

Critical Social Studies

Editors: JOCK YOUNG and PAUL WALTON

The contemporary world projects a perplexing picture of political, social and economic upheaval. In these challenging times the conventional wisdoms of orthodox social thought whether it be sociology, economics or cultural studies become inadequate. This series focuses on this intellectual crisis, selecting authors whose work seeks to transcend the limitations of conventional discourse. Its tone is scholarly rather than polemical, in the belief that significant theoretical work is needed to clear the way for a genuine transformation of the existing social order.

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The Political Economy of Science

Ideology of / in the
Natural Sciences

Edited by

Hilary Rose

and

Steven Rose

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To the heroic peoples of Indochina, who
demonstrated to the world how to struggle successfully
against the science and technology of profit and
oppression

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pp. 1 – 35. We thank the Editor for permission to reproduce it, with minor editorial changes, here. 'The Radicalisation of Science' first appeared in *The Socialist Register* (London: Merlin Press, 1972) and was subsequently reprinted in *Science for People*, 21 and 22 (1974).

Introduction

In 1971, we began to discuss the idea of collecting together material for books on the theme of ideology of/in the natural sciences with other activists in the radical science movement. The response was positive and unequivocal. We could see that the political struggles in which the movement was engaged, beginning in different ways in the various advanced capitalist countries – the Indochina war and pollution in the United States, Britain, Japan and Australia; the hierarchy and elite nature of scientific practice in France and Italy – nevertheless were moving towards a series of fundamental questions which underlay them all. Scientists who had begun by feeling that ‘their’ science had been betrayed in the defoliation campaign in Vietnam, or that ‘their’ scientific community was a hollow myth, began to ask such questions as: Whose science is it? Who pays for it? Who decides it? Who benefits from it?

Because the production system of science requires interaction between workers at the international level, through journals, conferences, research centres, and so forth, concerns and issues which were felt in one section of the system rapidly spread and were taken up elsewhere. (In practice the movement had to learn that the vaunted internationalism of science was a function of its mode of production, just as much as contemporary capitalism demands the existence of the multinational corporation.) None the less, the differing political traditions – Marxist in France and Italy, social democrat in Britain and populist in the United States – meant that problems were seen and articulated in different ways. In France and Italy following 1968 there were laboratory occupations and attempts to develop self-managing scientific collectives involving the workers in particular institutes. In Britain, the campaign against chemical and biological warfare developed in pressure-group style, with attempts to use the media, ask parliamentary questions, persuade trade-union branches to pass resolutions, and urge moral renunciation of CBW work on individual scientists. In the United States, the work of the Honeywell collective centred on raising the consciousness of workers at Honeywell plants, designing and making fragmentation weapons for use in Vietnam, concerning the

nature of their product. In Japan, the campaign around mercury poisoning at Minamata involved grass-root mobilisation amongst communities directly at risk from the pollutant. Some of these struggles were more politically advanced than others, and even in any given situation there were confused and contradictory ideas as to both the over-all strategy of the campaign and the immediate tactics involved. Political action has taken place in many different areas: within the scientific occupation itself; in conjunction with factory workers; with local communities; and in support of liberation struggles.

However, particularly in the United States and Britain, countries with the most developed scientific production systems, and hence the most organised scientific movements, these movements have been slow to develop a theoretical perspective which would enable them to articulate the links between struggles in the different areas. While particular groups have focused on, for instance, issues of the computer invasion of privacy, or alternative technologies, there was little clarity about the goals of the movement: was it to secure international law on CBW, to unionise or to radicalise scientists, to aid workers in their struggle against pollution in the work-place, or to act as a focal point in the general struggle to overthrow the capitalist system? Instead, a cheerful and energetic eclecticism prevailed. Initially, this was a strength, as new spaces for action were found – spaces, it is important to say, that were deemed not to exist by the old left orthodoxy – but by the early 1970s most activists were recognising the practical and urgent need for theory. They recognised that it was time to move beyond the early pragmatic phase to a stage at which the contradictions present within science could be seen as part of a general revolutionary perspective. This meant not only strengthening the movement's understanding of its own strategy, but also delineating its enemies in class terms, for without this the pragmatic eclecticism threatened merely to refresh and renew the existing social order. Providing the enemy used the same language of moral concern – and sometimes even the same populist rhetoric – it was difficult to distinguish friend from foe. For instance, when the Club of Rome – composed of those same industrialists and scientific elite who had been in charge of the production/pollution process – announced their collective concern with the finite earth, then, lacking a class perspective, the movement seemed only to carp ungenerously at a deathbed repentance. The invocation of 'the scientific community', like that of 'the national interest', sought to bind strata with an antagonistic relationship into one ideological whole.

The magnitude of the theoretical tasks confronting the movement – the need for a political economy of science in contemporary capitalism, its changing mode of production, the proletarianisation of scientific workers, the question of natural science as a generator of ideology, and of the ideology of science with its devaluation of all non-‘scientific’ knowledge, its elitism and the subtleties of its particular form of sexism and racism – all these needed definition and welding together theoretically. We had to achieve these tasks in the knowledge of the past history of theory and practice on the question of science in the revolutionary Marxist movement – and, in particular, the experience of the Soviet Union and China. Such an agenda was daunting for each of us individually – yet we all believed that to tackle it on the basis of our own separate experiences in different capitalist countries was imperative, and that collectively we could make a start. Geographical distance between us has meant that this has not been a fully collective programme in the sense that all its authors have participated in the writing of all sections, but rather that each has taken a particular section of the agenda and developed an analysis within a general shared framework, whilst in a few cases we have used material which was not written specifically for these books but seemed clearly in accord with their over-all theoretical position. By common consent, all royalties from the publication of the collection, in the several languages in which they are to appear, will go towards the development of scientific and technological education and reconstruction in Vietnam, by way of the Institute for Science and Technology in what was once Saigon, and is now Ho Chi Minh City, part of our recognition of the imperishable role that the struggle and sacrifice of the Vietnamese people has played in the theory and practice of revolution and of the transformation and recreation of human society.

The Political Economy of Science

The collection of essays have been organised into two volumes, with the common theme of ideology in/of the natural sciences. Whilst the two books are separate entities they reflect certain common concerns and are interrelated by a logical thread which this Introduction traces. The starting point has been an attempt to transcend both our own particular political pasts, and that of the revolutionary movement, which for too long has seemed to be polarised between, on the one hand, ‘orthodox Marxism’ with a rigid belief in the objectivity of the

natural sciences as a model to which Marxism, as scientific socialism, aspired, and on the other, an anarchism which has seen scientific rationality itself as part of the enemy. In order to recreate a revolutionary critique of the actual social functions of science as they exist in today's capitalist and state socialist societies, it is necessary to understand the origins and the limitations of this 'orthodox Marxist' view of science, which regards itself as operating in a tradition which stretches from the most recent pronouncements of the Soviet Academy of Sciences back through Stalin and Lenin to Engels, and hence Marx himself. We therefore begin, in the first chapter of *The Political Economy of Science*, by returning directly to what Marx and his close collaborator Engels themselves wrote about science, and in doing so rediscover in Marx those compelling theoretical insights which, however briefly and schematically they are presented, lie at the core of every one of those questions of theory and practice which are the concern of today's movement.

The second chapter of *The Political Economy of Science* moves directly forward from Marx and Engels to the issues of the 1970s, with which the whole of the rest of the book is concerned. In 'The Incorporation of Science', we ask what features characterise the present social function of science in Western capitalist societies and the Soviet Union. We argue that, today, science has two major functions, as part of the systems of production and of social control. Especially since the Second World War, science has itself become industrialised and enmeshed in the machinery of state. We examine two myths, the liberal academic myth of the autonomy of science and the 'orthodox Marxist' belief in the inevitable contradiction between science and capitalism, and show that neither accounts for the actual development of science and 'science policy' – the management of science – as it has occurred in Britain or the United States. Faced with capitalism's fusion of science and oppression, and the conspicuous failure of the Soviet Union to avoid the same development, the 'Frankfurt School', typified by such writers as Habermas, has claimed that scientific rationality is *inevitably* oppressive and has abandoned that optimism with which Marxists had maintained the automatically progressive nature of science. The question is whether capitalist science represents an unavoidable and fatal attempt at the domination of nature, or whether it can be confronted as a 'paper tiger', to make way for a genuine science for the people.

The next four chapters discuss in greater depth the questions, raised in Chapter 2, of the role of science in production and the consequences

for scientific workers. This issue raises fundamental questions for Marxists both at the theoretical level and in terms of political and organisational strategy. In the first place, where does science fall within the Marxist categories of 'base' and 'superstructure'? Is it part of the productive process? This is not an abstract question, for if it is purely superstructural, then scientists, whatever the contradictions within their role, cannot be regarded as workers, but primarily as within or associated with the ruling class, either by assisting in the structural maintenance of the capitalist apparatus, like lawyers or accountants, or as transmitters of its ideological values, like teachers or journalists. That is, they will in general find that the contradictions of capitalist society do not oppress them but serve to protect their privileges and position. On the other hand, if science is part of the productive process, 'scientists' are really scientific *workers* who sell their labour to the capitalist in parallel with other workers; like other workers, they become alienated from their creations, from the products of their labour — in a word, they are proletarians, and as such form part of the potential revolutionary forces within society.

This issue has long been a source of debate and discussion because upon it hangs the question of whether, politically, scientists are to be seen as friend or foe. This is particularly important in the present period of the incorporation of science, and the answers given by Marxists in earlier periods may no longer be appropriate today. These chapters argue, essentially, that science spans *both* base and superstructure; it has both a productive and an ideological role, the understanding of which is confused by reference to 'the scientific community' as an undifferentiated whole. In fact, this 'community' is divided into, on the one part, the majority of alienated, proletarianised *scientific workers*, and, on the other, the tiny majority of the elite carriers of bourgeois ideology, the *scientists*.

Chapter 3 is by a group of physicists and mathematicians, Giovanni Ciccotti, Marcello Cini and Michelangelo De Maria, associated with the *Manifesto* group in Italy. They approach the question of the role of science as a productive force from the perspective of Marx's theory of value. Today, they conclude, the role of applied science and technology can be seen as the production of information as a commodity, to be sold on the market just as are material commodities. The relation of scientific workers to their product is therefore comparable to that of manual workers; they are alienated from it. Science as commodity production is thus the dominant mode, which serves as a model for the

style of work even in fields which are not directly concerned with the production of information for sale, such 'pure' sciences as high-energy physics or biology. These fields have a dual role, generating an information 'base' on which the information-commodity market can rest, and serving as test-beds for the checking of advanced technology.

Chapters 4 and 5 take up the consequences of this role of science as a productive force for scientific workers themselves. André Gorz, the editor of *Temps Modernes*, asks: what are the implications of describing scientific workers as proletarianised? Science is still a privileged, elite activity: in industry scientific methods may be used by some categories of workers (production engineers for example) to oppress others by means of speed-ups and other forms of technological rationalisation; none the less, the fragmentation of scientific knowledge, and its ideological values, has come to make intellectuals increasingly the victims rather than the beneficiaries of the class system. The way forward lies in ridding expertise of its class nature, of breaking the barrier between expert and non-expert.

To a large extent, Mike Cooley shares Gorz's preoccupations, but brings to them the perspective of the shop-floor struggles which his own designers' and draughtsmen's union (TASS, a section of the Amalgamated Union of Engineering Workers, AUEW) has been involved in. Cooley shows how the increasing cost and rapidity of obsolescence of fixed capital impose increasing demands on both manual and intellectual workers in industry, with speed-ups, shift work, fragmentation of skills and dehumanisation. This proletarianisation began, as Gorz points out, in the chemical industry in the nineteenth century, but has now spread to designers and draughtsmen, architects, computer programmers and mathematicians in industry. However, as Cooley shows, a capitalism based on very complex, very expensive technology, develops the weaknesses of its own strengths. It is these points of vulnerability which proletarianised scientific workers, side by side with their manual worker comrades, must learn to probe and enlarge if the system is to be shattered and social transformation to occur.

The remaining chapters of *The Political Economy of Science* are concerned with a distinct theme, whose roots, as we show in Chapter 1, derive from Marx's and Engels' own writings, but which has burgeoned into major significance in recent years. This is the theme of the struggle between ideology and science within the natural sciences themselves. The analysis of this struggle is no easy task. Ideology is of its nature mystifying. Where the sharpness of the contradictions within the

capitalist mode of production continually force themselves into the consciousness of the worker, the very role of ideology is to obscure these contradictions and diminish the level of consciousness. Hence, whilst the superstructural battle and that in the work-place are part of the same conflict – indeed, they continuously interact – the dominant class pretends that there is no ideology, and so no grounds for battle: that science has once and for all driven out all ideology. In the second place, because of the abortive nature of the Soviet cultural revolution and the experience of Lysenkoism (discussed in Chapter 2 of *The Political Economy of Science* and Chapter 2 of *The Radicalisation of Science*), the continuity of the critique of ideology has been ruptured. Marxists are faced not only with the problem of starting afresh from the moment of rupture, but also with the analysis of the rupture itself. For many years, orthodox Marxism in its preoccupation with the objective world laid to one side complex questions of the superstructure, arguing for the most part that it was determined by the economic base; natural science, while belonging to both, was above ideology.

Yet battles in the superstructure are not some revolutionary luxury item which can be dealt with after the workers have destroyed capitalism, but are intrinsic to the political struggle itself. No one writing in these books has gone out to look for ‘ideology in astrophysics’, ‘ideology in inorganic chemistry’, in cell biology, biochemistry, and so on in the way which it seems Marxist scientists did in the 1930s, clutching their *Dialectics of Nature* and searching for thesis, antithesis and synthesis in the particular bit of the natural world they worked in. Instead, work on science’s role in perpetuating racism, exposing the implications of reproduction science for women, or the nature of the politics of ecology, has been written as part of an on-going struggle, not as an item of an academic agenda. For this reason these chapters do not represent an even spread over the natural sciences. So long as most of the current struggles relate to the biological sciences, then it is right that we work in this area. (It is not however the case that the cultural analysis in some sense ‘follows’ the existence of struggle at the point of production, nor is it a question of awarding prizes for priority in discovering racism to the Mansfield hosiery workers or those working on scientific racism, but rather that each should see the other as necessary.)

Chapters 6 and 7 of *The Political Economy of Science* interlock, in that the second, on scientific racism, is a special case of the critique of ideology in the neurobiological sciences contained in the first. Both chapters argue that many of the theories and linked technologies of

neurobiology, from drug therapy through behaviour modification to IQ testing, are fundamentally biologicistic. Biologism takes one part of the explanation of the human condition, excludes all other considerations, and announces that it has *the* explanation for aggression and altruism, war and class struggle, love and hate. Attempting to change the human condition is then presented as an absurd opposition to both our natural selves and the natural world. The everyday possibility and actuality that men and women have continuously changed their situations in the course of history is methodologically and philosophically excluded. Biologism, for all its apparent scientificity, is thus mere ideology, the legitimisation of the *status quo*. It is a method not of explaining people, but explaining them away as 'nothing but' assemblages of molecules, larger rats, naked apes or hairy computers. In biologism, reductionism, which was originally simply a powerful tool for examining specific problems under rigorously defined conditions, becomes saturated with ideology. Reductionism is thus part of the ideology of science, and in so far as the theories serve specific dominant classes, also legitimises and obscures ideology *within* science. The particular importance of biologism derives from the nature of the fight in which the bourgeois state must presently engage to protect itself. Where in the past its military effort was primarily against other nation-states or directed towards securing new colonies, with internal control a related but subsidiary question, since the growth of revolutionary guerilla movements, the main enemy is within. Faced with this internal enemy, methods of social control become of paramount importance to capitalism; biologism with its ideological justification and its techniques of manipulating and controlling people comes to the rescue.

Chapter 8 of *The Political Economy of Science*, while still concerned with biology, sets out to analyse the ingrained sexism of current developments in reproduction technology, from genetic engineering to hormone time capsules. This characterisation of science is opposed to that of the radical feminists such as Shulamith Firestone who see technology as essentially neutral and therefore capable of generating a 'technological fix' for the reproductive role of women. By contrast, the chapter argues the need to link the class and the women's struggle in the pursuit of human liberation, where science would serve the goal of nature humanised, and 'the long struggle from nature to a truly human culture' would be advanced.

The final chapter, by Hans Magnus Enzensberger, West German poet and political activist, is a critique of political ecology. In it, Enzensber-

ger is concerned with two tasks. One is to expose the ideological role played by the prophets of the ecology movement as it has mushroomed since the late 1960s, people like the Ehrlichs, Forrester and Meadows, the MIT modellers of 'the limits to growth' and the 'Club of Rome'. Enzensberger lays bare the links between the 'ecology movement' and imperialism, and shows that in their frequent apocalyptic pronouncements, the doomsters are playing a deeply ideological role. The second point is that the concern over pollution or global destruction cannot be dismissed as pure ideology or merely a consequence of capitalism that the transition to socialism will automatically resolve, as some Marxist groups tend to argue; this itself becomes an ideology which ignores the real material base for much of the present concern. The ecological hazards are not to be dismissed as trivial, and even after the destruction of capitalism they will remain major problems. 'Socialism, which was once a promise of liberation, has become a question of survival. If the ecological equilibrium is broken, then the rule of freedom will be further off than ever.'

The Radicalisation of Science

Whilst *The Political Economy of Science* is concerned primarily with the critique of existing capitalist science, much of the discussion in *The Radicalisation of Science* deals with attempts at its transformation. The first chapter of the book, originally written for the 1972 issue of *The Socialist Register* and subsequently reprinted in *Science for People*, gives the book its title. It represented the gathering together of our personal experiences within the scientists' movement at that time, an attempt to describe the origins, the brief history and perspectives for action of the movement. Even though our understanding of certain of the issues has sharpened in the intervening period, we decided to reprint it as it stands, both because it has served to fuel a necessary debate within the movement in the last few years, and because it represented the original programmatic guide for the present collection. However, we have updated it, and added a postscript from the vantage point of 1976. Chapter 2 takes up a topic which no discussion of the relationships between Marxism and the natural sciences can avoid. This is the Lysenko 'affair', 'problem', 'scandal' – as it has variously been described. Coming at a crucial time in the development both of the Soviet Union and of the attempts by Marxist scientists in the West to grapple with the problem of the relationship between science and social structures, it seemed

to provide the acid test of the possibilities of a socialist science. The consequences of the debate were disastrous – concretely for the geneticists who lost their lives in Stalin’s camps, for the development of Soviet genetics (and, less certainly, Soviet agriculture) and theoretically for the very idea of a socialist science. The period following 1948, the high point of Lysenkoism, marked a retreat in the Soviet Union to a ‘neutral ideology of science, and, in the West, a turning away of many scientists from the orthodox communist parties and even from Marxism itself; they were ‘forced to choose between their science and their political convictions’. As the period of Lysenkoism retreats, so it gains a mythology, and even Marxists have shied away from attempting to peel off these mythical accretions so as to subject the episode itself to rigorous Marxist analysis. Yet it is essential that we understand what happened, it only to help avoid a repetition of old mistakes. As Richard Lewontin and Richard Levins make clear, it is no good merely to see the episode as an example of the workings out of the ‘cult of the personality’, or a dreadful warning of the consequences of mixing biology and politics – nor yet as the high point of Soviet science before its retreat with the rise of revisionism. Rather, we must seek its roots in the objective conditions of Soviet agriculture and society, and understand it as an aspect of the tentative and inadequately articulated attempts within the Soviet Union of the 1930s and 1940s to achieve a cultural revolution – but one monstrously distorted by its imposition ‘from above’ by a mixture of administrative fiat and terror, rather than ‘from below’ by a creative social and political upsurge amongst the people themselves.

What was Lysenkoism most directly about, and what were its claims? As mathematical biologists, whose own research relates directly to the substance of the Lysenkoist claims, and as themselves politically engaged within the Science for the People movement in the United States (both refused membership of the US National Academy of Sciences on the grounds of its involvement with the Department of Defense and its perpetuation of the hierarchical, elite structure of American science) Lewontin and Levins are well placed to make the assessment. They begin by assessing the present significance and interest of the Lysenkoist controversy. They then briefly summarise the philosophical and scientific claims of Lysenkoism itself: what were Lysenko’s views on heredity and its relationship with the environment? (It might be helpful to those unfamiliar with the details to compare this discussion with that in Chapter 8 of *The Political Economy of Science*, where some of the same issues are discussed in relation to the IQ debate.)

Lysenko's views are contrasted with some of the almost mystical concepts which many classical geneticists of the Weismann school at the time held about the gene and its relationship to the environment. Then, in a crucial section of the argument, they discuss the objective conditions creating Lysenkoism: the weakness of Russian agriculture and its climatic problems, and the implications that these latter had for the interpretation of experiments and the use of statistics. The weaknesses of existing genetic theory, and its ideological role and links with philosophical reductionism and racism, are analysed.

Other vital factors were the reaction of the Russian peasantry to collectivisation, and the elite, bourgeois structure of Russian science which still remained the case even twenty years after the 1917 revolution. It is this feature – the challenge to the bourgeois expert – which represented that part of Lysenkoism which can be seen today, with the hindsight provided by the Chinese experience, as the attempt at cultural revolution.

Lewontin and Levins conclude by asking: Can there be a Marxist science? The answers they give, in terms of what the dialectical method can and should mean in science, may serve, in their emphasis on the unity of structure and process, the wholeness of things and the interpenetration of an object and its surroundings, as a key and summary statement of the major themes of both books.

The next two chapters of *The Radicalisation of Science* are concerned with the nature of the institution(s) of science as they have developed under contemporary capitalism, and particularly its sexist character. Monique Couture-Cherki, a solid-state physicist from Paris, and Liliane Stéhelin, a sociologist of science from Strasbourg, raise the question of sexism. Couture-Cherki points to the systematic exclusion of women from the higher ranks of science, their concentration in subordinate positions, and the powerful ideological pressures which are exerted to systematically exclude women from scientific achievement. Amongst these, the most powerful are the ideology of the family and the persistent attribution to women of more 'docile', 'feminine' characteristics, 'not appropriate to high scientific achievement', and so on. But can these be overcome? Liliane Stéhelin takes this question as her starting point. For her, the present forms of science are fundamentally interlocked with sexist, male ideology. In order to succeed in science, a woman is required to submerge – overcome – her feminine character and become an honorary male. To do this is the ultimate trap. Indeed, we can expect, at least in periods of labour shortage and capitalist

expansion, to see a steady effort made to eliminate the obvious barriers to women's progress in science, the provision of creches and better maternity arrangements, more efforts at 'equal opportunity' appointments, and so forth – if only because women represent a reserve of productive forces.

Yet the production code of science, its ideology, will remain fundamentally masculine; forced to compete within it, women will either succeed by denying their femaleness, or fail, confirming their inferiority. The task, therefore, is the attack on and subversion of the masculine code itself, which raises the question of whether there is indeed a feminine science as an alternative to masculine science in the same way as there is a socialist as opposed to a bourgeois science. This question leads Stéhelin into a consideration of the social and psychoanalytic view of women and into the question of the resynthesis of Marxism and psychoanalysis which has been a major concern of French Marxism in recent years. Can the masculine code of science be overcome? If so, she concludes, there is 'the promise that one day other women (with other men?) will be able to open the way for a new science'.

It is against this background that it becomes possible to raise the question of just what can be learned from the Chinese experience. Despite the greater accessibility of China, and the enthusiasm for what are seen as the lessons of the cultural revolution, an adequate account of what has been and is being achieved in China must start from an understanding of the particular circumstances of China's own social and economic development, rather than from timeless universals. Joseph Needham's chapter was originally given, in 1975, as a lecture in Montreal, and its lecture form is preserved here. In it, he first describes his own history and that of the *Science and Civilisation in China* project (Cambridge University Press, 1954 onwards), and then sets out to counterpose the historical development of Chinese science with the contradictions of science and the anti-science movement in Western capitalism as typified by, for instance, Theodore Roszak. Needham argues that the anti-science movement has emerged in the West in response both to the social function of science under capitalism and the claim that science represents the only valid way of understanding and apprehending the universe – an aspect of the scientific ideology of science with its overriding aim of the domination of nature. By contrast, he shows, the Chinese have historically never had such a scientific approach nor fallen prey to reductionism. This is not to say, Needham emphasises, that the practice of science in today's China has nothing in

common with that under capitalism, but it is a practice reflective of a dialectical conception of the interrelations of nature and humanity, and of a science done for and with the participation of the people as a whole. Needham's analysis is couched in characteristically more ethical and religious language than is familiar to many activists in the radical movement today; a language from within the tradition of English Christian communism, its moral passion echoing that of Digger Winstanley.

Chapter 6 is derived from an article in *The Black Scholar*, 'Science, Technology and Black Liberation', by Sam Anderson, a New York mathematician. In it, Anderson briefly outlines some reasons for the technological underdevelopment of Africa by European colonialism and the role of science in the emergence of capitalism, leading to the present situation in which, for the Third World countries, science has the two aspects of 'liberation' and 'exploitation'. The position of the black scientist in the United States (or Western Europe) has much in common with that of the woman scientist discussed by Couture-Cherki and Stéhelin — forced into an alien, bourgeoisified role. To combat this, and to contribute needed scientific and technological skills for the movement, Anderson calls for black scientists to organise.

The final chapter, by Jean-Marc Lévy-Leblond, theoretical physicist and one of the collective producing the radical science magazine *Impascience*, spans the themes of both ideologies, *of* and *in*. Because modern physics is a discipline founded at the birth of capitalism, it is, in certain important respects, the model to which all science aspires. Although its theories may have little ideological significance in themselves, physics as a social and cognitive institution is saturated with capitalist ideology, and the ideology of physics as a science becomes the dominant theme of Lévy-Leblond's chapter. To mathematise, to formalise, becomes the hallmark of the mature, hard science against the immature, soft science (the masculinity/femininity — superior/inferior metaphor is not lost). Nor is this only an issue in the natural sciences, as physics becomes the model for all human knowledge, and what cannot be encompassed by its mode of rationality is illegitimate.

Physics is thus at the heart of the ideology of expertise: the claim that, to be a physicist, particularly a theoretical physicist, gives an individual *as of right* the power and knowledge to speak with competence in almost any area.

Within physics, social practice is deeply hierarchical between scientist and student or technician — symbolised by science's reward system, at the peak of which come the Nobel Prizes. The Laureate, in fact a

narrow specialist, becomes transmuted by social alchemy into one of Plato's Men of Gold, to whom all humanity must defer. Another aspect of the hierarchy though is the divorce between theory (high prestige) and practice (low prestige), epitomised by the elite nature of theoretical physics and the lower status of the experimental science of engineering. Lower still, yet equally hierarchised, comes teaching. This divorce affects the development of the subject of physics and, at the same time, lays it open to the type of ideological exploitation discussed in relation to biology in other chapters. The divorce from practice means that physicists are increasingly concerned with an artificial world of their own construction, outside the experience of common problems which physics used to be concerned to explain. The solution for these problems will be the solution for science as a whole.

The themes of the chapters in these two books reflect a common agenda, an agenda shared with many of the activists in the radical science movement who have been discussing and working out these issues in practice over the last few years. At an earlier stage, many of the chapters have formed part of, and been improved by, this discussion. By collecting and developing the arguments on paper, we believe that the theory and practice of the movement will be advanced. Nevertheless, it is important not to forget differences. These reflect the fact that we belong to a social movement with diffuse aims and not to a single party with a clear line and agreed priorities. What we hold in common is a desire to work towards a new society where a new science and technology can serve the interests of all the people.