the use of science in production takes place

ultimately at their expense, that it implies in the first place speed-up and in the second unemployment. It is only in a state where the workers themselves are in control and where unemployment is impossible that this natural and quite rational fear of science is removed. At the same time science under socialism is made a popular possession in a way never possible in capitalist countries, where the study and practice of science are more or less an exclusive privilege of the middle and upper classes, and of such rare specimens of the working class as can be easily assimilated into them. In the Soviet Union and the New Democracies this monopoly is also completely broken down. Science becomes the property of the whole people, firstly by ensuring that most scientists are drawn from the working people, and then by directly involving working people in scientific research relevant to their own problems;* and so it rouses an interest only equivalent to that held in the countries of capitalism in sport or crime.

As a result of this experience we can see how the possibilities of the development of science under capitalism are crippled, because all scientific activity is retained in the hands of a small and quasihereditary class. This inevitably slows down all scientific development, quite apart from the limitations imposed by a class outlook. For the rapidity of advance of any enterprise is not merely proportional to the number of people engaged in it, but also depends far more on the possibilities of finding people with a specific talent, and on the stimulation of one person by another. Such possibilities and such stimulation are hampered by the capitalist monopoly of science. But they are the immediate results of the popular expansion of science under socialism.

The constructive use of science in socialist countries and the work of trying to build communism on the basis of a successful socialism in the sense that Marx foresaw, are already the beginning of the next round of dialectical transformation. But this change is radically different from that by which capitalism was transformed, and is still being transformed, into socialism. That was a violent change made necessary by the class division of the older society. With the abolition of classes the struggle becomes one not between men and men, but takes place in the field of ideas and in the means of handling material problems. Its methods are those of criticism and self-criticism. In Zhdanov's words:

* See G. Fish, *The People's Academy*, Moscow, 1949.

"In our Soviet society, where antagonistic classes have been liquidated, the struggle between the old and the new, and consequently the development from the lower to the higher, proceeds not in the form of struggle between antagonistic classes and of cataclysms, as is the case under capitalism, but in the form of criticism and self-criticism, which is the real motive force of our development, a powerful instrument in the hands of the Communist Party. This is incontestably a new aspect of movement, a new type of development, a new dialectical law."³⁶

We are witnessing today in the Soviet Union, as also in the New Democracies and in China, not only great material achievements but an exciting new phase in human intellectual development, one in which the ideas of Marx are a stimulus to new achievements both material and intellectual, and where that understanding of the world of which he dreamt is coming into existence. For the philosopher has in fact started to change the world, and what we have seen now is but a small foretaste of things to come. The struggle is still in front of us, but we can be confident of the future, for man through knowledge is at last becoming master of his fate. It is then, as Marx has shown us, that his real history begins.

I can most fitly conclude in the words of Engels at the graveside of Marx, where he emphasized Marx's contribution to the deepening and enlarging of the field of science:

"Just as Darwin discovered the law of evolution in organic nature, so Marx discovered the law of evolution in human history; he discovered the simple fact, hitherto concealed by an overgrowth of ideology, that mankind must first of all eat and drink, have shelter and clothing, before it can pursue politics, science, religion, art, etc., and that therefore the production of the immediate material means of subsistence and consequently the degree of economic development attained by a given people or during a given epoch, form the foundation upon which the state institutions, the legal conceptions, the art and even the religious ideas of the people concerned have been evolved, and in the light of which these things must therefore be explained, instead of vice versa as had hitherto been the case.

"But that is not all. Marx also discovered the special law of motion governing the present-day capitalist mode of production and the bourgeois society that this mode of production has created.

The discovery of surplus value suddenly threw light on the problem in trying to solve which all previous investigators, both bourgeois economists and socialist critics, had been groping in the dark.

"Two such discoveries would be enough for one lifetime. Happy the man to whom it is granted to make even one such discovery. But in every single field which Marx investigated—and he investigated very many fields, none of them superficially—in every field, even in that of mathematics, he made independent discoveries.

"Such was the man of science. But this was not even half the man. Science was for Marx a historically dynamic, revolutionary force. However great the joy with which he welcomed a new discovery in some theoretical science whose practical application perhaps it was as yet quite impossible to envisage, he experienced quite another kind of joy when the discovery involved immediate revolutionary changes in industry and in the general course of history."³⁷

REFERENCE NOTES

1. *Marx-Engels Gesamtausgabe*, Berlin, 1932, Vol. III, Part 2, pp. 114-15.
2. Karl Marx and Frederick Engels, *The German Ideology*, New York, 1947, p. 38.
3. Frederick Engels, *Ludwig Feuerbach and the Outcome of Classical German Philosophy*, New York, 1941, pp. 10-11.
4. *Ibid.*, p. 12.
5. *Ibid.*, pp. 15-16.
6. Henry F. Mins, "Marx's Doctoral Dissertation," *Science and Society*, New York, Vol. XII, No. 1. (Winter 1948), p. 166.
7. *Marx-Engels Gesamtausgabe*, Berlin, 1927, Vol. I, Part 1.
8. *Ibid.*
9. R. Pascal, *Karl Marx, His Apprenticeship to Politics* (Labour Monthly Pamphlet), London, 1942, pp. 8-9.
10. Karl Marx, *Capital*, Vol. I, New York, 1947, p. xxx.
11. Karl Marx, *The Poverty of Philosophy*, New York, pp. 106-07.
12. Karl Marx and Frederick Engels, *Selected Correspondence*, New York, 1942, p. 126.
13. *Ibid.*, p. 125.
14. Marx and Engels, *The German Ideology*, p. 16.
15. *Ibid.*, p. 197.
16. *Ibid.*, pp. 197-98.
17. *Ibid.*, pp. 198-99.
18. *Ibid.*, p. 199.
19. "Ökonomisch-philosophische Manuskripte" (1844), *Marx-Engels Gesamtausgabe*, Vol. III, Part 1, pp. 122-23.
20. Karl Marx, *Critique of the Gotha Programme*, New York, 1938, p. 10.
21. Marx and Engels, *The German Ideology*, p. 36.
22. *Selected Correspondence*, p. 517.
23. Marx and Engels, *The German Ideology*, p. 39.
24. Frederick Engels, *Anti-Dühring*, New York, 1939, p. 15.
25. *Selected Correspondence*, p. 141.
26. Marx, *Capital*, Vol. I, pp. 367-68.
27. *Ibid.*, pp. 368, 370-71.
28. *Ibid.*, p. 380.
29. *Ibid.*, p. 382.
30. Karl Marx, *Capital*, Vol. III, Chicago, 1909, p. 124.
31. Marx, *Capital*, Vol. I, p. 355.
32. Karl Marx and Frederick Engels, *Selected Works*, New York, Vol. II, pp. 427-428.
33. Paul Lafargue, "Reminiscences of Marx," in Karl Marx and Frederick Engels, *Selected Works*, New York, Vol. I, pp. 81-82.
34. Vannevar Bush, *Modern Arms and Free Men*, New York, 1949.
35. "Outline of a Criticism of Political Economy" (1843), quoted in Marx and Engels, *Selected Correspondence*, p. 33.
36. Andrei A. Zhdanov, *Essays on Literature, Philosophy, and Music*, New York, 1950, pp. 71-72.
37. Marx and Engels, *Selected Works*, Vol. I, pp. 16-17.

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