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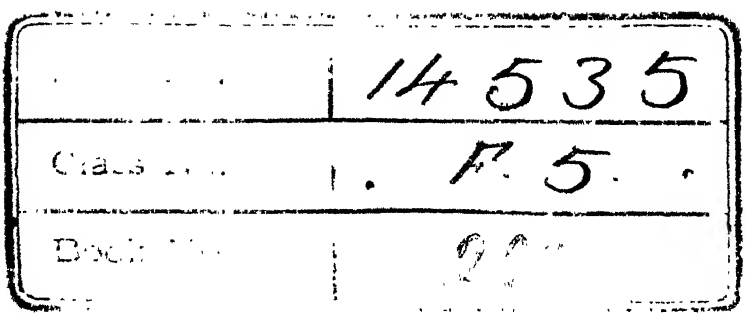

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WOKING

TO

JOHN BOYD ORR

AND

ELIZABETH PEARSON ORR

WHO

"IN THIS LONG DECLINE
SO SPITEFUL, DUSTY AND DIVIDED"
HAVE OCCASIONALLY
COMPELLED ME TO WONDER WHETHER
AFTER ALL BRITISH SOCIAL CULTURE IS
IRREMEDIABLY DECADENT

Why Dangerous Thoughts?

MY MARXIST FRIENDS—the sentiment of friendship is, I fear, unilateral—perpetually assure me that I have to choose between Fascism and Communism. They say there is no halfway house. If they are right I shall probably be tortured to death in a concentration camp, unless I apply my biological knowledge to the task of devising ways of terminating a hopeless existence with less personal inconvenience and discomfort. When it comes to that, it will not matter to me whether the successful Dictator is Sir Oswald Mosley or Mr. Victor Gollancz.

In the meantime my dilemma does not seem to me to be different from that of anyone else who at any other time in history has been more anxious to be right than to stay Left. Maybe the friends of Servetus pointed out to him that he had to choose between the Holy Inquisition and Calvin. If Karl Marx had been persuaded to make a straight choice between Disraeli and Gladstone there would have been no Marxists. I am open to rational persuasion that Marxists may be right. Whether they will succeed in getting other people to think so, has nothing to do with the issue. My Nonconformist forebears went to their graves outside the parish in the comfortable assurance "beloved, we are of God and the whole world lieth in wickedness." Perhaps because I have their genes or perhaps because the human family is a mechanism for transmitting its own social environment, I am willing to take a sporting chance that I may be right in the long run, even if no orthodox church endorses my views.

In so far as I have not yet succeeded in equipping myself with a church which does endorse them, the views expressed in these pages may appropriately be called *Dangerous Thoughts*. Besides,

there are only two topics about which it is still dangerous to be flippant in Britain—football in England, and in Scotland the University of Oxford.

LANCELOT HOGBEN

TORPHINS

August 1939

POSTSCRIPT.—These essays are based on addresses given from time to time at dates indicated in the footnotes. They were sent to the press before the outbreak of hostilities. In view of the subject-matter and the censorship, the last has been omitted in the page proof stage. In other circumstances I could have wished to do more justice to George Dalgarno, an Aberdonian to whom the subject of the second essay in this volume was indebted. Among the stacks of polite learning in the library of his *alma mater*, I have been unable to find the works of this great Scotsman who, though a grammarian, was also a humanist.

September 1939

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I

The Creed of a Scientific Humanist[1]

IF I HAD been asked to give a label to my creed, when I was starting in my profession as a scientific worker, I should have called it Socialism. That was twenty-five years ago. To-day I prefer to call it scientific humanism. Scientific humanism is the creed I profess and the profession I try to practise. This does not mean that the socialist creed of my adolescence was contrary to the scientific outlook, or that I have renounced it. I still believe that no system in which credit and industry are privately owned can take the fullest advantage of new scientific knowledge for the satisfaction of common needs.

What it does mean is that when I was younger my political left hand did not bother about what my professional right hand was doing. I did not yet realize how the pursuit of science is bound up with the responsibilities of citizenship in a society which has been transformed by scientific knowledge. When I began to do so, I saw that Socialism can mean two different ways of using scientific discoveries.

In pre-war days few except Socialists clearly recognized that cyclical depression is an inherent characteristic of competitive industry conducted for private gain. During the period which elapsed between the end of the Great War and the beginning of the great depression most of the older generation of political leaders still believed that capitalism has a self-regulating capacity for promoting progress in knowledge and general well-being, except in so far as it is embarrassed by wars and strikes. Meanwhile, a new generation had grown accustomed to State control over war industries and large relief schemes for a permanent army of

[1] From *I Believe* (London: George Allen & Unwin; New York: Simon Schuster).

unemployed. In these circumstances all that the Socialists had preached seemed to be vindicated by events. The last generation which believed in *laisser-faire* was passing away, and the success of Socialism seemed to be assured.

In Germany and Britain nothing of the sort happened. From the moment when all hope of return to pre-war conditions was officially abandoned by Conservative politicians the official Socialist parties entered an eclipse which has lasted ever since. How it so happened is a question which admits of many answers. One is that the only things about which all Socialists could agree were now generally accepted. To all but themselves the new situation exposed differences which cut across the sectarian strategies of Social Democrat and Communist or of Stalinist and Trotskyist. While *laisser-faire* was in the ascendant Socialism meant having some plan in contradistinction to having *none*. The collapse of Liberalism meant that Socialism could no longer survive by asserting the need for planning in the abstract. What Socialists had long forgotten was now clear to their competitors. From its inception there had been two sorts of Socialism, each with a plan of its own.

One Socialism starts where orthodox free trade leaves off. It embraces or assumes the Liberal doctrine that prosperity is measured by the number and variety of saleable commodities which the consumer is "free" to purchase. Its chief quarrel with Liberalism is that inequalities of spending power and recurrent unemployment restrict the choice of a large section of the population. To remedy this it proposes to redistribute spending power more equitably by fixing prices, by restricting income to services (past, present, or future) and by statutory limitation of working hours adjusted under public ownership. In short it does not criticize the way in which capitalist society uses scientific knowledge. It is primarily a protest against how it distributes its products, and the change at which it aims is primarily a change in the *administrative* machinery of industry. Its success does not entail any radical change in the creative policy of industry. Under a Socialist regime conceived in such terms industry will continue to produce much

the same things as before. As a corollary, the intellectual leadership of Socialism will be recruited from lawyers and journalists. The realization of Socialism so defined therefore demands no far-reaching educational reforms.

The other Socialism, that of Robert Owen, of Charles Kingsley, of Edward Carpenter, and of William Morris, began as a protest against the dreary squalor which was effacing the common wealth of the countryside during the earlier stages of steam-power production. It denounced the worldly wisdom which chose an ever-increasing multiplicity of gewgaws and passive distractions as the goal of co-operative endeavour. In opposition to the Liberal doctrine that prosperity is being able to choose the greatest variety of goods, it asserted the need to decide whether the dark satanic mills were making things which are good for men to choose. There was at first no clear recognition that science could create the prospect of a new heaven for uncongested traffic and a new earth for spacious living.

The Utopians—as they are usually called—anticipated scientific humanism because they saw clearly that human needs cannot be assessed in terms of "consumers' choice" and because they saw the hypertrophied metropolitanism of capitalist evolution creating psychological strains for which redistribution of spending power furnishes no sufficient remedy. Throughout the period which begins with the inspired prose of Owen and ends with the uninspired verse of Morris, steam was still the only source of power for factory production, electrolytic processes of chemical manufacture were in their infancy, and motor transport was unknown. Inescapably a higher level of productivity had been achieved at the price of urban congestion, and no radical departure from the fundamental plan of capitalism could be accomplished without lowering the available potential of leisure and creature comforts. So the term Utopian became a term of abuse. Socialists wise in the wisdom of the world as it then was made it their chief business to convince the clerk that the municipal milkman will wake him as punctually as the boy from the shop at the end of the street, or that a nationally owned railway service will get him to the office as early as the company which now owns the trains.

To-day scientific knowledge offers us the possibility of a new plan of social living more akin to the Utopia of a William Morris or an Edward Carpenter. Mobile power, aviation, and electrical communications make it possible to distribute population at a high level of productive capacity without the disabilities of cultural isolation. A high potential of leisure and creature comforts no longer demands the beehive pattern of social living. Co-operative organization in the age of hydroelectric power, of light metals, of artificial fertilizers, and of applied genetics offer us new instruments of manufacture, new means of transport, and new means of communications, both to restore the serenity of small community life and to promote a lively sympathy with folk in other lands. Broadcasting has now brought the cultural benefits of travel to the bedside, and scientific horticulture offers us a programme of bio-esthetic planning which may prove more congenial to basic human needs than the spectacle of a sixpenny store building.

The straphanging multitudes of our great cities need circuses as well as bread. It is no longer Utopian to ask what sort of circus human nature demands. The Third Reich has given its own answer. The answer is Jew-baiting, war, and neopagan weddings. The revolt against the beehive city of competitive industrialism has already become a retreat into barbarism. The retreat will continue unless science can foster a lively recognition of the positive achievements of civilization by reinstating faith in a future of constructive effort. It will not be arrested by old-school-tie Socialists fresh from the exploits of the Oxford Union or by a radical intelligentsia whose social culture is a judicious blending of flexions and genuflexions.

Seventy years ago it was still possible to discuss whether poverty is morally tolerable or materially inevitable. It was still possible to discuss whether war is spiritually edifying or socially escapable. All this is changed. Poverty in the sense in which it was then defined, the sense in which the word is intelligible to the social biologist, is not materially inevitable. The only obstacle to removing it is lack of social initiative. War is not a moral

picnic. It threatens to destroy the entire fabric of our civilization if we do not eradicate it with as much promptitude and ruthlessness as we have eradicated or are eradicating smallpox, malaria, and yellow fever.

§ 2

Thus the civilized world of to-day vacillates between deep disillusionments and great expectations of imminent possibilities. Mass unemployment has destroyed confidence in progress and prosperity through private enterprise, while abundant intimations of available plenty dazzle us with new potentials of social achievement made possible by advancing scientific knowledge. In the day-to-day drama of politics partisans of the progressive movements are preoccupied with eleemosynary makeshifts and have done little to show how public enterprise can take creative initiative from production for private gain. So it is becoming daily obvious that education for political leadership in democratic countries was not devised to take advantage of our new opportunities, and it is becoming equally obvious that the machinery of democratic government was not devised to exploit expert knowledge for general well-being.

Advancing scientific knowledge has swept away many beliefs which sustained popular aspirations in the formative stages of modern democracy. The providential dispensation which endorsed the same plan of governance for Church and State, the mythology of the Beautiful Savage, and metaphysical libertarianism with its hypertrophied insistence on diversity of personal preference do not belong to the century in which we are living. In their place modern science now offers us a *New Social Contract.* The social contract of scientific humanism is the recognition that the sufficient basis for rational co-operation between citizens is scientific investigation of the common needs of mankind, a scientific inventory of resources available for satisfying them, and a realistic survey of how modern social institutions contribute to or militate against the use of such resources for the satisfaction of fundamental human needs.

Power to shape the future course of events so as to extend benefits of advancing scientific knowledge for the satisfaction of common human needs must be guided by an understanding of the impact of science on human society. So the New Social Contract demands a new orientation of educational values and new qualifications for civic responsibilities. While others call for change in the methods of education and rightly demand removal of restrictions to educational opportunities, scientific humanism also asserts the need for a far-reaching reformation in the content of education to endow the pursuit of knowledge with a new sense of social relevance. The scientific humanist believes that an educational reformation so conceived is an indispensable prerequisite to genuine social advance.

Herein lies an essential difference between the standpoint of scientific humanism and current views of political partisans who aspire to a progressive outlook. People who call themselves progressives generally adopt one of two attitudes to education. In so far as Liberals and moderate Socialists deign to trouble themselves about educational issues their concern is to utilize a more ample reservoir of talent in the service of the community. Socialists of the extreme Left are chiefly concerned with propagating a creed which is partly based on the teaching of the Prussian mystic Hegel and partly on a shrewd analysis of the impact of early nineteenth-century technology on mid-nineteenth-century social institutions. In practice such differences are trivial, because so many people now believe that a war against the dictator countries is inevitable. Education is therefore an effeminate topic.

For several reasons I cannot share this conviction. There are three possibilities ahead of us. The first a series of world wars, resulting in the complete destruction of civilization as depicted in Cicely Hamilton's novel, *Lest Ye Die*. The second is that world war will come, but stop before civilization is completely destroyed. The third is that hell will not be let loose, because the warlike temper of the dictator countries will exhaust itself or because an effective policy of constructive pacification will

mature in the so-called democratic countries. If the first, or most likely, happens no social effort is worth while. So the rational alternative to suicide for parents is to take a chance on the second or third.

Either way it is important to base social action on correct views about how new scientific knowledge affects the potential of social change. I believe that this must force us to conclusions which are not palatable to die-hard progressives of the nineteenth century. I believe also that the eclipse of the progressive outlook is specially due to wrong views about the impact of new scientific knowledge on contemporary social change. To illustrate this I shall cite two examples. One is the fact that many progressives believed in the immediate collapse of Hitler's power, when he announced the policy of autarchy. The other is that most Socialists believe that the relative increase of the employed section of the community is necessarily propitious to their aims.

The belief that increasing scientific knowledge makes for closer economic interdependence, and, what was often stated as a corollary to this, the belief that this interdependence provides a guarantee of world peace, were dogmas almost universally held by progressive thinkers in the nineteenth century. This was not unnatural in the first flush of surprise which followed the introduction of steam navigation, trans-continental railways, and oceanic telegraphy. Our own perspective should be different. We need only recall that Chile saltpetre can now be made anywhere, that hospitals are using radioactive sodium prepared from ordinary salt instead of having to import the rare radioactive minerals, that the Channel Islands are no longer regarded as a sufficient guarantee of the genetic credentials of cattle, that we may soon be making most of our machinery of aluminium from the clay of our soils and magnesium from sea salt, that we are already beginning to feed our pigs on the disintegration products of wood pulp, to grow several crops of tomatoes a year by tank gardening, and to produce sugar by the agency of bacteria from vegetable waste matter.

Without committing ourselves to any dogmatic assertions

about how far this will go on, what we can at least say is this. The effect of scientific discovery during the past two centuries has been mainly to increase the potential of local self-sufficiency consistent with the satisfaction of fundamental human needs. One result is that we can now entertain the possibility of a less centralized, and therefore less bureaucratic and less congested, type of world organization as a goal for rationally guided effort. The warmongers of Central Europe and elsewhere know too well that free trade is no longer part of the ideological temper of the age in which we live, and that the appeal for national self-sufficiency canalizes discontent with the dreary futilities of planless mechanization in congested modern communities. It is therefore a tragic fact that those who have the will to peace too often resist propaganda for promoting a greater measure of local self-sufficiency with arguments which antedate the synthetic manufacture of nitrate fertilizers.

Of itself the appeal for local self-sufficiency is neither good nor bad. In Fascist States social policy is dominated by the death wish, and self-sufficiency is advocated as a means of warmaking without regard for the social welfare of the citizen. Where social policy becomes alert to the new powers and inventions available for human well-being, the satisfaction of basic human needs will take precedence over the multiplication of useless commodities to distract neurotic urban populations, and the merits of more or less industrial specialization will be examined with proper regard to the distribution of population in congenial and healthy surroundings. Because the doctrine of free trade was sustained by the moral conviction that the greatest good of the greatest number is the same as the greatest number of goods available to the greatest number of people, its apostles accepted the urban squalor of a coal economy as the inevitable price for their own definition of prosperity. For privacy and serenity of life, the satisfactions of parenthood and the graces of human fellowship in modest communities they offered mankind the compensation of the department store and labour-saving flats in flowerless streets. Fascism is the reaction of outraged human nature

endowed with enough intelligence to be exasperated, and too demoralized to explore an alternative constructive use for the new powers at hand.

One feature of the impact of new technical resources during the first phase of steam-power production was a steady reduction in the demand for skilled handicraftsmen. This encouraged Socialists to believe that society was splitting up into a small parasitic class of owners and an ever-growing, increasingly militant class of employees with common political aspirations. A skyscraper of social tactic was built on this foundation of *a priori* psychology which was in essence legalistic like the political theories of the orthodox parties. The implicit assumption is that the physical character of a man's work, the surroundings in which it is carried out, monotony, initiative, solitude, propinquity to home environment, accessibility to outdoor exercise are all negligible in their effect upon his political affiliations in comparison with the legal contract regulating his employment. This is bad human biology. The reaction of a human being to the contents of books or to the sound of the human voice is affected by his work in many ways. It depends among other things upon whether he is physically weary or merely bored, upon whether he does work that is fatiguing or work that is monotonous. Consequently we should not expect that a miner will necessarily react to the same type of political propaganda in the same way as the clerk in a department store.

Even before the introduction of electricity as a source of power, the conduct of a mechanized and more highly urbanized society had initiated changes which counteracted the cultural process of levelling down. Universal schooling, a popular Press, free libraries succeeded one another in countries with a democratic constitution. With the coming of electricity as a source of power industry came under the impact of new problems of costing and new technical advantages of mobility. Where it has been introduced into the factory, it has created a new demand for a new type of skill and special training, while dispensing with a large volume of unskilled and casual labour which can be done by

machinery. To see the impact of the new technical forces most clearly we need to examine the statistics of a country which is in a more advanced state of technical development than Britain. In his recent book, *Insurgent America*, Alfred Bingham's analysis of the growth of social classes during recent years shows that the new type of skilled administrative employee has steadily increased in proportion to labourers performing heavy unskilled work in the United States.

Thus modern technology has brought into being a social group with social aspirations and a social status of its own. Its social aspirations for further opportunity of employment can be realized only by the further extension of technical improvements which have encouraged its growth. For the time being at least, it is still growing and at present, politically inarticulate. It may therefore play a decisive role in the success of any social movement which can claim its allegiance. In a period of social crisis its importance should not be judged by its numerical strength, because its personnel commands resources against which mere man power is helpless and barricades are literary illusions. If it can be enlisted in a task which will offer far greater opportunities of creative service than it now enjoys, the transition from a discredited and demoralized competitive, to a rationally planned industrial, system is assured. If it is driven by hysterical fear to support any dictator movement which offers the prospect of a breathing space, it may become the instrument for destroying democracy and freedom of discourse.

§ 3

Freedom of discourse is a necessary pre-condition of Socialism *en rapport* with scientific humanism. Parliamentary democracy as it now exists is not. Whatever happens democracy in its present form will not survive. It is dying of its own inherent dilatoriness in a world which demands decisive courses and prompt decisions. The social economy of which it was an instrument is in process of rapid dissolution; and must inescapably make way for an economy of abundance or for a more rigid caste system within

the framework of a semi-collectivist organization for the prosecution of wars which will eventually destroy civilization. The immediate problems of Socialism conceived in terms of the abundance which science has made available are therefore twofold. We must take immediate steps to lay the foundations of world government by federating nations whose will to peace and prosperity is greater than their aspirations to national sovereignty or empire. We must also develop new organs of local government to enlist expert knowledge for the satisfaction of common human needs.

With its lop-sided insistence on individual preference and its obsessional loyalty to the ideology of the city states of Mediterranean civilization liberal democracy is not equipped to discharge this function. Enlisting expert knowledge for the service of our common humanity presupposes more extensive initiative for a civil service with knowledge of the new potential of human welfare, vigilant supervision by representatives with an educational equipment which few if any contemporary politicians possess, a greater measure of *ad hoc* selection to clarify the decisions which the electorate is called on to make, and the acceptance of the new social contract which scientific humanism demands. Such acceptance is compatible with party freedom for discussion beyond a certain level. It is *not* compatible with the existence of any party organization which frankly stands for the preservation of class privilege without regard to general social well-being.

The defence of parliamentary democracy in its present form[1] is the negation of Socialism and a tactic which invites certain defeat. The enthusiasm with which Communists of the *Front Populaire* have lately espoused its cause while they still decline to repudiate a creed of insurrectionary violence is therefore a sinister feature of the collapsing morale of the civilization in which we live. Partisans of privilege needs must lie. Their common humanity would paralyse their will to obstruct social progress if they relinquished the luxury of mendacity. Men and women

[1] This is not intended to apply to Scandinavian countries (see p. 208).

who wish to play their part in progress to a Socialist order of society have no need to lie. Truth is their most powerful weapon, and the habit of telling the truth is an essential of a Socialist morality consonant with the social contract of scientific humanism.

Of the new social order which may emerge if truth prevails no one has written with more eloquent lucidity than my friend J. D. Bernal, himself a Marxist. With these words he brings to an end his invaluable book *The Social Function of Science:*

> Already we have in the practice of science the prototype for all human common action. The task which the scientists have undertaken—the understanding and control of nature and of man himself—is merely the conscious expression of the task of human society. The methods by which this task is attempted, however imperfectly they are realized, are the methods by which humanity is most likely to secure its own future. In its endeavour, science is communism. In science men have learned consciously to subordinate themselves to a common purpose without losing the individuality of their achievements. Each one knows that his work depends on that of his predecessors and colleagues, and that it can only reach its fruition through the work of his successors. In science men collaborate not because they are forced to by superior authority or because they blindly follow some chosen leader, but because they realize that only in this willing collaboration can each man find his goal. Not orders, but advice, determines action. Each man knows that only by advice, honestly and disinterestedly given, can his work succeed, because such advice expresses as near as may be the inexorable logic of the material world, stubborn fact. Facts cannot be forced to our desires, and freedom comes by admitting this necessity and not by pretending to ignore it. These are things that have been learned painfully and incompletely in the pursuit of science. Only in the wider tasks of humanity will their full use be found.

2

John Wilkins

Parliamentarian and Pioneer of Scientific Humanism

FOR TWO CENTURIES the name of Isaac Newton has been the focus of a mythology sustained by comparative ignorance of his contemporaries whose contributions are lavishly attributed to him in text-books still in use. Newton himself was never lavish in his acknowledgments. So his debt to Hooke, to Huyghens, and to Flamsteed, has received scanty recognition till recent years. Among the same circle of men who significantly contributed to the Newtonian world-view, few, if any, are less known than John Wilkins. That his name may be placed side by side with those of Petty, Boyle, Hooke, Brouncker, Halley, or Newton as one of the founders of the great tradition of English empiricism would be sufficient praise. He has also a claim on posterity which is unique of its kind and times. Wilkins was probably the first man to conceive and to devise an artificial international language. If he was not actually the first, it may at least be said that no one has since attempted a similar project with an equally spacious end in view.[1]

Wilkins was one of the more senior among the founders and original fellows of the Royal Society. He was born in 1614, and graduated at Oxford in 1631, where he became a tutor. Subsequently he went to London, where he acted as private chaplain to several notabilities. In 1638 he published anonymously *The Discovery of a World in the Moone*, to which a *Discourse on the Possibility of a Passage thither* was added as an appendix in an edition issued two years later. From 1645 onwards he was asso-

[1] The *Ars Signorum* of George Dalgarno, an Aberdonian domiciled in Oxford, appeared in 1661 seven years before Wilkins's *Essay*.

ciated with Boyle, Petty, and others in the weekly gatherings of the *Invisible College*, parent body of the Royal Society. Three years later appeared his best-known book, *Mathematical Magick*, or *The Wonders that may be performed by Mechanical Geometry*.

Wilkins was the second husband of Cromwell's sister Robina. As an active partisan of Parliament during the Civil War, he took the Covenant. During his period of office as Warden of Wadham from 1648 onwards, the alumni of the College included Christopher Wren and Thomas Sprat, later Lord Bishop of Rochester and first historian of the Society. He became Master of Trinity College, Cambridge, in 1659, and as one of the leading Left Intellectuals of the time, was deposed at the Restoration. In that capacity he was closely acquainted with Newton's teachers, though he did not come into direct contact with Newton, who entered the College in 1661. At a meeting held in Gresham College to discuss a College for "The Promotion of Physico-Mathematicall Experimentall Learning" on November 28, 1660, Wilkins took the chair. Within a month the King approved of the design, and joined the Society, to which he gave its Royal Charter in July 1662. In 1668, five years before his death, he was made Bishop of Chester, and in that office showed a cordial tolerance towards dissenters. In the same year appeared his most notable work, *An Essay towards a Real Character and a Philosophical Language*.

The first book cited in the foregoing paragraphs was composed a few years before the death of Galileo. Wilkins was responsible for popularizing Galileo's views in Great Britain by making them the subject of a scientific fantasy two and a half centuries before Mr. Wells wrote *The First Men in the Moon*. It is noteworthy for several reasons. One is that Wilkins anticipates the rocketeers and the inter-planetary travel society of the present generation by discussing at some length the ease with which a body would travel through space if propelled with enough initial force to carry it beyond the region of the earth's gravitational field. This leads him to a statement of universal gravitation in the following words:

> But now the true nature of gravitie is this. Tis such a respective mutuall desire of union, whereby condensed bodies, when they come within the sphere of their owne vigor doe naturally apply themselves one to another by attraction or coition. . . . It will follow, that if a man were above the sphere of this magneticall vertue which proceeds from the earth, hee might there stand as firmely as in the open air, as he can now upon the ground: and not only so, but he may also move with far greater swiftness than any living creatures here below because then he is without all gravity, being not attracted in any way. . . . Tis commonly granted that if there were a hole quite through the centre of the earth, though any heavy body . . . were let fall into it, yet when it came to the centre, it would there rest immovable in the air.

In this passage we have an early statement of the problem which Newton explored in his first attempt to test the inverse square law. There is also a broad hint of the hollow earth problem for which Newton first gave the correct and paradoxical solution which enabled Priestley and Cavendish to establish the law of electrical attraction. In his various essays towards the popularization of the Galilean view among his fellow-countrymen, Wilkins was the protagonist of the Broad Church doctrine behind which the materialism of Boyle and Hooke took shelter. The following, taken from *The Earth may be a Planet*, gives advance ecclesiastical publicity to Boyle's belief that the Deity had wound up the Cosmic Watch and entrusted the task of detecting its laws of motion to the Council and Fellows of the Royal Society:

> Divers men have fallen into great absurdities whilest they have looked for the grounds of philosophy from the words of Scripture and therefore it may bee dangerous on this point also to adhere so closely unto the Letter of the Text. . . . These expressions concerning the founding or establishing of Heaven or Earth were not intended to shew the immoveableness of either, but rather to manifest the wisedome of Providence, who had so called these parts of the World in their proper situations that no naturall cause could displace them or make them decline from their appointed course. . . . Thus have I in some measure cleered the chiefe arguments from Scripture against this opinion. For which

notwithstanding I have not thence cited any: because I conceive the Holy Writ being chiefly intended to inform us of such things as concerne our faith and obedience. Wee cannot thence take any proper proofe for the confirmation of naturall secrets.

§ 2

As Essay towards a Real Character and a Philosophical Language was printed by order of the Council of the Royal Society on Monday, April 13, 1668. In the Epistle Dedicatory addressed to the President, Lord Brouncker, "together with the rest of the Council and Fellows," the author tells us that the work was "well nigh finished" and in part printed, when "it happened to be burnt in the late dreadful fire," which destroyed all the original unprinted, and all except two copies of the printed part. It had been prepared at the express request, or as he says, "by several orders" of the Society in conformity with their original plan of promoting all kinds of useful knowledge, and, as Wilkins put it, "facilitating mutual commerce amongst the several nations of the world." The author continues:

> And if upon such an amendment and recommendation by the Society the design here proposed should happen to come into common use, It would requite the Honour you bestow upon it with abundant Interest. The being Instrumental in any such discovery as *does tend to the Universal good of Mankind*, being sufficient not only to make the Authors of it famous, but also the Times and Places wherein they live.

Wilkins then illustrates how the science of language may fulfil its Baconian goal by endowing human life with new powers and inventions. The first is to remove barriers opposed to the spread of culture and mutual understanding between nations by the coexistence of multitudinous tongues.

> He that knows how to estimate that judgment inflicted on mankind in the Curse of the Confusion with all the unhappy consequences of it may thereby judge what great advantage and benefit there will be in a remedy against it. Men are content to

bestow much time and pains on the Study of Languages in order to their more easy conversing with those of other Nations. Tis said of Mithridates, King of Pontus, that he was skilled in Two and twenty several Tongues which were spoken with several Provinces under his Dominion. Which, though it were a very extraordinary attainment, yet how short a remedy was it against the Curse of Confusion considering the vast multitude of Languages that are in the World.

Besides this "most obvious advantage" he places the second, or, as we should now say, the *semantic* aspect of language reform. The design would likewise contribute much

to the clearing of some of our Modern differences in Religion by unmasking many wild errors that shelter themselves in affected phrases, which being Philosophically unfolded, and rendered according to the general and natural importance of Words will appear to be inconsistencies and contradictions. And several of those pretended, mysterious and profound notions expressed in great swelling words being this way examined will appear to be either nonsense or very flat and jejune. And though it should be of no other use but this, yet were it in these days well worth a man's pains and study considering the Common mischief that is done and the many impostures and cheats that are put upon men under the disguise of affected and insignificant phrases.

While confessing to slender expectations concerning the issue of the attempt to establish either a real character or a philosophical language for common use among the nations of the world, he takes courage from contemplating improvements in the arts of discourse, and cites two in particular:

Logarithms were an Invention of excellent Art and Usefulness. And yet it was a considerable time before the Learned Men in other parts did so farr take notice of them as to bring them into use. The art of Shorthand is in its kind an ingenious device of considerable usefulness much wondered at by travellers that have seen the experience of it in England.[1] And yet, though it be above Three score years since it was first Invented, tis not to this

[1] This probably refers to John Willis's book on the *Art of Stenography*.

> day (for aught I can learn) brought into common practice in any other Nation. And there is reason enough to expect the like Fate for the design here proposed.

The Essay itself is divided into four parts, of which the first part deals with the natural history of discourse. In opposition to the pedantic tradition which advertises the wares of the teacher by extolling the merits of his subject, Wilkins is at pains to promote a conscious need of reform by diagnosing the defects of current and ancient languages. With one or two exceptions, such as the anomalous position of Lithuanian in the Slavonic group, his classification of eleven families includes the main divisions of the Aryan tongues, as now recognized, without separating them as a group from the Uro-altaic and Basque ("Cantabrian") or from the various languages of Asia, Africa or North America also cited in the list. In short, the classification of languages follows Scaliger, and reflects the contemporary practice of the herbarium, antedating the new principles of classification which invaded both chemistry and philology after the work of Linnaeus and Cuvier.

As with biology, so with philology, the obstacle to an evolutionary classification was the lack of codified knowledge. The Miltonic picture of the Creation was not as yet a dogma which could expose Hooke's interpretation of fossils to the charge of impiety, and its corollary that Hebrew was the medium of discourse of the Garden of Eden did not as yet present a stone wall to evolutionary linguistics in Protestant countries. Wilkins dismisses it with good-humoured Broad Church casuistry:

> From the several defects and imperfections which seem to be in this Language, it may be guessed not to be the same which was consecrated with our first Parents and spoken by *Adam* in *Paradise*.

Needless to say, defects of spelling receive their full share as a prelude to a Real Character, and here we may possibly discern the influence of contemporary social circumstances propitious to what would otherwise seem to be an incredibly daring project

at such a time in the world's history. There were several reasons why the Royal Society had good reason to concern itself with the art of discourse. Having set its face against the "notional or disputatious way," it looked askance at the rhetorical exploits of Sir Thomas Browne. Sprat expresses the prevailing sentiment, when he declares:

> In these and all other businesses that have come under their care, there is one thing more about which the Society has been most solicitous, and that is the manner of their discourse, which, unless they had been very watchful to keep in due temper, the whole spirit and vigour of their design had been soon eaten out by the luxury and redundance of speech. The ill effects of this superfluity of talking have already overwhelmed most arts and professions, in so much that when I consider the means of happy living and the causes of their corruption, I can hardly forbear recanting what I said before, and concluding that eloquence ought to be banished out of all civil Societies as a thing fatal to peace and good manners.

What is more important in this context is that the Society's initial policy was advisedly non-academic. Its first members were not exclusively men of academic training. It sought close co-operation with shipowners, large-scale farmers and industrialists, in compiling its various "histories" of new inventions and improvement of all kinds. Hence it is not remarkable that we find Wilkins referring to the use of *Shorthand*, which had received some topical notoriety on account of its use in the great political trials of the time. In his essays, *Not Without Prejudice*, Lord Hewart says that shorthand reports had been taken of the King's Speech on the occasion of the impeachment of the five members and of the trial of John Lilburne, the leveller.

In the age of patronage the common practice of scientific men was either to disguise recipes of lucrative inventions in cryptograms[1] (perpetuated in the so-called formulae of crime fiction

[1] In 1641 Wilkins had published an anonymous brochure on codes called the *Secret Messenger*. Possibly its primary intention was to furnish a prophylactic against the Star Chamber.

and films), or to bury general principles in Latin texts set forth in the form of propositions in conformity to classical models. To perpetuate this tradition would have been to defeat the Society's policy of preserving social contacts which would keep the "true and lawful goal of science" before it. That it adopted the vernacular medium for publication was a logical consequence. None the less, this had one great demerit. Latin was at least a medium more suited to its constant transactions with the learned societies of France, Italy—and more especially Holland—in conformity, as explicitly emphasized by Sprat, with its intention of promoting international scientific intercourse.

Other social circumstances conspired to encourage linguistic scholarship in close association with naturalistic studies. Colonial enterprise which followed the Great Navigations led to the publication of miscellanies in which plants, beasts, minerals, languages, and customs rubbed shoulders. It was no accident that a sixteenth-century naturalist, Conrad Gesner, was also the author of *Mithridates*, a philological bestiary or linguistic herbal in which the Lord's Prayer is exhibited in twenty-two tongues.

Voltaire's *Panglosse* reminds us that we owe syphilis, cochineal, and chocolate to the Conquistadores. In fairness he might have added our first knowledge of quinine and of the Amerindian dialects. Within a few decades of the rape of Mexico a grammar and lexicon of Mexican appeared. A text-book and dictionary of Peruvian was published in 1614. More important contributions to the comparative study of language came from the East. In 1530 an Italian, Theseus Ambrodgio, published a treatise on ten Oriental languages, including Syriac, Chaldaean, and Armenian. Soon after Coptic and Ethiopian were made available to European scholars. In 1603 a lexicon of Malay was compiled, and during the next half century Portuguese missionaries in Goa and elsewhere prepared grammars and lexicons of vernaculars used in Southern India. A book on the language of the Congo was published in 1659. Meanwhile Chinese, of which the first European dictionary was published by a German in 1667, had become known to Europe through the work of Jesuit missionaries.

That educated men of Peking and Canton could read the same script without being able to utter mutually intelligible sounds was a dramatic novelty at the time when Wilkins wrote his essay.[1]

The final chapter of the first Part is a fitting end to the study of the defects of languages as they exist and are known to have existed. Since no languages have been devised "according to the rules of Art," it is the proper concern of humane science to set forth the characteristics of efficient communication among mankind as a world-wide species, and grammar, which is now "adapted to what was already in being," should be "rather the Rule of making it so." The final task must be to examine nature external and human, that the sounds of discourse and their visible signs may be chosen in conformity therewith. In this way, by "a just Enumeration and description of such things or notions as are to have marks or names assigned to them," the theory or rational grammar will also be "suited to the nature of things." The remainder of the task will be "so to contrive the enumeration of things and notions . . . without *Redundancy* or *Deficiency* as to the number of them, and regular as to their *Place* and *Order*."

The execution of this task undertaken in the second Part, in which the enumeration is set forth, extinguishes the high hopes inspired by the brave words in the Epistle Dedicatory. A taxonomical technique to accommodate the state of natural knowledge available in that time was not in being, and the efforts of Wilkins to provide one with the tools of an age when all pre-existing ideas about man's place in nature were in the melting-pot, is comparable to a child setting out to build a modern battleship with

[1] My friend Dr. F. Bodmer reminds me that increased trade and travel led to closer study of languages nearer home. In 1571 the publication of Otfried's tenth-century *Evangelien harmonie* made Old High German accessible. In 1589 Busbecq wrote of the relic of Gothic in the Crimea. Extracts of the Gothic bible at Uppsala were published eight years later. A Dalmatian grammar appeared in 1604, to be followed by grammars of Turkish in 1612, Estonian in 1637, modern Greek in 1638, Danish and Lappish in 1640, Finnish in 1649, Lithuanian in 1653, and Anglo-Saxon in 1689. An Albanesian lexicon appeared in 1638, a Swedish in 1640, and an Icelandic in 1683.

a tooth-pick or a nail-file. Every viewpoint from which a more or less consistent classification of nature might be attempted, converges to a morass of confusion, in which theocentric, heliocentric, geocentric, anthropomorphic, aesthetic, individualistic, and social categories overlap. The truth is that it embodies all the essential defects which Aristotle's System of Nature borrowed from Plato. As such, it was a backward step in the Society's philosophical progress away from the "notional or disputatious way" of the ancients, and is factually behind the current state of knowledge in several details.

This can be seen even in the table of forty primary categories to which names are to be assigned. *Things* known to him, and Wilkins's *notions*, may be "general, i.e. transcendental" (general I, mixed relations II, relations of action III), or words (discourse IV). They may be special, i.e. creator V, or creature. Creatures may be considered collectively (world VI) or distributively, according to the several kinds of beings, which may be considered as *substances* or *accidents*. Substances are inanimate (element VII), or species and parts. Species in turn may be vegetative and imperfect as stone VIII, metal IX; vegetative and perfect as "herb," considered according to leaf X, to flower XI, or to seed-vessel XII; as shrub XIII, or tree XIV, or they may be sensitive and bloodless (XV), and sanguineous (fish XVI, bird XVII, beast XVIII). Parts are either peculiar XIX, or general XX. Then follow accidents (in almost every sense of the word), classified under quantity, quality, action, and relation (i.e. social relations in contra-distinction to physical ones, under I and II, or to circles, which are a sub-category of *world* VI). These bring the list up to forty.

Thus herbs, in contra-distinction to shrubs, are considered as different things *sub specie aeternitas*, according as they are classified in the ensuing hierarchical system by different floral organs. There are three levels in the hierarchy: *genus* (as above), *differences*, and *species*. The classification of living creatures is arbitrary, and vastly inferior to the contemporary work of Morrison and others, and the section on animals contains a long and irrelevant digression on the food supply of Noah's Ark. Perhaps the non-biological

reader will best recognize the arbitrary character of Wilkins's procedure by the way in which he divides the stones and metals. At the second level in the hierarchy, stones may be vulgar (e.g. brick, slate, flint, and gravel); middle-prized (e.g. marble, coral, amber); precious (e.g. pearl, opal); transparent (diamond, amethyst, etc.), and insoluble earthy concretions (e.g. chalk, arsenic, and pit coal). Metals may be natural (gold, tin, etc.), factitious (alloys), imperfect (e.g. quicksilver and vermilion), or recrementitions (e.g. litharge, rust, and metallic filings).

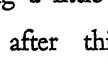
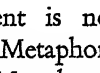
After this recital it would be tedious to follow Wilkins through the finer grades of his classification of species, or to examine his sub-divisions of qualities or relations. It would also be unnecessary to add that relations of time, space, and motion are confused. Surprising necessities arise in the task of invention. For instance, motions include, in the ensuing order, (i) animal motions such as hiccough, peristalsis, or "pandiculation (retching, stretching)," (ii) purgations (e.g. belching, vomiting, dunging), and (iii) recreations (charts, draughts, wrestling, dice). It goes without saying that few of the words in the successive sub-divisions of spiritual and ecclesiastical relations would occur in the *Dictionary of Sensible Words* proposed by Wilkins's contemporary, Sir William Petty.

The third section of the Essay, which aims at setting forth the principles of natural grammar, is not specially noteworthy. Wilkins uses traditional grammatical categories which have served to describe the morphological characteristics of the more highly synthetic representatives of the Aryan family, and he does not come to grips with the need for a new classification of functional categories as a basis for the ensuing task. None the less, it is notable for two reasons. One is that it anticipates the method of Mr. C. K. Ogden, the inventor of Basic English, by using a vector diagram to explain the use of directives (prepositions and prepositional adverbs). The other is that it discusses the need for a universal alphabet, and puts forward a proposal essentially analogous to the modern international phonetic script by redefining the significance attached to ambiguous signs for

consonants in the Roman alphabet, and supplementing the vowels of the latter with additional signs borrowed from the Greek. It also proposes a more compact script in which the consonants are represented by lines and the vowels by circles or dots placed in one of three positions, as in modern commercial shorthand.

This device is not the Real Character described in the fourth Part of the Essay, where he short-circuits the double process of first learning the universal language as a phonetic entity, and then mastering its visual expression. The Real Character itself is a system of ideograms, based on the hierarchy of things and notions to which marks are to be assigned as set forth in Part II, and supplemented with signs for grammatical relations tabulated in Part III. Thus each *genus* has a sign which refers to its tabular number and can be modified by various appendages referred to the tabular number of *difference* and *species*. Thus the sign  corresponds to the *genus* XXIII, Oeconomical Relations. The signs ∠ ⌞ added to the left of the bar, or ⟍ ⌟ added to the right, signify the first and second *difference* or *species* respectively. With these clues the reader may reconstruct the essential features of the system from two examples of the exegesis which follows the Lord's Prayer as it would be represented in Real Character. The words which will be chosen for illustrative purposes are the second  (= parent), and the fourteenth (*coming*). Neither of these words occurs in the Authorized Version. The first is substituted for "father" for reasons explained by the author (*vide infra*). The second, which occurs as part of the periphrasis *may it be coming*, replacing the verb in "Thy Kingdom *come*," draws attention to a purely operative use of verbs, as in Gaelic, or Basic English. The author's annotations are as follows:

> "  This next character" (following one which belongs to a purely grammatical category) "being of a bigger proportion, must therefore represent some Integral Notion. The genus of it, *viz.*  is appointed to signifie Oeconomical *Relation*. And whereas the transverse Line at the end towards the *left* hand hath

an affix making an *acute* angle with the *upper* side of the Line, therefore doth it refer to the *first* difference of that Genus, which according to the Tables, is relation of Consanguinity: And there being an affix making a *Right Angle* at the other end of the same line, therefore doth it signifie the second species under this Difference, by which the notion of *Parent* is defined. . . . If it were to be rendered Father in the strictest sense it would be necessary that the Transcendental Note of male should be joyned to it, being a little hook on the top over the middle of the Character after this manner  . . . . And because the word Parent is not here used according to the strictest sense but Metaphorically, therefore might the Transcendental Note of *Metaphor* be put over the head of it, after this manner  . . .

 (= coming.) "The genus denoted by this Character is Transcendental Action." This is given in the Table as Relations of Action III, with the sign  . "The affix on the Difference side making an *acute* angle with the *lower* side doth signifie the sixth Difference which according to the Tables doth refer to *Ition*, going or passing; the affix on the Species side being the first doth according to the Tables refer to the word *Coming*, which is described to be motion to a place nearer to us. The Hook on the Difference doth signifie *Active Voice*, and the Hook on the other Affix, the notion of *Adjective*, viz., Coming."

The reader of Wilkins may well be curious to know whether the author took his cue *directly* from a knowledge of Chinese. He answers this question himself. Towards the conclusion he discusses its superiority to other means of international discourse, and rightly dismisses Newton's Latin because no synthetic language can be as easy to learn or to use without ambiguity as is any analytical one. He then deals with the defects of Chinese in a discussion based on Lodowick's commentary on the Lord's Prayer in that language. It appears that first hand acquaintance with the latter was subsequent to the intention of the Essay, since he declares:

> In some particulars they seem to found their character upon the *Philosophy of Things*, yet 'tis not so in others. The Character for a precious stone must be used with additions to it for several kinds of *Gems*, as *Pearls*, etc. So the Character for any kind of *Tree* must have joined to it the Character for Wood, and the letter that signifies *Metals* must be annexed to the Character of *Iron*, *Copper*, *Steel*, etc. The meeting of which passage was no small satisfaction to me in reference to that way which I had *before* pitched upon for the most natural expression of things. But this (saith he) is no constant Rule amongst them. It should seem to be observed only in some few *species* of nature which are most obvious, there being reason to doubt whether had any such general Theory of Philosophy as might serve for all other things and notions. In this it is to be acknowledged that they have a great advantage above the Latin, because their words are not declined by *Terminations*, but by *Particles*, which makes their Grammar much more easie than that of Latin.

The Real Character as outlined in the preceding paragraphs is a written language for direct translation from any variety of speech by use of the Tables. To bring it to life as a means of oral discourse, Wilkins assigns to each of the genera a syllable consisting of a consonant followed by a vowel in the phonetic script of Part III. Differences are represented by consonants and species by vowels, so that a typical name-word has the trisyllabic somewhat Semitic form of *Gestapo*. Being rich in vowels, the Philosophical Language has a characteristic which, though often regarded as pleasing to the ear, certainly impedes ready recognition of separate words in the initial stages of learning. That ready recognition of individual words—the only special merit of German—is a desideratum of a language selected or devised for international use, is one of the few relevant considerations which seem to have escaped the author's attention.

§ 3

There is no need to describe in detail the technique of oral discourse in a tongue which never uttered an intelligible sound.

We may well wonder whether the author really hoped to induce any considerable section of mankind to communicate in a phonetic form of symbolic logic. Even as a means of written communication it was doomed to failure for reasons which the author might have realized if he had pursued further the analogy with Chinese with its ideograms "for a few species of nature which are most obvious." The author inadvertently pronounces the verdict of history on his own magnificent failure when he reflects upon the failure of Chinese culture to equip itself with "such general Theory or Philosophy as might serve for all things and notions." In the words of My Lord Verulam, "the subtlety of nature is greater many times over than the subtlety of argument."

Max Müller (*The Science of Language*, vol. ii), who is among the few who have paid a just tribute to this magnificent failure, pronounces the only reasonable verdict, when he says:

> If a plant classified according to the system of Linnaeus or according to that of Wilkins has its own peculiar place in their synopsis of knowledge, and its own peculiar sign in their summary of philosophical knowledge, every change in the classification of plants would necessitate a change in the philosophical nomenclature. The whale, for instance, is classified by Bishop Wilkins as a fish, falling under the division of *viviparous* and *oblong*. Fishes in general are classed as *substances*, *animate*, *sensitive*, *sanguineous* and the sign attached to the whale by Bishop Wilkins expresses every one of those differences in his system of knowledge. As soon, therefore, as we treat the whale no longer as a fish but as a mammal, its place is shifted, and its sign or name would mislead us quite as much as the names of rainbow, thunderbolt, sunset, and others.

As we turn the pages of the tables in which the mineral kingdom is represented by sixty-eight substances (less than the number of now known elements, with their innumerable compounds), while less than one hundred and fifty species exhaust the invertebrate fauna of the world, we read a new meaning in Mr. Wells's suggestion that Chinese culture was permanently fossilized in the

sedimentary rockiness of its own script. Sinologues tell us how Chinese scholarship in turn supplemented pictograms with ideograms and ideograms with phonograms to accommodate the demands of discourse to man's growing knowledge. The undertaking which Wilkins essayed had already been tried with results which sufficiently demonstrate the inescapable consequence of constructing a world language of scientific discourse on such foundations. To Wilkins's project, as to the Kingdom of God in Munster, we may well apply Samuel Butler's miquotation: " 'Tis better to have loved and lost than never to have lost at all." Had the Royal Society adopted the proposal in its subsequent publications, and had it also succeeded in gaining general assent to the practice, it would have petrified scientific discovery at the level of attainment represented by the contents of the *Pseudodoxia Epidemica*.

As with the language of size and order, so it is with the language of things and attributes. Science needs techniques of discourse appropriate to the subject-matter. In their respective fields, Linnaeus and Lavoisier initiated a flexible vocabulary of international discourse a century later. From such modest beginnings the only world of verbal discourse which is truly world-wide has become an enduring benefit to human culture. Meanwhile, the limitations imposed on scientific intercourse by the absence of any medium of common speech have multiplied, and friction between linguistic minorities now provides the sparks which may light a bonfire on which natural science is compelled to pour the petrol for its own destruction and that of civilization. No project, if well conceived, could contribute more to the universal good of mankind. Truly the failure of a first attempt is more commendable than the cynicism which basks in the gentlemanly uselessness of polite learning, and declines the title of humane studies to any pursuits directed to humane ends. If the object of Wilkins was to make the author of the Real Character famous, his greatest mistake was to associate himself with a University located in a town which had not yet established world-wide fame for the manufacture of automobiles.

The truth is that the complacent isolation of linguistic studies from the pursuit of natural science under the influence of the mediaeval foundations receives no support from the record of subsequent progress. When the science of language received a new impetus in Britain from the study of Sanskrit, the focus of active scientific research directed to human use had shifted to Edinburgh, where a new Royal Society had revived the social pre-occupations of its predecessor. In 1802, Alexander Murray, subsequently a fellow of the Edinburgh Society, published a *History of European Languages*, in which he explored the parallel between Gaelic and Sanskrit. Thus began a new chapter in the natural history of human behaviour. The subsequent work of Müller, Bopp, and their followers is redolent with the explicit influence of classificatory technique directly imported from contemporary naturalistic studies. The interest which their theories excited was in no small measure a consequence of the impact of evolutionary speculation on contemporary thought.

In our day and generation, when every imaginative person must needs be haunted by the prostitution of science to purposes of destruction, the Curse of the Confusion for which Wilkins sought a remedy is tenfold more apparent. His failure will not have been fruitless if at last the agony of war compels mankind to perfect a new instrument of common understanding. Though the remedy itself was ill-conceived, his diagnosis has lessons from which many of our contemporaries can still profit. A common medium of world citizenship must be easy to learn, and a language which is easy to learn must among others incorporate the principles which Wilkins already recognized. He stated explicitly the necessity of the analytical structure based on operative use of particles which dispense with grammatically redundant terminations or mutations. He also recognized implicitly that the verb is the least essential part of speech.

Ogden's Basic English, with its twelve operative verbs, compresses the minimum necessary non-technical vocabulary for adequate self-expression into eight hundred and fifty items which can be printed on a single sheet, because its simple grammar is

based on universal rules for the precise use of particles, and because it dispenses altogether with the vast battery of tautological verbs which duplicate the content of every substantive and adjective in most Aryan languages and in Esperanto. The latter with its separate flexions for the infinitive, six different participles, three tenses, and three moods of the verb, number flexion of the adjective, both number and case flexion of the noun together with a separate adverbial flexion of the adjective, cannot be a dangerous, if energetic rival. Esperanto is a concoction of the schoolroom. It is based on the pedagogue's misconception that the verb is the most important part of the sentence, and the pedagogue's predilection for the grosser defects of the Latin dialects.

Admittedly, Basic English does not fulfil every requirement of an ideal international language, because the traditional English spelling which it retains is based on no phonetic principles. This disadvantage, minimized by the tremendous economy effected in the definition of its eight hundred and fifty word vocabulary, is more than balanced by the fact that it provides a quick means to self-expression in a language spoken by five hundred million people who enjoy the immense amenity of cheaply produced books. It would be easy to incorporate in an artificial language without the last advantage several simplifications. For instance, a phonetic and reformed Gaelic with the verb *to be*, used either substantively alone or copulatively alone, could dispense entirely with the need for any other verbs. The progress of Basic English is assured if it has to compete with no more serious competitor than Esperanto. Meanwhile, phonetics is the only constructive branch of linguistics taught in British Universities. That their official attitude to the linguistic conditions of lasting world-peace has been consistently hostile is the most poignant exposure of their claim to foster *humane* studies.

When we put down the *Essay towards a Real Character*, the curtain falls on a drama which ends in a challenge to progressive thought in every generation, the more so as we become historically conscious of the social agencies which determine the progress of

man's command over nature and the more so as we become more determinisitic in our attitude to human relations. Inevitably we ask ourselves: Was the effort expended on so brave a plan completely fruitless because born out of its time? Upon the horns of the same perennial dilemma levellers of all ages are impaled. If our answer is affirmative we relinquish the moral luxury of hope. If it is negative, it is difficult to furnish reason for the hope that is within us. Perhaps after all, the difficulty is not final. When times are propitious to reform, the first social mutations of the Babbit Warren can gather courage from the greater loneliness in which scarcely now remembered men conceived the same high enterprise.

3

Race and Prejudice

THE BEST OF US have prejudices and the wisest of us harbour superstitions. To blame us for having them is as foolish as to blame us—individually—for catching whooping-cough at the age of eighteen months. For my part I am not ashamed to admit that I am not favourably disposed to an examination candidate who cannot write legibly, to men who grow beards before they attain the fiftieth decade, or to platinum blondes. I do not choose my friends from footballers, foxhunters, professional musicians, or yachtsmen. I will confess without a blush that I try to avoid (*a*) walking under ladders, (*b*) spilling salt, (*c*) looking at the new moon through the windscreen of my car.

Having disclosed these disabilities, let me hasten to add some extenuating circumstances. I try to give an illegible examinee a fair deal. I do not advocate the disfranchisement of middle-aged men with beards. I do not wish to exclude platinum blondes from the legal or engineering professions. I should not attempt to dissuade any of my friends from marrying a yachtsman or a professional musician. I am in favour of providing for the children of foxhunters and footballers the same educational facilities which I demand for my own children. I regard my reactions to leaning ladders, spilt salt, and new moons seen through glass as peculiarities of my own temperament, and do not expect to persuade anyone else that any of these objects have exceptional capabilities for interfering with natural laws. So when I devote my leisure to the pastime of challenging other people's prejudices or superstitions, I am only concerned with helping them to see that they are prejudices and superstitions—legitimate enough as long as

we do *not* claim that they are anything else, but thoroughly reprehensible when we do.

Of all prejudices none is more comprehensible than a preference for skin colour—if it stops there. No superstition is more reprehensible than superstition about race if it is not recognized as such. People who really believe that seeing the new moon through glass may affect the security of their investments are in my view misguided, especially if the belief is coupled with the conviction that there are other sources of knowledge besides genuine scientific enquiry. On the other hand, it can be said in their favour that they rarely, if ever, claim the authority of science to sustain them. It is not so with colour prejudice. An influential current of contemporary superstition (called *Rassenhygiene* in Germany and Eugenics in England) claims the authority of science for sentiments which are the negation of civilized decency and for doctrines which are in open contradiction to historical truth. Prejudice against the presence or absence of melanin in the deeper layers of the skin, though of itself as natural and harmless as prejudice against freckles, can therefore be an obstacle to common honesty and to the solution of pressing social problems which could easily be solved by using the science we have.

In Britain it is not as yet common to meet educated people who believe that the major constructive achievements of civilization have been exclusively sponsored by tall dolichocephalics with blue eyes, fair hair, and no sense of humour. We are more hypocritical. As an Englishman I am happy to record that this is so. Hypocrisy implies a recognized standard of decency and a quality of intellectual ingenuity which Dr. Goebbels does not possess. The English intelligentsia has its own genre of race prejudice. In the retreat to the *Doctor Angelicus* some of our anthropologists (long since outstripped by professors of political economy) have now reached the eighteenth century. There they have rediscovered the Beautiful Savage, and have upholstered Hertzog's segregation policy for starving out the Bantu with a pedantically sentimental plea for the right of the native to evolve along his own peculiar line of self-expression. Though we do

not advertise to the whole world that the Jews are too clever for us, we have lost the magnificent self-assurance which makes a conquering people force its own standards of behaviour on everyone else.

As Englishmen we have educational advantages which the Germans lack. An occasional lapse into lucidity is not thwarted by the picturesque resources of a language with word order admirably adapted to combat temptation to rational discourse. So we do not need to excuse our inability to converse or write intelligibly by emphasizing our contributions to the instrumental hymnology of other nations. On the other hand, common honesty should compel us to admit that we have other characteristics which a mere foreigner might make the subject of unfavourable comparison. One is our facility for sweating through our moral pores when we feel the need to get guilt out of the body politic. We suffered no ethical dyspepsia from the extension of the colour bar system in South Africa because we had already had our say about the Belgian Congo, where natives do skilled work and may even become minor officials. If we are nice-minded about the Jewish question and likely to remain so, one contributory circumstance is the fact that in Britain there are not enough Jews to use up the dole.

The Jews are not big enough for the job which our local blackshirts have undertaken. Scotsmen would be a better bait for the southern English. The vacancies which would occur in Whitehall if Englishmen domiciled in Scotland were repatriated on condition that all Scotsmen returned to their native heather would guarantee the whole-hearted support of the English professional classes to a rigorous segregation policy. Cornwall has lately made a constructive gesture by reviving the ancient Brython language with ritual pomp in Falmouth Cathedral. Maybe we shall see a movement to rebuild British homes burnt by blue-eyed, yellow-haired, humourless savages who ravished Brython women, put Brython villages to the sword, laid waste the Gorsedd circles, and left the countryside littered with vowels.

In matters which affect the contact of communities a little

horse-sense goes farther than the small supply of scientific knowledge as yet to hand. With full responsibility for my words as a professional biologist, I do not hesitate to say that all existing and genuine scientific knowledge about the way in which the physical characteristics of human communities are related to their cultural capabilities can be written out on the back of a postage stamp. This does not mean that there is no extant literature sufficiently prosy to pass for science among those who do not know better. That the cranial capacities of Anatole France and of Leibnitz were each less than the lowest recorded average of any ethnic group does not discourage painstaking anatomists from continuing to catalogue similar measurements in Kenya and the Transkei, or the *Eugenics Review* and the *Transactions of the Royal Society of South Africa* from publishing their results in tabular form. A few years ago (1930) a voluminous study on the social and physical characteristics of negro, White (their spelling), and hybrids in Jamaica was published by the Carnegie Institution of Washington. A considerable proportion of the melanic subjects were convicts, the whites being exclusively chosen from more congenial walks of life. One of their more striking conclusions is worthy of citation without further comment:

> The Blacks seem to do better in simple mental arithmetic and with numerical series than the Whites. . . . It seems a plausible hypothesis for which there is a considerable support, that the more complicated a brain, the more numerous its association fibres, the less satisfactorily it performs the simple numerical problems which a calculating machine does so quickly and accurately.

The intellectual strain to which one is exposed by reasoning conducted on these lines sometimes interferes with sport. The form of sport to which I am most addicted is consequential conversation. I was deprived of it during four years' sojourn among the *chromatocracy* of South Africa by repeated attempts to communicate through the medium of dialogue like this:

> *Almost any South African Graduate:* If you had lived in this

country as long as I have, you would know that a native can't be taught to read or write.

Myself: Have you ever visited Fort Hare Missionary College?

Almost any S.A.G.: Don't talk to me about missionaries.

Myself: Well, I have. I have seen a class of pure blood Bantu students from the Cis-Kei working out differential equations.

Almost any S.A.G.: What would you do if a black man raped your sister?

As an experimental scientist I know of only one way of finding out whether mixed marriages are advisable. That is to encourage them where we can assure the offspring the same cultural advantages as children whose parents belong to the same ethnic group. They seem to be doing this at present in the Soviet Union. To some extent it has been done without noticeably disastrous consequences in the British West Indies, where, according to my negro students from St. Kitts, there is relatively little nonsense about the "instinctive" [*sic*] social incompatibility alleged to result from the action of tyrosinase. The most successful parental achievement of which I have had a close-up view was the F.1 generation of a Swede-Bengalee cross. Of three children the daughter acquitted herself with great credit in the mathematical and economics triposes at Cambridge. A charming lady, she now has a responsible post at Geneva. The eldest son, a lifelong friend of mine, obtained a double first in the natural sciences triposes. He is an extremely handsome as well as a very congenial person. Unfortunately the youngest son went to Oxford, where he obtained a first in Greats and was permanently incapacitated for lucid statement or realistic judgments about current social questions. I think that his headmaster rather than his parents were to blame for letting so much natural ability go to seed.

Aside from the example cited, in the successful mixed marriages I have known one partner has been a Scot. Maybe this is a portent. For two hundred and fifty years the Scots were busy educating the English. Naturally they now feel equal to the task of educating anybody. Dogged self-assurance of that sort is a necessary prerequisite for one of the partners in a durable

marriage, and in the long run for sane and salutary relations between men and women of all sorts. From whatever angle you look at the colour question you see the same tiresome characteristic for which John Knox discovered the remedy. Scots can manufacture jokes at their own expense because they also believe that education's a grand thing. The Union of South Africa recently refused a large grant from an American foundation to set up a medical school for the natives on the Rand. General Hertzog does not believe in education, and no one could imagine him making a joke about the backveld farmer.

One of the most deplorable results of the Versailles Treaty has been completely overlooked in most discussions of ethnic contacts. Under the beneficent Laodiceanism of the English social climate ex-members of the Hebrew branch of respectable British nonconformity had acquired sufficient poise to compete with the Aberdeen output in "racial" good-humour. Since 1933 decent people can no longer repeat a joke containing a Jew without incurring the charge of "Anti-Semitism." Persecution does not make people more affable or more entertaining. That is a sufficient reason for not persecuting people.

From one point of view it is rather surprising that Liberal economists who accept the trade cycle as an immutable natural law are so infuriated by what Hitler has done. If cyclical economic depression is an inescapable feature of human life on this planet, an obvious way of making the best of it is to put the policeman on the dole and reclothe the unemployed as policemen. When the new police become uppish and the new unemployed become restive the process can be reversed, until a new depression comes along and a fresh biological cycle starts. Since policemen and unemployed are not plausibly differentiated as sub-species of *Homo*, it is better to divide the population into groups with something more tangible to distinguish them, as for instance large noses and smaller ones. Seeing that we know very little about the association of nose size and employability, future discoveries in social biology can be systematically released to meet any contingency. When the iron "laws" of liberal economics

call for a reshuffle of the biological constituents of the population, new arguments for a large nose boom and a little nose depression can always be concocted. In this way the biological cycle can be made to keep in step with the dictates of the dismal "science," and if nose differences lose their popular appeal, the red-haired, the freckled, the double-jointed, and people suspected of a sense of humour are always with us.

That there is as yet no certain scientific knowledge about the cultural capabilities of different communities does not mean that scientific workers have no interest in the issue. Science cannot advance rapidly when people refuse to recognize their prejudices as prejudices. It does advance rapidly when the fullest use is made of the benefits it can bestow. The time will soon come when scientific workers will be forced to choose between two alternatives. One is the social programme of the Fascist States, where pseudo-scientific rationalizations are advanced to withhold social privileges, restrict production, and so deprive science of the stimulus which it derives from expanding industry. The other is the extension of social privileges, the expansion of industry by increasing consumption, and the encouragement of science by offering it new problems and by developing a new awareness of its importance within the framework of a planned economy of abundance. Those who choose the first are betraying science and betraying Western culture, of which experimental science is the chief glory.

The social creed which is now fashionable in modern Germany is not an indigenous product and is by no means confined to Central Europe. Precisely the same views are widely current in Britain and in America, where they are called by another name. I have never admired the intellectual courage which equips a man to attack the views of those who have no means of damaging his reputation, especially when it adds to the popularity he enjoys in his own social milieu. To me it has always seemed more diverting to examine the prejudices of people with whom I come into contact. So it has been a source of cynical amusement to follow the moral evolution of Mr. Carr Saunders,[1] who on more

[1] Vide "Europe Overseas" in *We Europeans*.

than one occasion has attacked me in his capacity as an English eugenist and now enjoys the fashionable role of a liberal critic of the Nazi creed.

There is of course a parochial distinction between *Rassenhygiene* and its sister cult in Britain. In Germany the Jew is the scapegoat. In Britain the entire working class is the menace. Dr. Edgar Schuster, the prosaic author of a book which bears the title *Eugenics*, states the view of Mr. Carr Saunders's co-religionists in the following passage:

> The London County Council sets up educational ladders in all parts of the Metropolis, but finds it difficult to get boys to go up them. The number of children in the schools maintained by the rates who are bright enough to make it worth while to give them the scholarships provided by the London ratepayer is hardly enough to fill them. No difficulty is experienced in filling those at the Public Schools or the Universities with boys of a very respectable level of intelligence, whose fathers belong mostly to the professional classes.[1]

A passage from *The Family and the Nation* by the Whethams illustrates the same engaging temper:

> Better that an able carpenter should develop slowly into a small builder leaving six tall sons to play their part manfully, and perchance rise one step more, than that he should be converted by a County Council Scholarship into a primary schoolmaster, or second-grade Civil Service clerk. . . . They were good sociologists as well as good divines who taught "to learn and labour truly to get mine own living, and to do my duty in that state of life into which it shall please God to call me. . . ." Scholarships have their dangers when used to raise those who win them too suddenly and completely out of their *natural* class. . . . In the

[1] In the course of scaling the educational ladders of the metropolis the brighter boys become accustomed by their expensive environment to certain grammatical conventions. There may be readers of Dr. Schuster's books who share the same limitations. Let me assist them to understand this passage by pointing out that "who" and "whose" refer to children and boys respectively. They do not refer to rates and intelligence, as their position in the sentence might lead the County School reader to suspect.

matter of education there is a tendency to attribute far too much of effect to outside and expensive environment and to lay too little stress on heredity and the traditions of the family. . . ." (Italics inserted.)

The intervention of the deity in this paragraph suggests that it is intended as a pious reflection rather than the disclosure of a scientific discovery. Dr. Whetham and his wife temper their Darwinism by the admission that the "ablest and strongest" do not always survive an examination.

> The policy of competitive examination, when driven to excess, has resulted in closing partially the doors of various honourable professions to those who in due course of time would have been best fitted to excel in them. During the last two centuries the landed and official classes could be certain of obtaining for many of their sons posts in which, at all events, a living wage was secure. Now the posts are filled by competitive examination from a wider sphere. . . .

The Whethams sum up the eugenic diagnosis of the national educational problem in the following passage:

> Our public and elementary schools have been much to blame, the one in that they failed to modify the type of education to suit the altering conditions of national life, the other that they tended to depreciate manual activity and craftsmanship, and over-supplied the ranks of the clerks and penmen. The great public schools go on training their boys chiefly in classics and ancient literature, when the demand has been for men of science, for economists, engineers, and scientific agriculturalists, of the same class and breeding as the men supplied by the public schools. *The classically trained men have difficulty in finding openings in after life, owing to their type of education. The men educated scientifically in schools of other types are often rejected because their heredity and training leave them unfit to deal with men, especially with workmen, foreigners, and natives. Moreover, from the employer's point of view, they often lack the guarantee of character and the untuitive sense of masterfulness that are the usual concomitants of the man of good family.* . . . (Italics inserted.)

A quotation from Major Darwin's book, *Eugenic Reform*, may be added, because no writer claims greater authority as an official spokesman of the eugenic movement in Great Britain.

> It may be suggested that the award of scholarships would result in the picking out of the best of each social class; and that by thus giving advantages to a selected few over their early associates, they would be made more likely to marry with eugenic consequences. This beneficial effect of scholarships is, however, in my opinion, likely to be outweighed by influence acting in the opposite direction. . . . Scholars certainly form a carefully selected and valuable group of the community, and if it be true that on the whole scholarships tend to diminish the fertility of their recipients, their award must be held to produce eugenic consequences. To aid a few exceptional persons to mount to the top of the social ladder by the award of valuable scholarships would probably be *less harmful* to the race than to aid a *larger number of persons* to climb up a single step by the award of many minor scholarships. . . . There is, however, yet another side of this question which has to be taken into account, and that is the effect of the award of scholarships to members of a lower stratum on the fertility of potential parents belonging to the higher strata into which these selected scholars would enter as recruits. The effect on potential parents of any increase in competition from outside their own social stratum must be to make them feel less secure in regard to the prospects of any children they might have in the future, and this feeling of insecurity would tend to make them less fertile. Hence the award of scholarships tend to produce infertility not only in the social stratum primarily affected, but also in all the strata above it. And the only complete remedy for *the harm done by scholarships—and also by educational facilities generally—in promoting infertility by facilitating the transfer between classes would be by the introduction of a caste system so rigid as to prohibit all movement between the different social strata.* . . . (Italics inserted.)

Education is not the only evil against which the missionary zeal of the eugenic movement is directed. The pastime of decking out the jackdaws of class prejudice in the peacock feathers of

biological jargon takes its tone from the national environment. In America a mushroom growth of capitalist enterprise has attracted foreign immigrants more rapidly than the inflexible constitution of the United States can deal with the problem of educating them in conformity with its requirements. The prosperous section of the American community is glad to put the blame for the lawlessness of its large cities upon any agency but the reckless individualism of which it is the logical consequence. American eugenics is mainly a testimonial to the superior merits of the so-called Nordic race. In *Mankind at the Crossroads*, one of its principal exponents, Professor East, brings the laws of hereditary transmission into harmonious relationship with the lynch law of what Mencken calls the Total Immersion Belt, when he naïvely assures us that "only when there is white blood in his veins does the negro (spelt with a small letter in contradistinction to Nordic) cry out against the supposed injustice of his condition, and then only when in contact with numerically superior whites."

The humane and disinterested temper which these citations illustrate may be found in any back numbers of the *Eugenics Review* with its sensational full-page advertisements calling for recruits to assist the National Citizens Union in its "educational campaign against socialism." The policy of this sprightly periodical is chiefly concerned with a demand for the reduction of social services. In particular it attacks provision of proper sanitation for the working class by the solemn and repeated assurance that "school and state medical services are dysgenic" (vol. xxiii, p. 307). The political Darwinism of the *Eugenics Review* is only directed against medical attention for those who cannot afford it. In lamenting upon "the effects of the continued decline in infant mortality that has been so laboriously and expensively achieved in recent years," we are told that "year by year a greater proportion of weaklings must have been saved—temporarily—by more and more intensive nurture, and this may well account for the subtle insidious change in the stamina of young persons" (vol. xxiv, p. 66). If its parents are wealthy enough to call in a Harley Street specialist when occasion demands, a physically

weak child has a much greater chance of surviving to maturity and leaving issue than it would have if its parents were poor and had to rely on the amenities of the social services. Those who hold that State medical services are dysgenic might be expected to direct their attention to the waste of medical attention upon the children of the rich, and join forces with the Christian Scientists and the peculiar people who at least practise what they preach.

To get rid of sanitation is not enough. To make certain that only the very fittest survive, old age pensions and State insurance must share the same fate. "Only an unbeliever in heredity could make the world safe for democracy by promising ninepence of other people's money for fourpence, and thus raise the cost of maintaining the nation's beneficiaries including the recipients of poor relief, inebriates, lunatics and mental defectives" (vol. xxiii, p. 364). After this we are not surprised to be told in an editorial that the distinction between earned and unearned income for purposes of taxation is dysgenic. In another editorial upon the "unparalleled depression and enhanced income tax" the study of monetary policy, adverse trade balances and production crises receives a new impetus from the naïve announcement that "the Social Problem Group has much to do with both those national calamities." A review by Dean Inge (xxiii, p. 265) strikes an even more positive note: "The world contains far more workers than it can employ. . . . To allow the continued procreation of an army of workless parasites who may at any moment turn and rend those who feed them is lunacy. . . ."

So it seems that the Eugenic State will be able to get along without sanitation and without the working class. Will it need logic as we do? An editorial comment on the genetics of feeble-mindedness encourages us to hope that it can dispense with logic as well (xxiii, p. 297). "Dr. Williams here confirms Dr. E. O. Lewis (in the Wood Report), who found that the grosser grades of defect occurred sporadically in all classes of society but that the feebleminded were largely concentrated in the 'social problem' group. The general implication of these and similar studies is

that the severer forms of defect—notably mongolian imbecility —are usually due to extrinsic factors, while feeblemindedness, which is much the commonest type of amentia, is most often hereditary." Here we have a new equipment of biological definitions. When a trait is only found within a restricted environment we are to describe it as hereditary. When it occurs in almost any kind of environment we are to say that it is due to extrinsic factors.

The reckless stupidity with which the spokesmen of the eugenic movement have done their best to alienate the working classes is all the more pitiable, because some of their practical proposals are worthy of thoughtful consideration. They are capable of standing on their own merits without the accompanying refrain, "What is so shocking is the waste of money" (xxiii, p. 199). As a biologist I think that more might be said for than against compulsory sterilization for certain conditions. As a citizen I refuse to be horrified by the present expenditure on mental diseases, while civilization is burning its wheat, cotton, and coffee crops because it has not devised a rational system for controlling the production and distribution of the amenities which science creates in such profusion. The problem of mental disease is worthy of earnest consideration. When the worst has been said about it, it is not likely to become an insoluble problem during our own lifetime. The problem of world peace may become insoluble within the next decade. Even before rearmament began Great Britain spent rather more than ten times as much on armaments as upon all classes of mental cases. At any moment Western civilization may be plunged into a war which will destroy it irreparably. Those who hold this view will regard the type of insanity which leads eugenists to contemplate the present expenditure on armaments with equanimity as a far greater menace to civilization than the upkeep of a few witless and voteless creatures in our poorhouses.

Obviously it is not a matter of scientific judgment whether one chooses to deplore the fees paid to dukes as mining royalties or the fees paid to doctors for the care of the defective and insane.

It is a matter of political taste and native egotism. The eugenic movement of this country has always been, and still remains, an organization of a small section of the professional class with a strongly conservative bias directed to restrict the further extension of educational opportunities. It has drawn its personnel and funds from the childless rentier—twentieth-century Bourbons who have earned nothing and begotten nothing.

A leading eugenist in a recent issue of the *Eugenics Review* writes: "Economic competition and the necessity to pay for increasing provision for the support of the incapable and their offspring have progressively increased the economic pressure on the better endowed, who are thus forced to delay marriage and limit their offspring. In this way both economically and mentally the country is being led towards bankruptcy." I find it very difficult to follow this argument at any stage. Most eugenists with whom I am acquainted have no children. A few have two. I myself have four. I lack the aristocratic confidence which leads eugenists to harp upon the superiority of their own progeny. Still, I have sufficient confidence in the likelihood that my own children will be tolerably competent to entrust their future to schools from which the nation now recruits a large proportion of its professional men and women. My own children can enjoy the benefits of social intercourse with the children of eugenists. Since the educational services are as much at the disposal of eugenists as of anyone else, one would expect to find their highly gifted progeny carrying everything before them in the elementary and secondary schools, where they would compete with working-class children who have not been reared in a hothouse cultural environment. That one does not shows very clearly that the reasons which eugenists give for their own sterility are not sufficient.

At present the professional classes of this country do not produce sufficient children to maintain themselves as a unit. It is quite clear that very few professional people can now afford to educate their children in the type of institution from which the professional class was formerly recruited. To the extent that the

professional class restrict their families for this reason their infertility is due to a social custom which can be changed by absorbing into a system of free secondary education such as that which Professor Tawney has outlined schools which now demand high fees in return for the social prestige they confer. Differential fertility is a necessary corollary of the genteel poverty which opposes the extension of the social services, while refusing to benefit from those which exist. It is the penalty the professional classes pay for cherishing their inalienable right to privileges which their children will inevitably forfeit.

I have kept to the last my favourite press cutting for an anthology of eugenics. It comes from an article by Professor R. A. Fisher in the official organ of the Eugenics Society, which (as he fitly states) "has always been especially interested" in "that portion which is popularly called the upper and middle classes." Professor Fisher asks the question, "Who are the middle class?" The answer he gives is this:

> In consequence of this selective process this class has necessarily become differentiated in certain hereditary respects from the general body of the population from which it is continually recruited. In the case of intelligence this difference is readily demonstrable by applying the psychological tests to the children of different occupational groups. But we should be altogether mistaken if we took it that the only important difference lay in intelligence. There must be at least a dozen other psychological characters of importance governing self-control, ambition, judgment of character, aesthetic taste, foresight, *grasp of moral principle* which have been at least as influential as intelligence in guiding the process of social promotion during the last two centuries of which our class is the product.

The italics are inserted. Perhaps no better word than grasp could have been chosen in this context.

4

The Contemporary Challenge to Freedom of Thought[1]

AGITATION FOR THE removal of religious tests in the English universities coincided with a vigorous episcopal crusade against the evolutionary doctrine. This circumstance is chiefly responsible for the growth of a movement to check the influence of the Churches on English educational policy and public discussion of such matters as the age of the earth, the spiritual value of venereal disease, and the personal convenience of anaesthetics. It attracted leaders of scientific thought who wanted to be free to discuss their discoveries, manufacturers who wanted to promote technical instruction, social pioneers who were exasperated with clerical landlordism or episcopal opposition to reforms, and neo-pagan aesthetes who recognized scope for a new priestcraft without the tiresome taboos of the old order.

This ragbag was liberal rationalism and free thought as the terms were used in the opening years of the present century. You were a free thinker if, like T. H. Huxley or Sir Arthur Keith, you did not believe in table turning and asserted the need for biological knowledge as a foundation for rational citizenship. You are also a free thinker if, like Aldous Huxley, you believe in spirits, or if, like Bernard Shaw, you would incarcerate biologists for torturing dumb animals. You were a free thinker if you thought, as did Herbert Spencer, that cut-throat competition is a necessary basis of production. You are likewise a free thinker if you think, as Karl Marx thought, that capitalism is burglary sanctified by superstition. You were a free thinker, if you wanted

[1] An address delivered to the Conference of the World Union of Free Thinkers in London, September 1938.

to retreat with Mr. Lowes Dickinson into a parochial anachronism called the Greek Way of Life. So also are those who wish to hurry forward to the antiseptic World-State of Mr. Wells.

Such an alliance could hold together only while the signatories to the pact had good reason to fear the power which the Churches could exercise against them, or had no reason to fear more powerful antagonism from other quarters. If more powerful impediments do indeed exist, those of us who are scientific workers are forced to re-examine the meaning we confer on rationalism and free thought, when we identify them with our own convictions.

It is then clear that many people who are not scientific workers do not use them in the same sense as we do. When some people talk about rational argument they mean confidence in a logical edifice built on a foundation of self-evident principles. The scientific worker distrusts the exercise of man's reasoning powers except in so far as they are continually disciplined by factual verification and search for new data. Those who identify rationalism with an undue respect for verbal logic generally identify freedom of thought with permission to persist in discussing age-old conundrums without guidance of new information or intention to arrive at a definite conclusion which might influence human conduct. Scientific workers need have no interest in this pastime and no special sympathy for creating or preserving opportunities for exercising it.

It is plain humbug for a teacher of chemistry to say that he aims at giving his student an open mind about the atomic weights of the elements. His aim is to lead the student to definite conclusions which can be used as recipes for chemical manufacture, and the freedom which he demands is the freedom to test their usefulness in the domain of action. The job of the scientific worker is to find out what the world is like, and to communicate his discoveries about it. As a citizen it is also his responsibility to discuss their social relevance with other citizens. Among scientific workers intellectual freedom therefore means the removal of

social obstacles to discovery, communication, or public interpretation of new facts. So how to preserve it raises the question: What impediments to scientific enquiry exist in contemporary society?

It is obvious that organized Christianity was an impediment to scientific enquiry in the Italy of Galileo, in the France of Descartes, in the Germany of Haeckel, and in the England of Darwin. Because somewhat similar conditions exist in other countries to-day, it is a privilege and a duty to express the international unity of the scientific outlook through the World Union of Free Thinkers. On the other hand it is not obvious that the Churches now constitute a powerful obstacle to scientific enquiry in Protestant countries such as Britain, Sweden, or Iceland, and it is not obvious that a liberal form of Christianity such as Quakerism need be hostile to the growth of science and its applications in man's social life.

§ 2

A fruitful discussion of intellectual freedom from the standpoint of the scientific worker must begin with a study of social forces which impel and impede scientific progress. The conventional and idealistic view is that scientific discovery owes its impetus to curiosity, and that the principal obstacle to its fulfilment is superstition. Given the facts that man is (*a*) curious and (*b*) superstitious, we can still ask in what circumstances his behaviour is more curious or more superstitious. The common-sense view to which we are led by study of the history of science is that material necessity is the mother of invention. Curiosity predominates when social conditions conspire to force new and urgent problems on the attention of a sufficiently extensive personnel. Contrariwise, discovery does not flourish when social conditions provide cheap substitutes for ingenuity.

Cheap labour and cheap valuation of human life act as a check on discovery. The Attic Greek culture which drew material inspiration from the surplus wealth created by slave labour in the silver mines was scientifically sterile, because it was the culture

of a leisured class divorced from contact with the instruments of production. In the history of science few social circumstances have been as important as those which led to the disappearance of chattel slavery. This view, well supported by Professor Farrington's recent book on Greek civilization, is repeatedly illustrated in *Science for the Citizen*. If we accept it, we are able to approach the conflicts between Christianity and science from a new viewpoint. For our present purpose we must distinguish two parallel and opposing currents in Christian syncretism. One may be called the Spartacist ethic derived from its *Essene* background. The other was the Platonic metaphysics for the reception of which the Pauline teaching prepared the way.

Inspired by the former, monks founded hospitals to which the progress of science owes far more than most free thinkers are willing to admit. Christian medicine opened the doors to the Jewish missionaries of Moorish science, and it can scarcely be doubted that the influence of the early Church encouraged the decline of chattel slavery. The overthrow of the pagan schools of Alexandria was the partial destruction of a culture which had long since fossilized and could no longer provide guidance for fresh human achievements. Unhappily the cosmogony of the Timaeus, already enshrined in Christian theology, outlived the sound navigational science which was salvaged by the Moors. Progressively, the official metaphysic of Christianity approximated to a Platonism which accepted the necessity of servile labour and, as a corollary, exalted ratiocination out of contact with the mundane realities from which science draws its sustenance.

As Platonism supplanted Essenism, the Platonic ingredients of Aristotle's ethics and Aristotle's physics had long since displaced the temper of the *Natural History*, when the Parliament of Paris passed the well-known law of 1624, prescribing that chemists of the Sorbonne must conform to the teachings of Aristotle on pain of death or confiscation of goods. Each department of knowledge which is recognized as a science in the modern sense of the word has felt the same paralysing grip. The dead hand of

Christian Platonism which checked the progress of Astronomy, of Chemistry, of Physics, and of Biology guided the pen of Gladstone in his luckless onslaught on the evolutionists. In the year after the publication of Darwin's book Gladstone expressed the official view of the English governing classes in a memorandum for Lord Lyttelton with reference to the Public Schools Commission.[1]

> Why, after all, is the classical training paramount . . . ? Is it because we find it established, because it improves memory and taste or gives precision or develops the faculty of speech? All these are but . . . narrow glimpses of a great and comprehensive truth. . . . The modern European civilization . . . is the compound of two great factors, the Christian religion for the spirit of man and the Greek, and in a secondary degree the Roman, discipline for his mind and intellect. St. Paul is the apostle of the Gentiles and in his own person a symbol of this great wedding —the place of Aristotle and Plato in Christian education is not arbitary nor in principle mutable.

Much water has passed under the bridges since Gladstone told Parliament that "after all science is but a small part of education."[2] The Universities Test Acts have been repealed. Natural Science and the humanities are now co-partners in university property and according to the more or less explicit articles of partnership there are two sorts of knowledge: useful or scientific, and humane or gentlemanly. Useful knowledge leads you to definite conclusions, and (like 1066) this is a good thing because it gives us motor cars promoting travel whereby gentlemen can come to no conclusions about more topics. The mission of humane knowledge is to prevent you from coming to definite conclusions by propounding the unanswerable. This is also a good thing. When curiosity might tempt them to conclusions which prompt ungentlemanly effort or disloyalty to the property rights of other gentlemen, it takes gentlemen out of danger.

[1] Morley, Appendix, p. 445, 1911 edition, ref. to Vol. ii, p. 236.
[2] Morley, Book III, Chap. VIII.

In short the social function of the new compromise is to protect the study of human society from what is called empiricism (of approved topics) and muck-raking (when the subject is a forbidden one). To those of us who live in Britain evolution is no longer a forbidden topic. The perennial eclecticism of Protestant Christianity has in turn assimilated evolution, the higher criticism and birth control, if undertaken in a prayerful spirit. To some extent it retains its hold on people because its more vocal spokesmen include many men of humane and generous outlook anxious to redress remediable social grievances. In Britain an organized movement to assert the claims of free scientific enquiry in *higher* education would be scarcely necessary, if we had to reckon with no serious opposition from other bodies.

None the less the birth-throes of a new science are still painful. Although we do not confine a man to a Bishop's palace with the use of books when he looks up a telescope and announces a new truth about the satellites of Jupiter, penalties for enquiry into forbidden topics are scarcely less discouraging than in former times. If he pries into the balance sheet of a great financial corporation and publishes the truth about it, we send him to hard labour without writing materials. We no longer call it heresy. Our secular theologians call it criminal libel.

To-day active opposition to realistic research is mainly directed against attempts to study how man can enlist the new powers which science has placed at his disposal for the satisfaction of common social needs and the prolongation of human life. This opposition takes different forms in different countries. In some it is honestly anti-rationalistic. In our own it is professedly "rational." An example of the former is Fascist propaganda which exploits fear of unknown contingencies and sentiments of frustration which fasten on the foreigner in our midst as the convenient symbol of inconvenient innovations. In Britain the main obstruction to scientific humanism is the old enemy of science. No longer the ritual Platonism of the Churches, it is now the secular Platonism of the universities.

Two features of a culture which has its social basis in servile

labour are exemplified by Platonism. Both are hostile to the scientific outlook and both were recognized as such by the pioneers of the English Royal Society, when the foundations of English empirical tradition were established. One is a pernicious belief in the all-sufficiency of formal reasoning unchecked by search for new information. The two Bacons in succession led the revolt against it. Sprat, episcopal author of the first history of the Royal Society, and Joseph Glanville, the contemporary free thinker, who wrote about the hallowed pastime of witch burning, afterwards called it the "notional" or "disputatious" way. The other hallmark of a leisure-class culture is ostentatious insistence upon sheer uselessness. In contradistinction to this conception of gentlemanly erudition Robert Boyle urged that the Invisible College value only "such knowledge as hath a tendency to use."

For topical illustrations of the "disputatious" or "notional" way no comparison between anatomy or astronomy in the mediaeval universities and the teaching of economics in the universities of Britain at the present day could be more damaging than the remarks of Sir William Beveridge in his recent farewell address to the London School of Economics. The futility of contemporary social studies in Britain is directly traceable to the dominant Platonism of the humanistic teaching in the older universities, especially Oxford. A course of Greats (ancient or modern) accompanied by practical exploits in the Union debating society provide the chief method of preparing students for research and teaching in economics and sociology. The results might be anticipated, if only because the research mentality is negatively correlated with great facility in *oral* discourse.

Uncontaminated exaltation of uselessness in its most benign form is best studied among teachers of languages. They are as peace-loving as most of us. They are more alert than the average citizen to the linguistic misunderstandings which armament manufacturers and dictators are swift to exploit. Above all they are in a position to realize how much the furtherance of an enduring world peace is bound up with promoting a world language; and they have the raw materials at their finger-tips.

So we naturally expect to find them foremost in making a constructive contribution to the problem of linguistic minorities. Alas, the truth is far otherwise! To endow human life with *new* powers and inventions, as Bacon defined the goal of naturalistic studies, is not the aim of humanistic teaching in British universities. In Great Britain the only important research undertaken to promote the development of an international language is that of Mr. C. K. Ogden in the Orthological Institute. Like the Royal Institution where Davy and Faraday laboured, it has no connection with a university.

There is still a third way in which the influence of Platonism in English university policy can obstruct the rational recognition of the new constructive powers which science has placed at our disposal. Such an educational reformation must begin with a new outlook on the teaching of science. Science has been introduced for vocational reasons without regard to its social background, its social impact, or its social potentialities. A reformation of this kind could be carried through speedily if the departments of education in our universities were willing to give the lead. In junior positions we have some excellent young men and women with a vision of what education might and should be. A big obstacle to the success of their efforts is the fact that a degree in classical philosophy at a mediaeval university is an almost indispensable preliminary for promotion to professorial responsibility.

The suppositious merit of the humanistic teaching which British universities provide is that it encourages tolerance. When a deep understanding of the social forces moulding contemporary society is needed a broad mind is a high price to pay for an empty head or—what comes to the same in the end—a head filled with no information relevant to the specific peculiarities of our own civilization. This dichotomy between humanistic studies which bask in the enjoyment of a refined uselessness and natural science which endows human life with new powers and inventions is surely a key to the outstanding paradox of modern rationalism. We are witnessing two concurrent pro-

cesses. For the time being confidence in the exercise of man's reasoning powers applied to the manufacture of substitutes, the production of power, the control of diseases and the discovery of new means for communication and transport is growing. Meanwhile confidence in the use of reason for adapting our social institutions to the new task of exploiting new found knowledge for the satisfaction of common human needs is losing ground on all sides. So the kingdom of reason suffereth violence, and the violent take it by force. The apparent growth of rationalism in the domain of external nature may soon be arrested, and even if science and civilization do not perish together in a general conflagration, both will suffer a heavy set-back for years to come.

§ 3

We live in a community in which all branches of natural science are to some extent subsidized by the State. There is no longer any vigorous opposition to the teaching of science from the Christian Churches, and a totalitarian Government which might impose the teaching of a particular biological or other doctrine has not yet established itself in this country. It is more likely that a Totalitarian movement will attain than that the Christian Churches will *regain* the power to restrict scientific enquiry. So we need be far less interested in philosophical differences which separate us from liberal Christians who share similar social views than we might have been fifteen years ago. What concerns us more is how those who share the scientific outlook should meet the challenge of Totalitarianism.

On a long view those who believe that the challenge of Totalitarian movements calls for a united intellectual front "to defend our social heritage" invite defeat. Such makeshifts claim rational assent in so far as we are convinced about two things. One is that there is immediate danger of the rapid spread of Totalitarian doctrines in Britain. The other is that there is much likelihood of early collapse of the dictator cult. The prospect of a protracted conflict of ideologies admits no easy solution. It

calls for candid admission of the shortcomings of a social culture which is not training a personnel competent to give constructive leadership in a democratic society. The present task of rationalism is to take the initiative in exposing the defects of our existing educational system and in providing proper remedies.

Totalitarianism of the German type is in part a response to the hopeless monotony of life in the beehive city of modern industrialism. To that extent reason can offer but one antidote to its allurements. Our task should be to awaken a lively sense of the social possibilities of the new powers which science confers. The real obstacles to freedom of thought to-day are obstacles to the co-ordinated realistic study of social institutions from this standpoint. In Britain those obstacles come chiefly from the humanistic teaching of the universities, where Platonism remains more firmly rooted, because no longer the handmaid of theology. Secular Platonism has a seductive serenity which permits its votaries to believe they are rational when they are merely suspending violent effort. The pleasant aspect which this confers leads persons of all persuasions to seek them as allies in circumstances when quality is less important than quantity.

It is enough that those who attack are united by the common aim of crushing the enemy. Such is the common denominator of rationalism when an established Church has forfeited its capacity to make converts without relinquishing its intention to control education. Allies in defence must be united by the more substantial ties of common loyalty to the institution they are defending. Hence the plea for a united intellectual front to protect liberal culture against the onslaught of a world movement with the fanatical vitality of sixth-century Islam derives no justification from the successful alliance of evolutionists and Oxford Liberals in the struggle against ecclesiastical control of the English universities. A defensive alliance against Fascism can too easily become an undertaking to whitewash the patent defects of a social culture which has ceased to inspire reverence. It becomes a Conservative rally to retain the culture of a privileged class with the defects inherent in a culture based on social privilege. It thus surrenders

the divine fire of rebellion to the perpetual custody of its opponents.

The Mediterranean civilization is on its death-bed. A vigorous rationalism prescribes Caesarian section. Genteel bulletins announcing that the patient is progressing favourably will not diminish the sales of fake medicines. In Britain the time has passed when men can be profitably united by the common tie of mere scepticism. The challenge of Fascism must be answered by a creed as positive as Fascism itself. There may yet be time to salvage what is best in European culture, as we know it, if we ourselves take the initiative of proclaiming our own shortcomings, the shoddiness of much we have inherited from the slave civilizations of the Mediterranean world, and the need for a great educational reformation to prepare man for the new Age of Plenty which lies at hand. This must be the *positive* minimum of a united front to meet the challenge of Fascism.

5

Sir William Petty and Political Arithmetic[1]

> It was by him stiled Political Arithmetick in as much as things of Government . . . and the happiness and greatness of the People are by the Ordinary Rules of Arithmetick brought into a sort of Demonstration. He was allowed by all to be the Inventor of this method of instruction, where the perplexed and intricate ways of the World are explaned by a very mean science; and had not the Doctrines of this Essay offended France, they had . . . found followers as well as improvements before this time to the advantage perhaps of mankind . . .—Shelborne's Preface to Petty's *Politicall Arithmitick*, 1691.

THE STUDY OF population is the only branch of social research with its own logical technique for the detection and co-ordination of factual data. This is not surprising when we recall the circumstances of its origin. The men who brought it into being were actively associated with the group which laid the foundations of the British empirical tradition of naturalistic enquiry. Some little-known information about the three founders of British demography—Graunt, Petty, and Halley—is given in a recent memoir by Dr. Kuczynski. The social context which brought them together is a theme worthy of more comment.

The names of all three are found in the original list of Fellows of the Royal Society when it received its charter in 1662. The "ingenious author of the *Bills of Mortality*" referred to in Sprat's History was of course John Graunt, the first writer on vital statistics. The first life table—that of Halley—was published in the *Philosophical Transactions* of 1693. Halley's position in the

[1] From *Political Arithmetic* (London: George Allen & Unwin).

world of natural science is made memorable by the comet which bears his name. The presence of Graunt and of Petty, author of the *Politicall Arithmitick*, demand an explanation. Especially is this true of Petty. Petty is sometimes claimed as an economist. The association of economics with science jars harshly on the modern ear.

The issue of the Lansdowne Collection of unpublished fragments (1927) has thrown new light on the intellectual outlook of Petty. "By turns cabin boy, hawker of sham jewellery, seaman, inventor, physician, Fellow and Vice-Principal of Brasenose, Professor of Anatomy at Oxford, and of Music at Gresham College, Surveyor, Member of Parliament, landed proprietor, philosopher, statistician and political economist," the author of the *Politicall Arithmitick* was in short *a man of affairs*. What is less known about him is that some of the earliest meetings, perhaps the first, of the "Invisible College" met in Petty's rooms at Oxford.[1] Besides Boyle and Petty, the group so called included Christopher Wren, Bishop Wilkins, Seth Ward the astronomer, and later Hooke. It was the parent body of the Royal Society, and Petty justly ranks with "the father of chemistry and the cousin of the Earl of Cork" as one of its co-founders.

Two circumstances conspired to encourage fruitful collaboration between men who, like Graunt and Petty, were pioneers of realistic social enquiry with men who, like Hooke and Newton, made Britain supreme in the domain of natural science. In the *Century of Inventions*[2] leaders of theoretical science were in close touch with inventors, sea captains, surveyors, and architects. They were acutely interested in the material forces propitious to the

[1] It would appear that the earliest meetings were in Petty's rather than in Boyle's rooms. In the introduction to their new edition of the Hooke Diaries, Robinson and Adams state: "They held a weekly meeting 'first at Dr. Petty's (in an apothecaries house) because of the convenience of inspecting drugs, and the like, as there was occasion; and after his removal to Ireland (though not so constantly), at the lodgings of Dr. Wilkins . . . and after his removal to Trinity College, Cambridge, at the lodgings of the Honourable Mr. Robert Boyle.' "

[2] Deliberate metalepsis. The Marquis of Worcester's title refers to the actual number listed.

advancement of scientific knowledge or otherwise. They were equally alive to the ideological obstacles which hindered the progress of discovery. In active revolt against the scholastic tradition of the universities the Invisible College had begun its informal sessions within a decade of the death of Galileo. Less than half a century had elapsed since the Parliament of Paris—so Voltaire tells us—enacted a law by which the chemists of the Sorbonne must conform to the teachings of Aristotle on pain of death and confiscation of goods. Shortly after Newton's death Voltaire wrote that Descartes "quitta la France parce qu'il cherchait la verité qu'était persecutée alors par *la misérable philosophie de l'école.*' Newton "a vécu honoré de ses compatriotes et a été enterré comme un roi qui aurait fait du bien a ses sujets . . . heureux et honoré dans sa patrie. Son grand bonheur a été non seulement d'être né dans un pays libre mais dans un temps où *les impertinences scolastiques* étant bannies la raison seule était cultivée."

Close association of scientific theory and social practice is a feature of the "adventurous hopefulness" of early English capitalism, sufficiently documented by Hessen in his essay on the *Economic Roots of Newton's Principia*, in Professor G. N. Clark's recent lectures, and in the Preface of the new volume of Hooke's Diaries edited by Robinson and Adam. The founders of the Invisible College were among the earliest apostles of the social creed of nineteenth-century capitalism. In his own words, Boyle's gospel was that "the goods of mankind may be much increased by the naturalist's insight into the trades." In a letter to a friend named Marcombes he says:

> The other humane studies I apply myself to are natural philosophy, the mechanics and husbandry, according to the principles of our new philosophical colledge that values no knowledge but *as it hath a tendency to use.* And therefore I shall make it one of our suits to you that you should take the pains to enquire a little more thoroughly into the ways of husbandry . . . which will make you extremely welcome to our invisible colledge.

In tracing the origins of the Invisible College during the years

which immediately preceded the first revolution of Stuart times, Sprat remarks:

> I shall only mention one great man who had the true imagination of the whole Extent of this Enterprise as it is now set on foot, and that is the Lord Bacon in whose books there are everywhere scattered the best arguments that can be produced for the Defence of experimental philosophy, and the best Directions that are needful to promote it.

Bacon's defence of experimental philosophy is now a well-thumbed brief. One of his directions to promote it is forgotten, though "adorned with so much art" as Sprat appraised. It would be hard to find a better statement of what Hessen calls the unity of theory and practice than the passage which opens with the following words in the *Novum Organum*:

> The roads to human power and to human knowledge lie close together, and are nearly the same; nevertheless, on account of the pernicious and inveterate habit of dwelling on abstractions, it is safer to begin and raise the sciences from those foundations which have relation to practice and let the active part be as the seal which prints and determines the contemplative counterpart.

In this spirit the Royal Society began its labours.

> They design [Sprat tells us] the multiplying and beautifying of the mechanick arts. . . . They intend the perfection of graving, statuary, limning, coining and all the works of smiths in iron or steel or silver. . . . They purpose the trial of all manner of operations by Fire. . . . They resolve to restore, to enlarge, to examine Physick. . . . They have bestowed much consideration on the propagation of Fruits and trees. . . . They have principally consulted the Advancement of Navigation. . . . They have employed much Time in examining the Fabrick of Ships, the forms of their sails, the shapes of their keels, the sorts of Timber, the planting of Fir, the bettering of pitch and Tar and Tackling.

The design included a conspectus of all the principal technological problems which affected British mercantile supremacy and the theoretical issue relevant to their solution. Of all these "histories" the most illuminating compilation is the *Heads of Enquiries* into the state of British Agriculture. Twenty-six major questionnaires were printed that they might be "the more universally known" and that persons skilful in husbandry might be "publickly invited to impart their knowledge herein for the common benefit of the country." The topics included "the several kinds of the soyls of England (sandy, gravelly, stony, clayie, chalky, light mould, healthy, marish, boggy, fenny or cold weeping ground)," when each was "employed for arable"; "what peculiar preparations are made use of to these soyls for each kind of grain, with what kind of manure they are prepared; when, how and in what quantity the manure is laid on"; "what kinds of ploughs are used"; "the kinds of grain or seed usual in England"; "how each of these is prepared for sowing," "there being many sorts of wheat . . . and so of oats . . . which of these grow in your country and in what soyl, and which of them thrive best there . . ."; "how they differ in goodness"; "what kinds of grain are most proper to succeed there"; "some of the common accidents and diseases befalling corn in the growth of it, being blasting, mildew, smut, what are conceived to be the causes thereof and what the remedies"; "annoyances the growing corn is subjected to, as weeds, worms, flies, birds, mice, moles, etc., how they are remedied"; "waies of preserving the several sorts of grain"; "how the above-mentioned sorts of soyl are prepared when they are used for Pasture or Meadow"; "the common annoyances of these pasture and meadow grounds."

Such are samples of the questions. The replies to them were placed after discussion in the archives from which they have been lately rescued by Lennard, who analyses them in an article in the *Economic History Review* (iv, 1932). Here deliberately and systematically organized science takes stock of the common experience of mankind to formulate problems for which precise

solutions are now available. Truly "a brave attempt to link up book learning and scientific research with the experience of practical farmers" as Lennard says. We may go further and say that it is the first comprehensive vision of a rationally planned ecology of mankind.

The direct affiliations of the Invisible College with sociological inquiries are less well known. Sprat gives an eloquent list of the "qualities which they have principally required in those whom they admitted." First he insists on freedom for different schools of religion or philosophical persuasion. "This they were obliged to do or else they would come far short of the largeness of their own declarations. For they openly profess not to lay the Foundation of an English, Scotch, Irish, Popish or Protestant philosophy, but a philosophy of mankind." Nationality was to be no barrier. "By this means they will be able to settle a constant intelligence throughout all civil nations and make the Royal Society the general bank and free port of the world." The third and most significant for our present theme was "the equal balance of all professions." Seeing that "so much is to be found in men of all conditions of that which is called pedantry in scholars," they were to take care lest "Mechanicks alone were to make a philosophy . . . and force it wholly to consist of springs and wheels and weights."

To be sure there were "some Arts on which they have no mind to intrench as the Politicks, Morality, and Oratory . . . because the reason, the Understanding, the tempers, the Will, the Passions of Men are so hard to be reduced to any certain observations of the senses and afford so much room to the observers to falsify or counterfeit." This omission was to be transitional. "Man's soul and body . . . are one natural engine of whose motions of all sorts there may be as certain an account given as those of a watch and a clock." Later on "when they shall have made more progress in material things they will be in a condition of pronouncing more boldly on them too." Where the facts were accessible to the senses there was to be no barrier to common intercourse between the natural and social sciences. "That they are likely to

continue this comprehensive Temper hereafter, I will shew by one instance, and it is the Recommendation which the King himself was pleased to make of the judicious author of the *Observations on the Bills of Mortality*, in whose election it was far from being a prejudice that he was a shopkeeper of London. . . . His Majesty gave his particular charge to his Society, that if they find any more such Tradesmen they should be sure to admit them all without any more ado."

Of the ideological milieu in which men like Graunt or Petty rubbed shoulders with Newton and Boyle, Flamsteed and Hooke, Sprat has much to say. There was then what there is not to-day, and perhaps has never since been in the history of English social culture. Copernicus had made a common platform for students of nature and society by showing that you cannot build a science on the shifting sands of self-evident principles. Sprat spoke for Graunt when he contrasted the Baconian method with that of their predecessors who

> began with some general definition of the things themselves according to their universal natures. . . . But though this notional war had been carried on with far more care and calmness amongst them than it was: yet it was never able to do any great good towards the enlargement of knowledge, because it relied on general terms which had not much foundation in knowledge. That this insisting altogether on established axioms is not the most useful way is not only clear in any such conceptions which they managed but also in those things which lie before every man's observation. . . . To make a prudent man in the affairs of state there must be a sagacity of judgment in particular things, a dexterity in discerning the advantages of occasion, a study of the humour and interests of the people. . . . The very way of disputing itself and inferring one thing from another alone is not at all proper for the spreading of knowledge. . . . For if but one link in the whole chain be loose, they wander far away and seldom or never recover their first ground again. It may easily be proved that those very themes on which they built their most subtile webs were not all collected by a sufficient information from the things themselves, which if it can be made out, I hope

it will be granted that the Force and Vigour of their wit did more hurt than good.

In England the scholastic tradition of the universities was sufficiently strong to frustrate the rapprochement which Petty favoured. How strong it still is may be judged by contrasting Sprat's remarks with the following citation from a recent book ostensibly composed to divulge *The Nature and Significance of Economic Science*. In it Professor Robbins writes:

> It will be convenient, therefore, at the outset of our investigations if, instead of attempting to derive the nature of economic generalizations from the pure categories of our subject-matter, we commence by examining a typical specimen. It is a well-known generalization of elementary Price Theory that, in a free market, intervention by some outside body to fix a price below the market price will lead to an excess of demand over supply. . . . Upon what foundations does it rest? . . . It should not be necessary to spend much time showing that it cannot rest on any appeal to History. . . . It is equally clear that our belief does not rest upon the results of controlled experiment. . . . In the last analysis, therefore, our proposition rests upon deductions which are implicit in our initial definition of the subject-matter of Economic Science (p. 72).

Lest it might be thought that this is an isolated passage wrested from its context, a further quotation states that "the truth of a particular theory is a matter of logical derivation from the general assumptions of the subject" (p. 106).

The author of the *Politicall Arithmitick* had anticipated a proper remedy for this notional warfare and "*les impertinences scolastiques*" by prescribing the education for a man prudent in the affairs of state.

> Hindrance [he says] of the advancement of learning hath beene because thought, theory, and practice, hath beene always divided in severall persons; because the ways of learning are too tedious for them to be joyned. And whereas all writings ought to be descriptions of things, they are now onely of words, books know

little of things, and the practicall men have not language nor method enough to describe [them] by words.

To remedy this he proposes "a supellex Philosophica worth 500£. Let the Studients of the Schoole," he says,

> have Languages, exercises and Draught, with a competency of Arithmetic, Algebra, Geometry, Geography and Chronology. Of motions and Mechanics. Of sounds, echoes, and Musick. Of Opticks, visions, and scenes. Of Magneticks. Of ships and sailing. Of Howsing. Of Land carriages. Of Pumps. Of Mills. Of Clocks and Clepsydras. Of Guns, Powder, and fireworks. Hydrostatics. Colorations. Figurations. Cloath, Leather, Hats, paper. Spining, Kniting, weaving. Meteors and Tides. Astronomy and Dialls. Ayre, fier, water. Ballisticks. Analysis of the People. Principall salts. Chymicall operations. Metalls, Quick silver. Glass and Gems. Fabrick of Animalls. Synopsis of Diseases. Botanicks. Georgicks. Insects. Bees, spiders, and silkworms. To expound the Museum of Gresham Colledge. To be performed in an yeare of 40 weekes. Each week to consist of 5 dayes, and each day of 3 howers. In all 600 howers. Let the Collegium consist of 20, under 3 masters, at 20£ per head. The Council of the Royall Society to bee Sponsores.

He suggests separate curricula for the education suitable to a man of affairs, a fop, and a courtier. For the first he recommends thirteen disciplines:

> Latine, French, etc. To write any hand. Printing and designing. Fencing and gymnastics. Singing at sight. Geometry, Arithmetic and Algebra. Anatomy and Chirugery. History of Trades. Cookery and Pharmacy. [Ars Veneris] Jugling and Legerdemain. Physicall secrets, receipts and experiments. Optics, Magnetics, Jewelling.

For the fop he recommends only:

> Dancing and Vaulting. To understand a horse and riding. To Play at severall games. The Art of Treating and dressing. The small moralls. Histrionic. Hunting and Hawking.

The reader will recognize which of these alternatives corresponds most closely to the intellectual preparation esteemed proper for a twentieth-century economist.

Petty's educational interests ranged over a wide field. He believed in teaching algebra as a branch of grammar. A delightful letter in which he discusses what algebra is might well be reproduced in every elementary text-book without excluding the quaint conclusion:

> Archimedes had Algebra 1,900 years ago but concealed it. Diophantus had it in great perfection 1,400 years since. Vieta, DesCartes, Roberval, Harriot, Pell, Outread, van Schoten and Dr. Wallis, have done much in this last age. It came out of Arabia by the Moores into Spaine and from thence hither, and W[illiam] P[etty] hath applyed it to other than purely mathematicall matters, viz. to policy by the name of *Politicall Arithmitick*, by reducing many termes of matter to termes of number, weight, and measure, in order to be handled Mathematically.

Part of his programme for educational reform anticipated Bentham and C. K. Ogden. There is a project (No. 46, op. cit.) for "The Dictionary of Sensible Words" setting forth "what words have the same meaning, what words have many meanings . . ." and "words which by having too many meanings have none." Whereto he appends *inter alia* God, gentleman, beauty, courage, martyr, and duty. We can well imagine the following excerpt from a modernized edition: ECONOMIST (*a*) American *see* AFFAIRS (man of), (*b*) English *see* METAPHYSICIAN (British).

The Lansdowne Collection contains several fragments of a prolegomena to social biology. Petty proposes a *scala naturae* and discusses wherein man differs from and resembles other brutes from a strictly behaviourist standpoint:

> Man being the first or Topp of this Scale, the question is what Animall shall bee next. . . . In the Opinion of most men, the Ape or rather the Drill (which is the largest and most manlike species of Apes) should claim the 2d. place unto which we have

preferred the Elephant, 1st because his shape is far neerer to that of Man than any other Animall's is, and for that his Actions as they have been reported by those who pretend to know them do in many points resemble those of a Man. Nevertheless [since] it be true that an Elephant can understand the language better then a Drill, and that the *Mens* of an Elephant doth come neerer the *Mens* of a man, although the shape of a Drill comes neerer the shape of a man, I shall choose (as I have done) to give preference unto the Elephant. Speech is more peculiar unto, and copious in a Man than in any other Animall, and consequently wee might in that respect give the 2d. place to Parrots, or that species of them in which the formation of Articular sounds and the imitation of Man's Speech is most conspicuous. Nor is an Ape so considerable to mee for imitating the externall and visible motions of the parts and Organs of a Man, as speaking Birds are for imitating, by a sort of reason and internall sence, the motion of the hidden and unseen instruments of speech, which are the Muscelle of the Lungs and Larynx. But it is plain that although Parrotts do pronounce words, that they do it but as sounds, and not like men, as the signs of things, Actions and Notions; and consequently this faculty of speaking birds extending onely to sounds and not to the Conceptions of the Mind. . . . Haveing admitted the Parrott to a right or Competition, I will not exclude the Bee, referring you to what Virgil and many observant Men have seriously and experimentally, not vainly or fabulously, spoaken of them; and among all the admirable operations of the Bee, I preferr his pollicy, assigning that faculty for the thing wherein hee comes neerest to Man. And pollicy or the Art of Government seems to bee the most considerable faculty of a Man.

Having reflected on the differentiae of the human species, he forestalls the exploits of Malthus in the significant assertion:

A man doth differ from all other animals in use of the female, and generation. By using the same without designe or desire of generation, and when generation is needless or impossible. In making such rules and lawes concerning the same, as no other animall doth; and all this while making all the acts and instruments thereof ridiculous, shamefulle and filthy, so as not to bee seen or

spoken of in the company and presence of [others without?] laughter.

Most remarkable of all the fragments are proposals for sex reform in Nos. 91 to 94 in the Lansdowne Collection. These include polygamy and family allowances. An elaborate exercise in *Politicall Arithmitick* is appended to the proposal that

> 50s. per annum bee allowd for keeping a child till full 7 yeares old, and 20s. for a woman lying in, to the publicq places or to each woman herselfe in particular. That at 7 yeares old the children bee disposed for 14 yeares after, and bee then free, having been taught some Trade. That every man and woman have a livelyhood *ut alibi*. That a woman is not bound to declare the father, but to the officer who was privy to the contract and *habet sub sigillo*. That this liberty for short marriages do not take away the present way, nor other covenants of cohabitation, estate, rewards, etc. That both parties shall sweare they [are] free from any fowle disease.

In a different context (Nos. 119, 120) he applies the *Politicall Arithmitick* to the simple machines: "By a common Pump a man can raise 32 gallons 30 (feet) high in a minute, or 8 tons in an hour." In short, Petty was a pioneer of Social Technology. He anticipated the only rational basis for costing the resources of human welfare in his papers on Taxation:

> Our Silver and Gold we call by several names, as in England by pounds, shillings, and pence, all of which may be called and understood by either of the three. But that which I would say upon this matter is, that all things ought to be valued by two natural Denominations, which is Land and Labour; that is, we ought to say, a Ship or garment is worth such a measure of Land, with such another measure of Labour; forasmuch as both Ships and Garments were the creatures of Lands and mens Labours thereupon.

Needless to say, Petty had his comic side. You cannot make spiritual omelets without breaking metaphysical eggs. Like Hooke and Boyle he had the knack of proffering his most radical

proposals within the framework of the prevailing ideology. He was scarcely in advance of his time in advocating "simple death" as a penalty for bankrupts and bedlam for "scepticall hereticks." In fairness, it may be added that a mark of interrogation was placed against the last. His views on religious and sexual freedom display the same devotion to business principles. Polyandry was permissible provided that "none copulate without a covenant." Polyandry without covenant was to be punished with death. For polygamy without covenant he proposed death expedited by gonadectomy without anaesthesia.[1] Heresy was permissible provided that a business contract preceded it and due notice of fresh deviations from theological rectitude was given:

> That the Persons desiring liberty must put themselves into tribes or Classes, by exact declaration, wherein they respectively differ in doctrine or worship from the State Religion; with a protestation that they beleive the said doctrine and worship necessary to the quiet of their Conscience here, and their Eternall Welfare after Death. . . . Upon all which there must bee a mutuall assurance, that such Liberty and Indulgence shall bee perpetuall, or not alterable but upon cleere conditions and long warning.

§ 2

Before the publication of the Lansdowne Collection we had known of Petty as a pioneer and as a man of affairs. We now see him in a new light. The tireless versatility and consuming curiosity of men like William Petty and Robert Hooke can only prosper when social circumstances sustain high hopes in those whose brains have not been addled by a cloistered sophistication. If Petty is justly claimed as the father of Political Economy, the character and interests of no man could differ more conspicuously from those of a university professor of economics. He had the first desideratum of a genuine man of science—the itch to discover things for himself. He could hunt for them in unexpected places. Valuing above all knowledge "as it hath a tendency to use" he

[1] Vide No. 146, Lansdowne Collection.

made no bones about admitting when he wanted to get something done. An impartial contemporary comparing the *Politicall Arithmitick* with the *Sceptical Chymist* might have been at pains to forecast whether the progress of chemistry would justify the comparison which Jeremy Bentham made a century later. Referring to Lavoisier's discoveries and the state of social enquiries Bentham exclaims, "Think of what chemistry was before that time—think of what it has since become!"

The training of an English economist makes no provision for studying the "history of trades, receipts and experiments, pharmacy and jewelling." So it will not be profitless to pursue Bentham's counsel. Between the work of Boyle and that of Lavoisier the course of chemistry did not run smooth. The reason why the *Sceptical Chymist* signalizes the dichotomy between modern chemistry and alchemy is that the air pump of "the immortal Mr. Boyle" had proved beyond dispute the existence of the third state of matter. Aristotle's self-evident doctrine that air is weightless had been conclusively disproved. The spirits of the retort were for the first time recognized as matter in an attenuated form, compressible—as Boyle had shown—according to ascertainable laws. The new laws of gas mechanics were established by the ungentlemanly process of manual experimentation without assistance from the original definitions of the subject. After nineteen centuries of Aristotelian futilities the common pump had come into its own. The doctrines which Aristotle had exercised the full powers of his ingenuity to discredit had been spread abroad by Gassendi's commentaries on Epicurus. Hooke's experiments on gunpowder and Mayow's work on breathing had set the stage for a correct understanding of combustion and oxidation. It seemed as if the world of science was ready for the recognition that matter, contrary to self-evident principles, is not continuous.

Seemingly every obstacle to useful knowledge about the most ancient of chemical industries had been removed. It was now known that metals gain weight when heated in air to form a *calx* (metallic oxide). A straightforward explanation of this fact is that they combine like charcoal or sulphur with Hooke's nitro-aerial

particles of the air itself. "The atoms of Democritus and Newton's particles of light" as Blake sung of them later were destined for tardy recognition. While the English empirical school were making the discoveries indispensable to fruitful definitions and salutary principles, Teutonic sophistication had anticipated Professor Hayek's belief that principles must be settled before realistic enquiry can be undertaken with impunity.[1] A school of Continental chemists staked the claim for preserving the purity of their subject from contamination with the new theoretical principles derived from the study of heat in the first phase of steam technology by fabricating a doctrine of elegant ingenuity. This last attempt to sustain the elemental nature of fire in Aristotle's system provides an instructive model. The argument runs as follows. It is self-evident that if things burn, they must contain the fire principle. A combustible substance is therefore a compound of a *calx* or non-combustible material with the fire principle *phlogiston*. Since the escape of phlogiston, when a combustible substance burns or a metal is oxidized, is accompanied by production of non-combustible material which actually weighs more than its predecessor, it is equally self-evident that phlogiston is endowed with the opposite of weight, i.e. *levity* or the power to make a body weigh less.

The social circumstances of the time provided matters too weighty to sustain the "levity" of Becher and Stahl. From the middle of the eighteenth to the first decades of the nineteenth century a succession of chemical industries were founded to meet the exhaustion of fuel supplies. Commercial production of sulphuric acid (1740) followed by Keir's alkali factory (1780), hydrogen balloons in the same decade, Murdoch's coal gas, bleaching powder, beet sugar, and phosphorus matches—all these preceded the revival of a robust materialism in England. The new theoretical leadership demanded by the circumstances of the time was supplied by such as Dalton, Davy, Faraday, who were largely recruited from a new fund of social personnel while the echoes of the phlogiston doctrine still reverberated in the established

[1] *Economica*, 1937.

universities. It now provides the comic relief of an early stage in the teaching of chemistry. When political arithmetic is as firmly rooted as chemistry in the social needs of mankind, marginal utility will have joined the same limbo with *entelechy* and the *caloric*.

In a printed lecture which will not have come before the notice of most who read this essay I have suggested that we might explore other differences between chemistry and social enquiries before we advance an answer to these questions. In it I have enumerated three characteristics which cannot fail to impress a student of natural science when he is brought into professional contact with the conduct of social studies in English universities. Following the *Novum Organum*, I have called two of them the Idol of Logic and the Idol of Purity.

The story of phlogiston reminds us that chemistry occupies its present position of prestige and power because it has learned the hard lesson that logic which may be a good servant is always a bad master. In their turn each of the natural sciences has had to learn the same lesson which Bacon stated in immortal phraseology: "It cannot be that axioms established by argumentation can suffice for the discovery of new works since the subtlety of nature is greater many times over than the subtlety of argument." Bacon was referring to external nature. His words are still more true of human nature and the institutions which arise from its peculiarities. Citations already given from the works of a contemporary economist sufficiently show how little the new humanistic studies have renounced the idolatry of logic. The theologians of the Sorbonne confined their speculation within the legal conventions of Aristotle's logic. Economic theory with more specious pretensions reverts to the Number Magic of the Pythagorean brotherhoods. The following is a representative specimen from a book by Dr. Hicks:[1]

> If now the employer's concession curve cuts the resistance curve on the horizontal part, the union will generally succeed in

[1] *Theory of Wages.*

> maintaining its claim; but if it cuts it at a lower point, compromise will be necessary and it is over such compromises that misunderstanding and strikes easily arise.

Readers who lack intellectual self-confidence may be trapped into believing that such exercises in draughtsmanship displayed in books on economics record the results of real measurements, as do curves in books on physics or biology. In contradistinction to realistic enquiries on how trade unions actually behave, economics is therefore inferred to be an "exact" science. The epithet is not a happy one. All genuine science is as exact as needs be for the tasks it undertakes and as exact as it can be with the instruments at its disposal. It is equally concerned with the qualitative and quantitative characteristics of behaviour, and all new sciences must traverse a wide territory of natural history before useful measurements can be made or fruitful hypotheses based on them can be tested. The relevant issue is whether the curves of the economists correspond to any measurements which have been made by them. An employer's concession "curve" is not a graph in which a set of co-ordinates lay off the measured concessions which employers can or do make. A "curve" of trade union resistance is not a graph in which a set of co-ordinates correspond to observations of the behaviour of trade unionists or their executives.

To see what relation this has to the methods of scientific inquiry it is only necessary to recall a "concession" curve or the resistance curve for a piece of wire. A curve which tells us how much a wire spring concedes to the load applied exhibits a series of points each based on the mean of careful measurements of the observed length of a particular spring when an observed load of guaranteed weight is suspended from it. A curve which tells us the relation of resistance to heat exhibits a series of points each based on a Wheatstone bridge observation of the conductivity of a real piece of metal and a reading obtained from a reliable and tangible thermometer. The corresponding measurements of the employers' concession and the trade union resistance curves exist in the brain

of Dr. Hicks. Since he does not suggest any substitute for the thermometer, balance, Wheatstone bridge, or micrometer scale, his ingenious artistry lacks the merit of a speculative hypothesis for more enterprising investigators to test. True science is *par excellence* such knowledge *as hath a tendency to use*. A scientific law embodies a recipe for doing something, and its final validification rests in the domain of action.

The immense confidence which certain scientific generalizations rightly command depends on a large-scale opportunities for testing their capacity to bear fruit in the commonplace activities of everyday life. Speculative extrapolations concerning the age of the universe change from day to day as astronomical knowledge advances, and we should be justified in treating astronomers with the same suspicion as politicians if the credentials of astronomy had no firmer basis. Our reliance on astronomy is justified by the fact that it provides the farmer with a calendar of the seasons, the fisherman with a table of tides, the statesman with a map, the Union Castle Line with the means of navigating a ship into port, and the Minister of Transport with fines from motorists who fail to light up after civil twilight ends. The only valid distinction between pure and applied research in natural science lies between enquiries concerned with issues which *may eventually* and issues which *already do* arise in the social practice of mankind. Consequently the pure scientist knows that he has everything to gain from encouragement of applied research, and if the last survivors of Darwin's generation still murmur doubts about Mendelism, the experimental geneticist goes on his way serenely confident that the *Feathered World* will continue to advertise day-old sex-linked chicks, or that rabbit furriers now know how to make pure lilac from blue beveren–chocolate havana crosses, and how to fix "Rex" on any colour pattern in two generations.

In science the final arbiter of truth is not the self-evidence of the initial statement nor the façade of flawless logic which conceals it. A subject which admits to the dignity of law statements based on logical manipulations of verbal assertions is not a science. What then is it? The newest apology of the Viennese school is

that economics, as Professor Robbins conceives it, does not claim to be a science. It is a logical technique which stands in much the same relation to realistic social studies as does Newtonian mechanics to experimental physics. It may be hoped that those who advance the analogy have examined how the principles of dynamics emerged from problems suggested by the introduction of artillery warfare and the technology of clock-making in an age when the determination of longitude at sea was a pivotal issue in maritime undertakings. Science does not settle its technique of discourse in isolation from the process of discovery. Men did not invent the calculus and then proceed to investigate the laws of motion. They discovered the need for a new logical technique in the process of discovering the laws of motion, and declared that the pre-existing logic was faulty in the teeth of derision from official logicians such as Berkeley.

Need we say more, if we but recall the historic reflection of Newton, prince of scientific logicians. Newton's first correct calculations of the earth's gravitational pull on the moon remained buried for a decade or more, because of what seemed to be a 10 per cent error due to a faulty figure for the moon's earth-distance as then recorded. *Hypothesis non fingo* was the epitaph with which they were laid aside. Whether the suggested similarity between mechanics and economics is pertinent is a matter susceptible to historical examination. This is somewhat unfortunate, because one of the axioms of the London and Vienna school is that history cannot teach them. Since history does not repeat itself, history (they say) cannot become a science. Accordingly (we presume) palaeontology is not a science, nor is petrology. Need we even stop with physics, in which, as Professor Levy reminds us, no experiment is ever repeated in *exactly* the same way?

We might have hoped that the substantial scholarship and English empirical common sense of the Webbs would have produced a more healthy attitude to social research. If the Webbs ever flattered themselves that they would find a following in the universities, they failed to reckon with the Idol of Purity. The special province of the Idol of Purity is to protect its worshippers

against dangerous thoughts. Chemists want to make new compounds and to discover new elements. If those who pursue the social sciences really wanted to make new institutions and discover new modes of social living, the social sciences might advance with equal rapidity. The plain truth is that the academic value of social research in our universities is largely rated on a futility scale. A social inquiry which leads to the conclusion that something has to be done or might be done is said to be "tendencious." In daily hymns to the Idol of Purity this refrain recurs with soporific solemnity like *selah* in the Psalms of David. If natural scientists prohibited all investigations when the research worker was suspected of wanting to find how to do something, science would come to a standstill.

Besides ensuring innocuous aimlessness when social enquiries make contact with the real world, the Idol of Purity prescribes a gentlemanly understanding that every discipline in the university curriculum is sufficient in its own right. Political science, economics, and sociology are entitled to arrive at incompatible conclusions so long as each refrains from examining the credentials of the others. During the evolutionary controversy biologists did not take this view of professional ethics. There were giants in those days. In natural science the greatest advances often occur in the region where two traditional disciplines overlap. No chemist is now anxious to tell you that what he is doing is too pure to have any connection with physics. The crippling effect of the Continental phlogiston doctrine, at a time when English physicists had set the stage for great theoretical developments, has taught the student of natural science that he cannot afford to circumscribe the boundaries of his enquiries in advance.

It is therefore difficult for a naturalist to understand why Professor Robbins is so anxious to convince us that Austrian economics, which, if a science, is presumably concerned with aspects of human behaviour, has nothing to do with psychology, which, if a science, is also concerned with characteristics of human behaviour. The urgency with which he defends the purity of his subject from contamination with empirical studies is perhaps

explained by his pre-Baconian conviction (p. 132) that "the relation of pork to human impulses . . . is verifiable by introspection." Genuine scientific knowledge of the biological basis of human nature, and the search for the laws which condition social habits and social preferences, are perforce dismissed with the assertion that in choosing between alternative systems of society "only a complete awareness of the implications of modern economic analysis can confer the capacity to judge rationally" (p. 139). If economists displayed a more becoming modesty towards their own intellectual limitations, it would be harsh to add that a rational judgment on the choice of social organization would demand considerably more knowledge of electricity, biochemistry, and genetics than writers on economics usually possess.

The fruitful association of social and naturalistic enquiries in the programme of the Invisible College was possible because Petty and others like him realized that what is a "weighty matter" is also a social question. Speaking of the origins of its successor, Sprat says "and from this Institution and Assembly it had been enough if no other advantage had come but this, that by this means there was a race of young men provided against the next age." If the present teaching of the new humanistic studies in our universities falls short of this, we need not seek the remedy afar. The exaltation of "pure" thought which bears no fruit in action exacts its own penalty in the growing disposition to regard reason and progress as exploded liberal superstitions. The younger generation have found out their teachers. A pitiable predilection for action without thought is the legitimate offspring of thought divorced from action.

§ 3

There are two ways in which scientific principles can be applied to social practice. One, the condition of expanding knowledge is to discover the ways and means of getting something done. This was Boyle's way, when he declared that the "goods of

mankind may be much increased by the naturalist's insight into the trades." The other, the signal of decadence, is to devise ingenious arguments for not doing something. This was the way of Malthus, whose essay was written to discredit Condorcet's belief that war, poverty, and disease are eradicable nuisances. Biology furnishes us with examples of both ways of using scientific theories. The *Heads of Enquiries* of the Royal Society in its early days, the present *Medical Research Council*, and Sir John Orr's studies on malnutrition illustrate the first. The *Rassenhygiene* of Dr. Frick and his professional hirelings in Hitler Germany illustrate the second. *Rassenhygiene* is the offspring of the crude selectionism whose first parent was Malthus.

It is symptomatic of the temper of social studies that the phlogistonist of demography is far better known than Petty or Graunt, both of whom made enduring contributions to the science of human welfare. The Essay on Population is a fitting footnote on the Baconian theme that "radical errors in the first concoction of the mind are not to be cured by the excellence of functions and remedies subsequent." The Malthusian argument, as we all know, was based on a self-evident principle inherent in the original definitions of human ingenuity and parenthood. For these he anticipated the contents of the Rhind papyrus in which the scribe Ahmes—seemingly prompted by the reflection that slaves fill a granary slowly and mice multiply rapidly—gives one of the earliest recorded examples of arithmetical and geometrical progressions. Intervening advances in technology and biology did not suggest to Malthus the need for clarifying either the limits of human ingenuity (a matter of thermodynamics) or the limits of human reproductive capacity (a matter of social physiology).

His views about the former were based on implicit assumptions which still obtrude themselves in the teaching of economics. Lacking the imaginative insight of the men who drew up the *Heads of Enquiries*, he was unable to foresee the possibility that biotechnology could make land a secondary asset of food production. His estimates of potential reproductive capacity were based on an adventitious remark of Benjamin Franklin. This we

now know was certainly wrong. From the first to last page of his apology of misery there is no single constructive suggestion for research nor hint of the scientific curiosity which we find in the pages of Graunt and Petty. Further attention to the substance of the Malthusian apology is unprofitable. In the second edition Malthus introduced a host of qualifications and negations to meet the criticisms which greeted the first. So most of his statements can be offset with others in the contrary sense, and when his disciples fall back from this line of defence they can reinforce their faith by the assurance that Malthus was less concerned to demonstrate fact than to disclose a "tendency." If the word *tendency* has any use in genuine science, it is to describe something that can be made to happen by isolating the appropriate situation. Apparently the disciples of Malthus think that what Malthus described would happen if they did not practise what Malthus presumably scheduled as "vice." The evidence marshalled by Carr Saunders leads one to doubt whether a situation described by the arithmetical jingle of the gloomy parson has any basis in recorded experience of human societies.

As phlogistonism failed to meet the social needs dictated by expanding chemical industry, current events are now compelling us to take up the problems of political arithmetic where Petty left them. Contrary to everything Malthus taught, productivity has increased beyond the most optimistic forecast of Robert Owen, while the rate of reproduction in all highly industrialized countries of the West has steadily declined. Since the rate of reproduction has sunk below the limit compatible with continued survival in many countries, the problem of how to arrest further decline has become, as Shelborne would say, "a matter of government and the greatness of the people."

As soon as you ask yourself *what would have to be done* to increase, diminish, or maintain at some fixed level the population of a community you discover that you need to know a host of different things which would not occur to you if you set yourself the more general question, "How do populations grow?" The objection commonly raised to this reorientation of social studies is that men

are not agreed about what they want. This objection is part of our theological heritage. It rests on the belief that man is naturally sinful and can be morally reclaimed by an act of faith or a course of ethics. The fact that there are some hypochondriacs who prefer to be ill does not prevent biologists from studying what you have to do to keep people healthy. Likewise the fact that some people still believe, like St. Francis, that poverty is a good thing need not prevent sociologists from studying how to get rid of it. We may expect social studies to enjoy the same prestige as the natural sciences when they are as firmly rooted in an accepted and acceptable social objective as the researches financed by the Medical Research Council. Medical science accepts the task of keeping individuals alive and treats arguments about whether it is worth while doing so as frivolous. Social science must undertake the responsibility for keeping the body politic alive or confine its claim for endowment to misanthropic millionaires.

Some years ago I prepared a draft of *Heads of Enquiries* into the growth of population. Its aim was to set down the main topics on which we need information before it is possible to devise any social policy which would re-establish fertility at the survival minimum. Subsequently modified by suggestions from a small group[1] who met to discuss the financial needs of realistic social research in the universities, it was as follows:

HEADS OF ENQUIRIES INTO THE POPULATION OF GREAT BRITAIN

I. AGENCIES INFLUENCING THE GROWTH AND DISTRIBUTION OF NUMBERS IN A COMMUNITY

1. Biological and social agencies related to
   (*a*) Fertility differentials.
   (*b*) Changes in character of marriage and in structure of the family group.
   (*c*) Differential mortality.

[1] The group included Professor Sargent Florence, G. D. H. Cole, and Colin Clark. The programme was printed without my permission and without acknowledgment to me in a book the title of which I have forgotten.

2. Resources available for maintaining population of a given size.
   (*a*) Basic material resources (biotechnical and metallurgical).
   (*b*) Unused physical productive capacity.
   (*c*) Unemployed human resources: their transferability and adaptability.

3. Regional distribution of population with respect to
   (*a*) Location and localization of industry.
   (*b*) Agencies determining present distribution of population, intra- and international movements of population growth of large towns.
   (*c*) Social consequences of increasing density of population and of occupational specialization.

4. Aggregate consumption of the community and demand for various types of labour as affected by regional and occupational distribution of population.

II. HOW RESOURCES OF GIFTED SOCIAL PERSONNEL ARE BIOLOGICALLY CONSERVED AND SOCIALLY UTILIZED

1. The educational recruitment of social classes.
2. Relation of maximal to initial earnings in the wage-earning and salaried classes.
3. Changes of occupation at various ages of life.
4. Vertical, horizontal, and regional mobility within industrial and social units (including the recruitment of administrative and political personnel).

III. INTER-RELATIONSHIP OF QUANTITATIVE AND QUALITATIVE ASPECTS OF THE POPULATION PROBLEM

1. Growth and delimitation of social classes.
2. Relation between total and employable population.
3. Effect of urban concentration (housing policy to be taken into account) and of occupation upon fertility and public hygiene.
4. Relation of population density to administrative and industrial efficiency.
5. Change in general standards of health, education, and social efficiency.

Some of the themes mentioned in the first part of our Heads of Enquiries are included there because circumstances already known justify a suspicion which may or may not be confirmed by subsequent enquiry. The phenomena of differential fertility disposes of the illusion that mere spending capacity favours a high reproductive capacity. Hence it is not likely that any changes in the distribution of spending power by such means as family allowances will suffice to re-establish the survival minimum. Other social circumstances of parenthood must be taken into account. In particular the urban rural differential prompts enquiry into the spacing of population. Urban congestion commends itself to enquiry for other sufficient reasons. The distribution of population in Britain has taken place during the past century with no prevision of aerial and chemical warfare. So the vast hypertrophy of London in recent years now constitutes one of the pivotal problems of national defence and the international repercussions of rearmament are commensurate with its urgency.

The distributive aspect of population best described as *metropolitanization* illustrates a difference between political arithmetic as Petty conceived it and the trivial issues which sometimes prompt laborious collections of economic statistics. While scholastic aims of the London and Vienna School justify us in restating Bacon's plea for searching out new facts, it is also necessary to insist that science is not an indiscriminate collection of unrecorded facts. In science hypothesis is suggested by facts, tested by the arbitrament of other facts, refined in the process of testing facts hitherto unknown, and so instrumental in exposing new ones to view. Without judgment in the choice of a problem worthy of our efforts and experience to guide profitable enquiry the fact-loving temperament is as useless as it is indispensable. Thus the study of how population is distributed especially demands the outlook of what Petty would call a man of affairs.

Two (of many) considerations which might throw light on the urban prolification of the London area suggest hypotheses which might be tested. One is the relative strength of trade union organizations in emigrant and immigrant districts, the provision

of amenities which compete with the attractions offered by employees' organizations, and other circumstances which influence the policy of firms towards those they employ. The other is the extent to which the localization of industry is influenced by a large local demand which reduces transport costs. This raises a wider issue involved in more general aspects of the distribution of population, and one which would naturally escape the attention of those who take a teleological view of the monetary system. In the last resort the rational basis for costing the social efficiency of a transport system is a balance sheet of human effort expended and material resources made available by it. Since thermodynamics is not at present an educational prerequisite for social studies it is not likely that enquiries of this kind will be undertaken in our universities for many years to come. In the meantime a realistic study of interlocking directorates might throw more light on what determines the concession of transport amenities than considerations relevant to price economics are likely to do.

§ 4

Petty's plea for a balance sheet based on energetics also claims our attention when we consider the technical amenities available for planning a redistribution of population for the maintenance of the survival minimum. In our provisional Heads of Enquiries this class of problems is referred to as *resources available for maintaining population*. Naturally we cannot rely on much enlightenment from those who advertise their limitations by recording "a sense almost of shame . . . at tedious discussions of technical education" and recoil with debutante sensibility from "spineless platitudes about manures."[1] Enquiries of this kind demand knowledge of "the history of trades" supplemented by "magnetics, optics, recipes, and jewelling."

We blundered into the age of coal and steel with no prevision. We are now blundering on the threshold of an era of technical changes which may have far more drastic consequences. Here are

[1] *Nature and Significance of Economics*, p. 65.

a few already in being: the production of mobile power from unlimited supplies of natural energy; electrical communications; the replacement of the heavy metal economy by the light metal alloys from universally distributed sources which can be made available for use without the necessity of high-temperature processes; the replacement of crude traditional building and clothing materials by synthetic plastics and cellulose derivatives; a vast increase in the realizable productivity of field and pasture, crop and stock through synthetic fertilizers, control of soil bacteria, genetic selection for fertility and disease resistance, elimination of parasites and the application of Gericke's water culture or tank-gardening.

In these circumstances men of affairs have the wit to realize that the impact of science on society is a cardinal issue for a science of wealth. Alas, few professors are men of affairs in Petty's sense! Unpleasantly aware that the infusion of a little genuine scientific knowledge would compel them to undertake researches for which they lack both requisite training and social inclination, orthodox economists have adroitly entrenched themselves behind a barricade of paradox which, stripped of rhetoric, reads like this:

(i) Wealth is what you have and the man next door has not;
(ii) If he had it, what you have would not be wealth;
(iii) Hence there can be no wealth without scarcity;
(iv) Since there cannot be scarcity if there is plenty, there cannot be plenty if there is wealth;
(v) If there were no wealth, there would be no economics;
(vi) Since we have economics, we cannot have plenty.

I offer no apology for using a plain English word in the plain sense in which Englishmen have always used, and will probably continue to use, it. If the word wealth is to be given a more precise meaning for scientific discussion, the necessary desideratum is to define human needs consistently with the Darwinian doctrine. The biologist is at one with the wholesome wisdom of Professor Tawney when he says that clever men emphasize the differences which separate them from their fellows and wise men emphasize

what they have in common. Man is an animal. He has certain needs which he shares with all other animals, e.g. the need to reproduce if he is to survive as a species. He has needs which he shares with particular groups of animals, e.g. his common mammalian needs. He has species needs, which any individual shares with all other members of *Homo sapiens*—diet, shelter, and protection from disease. Finally, he has idiosyncratic requirements, which result partly from the fact that individual members of the species do not have the same hereditary make-up, and probably in greater part because they do not share the same uterine, post-natal, and social environment. Whether you call these requirements "wants" or "needs," it is obvious that in plain English a plain Englishman who has the power to collect Persian carpets is not what is ordinarily called a wealthy man unless he also has the power to order a square meal.

Unless we have been permanently incapacitated for lucid discourse by prolonged preoccupation with the gold standard, the first questions which arise in seeking a basis of public enquiry are whether the common needs of men as members of the same species, phylum, and type of matter are at present satisfied, what resources for satisfying them exist, and how far these resources are used. Thermodynamics supplies the only kind of answer which a scientist can recognize as appropriate. A human being of a given size and age living at a given temperature requires among other things so many calories of organic materials of particular constitution and a certain amount of material of specified heat conductivity to compensate surface loss by convection and radiation. Whether a community has actual or potential plenty is therefore a calculus for which the materials exist in a world of discourse which Lord Stamp's recent lecture[1] nowhere penetrates.

Man can secure the requisite minimum of free energy by his own activities with or without the assistance of other species like the horse. He can secure it by liberating the potential energy stored in the earth's surface by the heat engine, in which case

[1] *The Calculus of Plenty.*

there is a permanent calorie debt of human effort entailed in overcoming gravitation. He can also secure it by harnessing natural forces to the production of mobile power. Taking these three major categories, the energy debt in human calories is greatest in the first and least in the last. The word plenty defined with reference to man's species needs has therefore a perfectly clear social meaning which remains in spite of the continued existence of Austrian economists. *Plenty is the excess of free energy over the collective calorie debt of human effort applied to securing the needs which all human beings share.* In this sense the statement that we are living in an age of vast potential plenty as compared with our grandfathers is a truism. It is convenient to conceal it beneath an avalanche of Austrian sophistication, because a very large number of Englishmen and their families are not receiving the bare minimum of daily calories which the British Medical Council prescribes. If they were equipped with the education which Petty prescribed, it would therefore be the business of those who profess a "science of wealth" to undertake enquiries like those of Sir John Orr.

It need hardly be said that exploration of the nature of universal human needs and the means of satisfying them includes many issues which lie outside the scope of Sir John Orr's investigations. This truism does not imply that they cease to be topics for realistic research or that they therefore become the proper perquisites of a scarcity dialectic. When the existence of a universal need is recognized the problem of satisfying it is a joint matter for public accountants and technicians. Health is a universal need. Radium is a necessary reagent of the modern health laboratory. If there is not enough available radium to supply the need, or if the balance sheet of human effort expended in securing supplies shows an inordinate item on the debtor side, nothing is gained by diverting funds from research into the bombardment of sodium atoms by helium nuclei to endow chairs in tautology. That the issue is not essentially different when we have to deal with universal needs which lie outside the scope of biological enquiry is easily seen with the aid of a plausible illustration.

From the late palaeolithic onwards men collected glittering objects such as meteorites and gold nuggets. Women painted their eyelids with malachite in predynastic Egypt, and the practice is believed to have led to the discovery of copper metallurgy. To-day Bantu tribes use clay as a cosmetic, and in recent history native chiefs have bartered away a mining concession for brass bangles. Hence a case might be made for regarding adornment of the person as a species need of *Homo sapiens*. We may assume that this is true for argumentative usage. To clarify the illustration, let us also make the unlikely assumption that mankind has a universal craving for pearls as a means of satisfying it. It is quite clear that the demand for pearls has two components. One is the intrinsic appeal they exert as objects pleasing to the eye. The other depends on knowing that they have monetary value. Its existence is clearly shown by the fact that culture pearls can only be distinguished from "real" ones by the use of laboratory tests. Since at most a few dozen scientists in England can carry out such tests, the price difference has nothing to do with intrinsic appeal of the objects. The existence of culture pearls shows that the supply side of the intrinsic preference does not lie beyond the capacity of technical skill. The preference for real ones calls for the service of the psychologist. His problem is how to educate people to enjoy available sources of satisfaction undistracted by an itch for extraneous ostentation. At present education encourages girls to regard it as "vulgar" to wear "imitations" and ladylike to wear the real article. So the problem of pearl scarcity is essentially one of educational technique. It calls for what Petty called "a dictionary of sensible words." It would present no insuperable difficulties if children were brought up to know that the correct meaning of the adjective vulgar is "of or pertaining to monetary values."

One objection which will at once be raised is that social psychology is not yet sufficiently advanced to give us much information about species needs which lie outside the field of biology, or to show us how to educate tastes. This is self-evident, and what needs to be done is equally obvious. The correct course is to call

a moratorium on mere talk and see that more psychological research is prosecuted energetically. It may also be urged that some human needs are not universal, and that they cannot be neglected from a public symposium, because their satisfaction may involve the efficiency of individuals whose special gifts are essential to social welfare. About this two things may be said. First, there can be no acceptable basis for a science of preventive social medicine unless the satisfaction of known universal needs is its first concern. Second, psychologists should have every encouragement to explore the distribution of human capabilities in their relation to the idiosyncratic requirements of individual human beings.

The belief that scarcity is an inescapable condition of settled social existence rests on one of two implicit assumptions. One is that the attempt to educate the human race so that ostentation is not a significant feature of man's social behaviour is an infringement against personal *freedom*. Psychological anti-vaccinationists who use the word freedom to signify the natural right of men and women to be unhappy and unhealthy through scientific ignorance, instead of being healthy and happy through the knowledge which science confers, need not detain us. The professional economist who is too sophisticated to retreat into the obscurities of libertarian mysticism will prefer the alternative assumption that the need for ostentation is a universal species characteristic. All attempts to eradicate the unconscionable nuisance and discord which arise from hypertrophied craving for personal distinction artificially fostered by advertisement propaganda and good breeding are therefore destined to failure. It may be earnestly hoped that those who entertain this view have sought divine guidance. No rational basis for it will be found in text-books of economics. Whatever can be said about human preferences with any plausibility rests on the laboratory materials supplied by anthropology and social history.

Graduates in the art of normative social surgery are invariably ready with a reason for the hope that is within them when anyone proposes radical operations on the body politic. The hope, need-

less to say, is that nothing will be done, and the reason which is always the same, is that, if anything were done, it would not "pay." The crushing cogency of the rebuke depends on the time-honoured recipe of metalepsis inherent in all purely dialectical disputation. Instead of inventing a scientific nomenclature free from extraneous associations, economics, like theology, borrows its terms from common speech, defines them in a sense different from and often opposite to their accepted meaning, erects a stone wall of verbal logic on craftily concealed foundations, and defies the plain man to scale it. According to Professor Robbins, the part of the real world with which economics is concerned is bounded above and below by the two covers of a dictionary. So when the engineer says that a social amenity is technically realizable, and the economist replies that it would not pay, the issue involved is merely one which concerns the "original definitions of the subject-matter."

When there is a science of *social technology* it will give us a balance sheet of human effort, materials, and natural resources expressed in the established equivalence between the various physical units of heat, kinetic energy, and potential energy. If it is complete, the balance sheet will include the necessary minimum of calorie debt involved in the human activity of administration. It need not include the large wastage of calories involved in maintaining the body heat, sudorific, and motor activity of speculators, a surfeit of solicitors, and a multiplicity of middlemen. As the word is used in its anti-social sense by the academic apologists of salesmanship, the armament industry "pays" better than a system of scientific food production socially planned to meet the known dietetic minimum needs of a population. When the thermodynamic balance sheet shows that the result of adopting a new process is to increase the free energy of the social system, and the social system operates to pile up a calorie debt of human effort in the manufacture of poison gas, thermite bombs, gas masks, and subterranean concrete shelters the professional employees of the banker exempt neither themselves nor us from the universal conservation of energy by asserting that

the new process will not pay. All they contribute to the discussion is the information that they agree among themselves to use the verb to pay in an anti-social sense. In effect they tell us that the system of costing adopted by the Bank of England does not exhibit the social adjustment of human effort to available sources of free energy. That is another way of saying that the existing credit system is not based on laws of nature like the accountancy of the engineer and biologist.

6

Naturalistic Studies in the Education of the Citizen[1]

THE DEMAND FOR instruction in the natural sciences as an essential constituent of a curriculum of humanistic studies is not a new theme. It is necessarily the educational creed of any powerful social group or community whose prosperity depends on the application and extension of scientific knowledge. Huxley was its prophet when industrial capitalism was approaching its zenith in mid-Victorian England. It had also been voiced in an earlier phase of capitalistic enterprise, when the Marquis of Worcester wrote *The Century of Inventions*, and Boyle reiterated his eloquent plea that "the goods of mankind may be much increased by the naturalist's insight into the trades." It assumed the dimensions of a nation-wide, though, alas! ephemeral movement when the *Heads of Enquiries* were drawn up by the Invisible College, and was even endorsed by the nation's epic poet. Referring to Milton's brief experience as a schoolmaster in Aldersgate, Johnson remarks in his *Lives of the Poets*:

> The purpose of Milton was to teach something more solid than the literature of the schools by reading those authors that treat of physical subjects, such as the Georgick and astronomical treatises of the ancients. . . . But the truth is that knowledge of external nature and the sciences which that knowledge requires or includes are not the great or frequent business of the human mind. Whether we provide for action or conversation, whether

[1] An address to the Educational Section of the British Association, 1935. (See *What Science Stands For*, by Sir John Orr, Professor A. V. Hill, Sir Richard Gregory, Professor Hogben, and others (London: George Allen & Unwin).

> we wish to be useful or pleasing, the first requisite is the religious and moral knowledge of right and wrong. . . . Prudence and justice are virtues for all times and all places, we are perpetually moralists, but we are geometricians only by chance. Our intercourse with intellectual nature is necessary: our speculations upon matter are voluntary and at leisure. Physiological learning is of such rare emergence, that one may know another half of his life without being able to estimate his skill in hydrostatics or astronomy, but his moral and prudential character appears at once.

To-day the physiological learning of Sir John Orr moves the nation's conscience more than volumes of rhetoric addressed to man's moral and prudential character. Man, in the Machine Age, is a geometrician perpetually, a moralist inadvertently at leisure. In this matter Johnson was the mouthpiece of the most decadent episode in the social culture of England since Elizabethan times. It is safe to say that there are few remaining educationists who would subscribe wholeheartedly to Johnson's verdict. Most modern educationists sympathize with the claims of natural science to a place in the education of the citizen and statesman.

Instruction in natural science as a preparation for citizenship can fulfil its aim only if it is extensive rather than intensive. Loading the curriculum with intensive courses in one or another restricted branch of natural science primarily adapted to the needs of pupils destined to become technicians, teachers, and investigators, offers no remedy for the present defects of a humanism which makes no contact with the fundamental features of modern civilization. So much is generally agreed. Differences arise only when discussion gets to grips with the contents of a general course of instruction with this end in view. Everybody has his or her views about what should be selected or rejected from an immense range of possible choice.

The trouble is not so much the lack of a programme as a surfeit of conflicting proposals. Weak-kneed compromises from time to time result in a prospectus too vague to provide the basis of a genuine intellectual discipline, or to put it more plainly from the

teacher's standpoint, too diffuse to make up a corpus of examinable knowledge. In striving for agreement it is always well to remember that compromises may be good or bad. Between the two is all that distinguishes a synthesis from a muddle. Bad compromises are the sort negotiated by morally tired people who refuse to take account of fundamental differences, where such exist. Good ones are accepted on the explicit recognition of their differences by people who are modest and patient enough to abide by the test of practice.

To arrive at agreement about the scope of a general course of science taught as part of the curriculum of humanistic studies, it is therefore imperative to make current sources of disagreement as explicit as possible at the outset. It is not enough to see the obvious dangers which arise because scientific specialists are prone to exaggerate the importance of their personal interests and because sentimental educational reformers are too apt to regard childhood as an end in itself. There will be no solid basis for agreement, unless we accept the fact that education is a social institution with a social function, and that, in consequence, the place of science in education is first and foremost a sociological issue.

That the view of Milton left no perceptible impress on his successors and that the eloquence of Huxley has had little influence on the educational practice of the present day calls for no surprise when we examine each in its own social context. What Professor Clark calls the adventurous hopefulness of Milton's times speedily succumbed in the ensuing stage of monopolistic capitalism. The *Heads of Enquiries* projected in the first years of the Royal Society languished, and the now familiar device of exalting pure science to the neglect and disparagement of its applications foreshadowed the eclipse which lasted from the death of Newton to the election of Davy. When a Director of the Bank of England appeals to the British Association for a moratorium on inventions we may justifiably wonder whether history is not repeating itself.

Be that as it may, the cogency of Huxley's case has hardly outlived its author. In essence Huxley's plea was moulded in

accord with the prevailing doctrine of *laisser-faire*. Thanks to science, mankind was now on the threshold of a millennium of prosperity, enlightenment, and peace. Provided that legislators did not interfere with the wheels of industry, expanding knowledge of nature could guarantee expanding vistas of human welfare. The citizen must be taught science to make him realize the felicitous inevitability of orderly progress in a world where the masters of industry competed to exploit the newest discoveries for his benefit. The engaging prospect so unfolded left no space for frozen patents, armament races, chaotic overproduction, mass unemployment, or subsidies to destroy the fruits of the soil.

To-day Western civilization is threatened by a widespread reaction against democratic institutions. The cult of virile sentiment and blind obedience to leaders with supposedly superior wisdom now challenges Huxley's robust materialism and salutary confidence in the human reason. Our newspapers and bankers are blaming science for the poverty which persists and the plenty which science has made possible. There is a present danger that public opinion will learn to identify science with the latest horrors of mechanized warfare. We watch with regret the passing of much which was generous and sane in the confident, complacent, and one-sided optimism of Huxley's generation.

If its claims really rest on the belief that advancing scientific knowledge of itself guarantees the continued welfare of mankind, events have stripped away any shred of plausibility for the claims of science to take its place in the education of the citizen and the statesman. The now manifest absurdity of this belief has indeed become the strongest argument for restating the claims of a scientific humanism. If the social consequences of technical progress since their time have failed to fulfil the high hopes of Huxley's contemporaries, the results might well have been anticipated from the dichotomy which they denounced. We have trained a generation of specialists to mind their own business and a generation of statesmen to legislate in ignorance of the technical forces which inexorably control the character

of social relations. The men who contributed most to the social framework within which the science of our own time has attained its present stature were profoundly indifferent to and ignorant of the impact of science on their own handiwork. At a time when cables were carrying messages across oceans Gladstone could ask Faraday whether electricity had a use. Thirty years after the great Liberal leader was dead, the fate of a democracy might depend on forestalling the capture of a radio station by a violent minority.

§ 2

It is necessary to put the social aspect of the teaching of science forcefully, because so much ambiguity arises when the *cultural* claims of science are put forward. We all know what is meant by the vocational aspect of education, and we wrongly assume that there is equally general agreement about the meaning of its cultural side. In theory the word cultural commonly covers two entirely different functions of an educational system. One is the private problem of helping the individual to discover for himself or herself congenial sources of enjoyment to occupy leisure in later life with the fullest allowance for variety of temperament. The other is the public business of equipping individuals with the knowledge necessary for the discharge of their mutual responsibilities as co-citizens of a democratic society without regard to the personal inclinations of the child. In practice what is called cultural education is neither the one nor the other. Good taste, which is synonymous with ostentatious refinement appropriate to a leisured class, takes precedence over the cultivation of individual satisfaction of temperamental needs and political rationalizations of a bygone age exclude the study of resources for welfare which a modern community can use or abuse.

The private aspect of education can be, and often is, grossly exaggerated in stating the cultural claims of science in modern education. Fifty years ago, when microscopy was a fashionable hobby for tired business men, there were relatively fewer avenues

of vocational choice for people with a personal inclination for scientific pursuits. Presumably there were relatively more misfits among the class of individuals who could choose their means of livelihood. Popular science of a very genuine order could then compete with the novel, drama, golf, and equitation for the entertainment of a type of person who would now encounter few obstacles to a career in science. The brilliant lucidity and simplicity of Faraday's addresses, Ball's lectures, and Huxley's writings have made way for pretentious omnibus productions, and sensational press-cuttings on controversies unintelligible to any but a few dozen specialists are ousting what was once intelligent and, at times, active participation in the progress of science as a pursuit of leisure. Increasing specialization and expanding outlets of vocational choice for individuals with a native inclination or aptitude for scientific studies must progressively limit the appeal of science as an active hobby.

Meanwhile, the demand of popular educational movements like the W.E.A. is for information about the social problems of our time. That science should be taught because it teaches children to be observant and curious is a dubious proposition. The case for science as an essential part of the education of the average man or woman does not rest on gratuitous assumptions about the transfer values of particular disciplines, nor on the individual satisfaction which a small class of individuals may derive from verbal disquisitions on the latest, least digested discoveries at the periphery of theoretical research. *The cultural claims of science rest on the social fact that the use and misuse of science intimately affects the everyday life of every citizen in a modern community.*

That there has been substantial progress in linking up the teaching of school science with everyday life must be thankfully admitted, if we compare such new texts as Hadley's *Everyday Physics* with a well-known book called *Statics and Dynamics* as representative of the teaching of physical science thirty years ago. The thanks are due to the efforts of educationists with very little encouragement from scientific specialists in the universities. While such ventures as the Macmillan series are encourag-

ing signs of progress, school teaching in formal science has still much to learn from such admirable productions as the current *Popular Science Educator* of the Amalgamated Press, which is doing its best to perpetuate Victorian lucidity. School books, even the best of them, are still execrably illustrated, and their design is imbued with the mediaeval tradition that the function of pictures, if any, is to ornament rather than to expound.

Making the fullest allowance for progress in the teaching of the physical sciences, there is nothing to justify complacency about the introduction of biology into the classroom. The type of instruction imposed on the schools by university specialists is just as academic as the old mechanics of perfectly smooth balls rolling down perfectly flat frictionless slopes. It has few, if any, explicit contacts with the social applications of biological discoveries or with the everyday experience of children brought up in congested urban centres, where the aspidistra, the cat, the dog, and perhaps the plane-tree are the only familiar representatives of the animal and vegetable kingdoms. One is tempted to conclude that the universities have thankfully relinquished the duller parts of elementary courses little changed since Huxley's generation and barely influenced by the vast developments of agricultural production in recent times.

While it is happily true that educationists are ahead of the scientific specialist in so far as the cultural teaching of science demands emphasis on its place in everyday life, the claims of science in the education of the citizen extend far beyond a passing familiarity with the way in which society at present uses the knowledge available for the advancement of human well-being. What is far more important is a recognition of the potential of human welfare inherent in scientific knowledge which existing social machinery fails to exploit for the commonweal. Even this neglected aspect of the problem which confronts us in designing a general course of science to take its place in the curriculum of humanistic studies does not exhaust all the issues which should claim pre-eminence. Others will emerge more clearly if we consider the dangers with which the preservation of democracy

is now faced. One is failure to anticipate the dire penalties we may pay for the misuse of science. Complacent acceptance of its prostitution to destructive ends and ignorance of the constructive alternatives which existing knowledge places at our disposal will have disastrous consequences for all of us, if the helplessness and horror of modern war is canalized in a revolt against science, a repudiation of the benefits which science can confer and a retreat to a lower level of civilized living.

In contradistinction to purely static emphasis on the place of science in everyday life to-day, education for citizenship demands a knowledge of how science is misused, how we fail to make the fullest use of science for our social well-being, and, in short, a vision of what human life could be if we planned all our resources intelligently. It calls for understanding of the way in which social agencies foster new discoveries and their useful application. In addition it must reinforce confidence in rational endeavour by emphasizing the role of advancing scientific knowledge in the growth of social institutions. This aspect of the cultural claims of science is perhaps least often stated, and there is a peculiar need to state it at the present time. A growing disposition among the adolescent generation to rate rational persuasion and educational methods as exploded liberal superstitions compels us to ask whether western democracy has devised an educational system capable of ensuring its own continuance.

The content of the present curriculum of humanistic studies discloses a sufficiently obvious reason for failure. The teaching of history presents the record of human life as a babel of emotional phrase-making and a panorama of commercial undertakings to the success or failure of which technical progress makes no explicit contribution. If he discusses why the Great Navigations took place when they did, the last thing which the historian generally thinks of asking is what kind of knowledge is needed to steer cargoes over long-distance westerly courses. There are, to be sure, honourable exceptions such as Professor Clark of Oxford. Unfortunately, his interests are not shared by his colleagues, many of whom seem lately to have gravitated away from

closer relations with naturalistic studies. Perhaps this is because the study of how inventions are made leads to dangerous thoughts.

Two conclusions follow from the general principles emphasized in the preceding remarks. The first is that *a course of general science adapted to the requirements of citizenship should be orientated towards the elucidation of the major constructive achievements of natural knowledge in the evolution of civilization.* Among the cardinal themes which thus replace the arbitrary division of science into separate "ologies," those which claim special attention are the construction of the calendar, the technique of navigation and map-making, the extension of deep-shaft mining and exhaustion of fuel supplies, the introduction of inanimate and mobile power, the discovery of chemical fertilizers and the principles of scientific breeding, the control of epidemic diseases, and the national dietetic minimum. School science should not be a selection from the competing claims of specialist disciplines. It should be the story of man's conquest of time-reckoning and space-measurement, of the search for materials and substitutes, of the liberation of natural sources of power, and of the struggle against hunger and disease. When it becomes this, the theoretical principles which have the greatest yield will emerge far more clearly, and there will be less reason for disagreeing about the relative importance of different aspects of scientific knowledge.

As a corollary, this implies that science for citizenship must be permeated with the historical outlook and taught in the closest association with historical studies. This suggestion must needs run the gauntlet of a powerful, and at the same time pardonable, body of prejudice which is expressed in a recent circular of the Board of Education. It has arisen because of a fashion which was once adopted to enliven the teaching of some sciences, notably chemistry and physiology, in the universities. It was called the historical approach because the tedium of the lecture room was from time to time relieved by lantern slides of bearded and very much superannuated scientists or of their birthplaces. Many of us can still recall how serial obituary notices of great uncles who have gone before helped us to return to the matter

in hand with redoubled zest. No doubt this method of instruction had the merit of familiarizing students who would not read Professor Pflugel's works with sartorial types of earlier periods. As it affected our general outlook, it left the impression that science has progressed by a succession of miraculous divinations of exceptionally gifted individuals who might have contrived to be born at any convenient time with much the same results. Needless to say, biographical anecdotage of this sort throws no light on the relation of science to the changing fabric of social life and their dependence on one another.

In matters affecting educational reform, it is more important to move in the right direction than to move at maximum speed. So no apology is necessary if changes as radical as those contemplated in this discussion cannot be implemented immediately. There is not the social personnel in the universities to supply the requisite training for teachers, still less teachers who could undertake the allotted task in the schools. On the other hand there are welcome piecemeal innovations, which, if duly encouraged, will make it easier to deal with the problem in a few years' time. If they seem unimportant in themselves, their collective effect may be significant.

One, which may seem at first sight too trivial to mention, is the provision of special instruction in the teaching of science by a few of our more forward university Departments of Education such as those of London and Liverpool. The Departments of Education in our universities have the power to lay the foundations of a new humanism with its roots in the scientific outlook, and incidentally to increase their prestige and importance, if they take the initiative in pressing the claims of the science teacher and his or her special needs on the Faculties of Science, which at present control the syllabuses.

They would also be well advised to disabuse local education authorities who entertain an undue reverence for the honours degree. To persons who are not well informed about university curricula the epithet signifies a qualification superior to the pass or general degree, as no doubt is true if the end in view is to

produce chemists and electricians for industry and biologists for museums and colonial services. In some of our universities the real distinction merely resides in the number of subjects taken. The London honours degree in science and the Oxford Honours School offer a qualification which is disgracefully narrow, if intended to qualify a person to teach science as a cultural subject; and the pass degree at London is at least better than its supposedly higher qualification. Even where there is a wide range of subjects taken, British science degrees are totally inadequate to meet the requirements of a teacher whose main concern is the average citizen rather than the pupil who will eventually specialize for professional scientific work. In the leading British universities there is no provision for instruction in astronomy, unless the student is specializing in mathematics.

This gap in the science teaching of the universities is specially relevant to the considerations which have been advanced, because astronomy is the oldest of the sciences, and its beginnings are the beginnings of science applied to man's social life. In none of the sciences are the relations of discovery to the social practice of mankind more clearly exhibited, and perhaps no other science is more relevant to information which most educated people have accepted on trust from their childhood onwards. Its neglect is all the more remarkable, because of the close association of astronomy and navigation in the story of Britain's mercantile supremacy.

One of the earliest things which most of us learned at school was that certain marks made across a map were called lines of latitude, and that the world we live in is approximately twenty-five thousand miles in circumference. Although considerable time is devoted in schools to a subject called geography, most children still leave the secondary school, and one may venture the guess that most science graduates leave the university, without realizing how a ship's captain determines the latitude of his vessel or hearing of the simple device with which Eratosthenes (B.C. 250) measured the earth's boundary within fifty miles of the true value. Although a child of ten could find the

latitude of his house correct to a degree on any clear night with the aid of a plumb line, a blackboard protractor, and a couple of screws with eyes, most children take latitude, like the Copernican hypothesis, as an act of religious faith, and curiously enough, if they are Protestants, think it odd that Catholics refused to accept it in the same spirit.

The infusion of a little elementary astronomy into the teaching of geography would raise one of the dullest school subjects to the dignity of a rational discipline, and, incidentally, revolutionize the teaching of elementary mathematics by providing illustrative materials of the class of problems which the more elementary branches of mathematics were designed to deal with. The new departments of geography in the universities could make a welcome and fundamental contribution to the equipment of a social personnel competent to advance the cultural claims of science, if they made a course in the methods and history of cosmography and calendrical practice compulsory for their students and optional for students in natural sciences. Professor E. G. R. Taylor of Birkbeck College is to be congratulated on her initiative in this matter.

Another welcome innovation has taken place at University College, where Professor Wolf has offered a course on the history of science and technology for students of education. In his recently published book on science in the seventeenth century[1] Professor Wolf has broken away from the biographical and obituary school of writers who are responsible for so much justifiable prejudice against the history of science, and has given us the first comprehensive British work in which the history of science and its application are dealt with in the same social context. Courses of this kind in the Departments of Education of our Universities and in our training colleges could provide a focus for collaboration between the historian and the man of science. At present there is no common meeting-place. Without one it is impossible to lay the foundations of a genuine scientific humanism. Recently

[1] *A History of Science, Technology, and Philosophy in the Sixteenth and Seventeenth Centuries* (London: George Allen & Unwin).

there has been some discussion about the introduction of a course in the history of science at Cambridge. Whether it leads to useful results[1] will depend on whether it is closely affiliated to the teaching of social and economic history or perpetuates the obituary tradition.

The indifference of men of science and educationists in the universities has relinquished one unique opportunity for implementing the cultural claims of science. It was offered shortly after the late European War, when the Civil Service Commission made a paper on *Everyday Science* compulsory for all candidates at examinations for higher grades. Provision of special instruction for such candidates, mainly drawn from the ranks of graduates who specialize in linguistic and historical disciplines, might have provided a nucleus for the training of teachers for general science as a cultural subject. The examination proved to be a farce, presumably because no such provision was made till last year, when the Commissioners took the retrograde, if comprehensible, step of omitting *Everyday Science* from the list of compulsory papers. The only official recognition of the need for scientific knowledge in the administration of the nation's affairs was thus withdrawn. Such decisions are not necessarily irrevocable, and it is still possible to bring the pressure of public opinion to bear on the Civil Service Commission. If it can be persuaded to reconsider the matter, the British Association would perform a useful service by appointing a joint committee of educationists and men of science to draw up a syllabus of instruction, and urge the universities to provide it.

§ 3

Whether science will take its needful place in the instruction of the citizen and statesman depends far less on the attitude of the scientific specialist than on that of the educationist. The scientific specialist is too much immersed in his work and too much imbued with an attitude of social indifference generated by

[1] It did not.

a long period of comparative prosperity and security to take an active part in the educational reformation which the present crisis in democratic societies calls for. The problems of the post-war world demand nothing short of a transvaluation of all educational values. Over-specialization is one of the great obstacles to their solution. If the educationist is to make a constructive contribution to the social problems of the present time, he will have to forfeit the luxury of false modesty in his dealings with the claims of specialists.

The danger is that educationists will seek a remedy by calling on the services of the metaphysician. Fifty years ago idealistic philosophers were content to preserve a lofty neutrality towards scientific questions. The old indifference has now made way for the new impudence of which the following sample is taken from a recent article by Mr. C. E. M. Joad:

> Enclosed within his special compartment the scientist arrives at more or less definite conclusions without stopping to think what relation they bear to the conclusions reached by other scientists working in *their* water-tight compartments. . . . Hence there arises a need of a clearing-house in which the results of the various sciences can be pooled and collated, in order that, looking at them as a whole, we may be able to infer what kind of universe it is that we inhabit. Philosophy is the clearing-house of science. . . .

Such claims put forward by an Oxford philosopher with no pretensions to professional training in science would have been dismissed by Huxley as impertinent rubbish. The picture Mr. Joad presents is a travesty of the facts. All the old landmarks of naturalistic studies are disappearing. The biologist who is a taxonomist must needs be a geologist. If he is a geneticist he must be something of a mathematician. If he is a physiologist he may be making fundamental contributions to physical chemistry. Physicists are turning chemists, and chemists find themselves wandering into biophysics. The specialization which makes it difficult for the scientist to take a lively and useful interest in his social responsibilities is in part the penalty for the wide range

which his technical enquiries cover. Even if he could afford to neglect progress in other disciplines continually encroaching on his special field, he would not expect to gain anything from instruction by specialists in early Mediterranean literature.

Natural science claims a place in the culture of the citizen in the age of hydroelectric power and aviation, because science has changed the world while philosophers have been content to reflect upon it. It is not the glory of science that it can give comprehensive and decisive answers to the conundrums which Mr. Joad propounds. Any answers it can offer must be hesitating and provisional. The true and lawful goal of science, said Bacon, is that human life be endowed with new powers and inventions. The place of science in the education of the citizen is to enlist him in the constructive task of using the new powers and inventions wisely.

In its main features the education of the prosperous middle classes of Western Europe and America has changed very little during the past three centuries. Dead languages are taught less. To meet the needs of commerce live languages are taught in the old dead way. The same geometry is no longer called Euclid. A smattering of science has been introduced because engineers, chemists, and doctors are in greater demand. So the intellectual training of the prosperous middle class in our own time can give them little assistance in understanding their own social destiny. In England, particularly, those who study social institutions remain grotesquely ignorant of how technical processes are shaping the world in which we live, while the scientist who is familiar with the technical processes is kept in childish ignorance about the social medium in which they operate. In these circumstances book learning has least appeal for those who are most socially alive. As measured by our present educational standards, intellectual eminence depends a great deal more upon an individualistic (or introverted) temperament and far less upon socially quickened intelligence than the specialist likes to admit. Training of the kind which middle-class education provides has produced brilliant specialists; and the most brilliant are least alive

to the social effects of the changes which they help to bring about. In the throes of world-wide unrest, the middle classes have begun to fear the results of their own inventiveness. They demand a halt to science, a demand which may be the death-cry of the most fertile culture the world has yet seen.

The kind of education which helped the merchant class to become prosperous three hundred years ago has lost its use and attraction for the more prosperous section of the middle class to-day. One result is the ultra-individualistic reaction which is called "experimental education." This generally means leaving the child of well-to-do parents to do just what he likes. Since no healthy child could be expected to enjoy most studies which have been prescribed by the traditional system, what happens is inevitable. The child learns nothing at all. So the teacher as well as the child enjoys the advantage of belonging to a leisure class. Much that is called "experimental" education is neither novel nor radical. It merely represents disintegration of discipline in the prosperous classes. Doing nothing is no solution of the educational problem for those who wish to preserve a civilization which owes its special characteristics to advancing knowledge of natural law. Experimental educationists have replaced braincraft divorced from handwork by handicraft divorced from brainwork. A vital problem of education to-day is to end the false antithesis between handwork and brainwork. If we wish to build the society which can guarantee leisure for everybody and safeguard everybody against poverty by making the fullest use of science, the practical man will have to be more of an intellectual, and the intellectual will have no function unless he is also a practical man.

7

Planning for Human Survival[1]

PEOPLE HAVE STOPPED ASKING, Can capitalism survive? No intelligent individual under forty-five years of age imagines that it can. What is less certain is an answer to the question, Can the human race survive? In stating the subject of this essay in these terms, let me insist that I shall not attempt to make any prediction about future events. I am a scientific worker. It is not my province to prophesy. Science is content to prescribe recipes for conduct, as where to put a telescope to see Pluto or when to turn up at the observatory if you wish to see it. Prediction is the prerogative of bookmakers, evangelists of a four-square gospel, and professors of political economy.

The survival of human beings depends on two things: the rate at which they die and the rate at which they are born. Science has increased our knowledge about agencies which affect both. It thus offers us increasing scope both for death control and for birth control. We can kill people more swiftly and on a far more generous scale than our ancestors could do, and we can keep many more of our babies alive. We know much more about how to regulate the rate at which babies are born without fear of exhausting the plenty potentially available for all. We can also decide to stop having them altogether without undue personal inconvenience. Knowledge of either kind may be used for good or evil. For instance, the United States is making war on citron bugs with poison gas and aeroplanes. Hence no sane person would suggest that distaste for war as an instrument of international policy betokens a hatred of science. One might also

[1] Fabian Lecture, 1936. (See *What is Ahead of Us?* by G. D. H. Cole, Sir Arthur Salter, Lancelot Hogben, and others. London: George Allen & Unwin.)

expect that no sane person would assume that well-informed concern for the consequences of declining fertility implies a repudiation of contraceptive amenities. Unfortunately very few birth controllers are sane in that sense. Death controllers of Hitler's kidney are singularly intolerant towards people who are still glad to be alive, and most birth controllers are fanatically enraged when they meet people who want to keep the human experiment going. Nothing here said will prevent them from misunderstanding what I shall say later on. If I preface these remarks by stating that I am in active sympathy with contraceptive practice, I do so only for the pleasure of demonstrating how few people can recall what they have heard half an hour before.

Most sensible people have enough imagination to realize that there is now a vast potential of destruction without parallel in human history, that the fate of civilization will probably depend on the attitude we adopt towards it, and that it has made the issue of sheer survival a pivotal concern of statesmanship. Few people are sufficiently familiar with the less heroic facts about fertility to realize that civilized mankind is now faced with a new potential of sterility, that the fate of civilization will depend on the steps we take to deal with it, and that it is likely to dominate all other issues of social policy in the near future.

I do not propose to go into great detail in stating the facts concerning population growth at the present time. They have been amply set forth in two books by Dr. Kuczynski, *The Measurement of Population Growth* and *Population Movements*, in Enid Charles's *Twilight of Parenthood*,[1] and in the *Struggle for Population* by David Glass. If their significance has attracted little comment in the realm of political discussion, it is doubtful whether there is any branch of social studies in which there is more complete unanimity about the facts themselves. The facts may be summed up in one brief statement. The level of fertility in the more highly industrialized countries has now sunk below the limit at which no concomitant fall in mortality can prevent

[1] Now reissued by Watts & Co. as the *Menace of Underpopulation*.

a continuous decline of population, unless people can be induced to have larger families. There are several reasons why this prospect fails to excite alarm. One is that the form in which public statistics of population are presented is apt to mislead people about what is really happening. Another is that we have scarcely thrown off the Malthusian mythology, and have had too little time to adjust ourselves to an age of potential plenty. A third is that many prevalent views about declining fertility are based on rationalizations of personal sentiment belied by the statistical data available.

Two features of public statistics contribute to the complacency which most people display. The first is that population has not yet begun to decline steadily in any country. The second is that the birth-rate conceals the most relevant features of the problem. The birth-rate gives the number of children born per annum per 1,000 members of the population. By itself a fall or rise in this tells us nothing about the reproductive capacity of a population. This is easily seen if you consider two populations both composed exclusively of partheno-genetic females who have had or will have the same number of children in the course of their lives. If in the same year one community is exclusively composed of women of child-bearing age and the other is half made up of individuals younger than fifteen years or older than fifty years of age, the number of births in the second will be roughly half as great as the number of births in the other. Consequently the birth-rate of the first for that year will be twice as great as that of the second.

The best way of deciding whether a community is capable of replacing itself is to measure fertility by the number of girl children born on the average to one woman in the course of her reproductive life. This can be done when public statistics record the age of the mother at the birth of each child. In England and Wales at the present level of fertility one hundred women on the average have eighty-five daughters in the course of the entire child-bearing period. There would thus be a 15 per cent deficit of replacement in each generation even if every daughter herself survived to become a mother. In other words

no further fall in mortality can arrest a continuous decline, and nothing short of immortality can safeguard us against extinction, unless fertility is raised by somewhat more than 15 per cent. This would not be achieved even if all women married, unless the average married woman had more children.

You may ask: Why then do the Registrar-General's returns still show a slight annual increase in the population of Britain? Leaving migration out of account, the reason for this is that there is a necessary time lag before a fall in fertility exerts its full effect if mortality is falling at the same time. That such a time lag may occur is easy to see with the help of a fictitious illustration. Imagine a community in which every woman died at the age of sixty and produced one female offspring in the course of her life. The female section of this community would be numerically stable as long as this fictitious state of affairs lasted. If a certain proportion of women became sterile while mortality remained the same, the annual births in the succeeding year would be less than the number of deaths. Conversely, it might happen that fertility remained fixed and mortality went down. For instance, we can imagine that all women of nearly sixty might live to be nearly sixty-one. So the number of annual deaths would suddenly drop in the ensuing year; and there would be an excess of births over deaths. A large enough drop in mortality would still lead to the same result if fertility fell at the same time. If mortality persisted at the new level, the proportion of older people in the population would increase to a certain limit and the population would continue to grow for some years; but if the average number of girls reared by the women remained less than one apiece, the population would eventually begin to decline and continue to do so.

The character of population growth in modern industrial communities resembles this fictitious situation in so far as it depends on a simultaneous fall of fertility and mortality. The fall in the latter can only check the effect of the former temporarily. An extension of the average duration of life beyond the child-bearing period has no effect on the *capacity* for further growth.

At a fixed level of fertility and mortality about sixty years elapse before the full effect of a lower fertility begins to operate. If no females died before fifty, and if the present level of fertility were kept constant, at the end of sixty years our population would be falling off by 15 per cent in a generation. Comprehensive estimates of the consequences of declining fertility on the future course of population in Great Britain have recently been made by Enid Charles. If fertility and mortality remain indefinitely at their present level, the population of England and Wales will be reduced to one-half its present size a hundred years hence. By then it would be declining at the rate of 25 per cent per generation, and would be reduced one-fifth its present size two hundred years hence. If fertility and mortality continue to fall off at the rate suggested by the experience of the last two decades, the population of England and Wales will be reduced to one-tenth of its present size a century from now.

Before lightly dismissing the prospect which is disclosed by these figures, other facts deserve attention. During the last twenty years the percentage fall in fertility has been greatest in those sections of the population with the highest fertility at the beginning of that period. In other words the differential fertility of the prosperous and poorer classes is rapidly disappearing. In its inception the fall of national fertility was mainly due to a change in that of the relatively well to do. Since the latter form a relatively small section of the population, fertility is almost certain to decline more steeply in the next two decades. So any estimates of the prospect of a rapid decline in population such as those given by Dr. Charles are likely to prove conservative.

§ 2

Sooner or later any Government, Socialist or otherwise, will have to face the task of raising fertility or to accept a downhill retreat to racial extinction. A few more figures will help to show the magnitude of the undertaking. At present marriage, death, and sterility rates, the maintenance of a population at a fixed level

demands a mean completed family of nearly three children. Although a Labour Government could easily halve the infant death toll, if (among other things) it were resolute enough to sack the higher officials at the Ministry of Health, it is quite certain that no juggling with death or marriage rates would reduce this estimate appreciably below two and a half. To maintain an average of three children per marriage there must be many families of four or more to offset families of two or one and none at all. The problem of maintaining a population is therefore the problem of getting most people to have at least three children, and this can only be done if a large number can be induced to have at least four. In other words we have to make the four-child family fashionable.

This simple feature of the problem is almost universally neglected. Its importance is emphasized by what is actually happening in countries where the recorded statistics enable us to estimate what changes in the size of the family accompany a declining fertility. This has been done recently by Enid Charles in a memoir on the Australian population. Her analysis shows us that the Australian decline has been accompanied by a proportionate increase of the two-child family over all others—including the one-child family. The implications of this fact are profoundly significant. Many people dismiss the urgency of the prospect discussed by asserting that most women want children. The problem of arresting a decline at any level appropriate to circumstances is not merely, or mainly, the problem of inducing people who would otherwise have no children to have one or two. It has not arisen because people refuse to have children. It exists because the two-child family is now the fashionable family. The task of rational birth control is to make the four-child family fashionable, and it exists because the whole influence of the birth-control movement has been exerted to exalt the two-child family as the social norm. Travellers say that the anthropoid apes cannot count beyond four. Birth controllers are usually incapable of counting beyond two. That birth-control advocates are quite sincere in professing that they do not want to stop people having

children is beside the point. By exalting the two-child norm they have made the parent of the four-child family an object of public pity or opprobrium, liable to unfavourable comparison with an edible rodent universally detested in Australia.

In adjusting themselves to facts about which there is no room for disagreement many people find it difficult to disengage themselves from the nightmare of overpopulation. The possibility of overpopulation which haunted social reformers during the past century is still taken seriously. This is partly due to ignorance concerning resources of power and substitutes which modern technology could make available for human welfare in a rationally planned economy. It may also take a more plausible form. Without contesting the potential of plenty which is now within reach, some advocates of birth control contend that there are too many people to be housed in genuine comfort. So up to a certain point a decline in population is welcome. That there is a psychological optimum of population density may well be true, and those of us who value privacy would be the last to deny it. It does not entitle us to overlook another consideration. As Enid Charles remarks, a pleasant scenic view half-way down a steep hill leading to a precipice is poor consolation to the driver of a car with no brake. Malthusian propaganda and the rather quaint physiology of Thomas Hardy's novels have conspired to inculcate a naïve teleology which invests parenthood with a perverse automatism. Human reproduction is assumed to proceed with its own momentum unless the most frantic propaganda is carried on to check it.

That this is a travesty of ascertained facts about the social behaviour of the human species is easily seen when we examine the reasons which are casually given for the present character of population growth, the proposals sometimes advanced by those who welcome a decline in population, and the answers they give, when asked to state how they would arrest it at a level appropriate to their inclinations. Two common reasons are given for the continuous decline of fertility in northern and western Europe during the past fifty years. Professor Sargent Florence

holds that it is due to the introduction of contraceptive devices. Taken by itself this is rather like saying that we wear clothes because sheep grow wool or because silk-worms secrete cocoons. The fact is that Fallopius wrote a treatise in the opening years of the seventeenth century on the commonest and safest appliance used to-day, and it was advertised in England two centuries ago. What demands an answer is not what means people use to limit their families. It is what circumstances in their social lives lead them to use whatever means are available to them. The distinction is important, because Hitler and Mussolini have also confused the means adopted with the end in view. They think that they can arrest the rapidly declining fertility of Germany and Italy by prohibiting particular methods of family limitation. History, which will record their failure, will read a new meaning in the adage that modern love laughs at locksmiths.

Another assertion, though not advanced by serious students of the problem, is almost ubiquitous in general discussions of population. The reasons why people have less children are said to be *economic*. It apparently implied that people would be induced to have more children if they were more prosperous. The tenacity of this delusion is remarkable in view of the one feature of differential fertility familiar to most ordinary people. Putting the matter crudely, it is hardly too much to say that in the initial stages of declining fertility the richer people are the less children they have. This is true through every grade of modern society except possibly the negligibly over-rich. The one thing which is certain about the decline of fertility in contemporary civilization is that it is not due to economic obstacles in the ordinary sense of the term. That is to say, it is not due to limitations imposed by the *spending capacity* of the individual parent. Hence it is not surprising that the only radical remedy which has been widely favoured has been a conspicuous failure. Mr. Glass has recently published a résumé of existing schemes of family endowment in various countries. Up to date no scheme has provided a sufficient incentive to raise fertility.

The advocates of family endowment may make the objection

that no allowances at present in force are big enough to achieve their object. Fortunately for their peace of mind, they do not venture to guess how big an inducement is necessary. A professional man who earns a thousand a year may be married to a woman earning a salary as high as his own. Nothing less than six hundred a year per child would maintain their joint standard of personal expenditure if they undertook to raise a family of four. Do the advocates of family endowment propose allowances on this scale within the economy of private profit, and have they any means of adjusting them to its concomitant inequalities of income? To ask the question is to supply the answer. The situation with which we are faced is one for which industrial capitalism offers no solution, because a system of family allowances which could conceivably provide a sufficient stimulus to raise fertility above the extinction potential would wreck it.

Few who are Socialists will quarrel with this conclusion, and if there were nothing more to say there would be no reason for raising the issue in this context. The reason for doing so is that Socialists are still largely prejudiced by the Malthusian mythology and too easily assume that population will look after itself if capitalism is abolished. There is no rational justification for this. Certain features of man's social behaviour are common to any kind of civilized society; and we may presume that any economy which replaces capitalism will share some of its characteristics. For instance, we may presume that men and women will still wear clothes if a socialist economy replaces capitalism. It is therefore naïve to welcome the admitted biological failure of capitalism, unless we are convinced that Socialism can ensure the irreducible minimum of fertility on which the permanence of civilized society depends. Sooner or later Socialists will have to face the following question. Is the pattern of sterility characteristic of declining capitalism wholly a consequence of social agencies inherent in capitalism as such, or is it in part or whole a consequence of social agencies which could still operate under Socialism? If the answer to the first question is negative, a positive population policy is a paramount concern of Socialism.

Some Socialists will reply that Russia has no population problem. To dismiss the issue on these grounds is superficial, if not flippant. Fertility which was higher in Russia than in any other European country before the war has actually declined since the Revolution. The recent restrictions on abortion do not encourage the belief that the present rulers of the U.S.S.R. are entirely happy about it. A generation must elapse before the data supplied by the Soviet Union itself can justify any rational judgment concerning the effect of present social policy on the attitude to parenthood. Meanwhile spending power is still low throughout the Union as a whole, the bulk of the population is not yet urbanized, and the study of differential fertility in other countries justifies the belief that Soviet industrialization is imitating many features propitious to sterility in the social structure of capitalist countries. For all these reasons the example of Russia can give us little guidance about the place of parenthood in a socialist economy, more especially if it replaces capitalism at a stage when fertility is below the biological minimum.

Before we could draw any conclusions from the Russian scene we should need to know how far Russia will proceed along the road to vocational equality in sex relations or whether the present headlong retreat to the patriarchal family is a temporary expedient, how far Soviet policy will favour a stable marriage relationship or whether easy divorce will be liquidated like abortion, how far the present enthusiasm for rapid industrialization will perpetuate the evils of urban congestion in capitalist countries or whether the demand for a modicum of decent privacy will assert itself as proletarian decorum. Even if we could yet answer these questions, the example of Russia would be of dubious significance. The psychological difficulties of raising fertility to the survival level when it has fallen far below it may be immeasurably greater than those of checking its descent below the survival minimum when it is still at a much higher level.

§ 3

In the meantime we have substantial materials for estimating what features of capitalist civilization are propitious to fertility or otherwise; and we can decide whether these need be perpetuated by a socialist economy. The necessary data are supplied by the existence of wide differences in actual fertility and the rate at which it is declining in different communities, occupations, and localities within the same national units. Among the more relevant features which emerge from a survey of the phenomena elucidated by extensive researches on differential fertility by Enid Charles are urban congestion, child labour, employment of women, stability of marriage, and low initial earnings in occupations with high maximal emoluments. Of these the most striking is the urban-rural fertility differential which is an almost universal feature of contemporary communities.

Among other features of differential fertility urban congestion claims pre-eminence, if only because it is not an essentially *new* feature of capitalist society. Some of the large cities of Europe were incapable of reproducing themselves long before a decline in national fertility began. Indeed, the past hundred years has seen the continual growth of the town at the expense of the surrounding countryside with a higher level of fertility. That high density of population generally goes with low fertility is beyond dispute. Difference of opinion only arises about explanations offered for it. One view is that the relatively high fertility of the countryside is due to ignorance of contraceptive amenities. Before accepting this as a sufficient reason we ought to ask why the conditions of life in a city favour the spread of contraceptive knowledge. In so far as urbanism favours low fertility some conspicuous features of city life may be grouped under three headings: positive obstacles to parenthood inherent in the conditions of urban congestion, alternative distractions which compete with the satisfaction of the claims of parenthood as a source of enjoyment, and the impact of a new pattern of social relations on the stability of the family group.

The recognition of some of the positive obstacles presents no difficulties to parents themselves, and it is necessary to mention them only because so few people are parents. Every mother of four knows that a garden surrounded by a wall is worth all the labour-saving devices yet invented. You may provide crèches, school feeding, family allowances, holidays with pay for expectant mothers, and a thousand and one other inducements. If you do not give people space, you will not make parenthood endurable. As a parent I have no doubt whatever in asserting that five children in a house surrounded by its own garden in a locality where there is little traffic are far less trouble than one child in a London flat. It is my deliberate opinion that family life in flats is incompatible with fertility, and if Socialists cannot think up anything better than the workers' flats in Vienna, we should be thankful that Dolfuss destroyed them before they had built sterility into the structure of a socialist society.

A second feature of urban life is sometimes dismissed too lightly because bishops are apt to make tiresome remarks about it. The drift of the population from country to town involves a continual displacement of active enjoyment by passive forms of satisfaction. For people who find their amusements in cultivating roses, growing their own salads, keeping bees or breeding rabbits in their own gardens, playing the piano, making their own clothes and household amenities, the use of leisure does not conflict with the demands of the home as the centre of family life. These pursuits are either impossible under urban conditions or disappear in competition with the passive distractions which city life offers. The cinema, which could be the greatest instrument yet devised for democratizing knowledge if every mathematical classroom were fitted with a projector, is mainly used to compensate for the unbearable tedium of life in a model flat. Crowds assemble to watch expert games which are only played by professionals or gentlemen. Having abandoned the family pew and the choir practice, we turn on the radio and listen to crooners. Side by side with the commercialization of passive enjoyment children and parents compete with one another in maintaining

a pattern of conspicuous expenditure. This being so, it is not surprising that no system of family allowances yet devised has encouraged people to have more children. The chief use of an income in modern life is to purchase substitutes for whatever satisfaction parenthood brings.

The pattern of passive satisfaction and conspicuous expenditure encouraged by an increasing multiplicity of useless commodities and new distractions is only one side of the psychological problem presented by urban concentration. In rural surroundings, where children grow up in contact with the recurrence of parenthood in animals and plants, the processes by which life renews itself are accepted as natural events. In the city reproduction is an unwarranted intrusion of hospital practice on the orderly routine of a mechanized existence. The machine, which neither grows nor begets, sets the fashion of human relationships. In the large community the family ceases to function as a focus for social relations, as the individual is free to choose associates more and more exclusively from persons of the same occupational and age groups.

One feature of the large community of conspicuous expenditure is of special interest in connection with the social class with the lowest fertility. This is the culture value which is increasingly attached to foreign travel. Perhaps no characteristic of modern life is more devastating to the stability of the family group. Within the professional class, whose fertility is now well below a 50 per cent replacement level, a married couple are faced by the deliberate choice between repudiating parenthood and accepting a cultural standard which is despised by other members of their occupational group. Familiarity with the names of Viennese hotels and a liberal smattering of linguistic bric-à-brac collected on vacational tours are now the indispensable stigmata of an educated person in a milieu where discussions on homo-sexuality excite less disgust than a reference to homework or whooping-cough. We are rapidly approaching a state of affairs in which the cultural barriers between the fertile and the infertile within one and the same social class are

as acute as any pre-existing barriers between contiguous social classes.

In all existing communities the family is the unit of human reproductive activity. Whether a society which wholly relegated the care of children to experts could maintain fertility at the survival minimum remains to be seen. It is a possibility which we cannot dismiss till it has been tried out. Meanwhile we can be certain of one thing. The large community of conspicuous expenditure is no longer compatible with family life, if indeed it ever was so; and the increasing drift to the large towns is leading to the destruction of family life, whether we actively assist the process or leave the issue to fate. If we leave the issue to fate, the advent of a socialist economy *en rapport* with the aims of Mr. Herbert Morrison will make the decline of population more swift, more certain, and more irretrievable than present circumstances suggest. A solution of the problem of modern population will be a Utopian solution.

Beyond reasonable doubt the social accompaniments of low fertility suggested by existing differences connected with locality and occupation are not necessarily restricted to a capitalist economy. To some extent, perhaps very largely, they are characteristic of industrialism rather than of capitalism as such, and the laudable project of relieving us from the dictatorship of the banks or the parasitism of the rentier of itself offers no guarantee that they will disappear.

Thus the study of population compels us to make a distinction between two radically different types of socialist planning. One may be called planning for survival, the other planning for purchasing power. These alternatives have nothing to do with any schisms which separate Socialists on matters of political strategy. Whatever views Socialists may hold on matters of party allegiance, most of them are now mainly concerned with the same main objective. They aim at keeping productive efficiency at a maximum by expanding the volume of effective demand through social control of production and remuneration. In other words they are less concerned with asking whether capitalist

industrialism produces the things men need most than with demanding that everyone should have access to any trash it is capable of producing.

In view of the rising popularity of Fascist doctrines, it is important to emphasize that the distribution of purchasing power to increase the volume of effective demand is essentially different from the view held by the pioneers of Socialism fifty or a hundred years ago, and it would have been regarded by them as a capitulation to the prevailing doctrine of *laisser-faire*, against which they revolted. Men like Owen and Morris were far less taken in by the glamour of capitalism than ourselves. They were not content to criticize it because it distributed its products unjustly, or because it was incapable of producing as large a quantity of goods as a planned economy could deliver. They also, and more especially, attacked it because it was not producing the kind of goods which are good for people to want and to strive for, and they were not hypnotized by the liberal delusion that things people have been educated to demand by capitalist advertisement are necessarily the things they *need* most.

To-day we are apt to dismiss their lament on the ugliness which capitalist enterprise has bequeathed us as mere aestheticism with no significance for a realistic political programme. In this context realism implies a servile acceptance of the three cardinal errors of early capitalist ideology. The first is the assumption that the greatest good of the greatest number is achieved by producing the greatest number of saleable goods and ensuring that the greatest number of people can take their choice. The second is that the large community is a necessary condition of high productive capacity. The third is that peace between nations can only be ensured by maximum division of labour with free trade. I believe that each of these postulates is biologically false, and that the results of acting as if they were true will be biologically disastrous. If Socialism accepts the distribution of purchasing power as its primary and sole concern, its success will merely aggravate the tendencies which have made capitalism a biological failure. Meanwhile it will not disarm criticism by capitulating to

liberal ideals. On the contrary, its preoccupation with an exclusively mechanical conception of scientific planning will make it easier for the fake biological doctrines of Fascism to canalize discontents which are more deep-seated than many of us realize and more widespread than poverty alone. If we neglect the significance of this, Socialism may make way for the circus man with a short moustache and the long whip.

Neither of these results need occur if Socialists are prepared to undertake a more radical critique of the social values which capitalism has imposed on us. The liberal ideology which has replaced the penetrating insight of the pioneers of English Socialism was adapted to the characteristics of capitalist development in an age when the chief source of power was coal, the sole instrument of chemical manufacture was heat, the basic constituents of metallurgical operations were iron and copper, the only method of quick transit was the train, and the principal capital asset of agriculture was the land itself. We are now on the threshold of an age of hydroelectric power, of electrolytic chemical processes, of light metals which exist in abundance everywhere. Cellulose is beginning to displace coal as a source of synthetic operations. Fertilizers and applied genetics have made land the least important part of capital equipment in food production. Civil aviation, the light car, television, and broadcasting provide an escape from the disadvantages of cultural isolation contingent on small community life. Urban congestion is unnecessary. A much higher potential of self-sufficiency exists, and the advent of a light metal economy could remove one of the principal sources of national rivalries. In these circumstances the Labour Party can think of nothing better than perpetuating the effete technology of coal by nationalizing the mines, tinkering with London's transport facilities, putting up tenements for two-child families, and bleating about the nationalization of the land without advancing a single constructive proposal for collectivizing the nation's food supply on a scientific basis.

It is not far from the truth to say that the much-despised aestheticism of the Utopians is being vindicated by events. In his

own time Morris contended that the drabness of capitalism is its chief condemnation. Hitler has now shown that people will go without butter if you give them circuses. Morris was a sound social psychologist in believing that a Socialist programme cannot afford to neglect the fact that people want their lives to be picturesque, and he was a sound biologist in believing that we could make Britain so beautiful that people would not feel the itch to travel. On the other hand, Miss Ellen Wilkinson is not a sound biologist or a shrewd social psychologist when she expresses surprise and anger because German women respond to Hitler's promise of home and husband. Home and family may be an intolerable imposition for the few gifted women who are capable of being first-rate doctors, lawyers, journalists, scientists, or artists. For most women it is not so. The majority of women, like the majority of men, would never be capable of being first-rate doctors, lawyers, journalists, scientists, or artists in any society we can imagine. Home life under almost any conditions offers more scope for initiative than the privilege of strap-hanging in one of the London Passenger Transport Board's amenities to the daily exhilarations of commercial typing and the thrills of lunch in a Lyons teashop.

While the urban-rural fertility differential directs attention to many features of town life which are inimical to parenthood, it is not a sufficient basis for a survival policy. To arrest the decline of a population at any appropriate level it may be necessary to apply simultaneously a very large number of expedients each of which would of itself have very little influence. Incentives which would reinstate a survival minimum among women with no outstanding talents for specialized work might have no effect on the average fertility of women who prefer to exercise gifts more specialized than the care of young children calls for. An effective population policy might in fact embrace features designed to furnish a more congenial setting for family life and devices for relieving parents of the burdens which family life imposes. Among other circumstances climate will play a large part in deciding what population policy is best fitted to local circumstances. In

Scandinavian countries flats with central heating are a necessity of comfortable existence through the long winters which restrict the scope of outside enjoyment; and metropolitanization has not yet reached pathological dimensions. The policy advocated by the Myrdals is specially concerned with the provision of crèches and nursery schools to lighten the burdens which parenthood imposes.

I have expressed the opinion that family allowances on a scale compatible with capitalist distribution applied within the framework of capitalist production are not likely to guarantee survival. This does not mean that family endowment can be dropped out of the programme of a socialist economy. When civilized countries recognize the menace of racial extinction, women may well be able to dictate their own terms, and I do not think it is profitable for a male to speculate upon what their terms will be. From the masculine standpoint one consideration is obvious. It is a monstrous injustice to expect men to undertake the financial responsibilities of parenthood and agree to equal pay for equal work. The attempt to induce the male population to co-operate in maintaining its continued existence is not likely to succeed in a society which endorses equal pay for equal work without paying for the cost of rearing a family.

From the feminine point of view it is difficult to see how a system of family endowment can be made to work if remuneration for parenthood is less than for other forms of socially useful activity. Hence planning for survival may entail a much closer approximation to equality of wealth than most Socialists now advocate. During the last few years we have witnessed what appeared to be a headlong retreat from the equalitarian view in the Soviet Union. The system of bonuses for motherhood introduced during the past year may provide a new illustration of progress by the interpenetration of opposites, and Equality, lately denounced as a social democratic deviation, may be reinstated as proletarian virtue. In pursuing our own line to the Equalitarian Commonwealth, we must either rehabilitate the socialist creed in alignment with the evident biological failure of the Acquisitive

Society, or allow the population issue to become a new bulwark of social reaction. There are sufficient signs that the Conservative Party is more alive to its existence than the Labour Party. This is the inevitable consequence of selecting our radical intelligentsia from the products of a moribund culture and conducting socialist propaganda in a way which inevitably antagonizes people equipped with scientific and technical knowledge.

8

Education for an Age of Plenty[1]

CULTURALLY AND POLITICALLY the twenty years which have elapsed since the Russian Revolution and the end of the European War have been a period of high hopes and bitter disillusionments. In many ways the sequence of events and the sentiments they have engendered invite comparison with British history during the half-century between the impeachment of Warren Hastings and the passage of the Reform Bill. History books which concern themselves mainly with political and economic changes pay little attention to one feature of British social life during this period. The year of the impeachment of Warren Hastings was the year in which the Royal Society of Edinburgh received its charter. The year in which the Reform Bill was introduced was the year in which Babbage, then Lucasian Professor in the Newtonian succession, published a now forgotten tract entitled *The Decline of Science in England*. Side by side with English economic expansion and political awakening a cultural revolution was in progress.

The object which Babbage had in view was to expose the decay of the official organs of British science at this time. Perhaps his plea is forgotten because a fresh efflorescence of British science had already begun while he was composing it—simultaneously Faraday announced the discovery of electro-magnetic induction. Maybe it is forgotten for another reason. The circumstances which prompted it are not flattering to the universities in which our historians are gently nurtured. Those of you who have read the works of Ure, of Bremner, of Babbage, and of others who

[1] An address given to the Sixteenth Annual Conference of the British Institute of Adult Education.

wrote on the new industries of this period will not need to be told that industry was then making big demands for theoretical guidance in chemistry and mechanics. The official English universities were totally unequipped to meet them. New universities came into existence to discharge the cultural task which industrial expansion imposed, and the established seats of learning took no steps to modernize their curricula till their prestige was seriously threatened by the establishment of competing institutions in the latter half of the nineteenth century.

The details of the struggle, which reached its climax in the repeal of religious tests at the universities, are less familiar facts and belong to the history of science rather than to the history of history books. Four have special reference to what I conceive to be the primary function of adult education to-day. The first is that during the whole century 1770–1870 the social personnel of British science was made up of men who had no formal training in the established English universities. Clerk Maxwell was invited to occupy the new chair of experimental physics at Cambridge in the year which brought the struggle for the repeal of the Test Acts to an end. Till then there had been no special provision for teaching electricity at Cambridge. It had turned a deaf ear to the eloquent plea of Babbage till Kelvin made a fortune of £180,000 by applying Cambridge mathematics to the Atlantic cable problem. During the preceding century no prominent leader of science had seen the inside of an English university. Priestley was not a university man; nor were Owen, Henry, and Davy. Faraday was not, neither was Joule. I can think only of one outstanding exception to this rule. Beddoes, who sponsored Davy's career, had been at Oxford. Apparently because of the unpopularity of his Jacobin persuasions, he left it to found one of the new institutions which were undertaking the tasks which established universities had neglected.

It is less well known that the foundation of these institutions was preceded by the formation of local associations including in their membership the creative personnel of the time. The foundation of new institutions for teaching, such as the Manchester

Institute of Technology and Owens College, was itself preceded by the formation of groups like the Manchester Literary and Philosophical Society and its predecessors, the Lunar Society at Birmingham and the Royal Society at Edinburgh. The personality of Beddoes at Bristol was the centre of a fourth group. The Martineaus and their friends at Norwich were another. The importance of these groups to the science of the time was immense. In 1790 no less than four members of the firm of Boulton and Watt were Fellows of the Royal Society. The Lunar Society included about ten in all.

These local academies which flourished at the end of the eighteenth century had one feature in common. Like the London Royal Society founded a century earlier, and like its American offspring, the Philadelphia Academy, they valued "such knowledge as hath a tendency to use." They were tendencious, and tendencious in more senses than one. The Lunar Society, known as the lunatics, was notorious in its Jacobin sympathies. Its members were the special target of the anti-Jacobin riots in Birmingham. One of its most distinguished members, Priestley, the discoverer of oxygen and laughing gas, was elected a member of the National Convention. He was famous both as a chemist and as one of the "English Patriots." The Manchester Literary and Philosophical Society was equally partisan. Like the Lunar Society, it sent delegates to the Club of the Jacobins.

The prestige now enjoyed by science in our universities was won because new social needs brought into being popular movements to voice the demand for a type of instruction then neglected by the higher seats of learning. The popular movement created its own organs of instruction and research. In general they had an explicit political orientation. The inadequacy of pre-existing institutions was subjected to outspoken criticism. The older established universities yielded to popular pressure only when new institutions with a new cultural outlook had already proved themselves to be more representative of the needs of the time. A university may be a good hotel or an elegant cenotaph for an established science. The history of universities

does not show that they are well equipped to serve as lying-in hospitals.

§ 2

If we examine the curriculum of a modern university, we may classify its constituents into three groups, which respectively include the names of branches of knowledge once useful, still useful, or possibly destined to be useful. Greek is an example of a subject which retains a high prestige because it was *once* recognized as a useful subject. In his lectures on Erasmus, Froude describes the time when the introduction of Greek into Oxford was the occasion of rioting. The partisans were known as "Greeks" and "Trojans." The latter supported the monastic orders, the Vulgate, and the *status quo*. The former stood for the re-examination of biblical texts and a critical attitude to innovations. To the impending struggles for reformation in the time of Sir Thomas More the "Greeks" and "Trojans" stand in much the same relation as Marxism and *Rassenhygiene* to the conflict between contemporary capitalism and communism.

Periods of intellectual renaissance are periods when education is *about something*, when it has a topical relation to social needs and to social aspirations which dominate the lives of men and women. If the Adult Education Movement has any future, it is because it does, or can, provide socially relevant instruction in this sense, and because it can satisfy a need which is not satisfied by existing organs of instruction. If, as I believe, it has failed in the past to do so, there is a special urgency in the plea for a frank recognition of its shortcomings and renewed effort to fulfil the only policy which can justify or sustain its continued existence. Democratic ideals of education are now involved in a life and death struggle as ruthless as the conflict between the Inquisition and the Reformed doctrine.

In Germany and Italy cultural and vocational education is now co-ordinated by the single aim of cultivating unquestioning obedience to the military machine, an arrogant sense of racial or national superiority, and the exaltation of war as the fulfilment

of human destiny. In Britain the challenge of the dictator countries has been taken up by two contrary schools of opinion. The difference between them recalls a distinction Mr. Wells once made between two kinds of pacifists. One he called the Genteel Whig and the other the disgruntled employee. Let us examine them and ask whether the Adult Education Movement may not be able to adopt a third and more effective policy.

The Genteel Whig is a fitting description for the school of thought represented by the *New Statesman* and Sir Ernest Simon. It is difficult to do justice to a point of view with which one has no sympathy at all. So I cannot hope to state their attitude with the eloquence which would please its advocates. Put in the most plausible form I suppose they contend that education should aim at giving an unbiassed view on controversial questions and that knowledge is worth pursuing for its "own" sake. The first assertion recalls a cynical and not necessarily justifiable remark by the veteran feminist Ellen Key, who said that nobody is justified in denouncing monogamy until someone has tried it. I cannot think of any form of legitimate instruction in which it is the business of a teacher to give an unbiased view on controversial questions. I cannot imagine an inspiring teacher conforming to this insipid recipe. I do not know of any body of accepted belief promoted in this way. The accepted technique of teaching chemistry does not imply that the Phlogiston theory has as much to be said for it as the Atomic theory. The belief that an education which aims at unbiased treatment of controversial topics can help to solve the problems of democracy is psychologically false and could only defeat its ostensible aim.

It is psychologically false for two reasons. One is that the unbiased teacher, if he exists and if time permitted him to state every possible argument for and against every proposition advanced, would be insipid and uninspiring. The other is that education which can help to salvage democracy is not exclusively a matter of information and reason. It has to stimulate *the will to constructive effort.* The utter insincerity of the view I am now discussing is easy to see with the aid of a topical example.

Those who hold it consistently would take pains to see that every citizen gave due weight to fool arguments concocted by military mystics to delude mankind into thinking that war is a sacrament or a picnic. Happily few of them would attempt to practise what they preach. When the fire alarm calls out the municipal fire engines they recognize that unbiased statement of the case for voluntary salvage corps is not what the situation demands.

Education which will help us to eradicate war cannot be unbiased. It must concern itself with what reasonable grounds can sustain our determination to do so and what course of social action can reasonably be expected to guarantee success. In reality the effect of ostensibly unbiased instruction would always be to give education a strongly conservative bias. Human beings are morally and mentally lazy. They are readier to grasp the force of arguments against any radical change in their social habits than to adventure with new expedients. Consequently teaching without any bias must always maintain the *status quo* and obstruct the impulse to courageous and creative social effort.

Among academically minded people there is a common delusion that a lack of bias and a passion for factual knowledge are closely connected with one another. Hence they assume that being unbiased and being scientific are much the same thing. In social affairs there is no necessary connection of this kind. All facts are not equally relevant to every course of action. We only know what class of facts are useful when we have decided upon what we are to do with them. When we have agreed to pursue a common aim in our common interests we can pursue the search for relevant facts. Liberals agree that war and disease are eradicable nuisances, and many of them are warm supporters of the efforts of teachers on behalf of the League of Nations or of the provision of teaching in physiology and hygiene. They do not propose that teachers of physiology should waste their time in stating the arguments in favour of Christian Science. If their impulse to eradicate poverty were as genuine as their disposition to advance the cause of peace or national health, they would not pretend that our common interest in abolishing poverty is a proper topic

for unbiased treatment. The unbiased treatment of controversial topics is a plea for conservatism and a public confession that liberal rationalism is not in earnest about the economic welfare of the masses.

The second article in the creed of the Genteel Whig demands more discussion because it is more widely held and more often stated. The hall-mark of genteel Whiggery in education is to draw a sharp distinction between knowledge cultivated as a means of livelihood and true intellectual culture, which is knowledge sought as an end in itself. Being an empirical Englishman I cannot escape the suspicion that people justify a thing as good in itself when they know of no sound reason to commend it to their opponents. It will generally be found that knowledge as an end in itself is knowledge once sought because it then had a vital relationship to pressing social needs and is now cultivated as an ornament of leisure. The defence of knowledge as an end in itself conceals a confusion between two aspects of the process by which knowledge is acquired. In general those who advance knowledge are those who have a strong personal interest in certain classes of problems for some reason connected with upbringing or constitution. Whether they are able to gratify this interest to a greater or lesser extent depends on a variety of circumstances such as whether their work advances the material or social aspirations of a powerful social group. What makes it important for the average citizen to have knowledge of this kind depends on whether such knowledge is or is not relevant to civic welfare.

In so far as the statement that knowledge should be sought as an end in itself has a legitimate meaning it can imply only one thing. The predilections of specialists who interest themselves in a particular class of problems are not necessarily, or even usually, connected with utilitarian considerations. The truth of this statement has no relevance to the education of the average citizen. An illustration will make the confusion of thought more explicit. Psychoanalysts say that surgery provides a legitimate form of sublimation for the sadistic impulses of people who have the manual skill which surgery demands. Whether this statement is

true or what precise meaning should be attached to it need not here detain us. Let us take it at its face value for the sake of argument. I believe that the history of science shows conclusively that surgery has advanced when there has been a pressing social demand to reduce human suffering. It may or may not be true that surgeons have a disposition to inflict suffering. If it is true, it is not the reason why citizens provide them with opportunities for their work or why it is necessary for citizens who are not themselves surgeons to realize that the study of surgery should be encouraged.

I have recently conducted a public experiment which has some bearing on the assertion that education is only truly popular when it is socially relevant. Once while in hospital I amused myself by writing a book which has sold over a hundred thousand copies in English-speaking countries and has been translated into eight languages during the first two years after publication. No one is more conscious of the defects of *Mathematics for the Million* than I am. The only unusual gift I lay claim to is the ability to see one of the things really clever people overlook. I attribute the sales of this book exclusively to one thing. People who were repelled by a subject which their teachers justified as an end in itself were excited to find it had some relation to the record of human achievement. They had not previously realized that mathematicians are useful, or that they pretend to be useless, only because the affectation of uselessness is the hall-mark of social prosperity.

The theme that knowledge should be sought for its own sake is popular among people with an academic training because few of us like to admit the shortcomings of our own intellectual equipment, especially when it is invested with a satisfactory measure of social prestige. It is easier for a university man to feel that he enjoys the best educational facilities of his time than to recognize how little of what he has been taught is of imminent importance. While he is content with the assertion that knowledge is worth seeking for its own sake, he is spared the necessity of asking himself whether his own intellectual resources can be

of any service to his contemporaries. The outcome is a belief very widely held among the supporters of adult education in our universities.

Briefly stated it is this. Upon the banks of the Isis there burns a bright beacon which has illuminated the dark night of British social culture with undimmed brilliance from the days of the Wycliffite preachers to the benefactions of Lord Nuffield. Thence Olympian runners with torches in their hands carry the Promethean flame into the Stygian darkness of Suburbia, Lancashire and the Midlands. The Olympian runners are W.E.A. tutors who have been to Oxford or have sat at the feet of authentic dons. After my brief remarks on the history of English social culture further comment on the arrogant complacency which is too common among university men would be out of place. Anything I might say about the futility of social studies in our universities has been said with more vigour and effect by Bernard Shaw and H. G. Wells. Those who will not heed Moses and the prophet will not heed me.

§ 3

The belief that freedom of thought can be justified by its sheer uselessness has nothing in common with the educational ideals of democracy when it was struggling to establish itself in Europe. It will not survive the challenge of dictatorship in our own time. If we cannot meet the challenge of dictatorship with a positive educational programme, we must make way for a more virile creed. The appeal of the Left Book Club, which turns to the closed system of Marxism with the fanatical vehemence of the racialist dogma in the Third Reich, is powerful because it is a virile creed. Though I have more sympathy for the Left Book Club than for the nebulous benevolence of the *New Statesman*, I do not suppose that my comments on it will conciliate its supporters, who treasure their resources of abuse for those who are nearest akin to themselves.

In stating the view that periods of economic renaissance are times when education is most closely allied to pressing social

needs and to emergent social aspirations I subscribe to a view which Luther and John Knox, Lenin or Mr. Victor Gollancz could equally endorse. Those who would most like to club me with a Left Book would agree with me in the following statement of what are the pressing needs of our own time. The advance of scientific knowledge has placed at our disposal unrecognized resources for the satisfaction of common human needs and sinister instruments for self-destruction. The distribution of the benefits of discovery as dividends to a restricted social class and the recurrent unemployment of capitalist society have become an obstacle to further social or cultural progress. The cultural task of education in the Age of Potential Plenty is to distribute knowledge of the constructive possibilities of human welfare within our reach, and to show us how to replace a defective social mechanism which prevents us from taking advantage of them. I see no reason for encouraging adult education if it does not start with this explicitly socialist bias. One of the reasons why we have universal education is that John Knox was biased in favour of founding the Kingdom of God in Edinburgh.

A large number of ordinarily intelligent people have begun to realize that political democracy is a sham if it cannot guarantee a much larger share in the benefits of advancing knowledge and improved technical skill to the average citizen. A very large number of ordinarily intelligent people who have no articulate sympathy for Socialism realize that capitalism has outlived its usefulness. Many more would come to the same conclusion if they had more information about the resources which scientific technology has placed within our reach. The task of salvaging democracy is a positive one. We shall not resist the challenge of dictatorship and the downward path from militarism to barbarism if we are content to defend a democracy which has ceased to satisfy the social aspirations of men and women. The educational task of salvaging democracy is to canalize the will to constructive social innovation by asserting the reasonable grounds for hopefulness in the human experiment, and to distribute knowledge

which can be instrumental in the co-operative task of social reconstruction.

At present the universities do not directly provide instruction which is directly helpful in either way. Consequently an Adult Education Movement which aims at retailing the culture of the universities is not socially relevant to the needs of our time. Voltaire tells us that in 1612 the chemists of the Sorbonne were compelled by the Parliament of Paris to confine their teaching within the limits of Aristotle's doctrine on pain of death and confiscation of goods. The mediaeval rubbish taught as economics in our universities is a survival of the Aristotelian belief that a science can be built up from a foundation of self-evident principles. Strong social pressure supported by a powerful popular movement forced our universities to abandon the chemistry of self-evident principles and establish it as a factual science. Nothing less will compel our universities to undertake the task of teaching and promoting a factual science of wealth.

The strength of the Marxist position lies in the fact that Marxists recognize this. As I see it, their weakness is that they do not offer a much better alternative. I believe that in the past the importance of Marx has been grossly underrated by the academically trained. A totally exaggerated confidence in his teaching is the natural reaction of the rising generation, who recognize that Marx was often more wise than his contemporaries. For the general attitude of Marx to social change very much may be said. I myself should be willing to call myself a Marxist in the same sense that I am a Darwinian. I can call myself a Darwinian conscientiously, because we all regard Darwin as the beginning rather than the end of a new chapter in biology. No one who calls himself a Darwinian need now hesitate to point out that Darwin's contemporary Mendel was decisively right on issues about which Darwin was demonstrably wrong. The danger of Marxism as a popular movement lies in the fact that it is a closed system. None of his more vocal disciples treat the teachings of Marx as a scientific hypothesis which must live dangerously, like other scientific hypotheses. Consequently Marxism is not, as

it should be, an incentive to the pursuit and spread of useful knowledge.

When theory prescribes a course of action which is conclusively discredited by the course of events the attitude of the Marxist is not the attitude of the scientific worker, who recognizes that a theory found wanting must be modified in the light of new data. Like a Plymouth Brother with a partiality for the prophecies of Daniel, he scours the texts to prove that faulty interpretation of the inspired message was due to party frailty. Biblemaking is a common manifestation of original sin, and in some measure all new doctrines—evolution among them in its own time—have been tainted with it. So this general criticism of Marxism would not be just if there were not more pressing and immediate reasons for hesitating to accept Marxism in its entirety as a social creed. To me it seems that the great danger in putting lexicography above research is that Marxist teaching faces new situations with threadbare theories. It is now vitally essential to get precise information which the teaching of Marx does not furnish.

The particular analysis of capitalism which Marx advanced was largely an *argumentum ad hominem*. He took the social psychology of the apologists of capitalism at its face value and showed what results would follow if they were correct about the way in which capitalism works. As such it was a brilliant *tour de force*. Since Marx was a genuine scientist in so far as he made a close factual study of capitalism in his own time, he was able to advance hypotheses which have been brilliantly confirmed by subsequent events. Since he wrote at a time when child labour was common in the factories, when universal education was not yet established, when a popular press was non-existent, and when the radio or the cinema were not yet conceived in the womb of time, Marx was not equipped with the necessary data for constructing a correct hypothesis about contemporary capitalist evolution. Inevitably he made blunders, for which we may be the sufferers if we do not recognize them. The failure of his followers to meet the challenge of the Nazi Party is a measure of the insufficiency of his teaching. The implicit confession of this insufficiency by

the subsequent *volte face* of the Marxists may be taken as a measure of the extent to which they blundered.

An essential part of the Marxist analysis was the doctrine of the increasing misery of the proletariat and the separation of society into the exploited and the exploiting classes. In common with the apologists of *laisser-faire*, Marx underestimated, and grossly underestimated, the tempo of technological progress. While he did not succumb to the cruder errors of Malthus, he failed to anticipate the effect of a rapid decline of population in highly industrialized countries. He seems to have thought that the disappearance of the skilled craftsman would signalize the cultural depression of the working classes. He did not realize that the disappearance of the old owner-manager type would call into being an employed class with special social privileges. So those who follow his teaching have grossly underestimated the reserves of strength which capitalism possesses and have directed their appeal to the most impoverished section of the wage-earning class in the belief that worsening conditions would eventually guarantee an effective majority of malcontents.

It is now abundantly clear that technological advances and declining fertility have conspired to arrest any such *dénouement* in the more highly industrialized countries. If capitalism commits suicide, the reason is likely to be war rather than the increasing misery of the proletariat. The Marxist case against capitalism is that capitalism makes for increasing poverty. If that is all that can be said against capitalism, the capitalist system will probably be able to look after itself. As I see it, the rational case against capitalism is not that it offers us increasing poverty but that it offers us stagnation. We now have unforeseen resources for planning the Age of Plenty if we set about it in the right way. The alternative is not revolution. It is the creeping paralysis of the servile state. In that respect Mr. Belloc was a better prophet and a safer guide than Karl Marx.

Even if the doctrine of social classes, as expounded by Marx, should prove to be true on a long view, no movement which relies for support on the wage-earning classes alone can forestall

the new industrial feudalism of Mr. Belloc's forecast. After exhausting their vocabulary of invective against class collaboration Marxists have learnt this expensive lesson themselves. The fact that they have done so does not solve the educational problems of democracy, while they cling to theories and refuse to face facts till they are broken by them. My contention is that Marxists have made blunders when they have been guided by theories which are wrong; that they have advanced their legitimate aims when they have been guided by a knowledge of facts, and that they will make other blunders so long as they refuse to recognize that their whole theory of capitalist evolution calls for drastic criticism in the light of new facts which Marx could not possibly have known in his time.

In the teaching of Marx there is much wisdom which the leaders of the Adult Education Movement can, and should, assimilate. Marxism as a system encourages a kind of mental inflexibility which can only hamper a democratic educational movement in facing the new tasks, new needs, and new difficulties of modern democracy. The Marxist is right in asserting that democracy is a sham, unless it can guarantee a much higher level of prosperity for the masses; and some Marxists are beginning to see that this prosperity cannot be won by a movement which relies exclusively on the support of the wage-earning classes, that it must also look for support to the growing class of employed persons such as teachers, clerical workers, and others collectively described as the salariat. Their ability to organize a united front of all grades of employees is still defeated by refusal to reconsider the supposedly increasing misery of the proletariat or to envisage its alternative. Capitalism does and can guarantee comparative comfort and security to a large section of its employees, who will not readily enlist themselves in any movement which teaches the inevitability of civil war as a prelude to a better state of affairs. Ordinary people bear the ills they have rather than fly to others they know not of. *Progress with Security* must be the watchword of a united front of employed persons with the will to bring in the Age of Plenty.

Education, which will help us to preserve democracy and to assure its further progress by mobilizing the will to constructive social effort, has urgent need for knowledge about the growth of social classes and the aspirations of citizens at different social levels. The professors of economic tautology in our universities cannot give answers to the questions we put. Their Marxist critics offer us a barren dialectic of social classes when our need is for factual analysis of social structure and social behaviour. It seems that the Adult Education Movement has only one course if it is to discharge a creative function in the Age of Potential Plenty and to meet the challenge of dictatorships to democratic ideals in education. We must not be content to take from the universities the crumbs that fall from the rich man's table. We must not turn a disillusioned ear to doctrinaire Marxism. We must ask ourselves what kind of knowledge we need if we wish to equip ourselves for the task of organizing the social exploitation of the new resources which science has placed at our disposal. In so far as the universities can provide men who have this knowledge we must welcome their co-operation. In so far as men with a university training can seek this knowledge we must encourage their efforts. In so far as the universities have failed to do so we must subject university teaching to vigorous and outspoken criticism.

In the past there have been two movements for adult education among the working classes of this country. One, the W.E.A., has been too content to let the universities dictate its policy. The other, represented by the Central Labour Colleges, has carried on its work with very little assistance from people with a highly specialized training. The orientation of the policy for which I plead differs from that of both.

The universities have vast resources of knowledge. Much of their work in training doctors, engineers, chemists, and the like would be carried out in very much the same way in any rationally organized society. So the criticisms which have been levelled against the universities in some quarters have been often ill-informed and far too sweeping. Well-merited criticisms which

might have been effective if they had been directed against the gross absurdities of economics and so-called political science have missed their mark, because they have been applied indiscriminately to the work of the universities as a whole.

The Central Labour College critics of the universities have also made another mistake. It is one thing to let the universities tell us what knowledge is good for us, and it is another thing to assert that we can get the knowledge we do need without taking advantage of the enormous resources of information which the universities possess. It is true that a student who has graduated with high honours in a university may leave it with the haziest ideas about the powers which a Cornish parish council can exercise. It is then right to say that he is not yet competent to do educational work in a Cornish rural area. The fact remains that the graduate teacher will generally know how to look for the requisite information, and even if, as in this example, there is a Fabian tract on the subject, his university library is more likely than the local library to have it catalogued. Three years spent in the most futile studies at a university have at least one advantage. Few who have not enjoyed the mixed blessings of university instruction know how to find their way to the libraries in which official documents reside.

If the university man is given a *carte blanche*, he will usually adopt the lazy device of modifying the general course prescribed by university tradition with more or less relevance to the tastes of his class and to the limitations of time and previous education. In so far as he does so, he is making no real contribution to the educational problems of democracy and merits all the criticisms of the *Plebs Magazine*. The mistake is not remedied by distributing sixpenny text-books and organizing study circles under leaders who have no direct access to first-hand information and cannot devote themselves to their task as a serious profession. All good education is propaganda. Good propaganda is not necessarily education. The Adult Education Movement should steer a middle course between aimless education which is servile in temper on the one hand, and a low level of workmanship on the other.

§ 4

The cultural revolution to which I alluded in my opening remarks suggests how this can be done. Natural science has had to outgrow the arbitrary divisions of knowledge prescribed by Aristotle, and year by year new sciences are born. The most urgent need of the Adult Education Movement is to throw overboard the existing classification of social sciences such as economics and frame a curriculum of factual studies relevant to the pressing social needs of our time. If we know what we want, we shall find men of specialist training equipped to play their part. In their turn the universities will benefit as they have benefited from popular pressure in the past. A welcome example of the new attitude is a recent *Highway* supplement on malnutrition. Malnutrition is not (as it should be) a department of social study in our universities. In designing this supplement the Editor, Mr. W. E. Williams, took a step towards devising the curriculum for the Age of Plenty. On the other hand he did not make the mistake of imagining he could do so without the co-operation of men with a university training. He enlisted scientific workers and medical men with the necessary specialist knowledge for the task.

The Adult Education Movement has no need for biology courses of the kind which exist in the universities. What it needs are courses on malnutrition, public health policy, and the revolution of agricultural technique made possible by recent biological discoveries. It has no need for courses of chemistry and physics on the university model. It needs courses on how an intelligent Government would bring new chemical industries to the depressed areas and how it could mobilize new resources of power. It has no need for elegant expositions of useless literature. It should further the study of language as a means to peaceful communication between nations. It has no need for university economics, university sociology, or university political science. It should be its business to organize courses on the changing structure of industrial management, the recruitment of social personnel, the

distribution of income, leisure and educational opportunities, the powers of local government, the new problems of population growth, the social influence of finance capital. If it demanded such teaching, it would widen its popular appeal and it would reinvigorate the teaching of social science in the universities by furnishing them with problems worthy of their resources.

Modern Europe is in the throes of a reaction against Liberal Rationalism. What applies to the reaction against democracy applies with equal force to the Retreat from Reason. The strength of the reaction against democracy is that, as democracy affects the lives of most people, it is a sham. The strength of the case against the liberal culture of the nineteenth century is that it cannot provide guidance for constructive social innovation to-day. To defend a static model of political democracy or to justify the barren intellectualism of our universities is to invite defeat. If British civilization chooses the downward path of militarism, neo-pagan mysticism, and storm-troop brutality, its fate will be the penalty of our own complacent and effeminate satisfaction with a social culture which has long since lost the creative vitality of its youth. It is not our task to defend John Stuart Mill or to justify Karl Marx. The movement for Adult Education should be a consecration to face new issues in the light of new knowledge. If British democracy has the vitality to accomplish a cultural synthesis, preserving the genial features of an outworn Liberalism while assimilating the crusading vigour of continental Marxism, it will be because men and women like ourselves have the will to create new instruments of research and education, readiness to recognize our own shortcomings, and the determination to create a system of representative government and popular instruction to take the fullest advantage of the new resources of social well-being.

9

Clarity is Not Enough[1]

A STRIKING THING about contemporary education is the increasing demand for mathematical training. In the eighteenth century the only departments of science which conspicuously called for it were astronomy and such branches of mechanics and optics as had arisen in connection with astronomical pursuits. Navigation was perhaps the only important profession for which any mathematical equipment was an indispensable prerequisite. Though an eighteenth-century H. G. Wells might have anticipated minor avenues of future employment for professional mathematicians as teachers attached to artillery or actuarial work, he would scarcely have foreseen that chemistry, power production, genetics, psychology, and social statistics would severally enlist the services of the mathematician. The educational problem which arises from the rapid mathematization of science during the past half-century has found us unprepared, and is largely an unsolved one.

A generation has passed since Sylvanus Thompson created a storm in a teacup by claiming an intelligible introduction to the infinitesimal calculus as the birthright of the engineer. Thompson's crusade enlisted the support of the military and naval colleges. What he planted Mercer watered. This was a substantial gain. We are now amazed at the ingenuity with which Edwards could have contrived to make his subject so repulsive to a healthy adolescent.

After Thompson came Mellor's plea for the student of physical chemistry. Partly because it relies largely on physical chemistry

[1] Presidential Address on the Needs and Difficulties of the Average Pupil to the London Branch of the Mathematical Association, November 27, 1937.

and partly in its genetical aspect as a science in its own right, biology is now facing the same issue. Elaborate analysis has been applied to the interpretation of experimental work on chromosome mapping, inbreeding, and the relation of nature to nurture. The result of this is that experimental biologists often discover too late in life that theory has outstripped their early equipment. Here and there tentative efforts to start courses in biomathematics have been made in our own country and in America. In a few years the curricula of our schools and universities will have to take cognizance of the new demand.

Where conspicuous aptitude or partiality for mathematics exists, the task of the teacher calls for little enterprise, imagination or skill. So long as professional outlets for mathematical knowledge were restricted to a very limited range of professional interests the supply of calculating prodigies was equal to the demand. While the demand was small enough to be satisfied by the available supply there was no social incentive for studying the technique of mathematical exposition. Within the social class with access to a professional education the boy who was naturally bright at mathematics could head for the navy—the others for the church, the bar, or medicine. If a boy could not do mathematics, he was deemed to be stupid, or to put it more charitably, his ambitions were canalized towards the episcopal benches in the House of Lords.

The present situation is that the demand for an irreducible minimum of mathematical proficiency vastly exceeds the supply of conspicuous natural talent. On that account the most signal contemporary contributions to educational technique are beginning to come from the ranks of mathematical teachers in technical institutes or military and naval colleges. Circumstances are forcing the teacher of mathematics to face a serious educational task, while his colleagues are occupied with topics which properly belong to the baby clinic, the consulting-room or the juvenile court. The serious problems of education are not concerned with the "problem child." They are concerned with the problem-subject. Mathematical teaching is the cardinal educational problem

of our time, because mathematics is *par excellence* the problem-subject of the curriculum. The existence of the Mathematical Association is a healthy indication that some members of the teaching profession recognize the differences between pediatrics and pedagogy.

A presidential address may excusably mitigate the serious labours of the year by a seasoning of comic relief. So I shall choose my text from Stephen Leacock's essay on *How to Make Education Agreeable*. Those of you who have read it will recall Leacock's complaints against the prosaic language in which Euclid states that a perpendicular is made to fall on a line, bisecting it at a point *C*. Every competent journalist knows how to make this announcement sufficiently arresting by a judicious selection of type announcing in headlines of diminishing size:

AWFUL CATASTROPHE

PERPENDICULAR FALLS HEADLONG ON A LINE

Line at CINCINNATI completely CUT

President of the Line makes statement.

Whereafter the class, says Leacock, would be breathlessly eager to hear the President's statement.

There is more in Leacock's little joke than a casual reading would suggest. Whatever else it is, mathematics is a technique of discourse for dealing with relations of size and order, in contradistinction to common discourse which is also (and more especially) concerned with relations of quality. *This limitation is inherent in the act of communication, and therefore asserts itself in the habits which a trained mathematician brings to the art of teaching.* From that fact the cardinal difficulties of mathematical teaching arise.

To be a good teacher and a good mathematician is almost as difficult as being a genuine saint and an expert politician. The world of discourse in which the mathematician lives is far from the untidy world of trial and error. Only the need for food at

irregular intervals forces him back to earth. His happier moments are spent in a better place. Orderly piles of related propositions are set out in neat rows along spacious avenues where accidents rarely happen. Even when they do there is no sense of imminent tragedy. It is a world without people. Unlike the celestial city of St. John there are no children playing in the streets. When the need for food brings him into contact with real ones the mathematician has long since forgotten the language in which they converse.

§ 2

What seems to me the source of most difficulties which beset the average pupil can be best seen by contrasting the characteristics of mathematics with the technique of common discourse. In everyday life communication is an art which involves far more than exhibiting an orderly sequence of propositions. Common discourse is effective, and is endorsed as correct, in so far as it discharges two tasks simultaneously. One is to specify relations, or in less pompous language, to convey information. The other is to enlist the *personal* attention and engage the *personal* interest of the individual or individuals to whom the communication is made. The fact that a statement is instructive in the sense that it contains no ambiguity or error does not satisfy the requirements of ordinary communication. Conversely, mere brightness does not justify itself if the content is shallow, equivocal, or otherwise misleading.

That the informative and emotive aspects of communication are truly separate is recognized by grammarians who classify the artifices devised for harmonizing their conflicting claims. There is an implicit recognition of this compromise in the definition of a *figure* of speech. The essentially personal relationship implied in the emotive function of ordinary language is recognized by the choice of form appropriate to the reading public or audience. No such distinction exists in the technique of discourse with which this Association is concerned. Brevity is the soul and substance of mathematical wit, and ambiguity or inconsistency

are the only unpardonable sins. In short, there is no personal relationship involved in the act of communication.

In so far as mathematics has an aesthetic appeal, it is one which has no explicit relation to the history or prejudices of the individual as such. There are, to be sure, individuals for whom mathematics exerts a coldly impersonal attraction, and I suppose that the majority of professional mathematicians, the bright boys, belong to this category. This is not of great educational importance. Adolescents and children who are readily accessible to the austere aestheticism implied in the statement that a proof is elegant are rare. They are not the ones who make mathematics the problem-subject of the classroom. Intense aesthetic satisfaction in mathematical pursuits is for most people an unattainable experience, or at the best an acquired taste. It is not, and cannot be, of itself a sufficient drive to proficiency. The teacher has to supply a powerful extrinsic motive of a more directly personal kind.

Many professional mathematicians show a sort of fussiness on this topic, as though any statement of this kind necessarily casts doubts on the sincerity of their individual predilections. So in saying this let me forestall a criticism which will be made, whether I do so or not. The aesthetic appeal of mathematics may be very real for a chosen few. The point at issue is not whether it is real, but whether it is common. In fact, mathematics has little spontaneous appeal for the overwhelming majority of ordinary human beings. Otherwise there would be no special difficulties about teaching it. Of itself this makes teaching mathematics more difficult than teaching biology, because children are generally interested in their own bodies and in growing things.

Still, this is not the aspect I propose to stress in what follows. The first and foremost difficulty lies less in the pupil than in the mathematician. The biologist, if he is a good biologist, brings to the teaching of his subject a recognition that a growing thing is something with its own laws of behaviour, and that the business of teaching is closely allied to an understanding of these laws. The temperament and training of a mathematician do not encourage this outlook. Once he has been hardened to the rigours

of the mathematical climate he has ceased to be able to see simple truths which any journalist or mother of six takes for granted. Disraeli said that it is easier to be critical than to be correct. He might have added that most people are less anxious to be correct than to avoid criticism. Being correct in teaching is putting over as much of your meaning as you can. The fact that a scientific or mathematical exposition can be faultlessly clear to anyone who can be induced to follow it is not of itself an educational achievement. If it is excruciatingly tiresome, no one will be induced to follow it. So its value as an act of communication will be nil.

Thirty or forty years ago a movement for the reform of mathematical teaching sponsored a luxuriant overgrowth of pedagogic literature with which we are still saddled. It amounted to this. Anyone with the wit to think up a slightly different arrangement of the propositions of Euclid could find a publisher and establish his credentials as an authentic pioneer. The educational world was shaken to its foundations by the daring announcement that Euclid had been banished from the classroom, and the same dismal figures reappeared in the new text-books without any visible stigmata to distinguish them from illustrations in extant mediaeval translations of Al Karismi's works. In so far as this succession of tedious familiarities had any intelligent rationale, I suppose the theory behind it was to give the teaching of elementary mathematics a more coherent logical texture.

How far pioneers of pre-war days achieved their end is not of much interest in this context. My submission is that their aims were based on an assumption which is certainly gratuitous. The assumption is that mathematics is a problem-subject, because it makes exorbitant demands for clear, consistent, and closely knit thinking. Whether this belief is right or wrong, it belongs to the province of psychology rather than of mathematics. Great proficiency in mathematics confers no special qualifications for deciding whether it is true.

My own view is that it is entirely wrong. As a biologist I do not underestimate the prevalence of individual, often inborn,

differences affecting the ease and quickness with which people can perform comparatively complicated manipulations with symbols. On the other hand, it is obvious that the exercise of clear thinking is largely a matter of whether the individual is sufficiently interested in being right about a question and has sufficient confidence in his own powers to face the strenuous effort involved in arriving at a correct conclusion. My contention is that mathematics is a problem-subject for two reatons. One is that no other subject offers so much temptation to be tedious. The other is that no other subject offers the teacher such great opportunities for wrecking the intellectual self-confidence of the pupil.

The first statement is illustrated sufficiently by the indisputable fact that the most atrocious examples of turgid, prolix, and circumlocutory English style can be collected by opening at random the pages of any text-book on mathematics. That it is especially easy to discourage and to destroy interest in mathematics is a matter of common observation. Why so many grown-up people who give evidence of their power to handle comparatively difficult processes of reasoning in the course of their daily work display an attitude of sheer fright towards any mathematical formulation of a problem is easy to understand. At an early stage in education they have been made to feel that their difficulties were due to their own intellectual defects rather than to the cultural limitations of their teachers. The surest way of creating this sense of inferiority is to let children think that they are being taught for their intellectual improvement.

Thirty years ago I asked my class teacher why we had to learn geometry. I was told that it was a training for the mind. Twenty years later my eldest daughter asked her class teacher the same question and received the same answer. At different schools three of my four children have put the same question, unprompted by their parents. They have always received the same reply with penny-in-the-slot regularity. Since the odds against this result would be 7 to 1 if only 50 per cent and 63 to 1 if only 25 per cent of mathematical teachers took this attitude to their jobs, the

result, though based on a small sample, is alarming. It is all the more alarming because the departure from random sampling favours the selection of good teachers. If we took education as seriously as Stalin takes engineering, we should punish the statement "it is obvious that" with the option of five pounds or thirty days.

When a mathematician ventilates his views on politics or biology you will rarely discover any confirmation for the belief that a native aptitude for clear thinking carries a man very far, unless it is reinforced by a genuine interest in what he is thinking about. If any first-year medical student in my classes made the statements about reflex action contained in Sir Arthur Eddington's *Gifford Lectures*, I should plough him. I should not do so because he did not know the relevant facts. I should do so because he had not learned to reason clearly about them, and I should do so knowing that I had failed as an educationist in what is the supreme task of good teaching. Experience has taught me that there is a powerful psychological resistance to clear reasoning about reflex action. Perhaps this is because it touches our dignity on the raw. Be that as it may, it is my first duty to discover and to remove this resistance. The rest will look after itself.

In education the unforgivable sin is to attribute our own failures to the inferiority of our victims. The limitations of our pupils and students make education an exciting adventure, in which a certain kind of modesty is indispensable to success. Among the laity it is the general opinion that mathematicians regard themselves as exceptionally clever people. This may be quite unjust. None the less, it is a special reason for emphasizing the cultivation of a modest demeanour as indispensable to the technique of mathematical teaching. Just as the training of a mathematician fails to stimulate the art of intimate and engaging discourse, it does little to encourage the sort of modesty which good teaching demands. Especially at Cambridge, where generalized ignorance about sex, politics, religion, and most other topics of foremost importance to ordinary human beings is no obstacle to a brilliant career, academic success in mathematics

makes peculiarly thrifty demands for a wide range of capacities. Since it calls for the exercise of a somewhat rare gift, mathematical students are especially liable to the delusion that quickness in manipulating intricate reasoning processes is all that distinguishes clever, capable and successful individuals from their less fortunate brethren.

Mathematics is a problem-subject primarily because the mathematician carries into the personal and individual relationship of teaching the impersonal detachment which properly belongs to a world of discourse in which symbols have no emotive value. If space permitted, I should be prepared to sustain the view I have expressed by quoting large-scale statistical enquiries of educational psychologists. Here I will content myself by saying that few if any modern psychologists or biologists attach much meaning to the statement that any single discipline is specifically a training for the mind. What education can do is to encourage people to exercise to the full their capacity for intricate and rapid reasoning in relation to specific problems in which their interest has been quickened.

§ 3

In my original notes for this lecture I wrote down the American idiom "so what?" to remind me of the difficulties which arise from failure to realize that *the art of being interesting is more important than the effort of being clear*. The class of difficulties which I include in the "so what?" category may be illustrated by comparing the teaching of chess with the teaching of determinants. An authentic chess player who wanted to convey his enthusiasm to someone who did not understand the game would begin his explanation by discovering whether his pupil or victim knew the rules of draughts or halma. He would indicate in a general way what the players aim at doing, and would explain what constitutes a win before facing the tedious and intricate task of memorizing the rules or studying the gambits and end games. If the same chess player adopted the educational technique employed in the chapter on determinants in any extant mathe-

matical text-book, his explanation would begin somewhat as follows:

> A chess board is a board of eight rows and eight columns, among which are distributed two sets of sixteen pieces, eight alike of one kind being called pawns. The remaining eight include three pairs of which each member is alike of one kind, together with two other unlike pieces. The initial condition is that pawns of one set occupy the second and pawns of the other set occupy the seventh row. . . .

If the members of this audience took the same attitude to their work as those who taught me the elements of mathematics, I should enjoy retaliating for the tortures of the classroom by continuing the parable. In the present circumstances I think I have said enough to explain why I have called this the "so what?" difficulty. No mathematician would dream of expecting that anyone would pick up the rules of chess or acquire an enthusiasm for that noble game if he got his first taste of it in this way. No reasonable person would feel compelled to attribute subnormal intelligence to anyone who resisted the attempt to be taught on these lines, or confessed complete failure to see what the teacher was driving at.

The primary task of the educationist is to establish the personal relationship of enlisting the personal interest of individual pupils in the exercise of their reasoning powers. Thus the problem of the mathematical teacher is not a problem of mathematics as such. The recipe for good mathematical teaching is to put into the teaching of mathematics something which does not belong to the subject-matter of mathematics as such. There are obviously many levels at which this can be done. As a biologist I cannot fail to notice that calf love for the teacher has sometimes supplied a powerful incentive to sustained effort. Happily or otherwise I can offer no general recipe for exploiting this technique, and I doubt whether an intensive teacher's course in Hollywood films would make it a measure of universal application. The aesthetic, which at its most primitive level is the play, motive is one which

an enthusiastic and efficient teacher will not neglect, though I do not think it carries us very far by itself. To avoid any appearance of excessive utilitarianism in my subsequent remarks, let me make some tentative suggestions about how the play motive could be exploited more efficiently.

The first thing to be clear about in this connection is that there is not much fun in trying to solve a puzzle unless you have some means of finding, or rather of convincing yourself that you have found, the right solution. From this point of view two types of elementary mathematics are obviously unsatisfactory materials for exploiting the aesthetic motive at its most primitive level. If a child is asked to solve a geometrical rider, the teacher's approval is his only way of finding out whether he has performed the prescribed ritual. That algebra is universally more popular than Euclidean geometry may be largely due to the fact that most problems arising out of school algebra can be checked by using ordinary numbers. On this account the solution of an algebraic problem contains an element of mildly exciting discovery. This is less true of permutations and combinations than of other elementary processes, because the labour involved in testing a result is usually prohibitive. The general practice of postponing permutations and combinations to a late stage may be taken as a tacit admission that they present difficulties out of all proportion to the logical processes involved.

In various ways much might be done to exploit the play motive, that is to say, getting children and adolescents to regard doing mathematics as real fun. One is perhaps more obvious to me as a biologist, because of the fruitful applications of Finite Differences to problems of selection and population. To the best of my knowledge no elementary courses touch on the type of series which can be illustrated by figurate numbers. Experience of children and the testimony of teachers who have carried out problems with figurate numbers at my suggestion have convinced me that they provide an almost inexhaustible fund of clean wholesome fun for children and adolescents who get no kick out of the customary and, as Sir Percy Nunn has emphasized,

unnecessarily retarded introduction to series by means of progressions.

Another mathematical device which is unnecessarily postponed till a comparatively late stage offers other intriguing possibilities for exploiting the play motive. Transformations from one numeral system to another can be made intelligible to very young children with the use of an abacus model, and the introduction of ancient systems like the Babylonian or Mayan calendrical numerals can give the treatment an engaging atmosphere of historical pageantry.

In passing, let me urge that we should resist the temptation to make the examination system an excuse for lack of enterprise in education. In the days when children were presented seriatim to third-, second- and first-class college of preceptors examinations the teacher had far less scope for departing from the routine prescribed by unimaginative text-books. That is no longer true. The junior examinations are disappearing. The secondary school teacher generally has a clear run of four years without any interruption.

If you have four years in which to get a class up to matriculation-level algebra, there is no earthly reason why you should follow the puerile routine of text-books in which identities and transformations, the algorithms, equations, and progressions succeed one another with monotonous regularity. I believe that the teacher would attain his object in the time allotted with far greater success by spending a year playing with figurate numbers and numeral systems, deferring the introduction of any literal symbolism till it could be introduced to capitalize discoveries which any child of normal intelligence can make for itself.

The "so what?" problem in mathematics has two aspects. One already mentioned is the existence of a ritual for writing text-books to conceal the intrinsic interest of fresh technique. The other is the wellnigh universal absence of any attempt in text-books to enlist secondary drives on the part of the pupil by explaining the practical use to which the technique can be applied. The distinction I want to make can be illustrated by the

opening paragraph of the chapter on Fourier's series in Gibson's *Elementary Treatise on the Calculus*. This begins with a bald announcement, which in common speech amounts to saying that some function of x may be represented by an infinite series of the sines and cosines of the integral products of x.

As Mr. Leacock would say, any smart pressman or columnist knows that this possibility has no news value when so stated. Its news value for the classroom depends on making quite clear *why it matters*. Until you have done this you have not tackled your first job as an educationist. You can do it in two ways: by exploiting its *intrinsic* and *extrinsic* interest. You can start by considering how predigested mathematical teaching leads you to have a hunch that such a series exists, and what class of mathematical puzzles could be solved by using its properties. You can also illustrate the human circumstances in which the problem arose by telling your class how Fourier's original contribution was first used in connection with the study of heat conduction, and why the holy trinity of Laplace, Legendre, and Lagrange refused to accept it for publication.

My own views on exploiting the extrinsic or humane aspect of mathematics to enlist the interest of the pupil are sufficiently well known. On this topic I shall confine myself to three constructive comments.

One is to draw your attention to a curious anomaly. In exhibiting the *referability* of the methods expounded, new books at the *intermediate* stage, though written for a more selected group of pupils, take more pains than do elementary text-books for more general use. So while new books on the infinitesimal calculus are well illustrated with examples of its practical use in engineering or artillery, scarcely any widely used text-book written for the matriculation course on geometry mentions its application to geographical truths which children are taught in the nursery. An evident obstacle to educational progress in this direction is the exclusion of descriptive astronomy from the present curriculum.

When the history of mathematics is taught as a record of the

progress of intellectual achievement it can do two things. By exhibiting the social background of mathematics and its uses in the common life of mankind it invests the study of mathematics with human value for those who are indifferent to its own austere beauty. By emphasizing its gradual growth it assuages and restores the self-confidence shattered by repeated assertions that a statement is *obvious*. For ordinary mortals it is reassuring to find that a supposedly obvious statement has defied the collective effort of all the best intelligences for several centuries.

§ 4

Another psychological error which arises from undue preoccupation with the logical difficulties of mathematics is that too little attention is paid to the part which memory plays in performing intricate mathematical operations. Teachers do not always remember to remind their pupils that certain things must be thoroughly *memorized*. The teacher's anxiety to gain the rational assent of his pupil often leads him to forget that memorizing the result is just as essential in mathematics as in any other subject. Solving a partial differential equation by Fourier's series is just as much a feat of memory as correctly describing the characteristics of a flowering plant when you only know its generic name. The teacher who is never tired of urging his pupils to work out their problems from first principles should be deprived of his next meal till he has repeated Kelvin's unhappy calculation on the age of the earth without assuming anything.

What is easily overlooked in relation to this aspect of mathematical teaching is that memory is exceedingly capricious. Facility in remembering different types of information is highly individualized. Speaking for myself, I may illustrate this by the fact that, although I like organic chemistry, I can carry few facts about carbon compounds in my head for more than a few weeks. Contrariwise, I have an encyclopaedic memory for trivial anatomical facts, which I have had no occasion to recall for twenty-

five years. Among my students I have often had individuals who shone at mathematics and found the greatest difficulty in remembering simple zoological terms when their derivation and significance had been repeatedly explained.

As a teacher of biology I recognize this as a special class of difficulties, and I strive to resist the temptation to blame the student for lack of ability to reason correctly about living creatures and their characteristics. One real difficulty which makes some pupils slow is not lack of ability to follow mathematical reasoning. More often than we care to admit it may be failure to capitalize results which must be committed to memory before complicated operations can be performed with alacrity. In all teaching it is advantageous to set out periodically a summary of information already acquired for careful memorization. This provides a platform for the next stage in the development of the subject and makes it easier to trace successive stages in retrospect.

No doubt our Victorian grandparents laid too much stress on the role of memory in education. None the less the pendulum has now swung too far in the opposite direction. It is high time to tell aldermen, rotary presidents, and Gifford lecturers that they do not justify their claims to originality in educational theory by warning us against cramming our children with facts. When we have done our best to interest, to stimulate, to win the confidence and to gain the rational assent of those we teach, they have got to do some real work themselves. The major part of it is systematic memorization of what they should have at once understood if we have done our job well. Part of doing it well is also to encourage them to undertake systematic memorization at each stage.

What I have said so far has been especially about pure mathematics, and may be summed up by saying that the teacher's job is less to make things clear than to give his pupils a powerful incentive for getting things clear for themselves. Three obstacles which he has to surmount are easy to recognize. The first is the paralysing sense of *unfamiliarity*, which I have called the "so what?" reaction. The second is a sense of *intellectual inferiority*,

which discourages further effort. The third is a disinclination for studies with no explicit *practical outcome*. This is common among healthy extroverts, even those who have a high level of intellectual capability. The teacher can forestall these difficulties, first by intelligent *anticipation*—the "so what?" technique—by cultivating a *modest friendliness* of deportment, and by equipping himself with the information to give his treatment of any problem the widest possible *referability*.

§ 5

The last remark might be taken to imply that the average pupil encounters less difficulties in studying applied than pure mathematics. Few teachers would agree that this is so. Many adolescents with no special partiality for mathematics prefer the pure to the applied sort, and experience more difficulty with the latter. I do not believe that they belong exclusively to the introvert type. On the contrary, my opinion, for what it is worth, is that the extrovert resistance to applied is just as great and often greater than to pure mathematics.

Where this resistance exists one difficulty of the average pupil is easy to recognize. In applied mathematics the pupil has to deal simultaneously with two intellectual problems. One is the ordeal of performing certain operations with symbols. The other is the relation between the counters and the real world. The latter is often made more difficult by the fact that the symbols are not the current coin of the realm of nature itself. They refer to the characteristics of a physical model, and not to the natural processes which are the ostensible topic of discussion. Inability to perform the prescribed ritual may, and I believe often does, result from preoccupation with the relevance of the symbols to the model or of the model to the process itself.

That this is not a wild surmise is easy to illustrate by observing the reactions of different individuals to problems of the type contained in the Week-end Book. The essential ingredient of any Bloomsbury conundrum is some irrelevant circumstance or unfamiliar situation which distracts attention from what would

otherwise be a straightforward issue. At the lowest level of naïveté this may be illustrated by the familiar riddle: do white sheep eat more than black ones? Everyone knows that individual white sheep do not eat conspicuously more than individual black ones, and that the latter are less common. The difficulty is easy to see. The milieu suggests that the right answer demands biological knowledge rather than arithmetical common sense.

Like many others among my own contemporaries, I probably got my first taste—or distaste—for mechanics from the same source as many members of this audience. The prescribed ritual of school mechanics has not moved very far in my own generation. The questions set in London University examinations, at all stages from matriculation to the degree, conduct the successful candidate through a labyrinth of tedious and devious algebraic manipulations to conclusions whose falsity is self-evident to any schoolboy with a taste for gadgeteering or to any practising mechanic.

The black sheep problem in the wolf's clothing of academic mechanics is illustrated by the following example taken from Loney's treatise on the *Dynamics of a Particle*:

> Assuming that the earth attracts points inside it with a force which varies as the distance from its centre, show that, if a straight frictionless airless tunnel be made from one point of the earth's surface to any other point, a train would traverse the tunnel in slightly less than three-quarters of an hour.

By the time the student has reached the degree stage oral tradition among undergraduates has equipped him with enough low cunning to detect the trick. He realizes that all the examiner requires is a piece of plain painstaking arithmetic according to a prescribed pattern. The engineering, like the genetics in the black sheep problem, is merely put in to make it more difficult. At the school certificate stage there is no robust corpus of undergraduate tradition to inoculate the pupil against the unnecessary distractions of our educational routine. So the teacher's task demands more intelligence.

The principles of mechanics discovered by Stevinus, Galileo, Hooke, Huyghens, and Newton have very little relevance to the mechanisms with which a boy is familiar. In real life he never meets perfectly smooth bodies sliding down perfectly flat slopes without any friction. He has more experience of motor bicycles which seize because of overheating. If he were enterprising enough to calculate the trajectory of Big Bertha when it shelled Paris, he would find that the actual range and height were less than half what would be inferred from the formula given in the text-book. Of course few boys would be so enterprising. The boy who was would have the making of a scientist in him, and the best way of training a scientist is not to start him off with wrong ideas about the way the world works.

As long as the teacher has to prepare pupils to pass examinations in mechanics conducted in the usual way he will find his task easier if he tells the whole truth. Half the truth, of course, is that the principles of mechanics in the Newtonian epoch were not designed to deal with modern mechanisms. So we must not be surprised or disappointed if they have to be supplemented by much more information before they can give us a useful guide to conduct in the everyday life of a secondary school pupil who lives in the age of the light car and the autogyro. A conscientious teacher will generally point this out and leave the pupil wondering why it is necessary to learn the principles if they do not fit the facts. So the other half of the truth, more rarely disclosed, is equally important. Galilean mechanics did provide a very useful guide to conduct in an age when sailing ships were first undertaking westerly courses to uncharted oceans.

In contradistinction to the "so what?" problem of allaying the sense of unfamiliarity or futility which discourages effort in pure mathematics, the *black sheep* problem of realism in applied mathematics may be discussed at various levels of relevance and at different levels of sophistication. At the lowest we may recall examples in compound proportion concocted to illustrate the untruth that too many cooks never spoil the broth. At a later stage we should distinguish between two different ways of

applying mathematics to the real world. Galileo's trajectory illustrates one, Maxwell's hypothesis the other.

Galileo's trajectory is a synthesis of quantitative laws which approximately describe the behaviour of Galilean cannon-balls in certain specified conditions, one being the principle of inertia employed in rectilinear markmanship, and the other being the constant initial acceleration of heavy bodies falling to earth. To be quite clear about what it involves it is necessary to specify the conditions, the limits of observational error, and the goodness of fit.

Generally, as with Galileo's pendulum, an additional source of psychological irrelevance is introduced into theories of this class by making approximations in the mathematical synthesis itself. For instance, the statement that the period of a simple pendulum swinging in a small circular arc is approximately constant implies more than the fact that it is liable to sources of error involved in the law of the inclined plane or in any other Galilean theorem from which you care to derive it. When you make use of the limit $\sin A = A$ radians you have made the pupil's foothold in the real world less secure, unless you have taken the initial precaution of tabulating the numerical errors involved for different angles of swing.[1]

In the elementary example cited the approximation is in the last stages of the development. In more advanced problems of applied mathematics it is often buried in the brickwork of a formidable architectural feat. Approximations are made to transform expressions which could not otherwise be reduced by means of familiar artifices. At this level it is almost impossible to determine the limits of validity involved, and to do so would require elaborate analysis. The bewildered student taken tortuously through the formalism of the earlier steps now feels that he has been led up the garden path. Sometimes he *has* been led up the

[1] There is a further source of psychological resistance to this. Young students and pupils are used to the *degree* as the unit of angular measurement, and the first reaction to a "small angle" is to identify it with something less than one degree. It is very easy for a beginner to forget that even 5° is a relatively small fraction of a radian.

garden path. His criticism is mathematically valid. Educationally this is the nemesis of a spurious rigidity. If applied mathematics were treated as the tool it is, and not as an end in itself, the student would look *forward* to the end-product of the development as the *means* of testing its truth. Instead he feels as if he has been caught in the act of cooking his result.

Whenever a pupil is told that something may be neglected because it is small his attention is immediately diverted from the logical texture of the interpretation. He finds himself asking how small it may be before it is entitled to mathematical exemption. You cannot sustain his confidence or enthusiasm if you leave him spluttering with the uncertainties of cosmic untidiness in midstream. A teacher of applied mathematics should teach his subject as he would teach swimming if he enjoyed it. The average pupil is like a young swimmer who can just keep afloat. He knows the strokes and can execute them with tolerable proficiency so long as he concentrates his effort on keeping his head above water. Approximations are like the first wave which sends water up his nostrils. He gulps, abandons hope and clutches at anything within reach. If you do not want him to sink and do want him to learn to swim, you have got to teach him to breathe. Half the difficulty of learning to swim is learning to keep your grip on reality by controlling the act of breathing.

This homely truth is sometimes dismissed by asserting that mathematical teaching is concerned with the logical structure of scientific hypothesis without regard to its truth. I do not believe that scientific truth and scientific logic can be kept so far apart. A scientific law is not correctly stated unless it contains within itself a recognition of its own limitations. In so far as applied mathematics is part of the methodological background of science, the mathematician who fails to clarify the sources and limits of numerical approximation is not fulfilling his role as logician.

In contradistinction to most problems of school mechanics *Ether* theories illustrate a higher level of sophistication. The quantitative laws which are found to give a good fit to observed data have not been derived by direct observation of processes

with which theory deals. They have been drawn from behaviour of physical models first suggested by crude and superficial similarities.

The edifice of scientific knowledge is supported by a scaffolding of deceased and dying metaphors. In the boyhood of science the props of the building were green shoots still rooted in the soil of daily experience, and the giants of physics and chemistry played hide-and-seek among them. Analogies drawn from familiar experience of sailing boats or watermills, and mathematical operations suggested by the same analogies, once furnished fruitful clues for research. The foundations of mathematical theories of immense importance in science were laid by men who could visualize these analogies vividly.

We too easily forget that this experience of everyday life in the eighteenth century is not our own, and that parables drawn from it have ceased to be vivid. When modern text-books of physics compare the electric current with the flow of water to illustrate the characteristics of the former they inevitably fail to achieve the end in view. They merely tell pupils who have already picked up something about electricity from everyday life in the twentieth century something which eighteenth-century school children knew about very elementary hydrodynamics.

In dealing with this difficulty of the average student the teacher of mathematics may turn to the Church for guidance. The parable of the mustard seed does not contain any doctrinal truths which defy the comprehension of the most obstinate unbeliever. Any curate who knows his job recognizes that the real difficulty about the mustard seed parable is connected with the conventions of systematic botany and with the physiology of plant growth in an Oriental climate. The serious business of preparing his sermon is to straighten out this tangle, and he takes you back to Palestine accordingly. The serious business of the teacher who wants to help the average student of electricity to understand Maxwell's equations is to make him visualize Maxwell's vortices and Maxwell's cosmic half-set jelly as vividly as Maxwell himself envisaged them.

Needless to say, vivid imagery which would enlist the imagination of the pupil or student in the intellectual task he is undertaking is the very last thing which will be found in text-books of mathematics. By the nature of his training the mathematician brings to the lecture-room, to the classroom, and to the making of a text-book a fastidiousness which is the father of tedium. Determined at all costs to avoid the pitfalls of ambiguity, he reduces the art of discourse to a lifeless jargon in circumstances where no danger of misunderstanding exists. The good English word *something* is not sufficiently technical. The applied mathematician is only happy when he has called it a *body*, and has thus made the sentence in which it is buried a coffin.

§ 6

My last remarks embrace all that I have tried to say in this lecture. Mathematics, as I see it, is primarily a problem-subject, because teaching mathematics successfully is very much like teaching anything else successfully. The first business of the teacher, whatever his subject, is to make it interesting, to discover what discourages his pupils, and to convey to them some of his own enthusiasm.

I believe that much could be done to improve the teaching of mathematics without any radical change in the examination system or in the general policy of education. For that reason I have tried to avoid any reference to innovations which would make the teacher's task more easy. To meet the new demands for mathematical proficiency I venture to suggest that the most urgent syllabus reform is a wholesale reduction of formal plane geometry to make way for a much earlier introduction to trigonometry, analytic geometry, calculus and solid figures. I also suggest that this might be helpfully supplemented by closer co-operation with the teaching of geography and elementary descriptive astronomy in the schools.

As it seems to me, the need for university reform is equally urgent. Mathematical graduates often leave the university com-

pletely ignorant of the history of their subject, and do not invariably possess any acquaintance with ordinary mathematical appliances such as almanacs, slide rules, verniers, or even computing machines. The aim is to develop an almost pathological proficiency in a limited range of technique, often of a kind which has long since outlived its usefulness or has not yet been proved to have any.

Beyond this looms the sinister fact that the task of teaching mathematics in Britain is hampered by an antiquated system of weights and measures. This is disastrous for education in more than one way. One is that the child is forced to undertake tedious arithmetical exploits at an age when he has no interest in manipulating large numbers. Hence he has often acquired an active hostility to number-lore long before he takes up the systematic study of mathematics. Another is that the current coin of physical discourse has little relation to the units of the practising engineer. This makes exact science a cult which has no very obvious relation to everyday life in Britain. In France the introduction of the metric system was only gained at the cost of a revolution. Mr. A. P. Herbert has shown that a university member can compel our own Parliament to make divorce easier. Is it too much to ask mathematical teachers to insist that every parliamentary representative for a university seat should give an undertaking to introduce a bill for the remarriage of arithmetic with common sense?

Mathematicians have another political responsibility connected with arithmetic. The recent analysis undertaken by Dr. Enid Charles shows that whatever changes in fertility and mortality may conceivably conspire to arrest a rapid decline of net population from 1945 onwards, nothing can now forestall a rapid and spectacular depletion of the school age groups during the *next two decades*. Therefore the choice lies between a period of acute unemployment for teachers or a drastic reform of educational routine. No teacher should teach for more than ten hours a week. By 1950 an enormous reduction of working hours can be achieved without any increase in the cost of education. My last word is to

suggest that teachers of mathematics should take the lead in seizing this opportunity. They will find the facts in a new book, *Political Arithmetic*,[1] which contains Dr. Charles's estimates of the oncoming shift in the school population.

[1] Published by George Allen & Unwin Ltd.

10

Havelock Ellis[1]

HAVELOCK ELLIS will be remembered as the leading English anthropologist of his generation. He has the hall-mark of the authentic prophet, being without honour only in his own country. The branch of anthropology which he has made his special province is not a subject of any university curriculum. He was the anthropologist of everyday life. His work was sustained by the conviction that the social behaviour of Wigan or Wimbledon is a proper subject for scientific study.

Such a belief undermines the foundations of English propriety. For all its grudging concessions to natural science as fit matter for vocational studies, the English educational system still bears the impress of the theologians who designed it. The Englishman is at liberty to treat foreigners who live in Waikiki or Wei-hai-wei as specimens. Gentlemen are gentlemen, made in the image of a gentleman. The leaders of English thought are as ever imbued with Dr. Johnson's belief that the pursuit of the natural sciences has little relevance to the study of man's "moral and prudential nature." The *London Mercury* reveals the fruits of an English classical education in the verdict: "Mr. Ellis, as he himself says of Swift, has a tendency to dwell upon excrement."

Quite other is the judgment of educated America. The editor of the *American Mercury* pronounces the verdict: "If the test of the personal culture of a man be the degree of freedom from the banal ideas and childish emotions which move the great masses of men, then Havelock Ellis is undoubtedly the most civilized Englishman of this generation." Mr. Mencken's view is a representative view of cultured men and women in the States. That

[1] From *Great Contemporaries* (London: Cassell & Co., New York, 1935).

they value the work of Havelock Ellis is not because Americans, like the Athenians, spend their time in nothing else but either to tell or to hear some new thing. It is because science has a recognized place in the American educational system. The educated American realizes that Mr. Gladstone was a member of the expensively uneducated classes.

What little there is to say about the life of Havelock Ellis except in so far as specific incidents bear on the progress of his enquiries has already been said at unnecessary length by Dr. Goldberg. For that purpose it is enough to say that he died at the age of eighty, that he graduated in medicine fifty years ago and that his first important book led to the prosecution of the bookseller on a criminal charge. Before his serious work began he moved in radical circles. During the 'eighties mysticism and Caledonian caution had not yet become the hall-mark of intellectual eminence. Huxley was still alive. Sidney and Beatrice Webb were embarking on their life work. They were peak years of the all too brief period during which European civilization asserted the supremacy of the human reason.

His first serious publication was *The Criminal*, which appeared in 1889. It was a pedestrian performance, scholarly enough, but devoid of originality, and was not the fruit of his own first-hand researches. When he composed it, Havelock Ellis was much too favourably impressed with the conclusions of a contemporary Continental school of anthropologists whose names have been kept alive by frequent recurrence in detective fiction. Their object was the prognosis of the criminal by physical stigmata. They were painstaking anatomists, indifferent statisticians and exceedingly weak sociologists. Had they been otherwise they would not have set out to solve a problem formulated in terms which they did not seek to define.

Crime is a classification of social behaviour relative to the social status of the individual, the place in which he lives, and the time at which he lives there. The majority of actions so classified are concerned with the regulation of the institution of private property. Whether they do or do not take place depends quite as

much upon what temporary and constantly changing arrangements society adopts for distributing property as upon what sort of individual interferes with such arrangements. The danger of confusing the two issues is tacitly though unwittingly recognized by well-to-do people when they use the word robbery for the introduction of a new death duty. The same relativity applies to actions classified as crimes when they have no direct relation to our ephemeral arrangements for property distribution. At sundry times and in divers places private homicide has ranked as a supreme duty and a supreme offence. Practices regarded as delectable pastimes in classical civilizations are now punished as unnatural vice in Northern Europe.

Man and Woman, first published in 1894, is more directly related to his subsequent studies. Havelock Ellis himself believed it was the necessary foundation for his subsequent studies in sex psychology. In this he does scant justice to the genuine importance of his life work. The truth is that he never clearly stated the problem with which he was preoccupied. He made no lasting contribution to methods for solving it, and he did not add very much to the corpus of relevant data bearing upon the subject. Writing in 1894, he was not in a position to do any of these things.

Stated in general terms, the theme of *Man and Woman* is the extent to which observed differences between men and women are due to nurture on the one hand or to constitution on the other. This issue has a very definite meaning in the light of modern research on sex determination. Microscopic and experimental studies, which began about ten years after the publication of *Man and Woman*, have removed it from the plane on which Havelock Ellis discussed it. We know that the hereditary potentialities of the individual have their material basis in minute bodies called chromosomes lodged within the microscopic bricks or cells of which our bodies are built up. We can recognize individual pairs of these chromosomes within the cell, one member of each pair being derived from the father, the other from the mother. Apart from one exceptional pair, the maternal

and paternal members of a pair are alike in each sex. The exceptional pair consists of two like members (called X and X) in the cells of a female, and two unlike members in the cells of the male (called X and Y). All the ova produced by the human mother have an X chromosome. Only half the sperm in the seminal discharge of the father have an X, the other half having a Y chromosome. If the latter fertilizes an ovum, the resulting individual has an X and a Y chromosome, being thus a male. If the former fertilizes an egg-cell the resulting individual has two X chromosomes, being thus a female. In very special circumstances the influence of the X or the Y chromosome may be overridden by the absence of the necessary conditions in the environment of the embryo. An individual may then have the constitution of one sex and the characteristics of the other. Apart from such very rare contingencies we may say that sex constitution is determined at the moment of fertilization.

Beyond recognizing in a confused way that some sex differences are more deep seated, or are established more early, than others, biology had very little to say about the constitutional difference between the sexes in the year 1894. It had even less to say about the way in which the constitutional difference manifests itself in different kinds of organisms and among different categories of manifest sexual characteristics. Throughout the animal kingdom the only universal difference between a male and a female is that the one produces seminal fluid and the other produces egg-cells. Generally this primary difference is coupled with anatomical distinctions (the plumage of the peacock or the antlers of the stag) and with more or less pronounced differences of behaviour associated with the sexual act (the courtship dance of scorpions and of some birds). These secondary characteristics may depend directly on the chromosomes or indirectly inasmuch as they are promoted by the secretion of the testis or ovary, when these organs begin to function.

The characteristic differences of sexual behaviour in most animals are affected very little by external conditions. They depend directly or indirectly on the constitutional difference.

Dr. Zuckermann's recent studies have shown us that this is not true of man's nearest allies, the monkeys. To a large extent the pattern of sexual behaviour in monkeys is made up of acts which are transmitted by learning. Conceivably the two sexes may have different aptitudes for learning different patterns. The fact remains that the constitutional factor is not all-important. Contrary to common belief, there is no uniform rule of male dominance in the baboon pack. The ancient Aryan tradition of church and kitchen was a biological innovation in the evolution of the Primates.

In monkeys, as Dr. Zuckermann has shown us, the problem of disentangling the constitutional factor is far more complicated than we used to think. In mankind it is far more complicated than in monkeys. Aside from differences of sexual behaviour directly related to sex itself, that is to say in common parlance, to courtship and philandering, men and women differ in a variety of social customs, more or less useful, e.g. the work they perform, and more or less ornamental, e.g. the clothes they wear. In the background of all these differences we are accustomed to conceptualize something which we vaguely call temperament, like the composite-face photographs sometimes shown at fairs. The composite female face of the 'nineties was clinging and confiding, like the young unmarried woman of Dickens. The composite male face was masterful and managing like Dickens's married women.

For any particular community at any particular stage in its history the sociological sex difference is something quite definite. Certain activities and modes of conduct are characteristically, with few exceptions, male, others characteristically, with few exceptions, female. Towards the end of the last century, when *Man and Woman* was written, it was commonly believed that such sociological sex differences are a direct consequence of the constitutional or biological sex difference. There was scriptural warrant for the belief, and the Biblical account of creation was only beginning to lose its hold. *Man and Woman* was mainly concerned with emphasizing the fact that the composite face is

composite. It is not, as people almost believed when a leading physician wrote *The Unexpurgated Case against Women's Suffrage*, the face of any particular person.

In the light of newer knowledge we can state the problem of sex difference in mankind much more explicitly than Havelock Ellis was able to do. We are not compelled to obscure its complexity by dragging into the discussion that very mystifying and happily obsolescent word *instinct*. Differences in social behaviour, whether courtship, vocation, or less easily classified manifestations of temperament and opportunity, always involve a process of *learning*. Any such difference may conceivably be interpreted in one of three ways. One possibility is that the X and Y chromosomes in the cells of the nervous system affect aptitude to learn one or another mode of behaviour. A second possibility is that this primary difference of constitution does not directly affect aptitude to learn one or another type of behaviour, but does so in a roundabout way, chiefly because the exercise of the reproductive function in one sex (the female) interferes with certain kinds of social conduct, as maternity interferes with military prowess or regular employment outside the home. A third possibility is that the inertia of social tradition conserves differences of sex behaviour, because similar or dissimilar kinds of conduct in some earlier form of social organization have become sexually differentiated for one of the two previous reasons.

The conservatism with which people cling to the first or naïve view of sex differences is partly due to the fact that we never see an individual of one sex brought up in exactly the same kind of social environment as individuals of the other sex. Several considerations which have accumulated since *Man and Woman* was written lead us to doubt whether it is correct. Precise and compendious researches directed to the measurement of intelligence by modern psychological tests have totally failed to reveal any significant intellectual difference between the sexes. The opponents of the early feminists triumphantly pointed to the failure of women to distinguish themselves in the more intellectualized vocations as evidence of a constitutional lack of

reasoning power. To-day it is as certain that their explanation was wrong as that their data were beyond dispute. So the same logic is used only in discussions about the capacities of backward peoples.

Of late years a wealth of new historical and geographical information about the distribution of sex differences has shaken the traditional belief that sex differences in social behaviour are directly determined by the primary difference of sex constitution. Although a polarization of behaviour with respect to sex is characteristic of all human societies, hardly any characteristic of human behaviour is predominantly associated with one sex in all societies at all times. Still more striking evidence against the traditional view of sex differences comes from recent research in the biological field.

The investigation of intermediate sexual types in the chocolate moth and the fruit fly has led to a new conception of how the X and Y chromosomes do their work. If the different behaviour of men and women rested on this primary difference of constitution we should be able to classify them in different grades of maleness and femaleness according to a very simple rule, such as the scale on which the sex intergrades of the chocolate moth can be arranged. Common experience shows that there is no such simple rule. One young man may be excessively athletic, masculine, as our parents would have said, in his hobbies. He is intellectually timid, feminine, as our grandparents would have said, in his profession. His brother may be pugnacious in cross-examining or in debate, masculinoid, as we were wont to say, in his intellectual life. He has a strong distaste for "manly" sports. In common parlance, he is *effeminate* on the physical side. So there seems to be no regular gradation of masculinity or feminity in human beings such as we can associate with differences in the "strength" of the X and Y chromosomes in different races of the chocolate moth.

§ 2

The substantial basis of the reputation which Havelock Ellis has justly gained rests on the encyclopaedic series of volumes in

which he has explored variations of sexual behaviour outside the range of what current custom considers to be normal. Unlike his earlier work, it contains a mine of personal research based on individual case histories. The first contribution deals with the inversion of the love object (homosexuality), the latest with the inversion of the love subject (eonism). Dealing as they do very largely with different aspects of the reversal of the usual pattern of sex behaviour, they throw into sharp relief the contrast between the phenomena of anatomical intersexuality, as studied by the geneticist, and sociological intersexuality, as it manifests itself in human society.

Apart from what we infer from the study of animals most of our knowledge of how the normal body discharges its functions comes from the examination of pathological conditions. In studying the body we find that the pathological condition is but an exaggeration of some aspect of the normal processes at work. Havelock Ellis realized that much the same may be true about man's "moral and prudential nature." In the 'nineties the idea was less commonplace than it has now become. More than a little intellectual courage was necessary to carry it to fruition.

Every biologist now knows how much our knowledge of the history of the carbohydrates in the chemical exchanges of the body owes to the study of diabetes, and what impetus cretinism and acromegaly have given to the study of the internal secretions. We do not discourage the study of alcaptonuria or Addison's disease, because we regard these conditions as a handicap to the body. To the study of man's "moral and prudential nature" the prevailing attitude is quite otherwise. When a deviation from the norm has been labelled a crime or a perversion it ceases to be an objective of intellectual curiosity and is appropriated by the two professions most conspicuously devoid of it. Havelock Ellis was fortunate in escaping from one of them without irreparable loss. In 1898, a year after the publication of *Sexual Inversions*, Mr. Bedborough was prosecuted for selling it. The prosecution ruined him. The author himself was not victimized. He withdrew the book from publication after a German edition had already

appeared. That the *Studies in Sex Psychology* are accessible in the English language is due to the enterprise of an American publisher.[1]

The importance of the *Studies in Sex Psychology* is not less because they make no pretence to transcend the level of natural history. In some quarters it is now the fashion to belittle the value of investigations which are not adapted to mathematical treatment. The usefulness of mathematics in advanced sciences such as physics or genetics has encouraged the notion that algebra is the hall-mark of science. Doubtless it is true that science only deals with precise relations. It is still more true that a great deal of the history of science is the record of how men have learned to enumerate the objects of scientific enquiry and to find out what sort of measurements it is profitable to make. In every science centuries of accurate observation have gone before numerical description. Without the Arabian physicians there would be no modern chemistry. Without the herbalist and Linnaeus there would have been no Mendel. The scientific study of man's social life has not passed beyond the stage when the work of a Linnaeus is a fresh landmark.

The real credentials of a science lie in its capacity to yield information which is a guide to practical conduct. From this standpoint the work of Havelock Ellis has a twofold significance. It provides the beginning of a new outlook on the sexual hygiene of the individual. It also focuses our attention on some essentially unstable features of the civilization in which we live. Our views about the best way of regulating the sexual conduct of the individual are tossed about between two extremes without any guidance based on scientific study of human nature. At one time the pendulum swings towards the crudely mechanical view which identifies the sexual response with nothing more than rhythmical muscular activity. At another it reverts to the crudely mystical view which exalts the spirituality of love and leaves the all too evident difficulties of sexual adjustment a prey to abstract nouns. The standpoint which emerges from Havelock Ellis's studies is

[1] Now published by John Lane the Bodley Head Ltd.

neither the one nor the other. It is more akin to the new biological outlook based on studies like those of Dr. Zuckermann.

Thus sexual adjustment is seen to be the building up of a composite pattern of social behaviour leading up to and including the physical consummation of the sexual life. Polarity, which is an essential feature in this composite pattern, has its basis in the temperament of the individual. Which partner to the relationship assumes the dominant or passive role in any facet of the social pattern is not primarily fixed by anatomical idiosyncrasies. The essential condition of adjustment is that two individuals are fitted by temperament to invest the physical goal of sexual intimacy with those subtle and apparently adventitious antecedents essential to a satisfactory consummation. In the end the naïvely physiological and the heroically romantic view of sex come to the same thing. A rational view of sexual union begins when we have ceased to speak of falling in love and have learned the meaning of growing in love.

How far differences of temperament such as determine the psycho-sexual make-up of the individual are determined by infantile experience, as Freud believes, how far by heredity, Havelock Ellis does not venture to assert. It is quite clear that he attaches great importance to the latter. The sociological importance of such a belief is considerable. If we hold the environmentalist view we are content to classify as a perversion any failure of the individual features to conform to the composite face. Having classified an individual as perverted he, or she, becomes an object for punishment, education, or medical treatment, according to taste, and society is vindicated. If we take the genetic point of view we may regard it as a desirable thing to change our social arrangements so as to accommodate the existence of very different patterns of sexual union. Our primary aim will be to found the sexual union upon an understanding of the psycho-sexual types of the individuals concerned.

Such a standpoint is as much opposed to what are commonly regarded as radical views about sex as to the traditional ideals. In their reaction against male dominance the early feminists

rejected polarity as a necessary condition of the sexual relationship and envisaged the partners to the ideal marriage as a pair of psychologically identical twins. Like their opponents they also wished every kind of sexual union to conform to the same pattern. So also Bertrand Russell seems to be convinced that we can find the composite face, if we only scrub hard enough to remove the grime. It is hardly a parody of Mr. Russell's view to say that something called a normal man knows by "instinct" exactly how to be quite happy with the normal woman and is only prevented from doing so because both were brought up in the tenets of the Christian religion when they were still normal children.

The social importance of the study of sex-psychology extends beyond the welfare of individual lives. Several of our leaders of scientific thought have attributed the social disequilibrium of the last few years to the fact that our knowledge of external nature has got too far ahead of our knowledge of human nature. While it may be doubted whether ignorance of human nature has much to do with the breakdown of our economic institutions there is very good reason to believe that it has much to do with the crumbling away of our social traditions under the stress of economic disaster. The nineteenth century telescoped into three generations an amazing panorama of social changes without parallel in the previous history of mankind. New patterns of social behaviour succeeded one another with astonishing rapidity during a period occupied by only seventy-five years. At the end of the nineteenth century it seemed as if Western civilization was progressing in orderly procession towards the general enlightenment, individual freedom, settled prosperity, and peace foretold by Condorcet and Godwin in the closing years of the century which preceded it. To-day the Swastika symbol of the Stone Age signalizes a headlong retreat to barbarism, and half Europe is beneath the heel of the sub-men.

Condorcet and Godwin, with their doctrine of human perfectibility, were not wrong, because, as their opponents said, human nature does not change. Of human nature, as of external nature,

Bacon's doctrine is equally true. To be commanded, Nature must be obeyed. The nineteenth century set out to change human nature without discovering its laws of change. It imposed new modes of behaviour on human beings without finding out how men must be educated if the new social pattern is to remain a stable one. Three aspects of this pageant of social change illustrate how new strains were put upon human nature without any attempt to fortify it with new means of resistance.

The opening years of the nineteenth century, following the Romilly bills in England, saw the sudden birth of a public attitude to the infliction of pain without parallel in previous history. Torture, public infliction of death and retributive ideas of justice were features of all ancient civilizations. While isolated sects like the Stoics or Essenes, and exceptional individuals like Erasmus or Voltaire, might condemn them, the growth of the public conscience against cruelty, wellnigh universal in the English-speaking world at the beginning of this century, did not become a formidable challenge until the American revolution. Another characteristic change of the nineteenth century was the emergence of the health cult. This was catalyzed by the discoveries of Pasteur and Lister and by better chemical technique for the manufacture of soap on a commercial scale. The habit of frequent washing, new to Northern climates, spread over a large section of the population. Fresh air became a fetish. A new ritual of domestic hygiene brought with it distaste for bodily odours and the fastidiousness which has now made the common marriage bed —or even the common bedroom—an object of opprobrium. A third feature of social change was the isolation of the individual. The growth of concentrated population made human life less gregarious. Large numbers of people found themselves transferred to suburbs, remote from their workmates, with no special roots where they were domiciled. As religious belief declined, one of the few ties between the family and a corporate social life disappeared.

The social reformers of the nineteenth century complacently reflected that human beings are better and safer when there is

less cruelty, less dirt, and more privacy for those who want it. They believed, and rightly believed, that cruelty, disease, and superstition are eradicable nuisances. Their weakness was that they completely failed to understand that, if eradicable, the need for cruelty, dirt, and superstition is deeply rooted in human nature fashioned by present social institutions and current methods of education. During a century which saw an extraordinary limitation of cruelty in public life, nobody asked, and few have yet asked seriously, what kind of education makes people less likely to be cruel. During a period of vast improvement in public health nobody except doctors troubled themselves with the prevalence of sexual neurosis. While mankind had been forced to be less cruel and less pugnacious it had not fully learned to enjoy alternative forms of excitement. While it had made great strides in the conquest of bodily disease it was becoming afraid of the uses of the body. While the individual had gained the freedom to be alone, he had lost the means of escaping from his own loneliness.

So with a growing sense of frustration civilized mankind becomes more aware of its losses than of its gains. Civilization itself becomes the enemy. Anticipating public sentiment, such writers as D. H. Lawrence enlist adolescence in the exaltation of barbarism. An Austrian house painter celebrates his rise to power by reviving mediaeval pageantry with orgies of sadism and coprophilia. The retreat to barbarism has begun and for years to come the life of Western civilization will inevitably be less gentle. There will be less reasonableness, less tolerance, more violence. We shall not harmonize the public needs of a progressive society with the private needs of individual human nature till we have a science of man's behaviour. Therein lies the social importance of pioneer labours such as those which Havelock Ellis has undertaken.

II

Marxism and the Middle Classes[1]

IT HAS LONG seemed to me that if there is any truth in Marxism, its usefulness as a code of social conduct must be judged in the light of the fact that it is itself the product of a particular historical situation with all the limitations of its own social milieu. Some of these limitations are easy to see in retrospect. Its fruitful emphasis on the role of technical innovation and the relation of the latter to institutional superstructures was circumscribed by the mechanical technology of the Ricardian age. Hence it was largely irrelevant to the class of problems which arise in contacts with backward cultures. It challenged the Malthusian bogy by asserting the inevitable triumph of the Fourth Estate. Hence it was more concerned with what makes for change than with what makes for stagnation. In a large measure the Nazi nonsense is the Nemesis of a social philosophy which could offer no clue to the habits of the aboriginal Tasmanian.

Marx put the problem of social change in the form dictated by nineteenth-century technology. If you are content with it, he gives you a satisfying and illuminating answer to the question: What makes the social automobile start up? According to Marx, technology is the petrol and class warfare is the piston rod. If you also want to know why the car does not start on a winter's morning, you have to go elsewhere for an answer. Marx did not want to dwell on the unpleasant side of social motoring. His car was a racing car. It always started up.

That was his great mistake in the psychology of propaganda. In an age of imperialist expansion, people wanted to know why

[1] Address to the Midlands Conference of the Workers' Educational Association, March 1939.

cars do not always start up, and the eugenists were ready with a quite simple, and at least intelligible, answer. Their story was that the car has a defective self-starting mechanism. All that you can do about it is to scrap it and buy another one. If Marx had paid a little attention to social lubrication and dust in the social carburettor, they would have been forced to produce evidence of mechanical defect.

As a rebellious offspring of scarcity dialectic and Malthusian gloom, Marxism could not escape a further limitation. An historical rationale of social effort is worth while if it does two things for us. One is to furnish rational grounds for hopefulness about human striving. The other is to show us what follies to avoid. Marx was in too great a hurry to bother about the second. Marxist history sets the faithful whistling to keep up their spirits, and leaves them a free hand to perpetuate the failures and stupidities of their grandparents.

One of the grosser forms of contemporary stupidity is the evangelical enthusiasm with which Marxists dilate upon the new underground transport system in Moscow. While it is not surprising that the first experiments in social planning on a large scale should imitate social ineptitudes which resulted from the absence of social planning, it is neither necessary nor profitable to conceal the fact. As an Anglo-American, as a good European, and equally as a man of science, I am glad that Calvin founded the kingdom of God in Geneva. Like all sensible people I think that science and human enlightenment would have suffered from the continued hegemony of Mediterranean Catholicism. Like all sensible people I also think that no useful purpose was served by burning Servetus. When I try to figure out contemporary events in the light of man's collective experience that is the way I look at the Russian scene.

As I see it, capitalism is no longer a creative force. It is a challenge to further progress of science and human enlightenment. It is due to be debunked. Russia has debunked it. Inevitably the first efforts to create a socialist order will have all the defects of a new thing. To condemn the movement towards world Socialism

because of the intolerance, fanaticism, and ruthlessness of Stalin is as silly as condemning Liberalism because of the fanaticism and ruthlessness of Calvin. To seek excuses for the mistakes of the Soviet Union is just as silly as to seek excuses for sending Servetus to the stake. Calvin's theology was rotten theology, fit for the slave-raiding buccaneers who bequeathed to us one of the most formidable unsolved problems of American democracy.

To defend the dogmas of dialectical materialism because they are the official creed of the first socialist republic is just as silly as defending the doctrine of predestination because Calvin believed in it. Protestant democracy won through because it established a social order which could take advantage of new technical possibilities. It did so in spite of its theologies, and not because of them. Consequently I can see no reason why the merits of the controversy between Stalinists and Trotskyists should have the slightest interest for Anglo-Americans like myself.

As far as we are concerned both are right, both are wrong, and both supremely irrelevant. As the French Revolution gave mankind a new hope, the Soviet Union can claim achievements which have also given mankind a new hope. A backward and illiterate people, brutalized by the Oriental ferocity of the Czarist regime, has become a great nation undertaking vast constructive projects which put capitalist enterprise to shame. It is becoming healthier, more prosperous, and more self-confident as France became healthier, more prosperous, and more self-confident while Napoleon was consolidating bourgeois property rights.

So much remains, whatever the Trotskyist critics of Stalin may say about it. Heaven alone knows whether it would have been better if the "sea-green incorruptible" had ruled France for twenty years longer. Heaven alone knows whether Russia itself will be better or worse for its whiff of grapeshot. What we do know is that a social philosophy which takes its sole empirical justification from the birth pangs of an unindustrialized, brutalized, and illiterate nation can provide no safe guidance for the task of mobilizing constructive social planning in mechanized societies, such as America and Britain.

§2

In countries such as Britain and America people who call themselves Marxists may be divided into two sharply contrasted groups. One is composed of men like J. D. Bernal who are sincerely examining the impact of technical innovation on the society in which they live, as Marx examined the impact of technical innovations on the society in which he lived. The other is made up of individuals who regulate their conduct in the light of conclusions which Marx drew from his own studies without regard to facts which he could not possibly have known in his time. The handful of individuals who belong to the first group are mainly scientific workers who are not unnaturally disillusioned by the exploits of the British Labour Party as an instrument for implementing an economy of abundance. Their training prevents them from believing that a man described as a Darwinian by people in Tennessee necessarily asserts that Darwin was never wrong or that biology has not advanced since Darwin's time. So they are not unduly sensitive about the label attached to their beliefs. Since they constitute a negligible minority of the political movements to which they attach themselves, Marxism as they interpret it has no special relevance to the influence of Marxism on contemporary social policies. As such Marxism cannot be judged by the effect which reading Marx may have on an individual whose intelligence has been fortified by scientific studies. It must stand or fall by the results produced when less intelligent people apply conclusions which Marx drew from events in his own time to a different social situation in our own generation.

For this reason I find it hard to understand why grown-up people constantly assure me that I have to choose between Fascism and Marxism. If acceptance of Marxism implies a course of action which cannot help us to advance towards an economy of abundance, espousing Marxism means giving Fascism the choice of weapons. National Socialism has drawn its mass following in large measure from the lower middle classes. Before taking sides

it is therefore important to understand why social democracy failed to win their support, and whether the teaching of Marx helps us to understand how to do so. It seems to me that if we approach our problem from the standpoint which Marx himself would have adopted, what has happened since his own time forces us to conclusions which are opposite to those stated in his writings and to the beliefs of the overwhelming majority of his followers who base their conduct on the literal inspiration of his works.

The great merit of Marx was that he saw very clearly how the policies and prejudices of his time had been shaped by the introduction of steam as a source of power in manufacturing processes. A vast extension of the factory system with concomitant shifting of the population had brought isolated craftsmen from their homes, and had concentrated them in compact milling or mining communities, where conditions were propitious to the growth of militant class solidarity. The new conditions made increasing demands for unskilled labour, and skilled craftsmanship was on the decline. If no new agencies had entered into the situation it is possible that the results might have been as Marx anticipated. A landless, letterless proletariat would have continued to grow in numbers and in militancy, till the owners of industry were expropriated by sheer force of numbers. The Communist Manifesto of 1848 was very emphatic in its assertion that the middle classes would be squeezed out of existence in the process of levelling down. It explicitly states that the poet, the lawyer, and the physician were becoming more and more the hired slaves of the master class and were thus *sinking* into the ranks of the proletariat. Resort to reasoned appeal was therefore futile and violent conflict was the inescapable climax.

Such was the forecast on which Marx based a social tactic which has failed in every highly industrialized country where his disciples have acted upon it. How and why it was wrong has been sufficiently discussed in another context.[1] Technological changes and educational expansion which have taken place since

[1] Page 19 *et seq.*

Marx was at the age when human beings are able to assimilate new situations have completely changed the course of social evolution, as Marx envisaged it. A continuous fall of the infantile death-rate, a rapid diminution of differential fertility during recent years, and a growing Woolworth sale of lipstick, gramophone needles, or silk stockings are statistical realities which point to the same inescapable conclusion. Contrary to Marxist prophecy the middle class *employee* represents a social group whose numbers and influence are steadily increasing. Their social mores and tastes now dominate the aspirations of the more prosperous wage earners as urbanization draws an ever larger proportion of the latter from the mining or milling communities of an earlier phase of industrialism *into large centres of conspicuous expenditure.*

The result of recent shifts of population is to take the primary worker away from centres were class solidarity is strongly entrenched. Where capitalism is most highly developed the employed wage earner is now a very different person from the landless letterless proletarian of Marx. Like Mr. Dolittle in *Pygmalion,* he is tied up and delivered into the hands of middle-class morality. The political morality of the middle classes is to bear the ills you have rather than fly to others that you know not of. Consequently the class war view of political strategy is foredoomed to failure as an instrument for realizing a planned economy of abundance. Like free trade economics it is a hangover from the ages of scarcity. Its appeal to a younger generation which vacillates between the compromises of the Popular Front and the militant intransigeance of the Old Bolsheviks is largely due to the failure of organized Labour to furnish a broad basis of agreement for constructive social innovations.

§ 3

It is admittedly true that in so far as Labour has failed, it has not failed because its responsible leaders ever believed that an effective Socialist Government could rely on the exclusive support of the wage earners. Labour has piped bravely in a boiled shirt and the

middle classes have not danced when the poll was announced. It has wept copiously at royal funerals and the middle classes have not mourned when it went out of office. One reason for this is that it has always confused the middle classes with the middle class. The middle class, which the innocuous insipidities of party manifestos were designed to coax, is a political Mrs. Harris. There is no such person. So-called middle-class people fall mostly into two groups sharply defined by differences of outlook, educations, aspirations, and tastes. One must be a bulwark of any progressive movement which can hope to gain and retain office. The other is made up of individuals whose activities would be quite unnecessary in a rationally planned society.

The first are the salariat; people whose employment is generally contingent on some recognized qualification based on extended formal education. They are the technicians, the teachers, the clerks and administrative workers, public officials and managers. Such people have everything to gain from extending public enterprise to take advantage of new technical knowledge. The others are the shopkeepers, the middlemen and agents of competitive capitalism. Much of the work they do is utterly useless. What is not could be done in a planned economy by co-operatives and municipal enterprise. It is too much to expect them to dance at their own funeral. So a united front which will advance towards a planned economy of abundance cannot be a united front of Labour and the middle class as a whole. It can only be a united front of wage earners and salaried employees.

Those who have sincerely and honestly striven to secure new allies for Labour, still think that they can do so, if they allay the fear that a Labour Government will undertake drastic innovations and daring social experiments. They think that it is necessary to train the middle classes slowly and patiently to realize that public enterprise can carry out with equal efficiency tasks hitherto discharged by private undertakings. Both these beliefs are based on a complete misunderstanding of what section of the middle classes can furnish allies for Socialism and what its real aspirations are. Industrial capitalism has brought into being a new social group

on whose special knowledge and training it depends in its last phase of parasitic incompetence. Individuals of which it is made up are more disposed to work for a surplus than to work for a profit. They have no abstract belief in capitalism as such. They have no rooted antipathy to the secure conditions of civil service employment. Getting rich quickly is not their chief end in life. What is more important to many of them is whether their activities enjoy social esteem, and whether they can foresee prospects of steady promotion with further opportunities for new and more interesting or more influential work, such as they have been accustomed to expect as a natural consequence of technical progress before chronic depression was a normal social occurrence.

By itself the nationalization of an undertaking such as the railways does not offer them any substantial prospects of greater opportunity or influence. That they do not respond enthusiastically to the proposal is not because they are necessarily hostile to nationalization on principle or really terrified that Lord Stamp would be dismissed. They know he would not. They know that railways would run to time as before. The Labour Party has told them once too often that it would make no difference to them. A party which hopes to gain their support must propose something which *will* make a difference to them.

A topical example is not far to seek. In Britain public enterprise took the initiative of creating a new undertaking to exploit a new technical amenity. Throughout the country there were new avenues of employment for special skill and education. There was no hoarse clamour against Bolshevism red in tooth and claw. There were no riots against expropriation. The B.B.C. is therefore a salutary object-lesson of public enterprise of this kind. If a progressive party wants to recruit allies to a programme of Socialism in Britain its first concern should not be to show that it is respectable. It will not overcome the innate snobbishness inherent in British social structure if it tries to do so. It will succeed if, and only if, it can advance a bold and challenging programme of technical expansion based on the socialization of industries in a backward state of development or

the creation of new industries to exploit resources of new knowledge buried in frozen patents of capitalist monopolies. The dread of Socialism as a disruptive movement will diminish with the growing recognition that Socialism introduces a new creative impulse into social life.

§ 4

In the declared policy of the Labour Party there has never been any clear-cut expression of its intention to proceed towards Socialism along these lines. On the contrary, the repeated pronouncements of its spokesman have made it clear that they would concentrate on the nationalization of well-established industries. They have even sought to soothe the middle classes by promising that initiative in creating new industries would be left to private efforts. The implications of these reassuring promises are instructive and can be made clear with the help of an example.

Let us suppose that a Labour Government had been in power in the year of my birth. In that memorable year Sir William Harcourt said that we are all Socialists nowadays and the first tentative motor vehicles appeared on the road. Since the hansom cab industry was at that time a well-established one, it was ripe for nationalization according to the official standpoint of the Labour Party. So let us also suppose that it was duly nationalized and examine the result. One of two things would have happened. The State might have maintained its monopoly in an effete method of locomotion by prohibiting the import or manufacture of motor cars. Alternatively, it might have scrapped the manufacture of hansom cabs as some municipalities are now scrapping their tram cars. Had it adopted the first the outside world would have said that our Socialism was a more conservative system of technological development than private enterprise. If it chose the second, we should be no nearer to a planned economy of public ownership; and we should probably have thrown the burden of winding up an effete industry on the middle-class tax-payer.

You may take your choice. Socialism conceived in these terms is either a fraud or a challenge to the further ex-

ploitation of new scientific knowledge and new technical skill. If you accept the inevitability of gradualness, you must also accept the inevitable decay of any industry. In these days of tank gardening and Gericke's water culture even agriculture is only permanent in the sense that locomotion of some sort is permanent. No flourishing modern industry existed in its present form when the wood economy came to an end in the latter half of the eighteenth century, and no capitalist industry would remain in being a hundred years hence if public enterprise took over the initiative of developing new resources. In its war with poverty Labour's success will depend on the fullest use of new scientific knowledge. It will attract the allies it needs, only if it can show that public enterprise has more technical initiative than decaying capitalist monopolies. By surrendering the initiative to capitalism it will drive them into the camp of the strong men who make promises.

To say that Labour has failed to secure the support of the middle classes because it has never been sufficiently clear about their composition or aspirations invites us to go a step further. In libraries stocked with monumental volumes devoted to trade union structure, industrial legislation, the co-operative movement, poor law, social surveys, subsidies, and interlocking directorates you will look in vain for a single comprehensive and statistically precise account of the growing body of employees who have no affiliations with the trade union movement. Thus indecisive policies and erroneous judgments are partly due to the absence of any corpus of radical scholarship and research concerned with contemporary changes of social structure except in so far as they affect organizations of wage earners. The young man from Oxford can tell us all about how the paperhanger lives. It is nobody's business to tell you how the straphanger lives.

This lack of necessary information about relevant social structure is not sufficiently explained by saying that the socialist information service is small or that Labour has been slow to endorse educational activities. The truth is that Labour research like Labour policy in general is what it is because the Labour

Party is first and foremost a trade union party. As such it seeks intellectual allies among those who have been trained to state a case. Since literary fluency is rarely, and aptitude for legal disputation is never, associated with the sort of curiosity which leads to fruitful research, the results might be expected. The intellectual outlook of the Labour Party is largely moulded by a legally minded intelligentsia who usually combine hostility to science with complete ignorance of its achievements and possibilities.

We are therefore left with the following question. Can a party whose policy is based on the block vote of the trade unions become an instrument for promoting a planned economy of abundance? Fifty years ago this was an axiom accepted equally by those who advocated the Marxist class war and by those who rejected it. It is not hard to see why this was so. Before it was possible to envisage the plenty which new scientific knowledge has now put at our disposal, Socialists had somewhat nebulous views about whether they were out to establish an equality of misery or an equality of prosperity. Marxists believed that capitalism would collapse because of the increasing misery of the masses, and ethical Socialists were too preoccupied with justice to give much thought to the organization of abundance. From either point of view the main task was to canalize the discontent of the wage earners, and the trade union movement as the corporate expression of their discontent seemed to be the appropriate tool for the business in hand. The precise circumstances in which a trade union will actively agitate for public ownership was a question which never entered their heads.

To-day we know the answer to it. From the standpoint of the stockbroker industry exists to pay dividends. From the standpoint of the trade union official industry exists to pay wages. Neither sees industry as a means of making natural wealth available for human uses. The primary business of a trade union official is to keep his union intact by securing what concessions the management will grant to its employees. Since technical innovation often leads to less opportunities of immediate employment and more profits to the shareholders, it is too much to expect

from him a cordial enthusiasm towards technical improvements; and since planning of new industries entails redistribution of workers with the concomitant danger of losing trade union subscriptions, it is also too much to expect that initiative in planning the use of new scientific knowledge under a system of public ownership will come from the Labour Party while the trade unions pay the piper.

A trade union will actively support the advancement of public enterprise in two circumstances. It will do so when and where national or local government can be induced to provide public amenities which raise the standard of life of the wage earner without exploiting new sources of natural wealth. It will also do so when an industry is on the verge of bankruptcy which threatens its employees with loss of work or wages and its shareholders with loss of dividends.[1] Shareholders and trade union officials can then make common cause. The State is asked to buy out a dying concern and support it in its old age. The middle classes have little share in the benefits which result from public enterprise conceived in these terms, and since it generally entails more taxation, it promotes a new class consciousness which is resentful to Trade Unionism. Fascism is a corporate expression of middle-class resentment. Either nationalization of decaying industries in the interests of the workers concerned or promotion of social services for the wage-earning section of the community leaves the control of natural wealth and the power to exploit it for private ends in private hands. The cost has to be met by taxation. The taxation of large incomes cripples industrial enterprise without substituting a new initiative, and the taxation of small incomes rallies the middle-class employee to the defence of privilege.

[1] The following quotation from the *News Chronicle* is eloquent: "State ownership of the four big British railway companies was advocated by Mr. William Whitelaw, chairman of the L.N.E.R., in a special interview with the *News Chronicle* last night. 'I am well aware that the advocacy of State ownership does not find support among many railway directors, but in this matter they will not forget that their sole responsibility is to their Stockholders, and not to any individual political theory.' "

The escape from this deadlock is easy to see if we concentrate on a less familiar situation. During a short visit to Iceland during the summer of last year I heard two views of what was happening. there. Some said that the Socialists had made the country bankrupt. Others pointed to the new hydro-electric power station which lights the streets of Reykjavik where the houses now have central heating from the natural hot springs which abound throughout the island. After a few days I found that both parties were right. I had come with introductions to two Cabinet Ministers who were touring Europe and America with the forlorn hope of raising a new loan. Ten years ago Iceland, which has no railways and has never been through the age of soot, could not boast that it possessed a single dynamo. To-day Reykjavik is a modern city struggling to attract tourists. It has the most up-to-date mental asylum which I have seen. The central heating, the electric lights, and the asylum are solid social achievements. None the less they are non-productive services which can be paid for only by taxing an impoverished local fishing industry and a few boatloads of trippers.

A century ago Babbage suggested that Iceland might become the power station of Europe. With its innumerable torrents and ubiquitous geysers Iceland has probably more resources of natural power than any piece of land of the same area in the world. Apart from the fact that farmers' wives bake their bread and do their washing with the help of the hot springs, the only exhibits of the productive use of natural power are glass hothouses to supply roses for the two hotels where summer tourists forgather. Meanwhile, the country is rife with scurvy owing to the lack of indigenous fresh fruit or vegetables and the lack of foreign currency which would pay for fruit from abroad. I am tempted to mention one other relevant fact. I visited the small university, where I was told that they have four professors. One teaches theology. One teaches law. A third teaches philology. According to my information, the fourth was responsible for any instruction which may have been given in medicine, chemistry, agriculture, or engineering. This may help you to see why the Socialist Party

has neither considered nor advanced any proposals for using hydroelectric power or natural heat to produce goods which would guarantee its search for a foreign loan and pay for the admirable social services which it has introduced.

The lesson of Iceland as I see it is that the policy of peaceful progress can only prosper *if redistribution of wealth keeps pace with public acquisition of resources for creating new wealth.* A programme which can promote a united front of all the employed classes must be bold and challenging in its demands for the betterment of the wage earner, bold also and challenging in its measures for technical expansion by creation of new socially owned industries which will enrich the commonwealth. While this will not be accomplished without the support of the trade unions, it will not be accomplished by a party whose policy is dictated by the trade unions; and it will not be accomplished by any party whose intellectual leaders do not understand the resources which science has made available for the satisfaction of common needs. Above all, it demands the co-operation of chemists, agriculturalists, engineers; men who have a vision of what human life could be if scientific knowledge were used for the benefit of mankind as a whole.

The necessary conditions of progress with security include reform of representative government to take advantage of necessary expert knowledge as well as a programme which will mobilize the good will of the electorate to take advantage of available resources for common well-being. Two reforms which would help to remedy the dilatoriness and inherent lack of constructive initiative in parliamentary democracy as it now exists could be carried out immediately by any progressive Government. Both have been suggested by scientific workers.

One is Sir John Orr's plea for a Ministry of Nutrition to co-ordinate the work of the existing Ministries of Health and Agriculture, with a view to scientific development of the nation's food resources in conformity with an optimum level of national nutrition. The other is Sir Daniel Hall's proposal to set up a permanent National Planning Council. The function and per-

sonnel of such a body would be totally different from the preposterous circus of scholastic economists commissioned by the last Labour Government to discourage its successors from attempting social innovations which would challenge the initiative of private enterprise or the dictatorship of the banks. A National Planning Council should be made up of outstanding (and upstanding) chemists, engineers, and agriculturalists. It should have power to reserve on behalf of the nation a first option on all patents, and its primary business should be to suggest immediate steps for the creation of socialized industries to exploit new discoveries.

To make expert knowledge available for constructive social innovation calls for a new personnel of politics, i.e. in the legislature, as well as for new organs of government and new consultative bodies. In Britain this is one of the most troublesome tasks which a programme of progress with security entails. No one with other opportunities for exercising a first-class intelligence and constructive imagination would contemplate a lifetime divided between the precarious duties of a member of the House of Commons and the apprenticeship of nursing a constituency before becoming one. We must therefore look elsewhere for new resources of legislative initiative to advance the plenty available for all. The example of our Scandinavian neighbours suggests a remedy. If Britain had a second chamber of experts co-opted to place their gifts at the disposal of the nation, a progressive party could enlist the services of enlightened talent in the work of legislation. What Sweden has done, Britain could do.

This is my answer to those who assert that the choice between Fascism and Marxism is the only choice before us. The attempt to establish a planned economy of human welfare by reasonable persuasion has not failed. It has not yet been tried.

12

Adult Education To-day[1]

THE AUTHORS OF *1066 and All That* have done a great service to education by forcing us to recognize that we waste an enormous amount of time and effort in secondary education by slow and laborious attempts to impart information which could be rapidly assimilated if the pupils had a wider experience of life. Their realistic representation of the impact of tonnage and poundage on adolescents who have never seen an income-tax return or a customs officer is all the more illuminating because historical study is a relatively congenial item in the school curriculum and a very necessary part of the intellectual equipment of a good citizen. I am inclined to believe that it would be a sensible plan to suspend any formal education during the period of puberty, when the elements of reading, writing, and calculation have been assimilated. Labour camps may be looked upon as a significant social innovation when, and if, the world has outgrown the uglier features of education in the totalitarian states.

For that reason alone the Adult Education movement seems to me to be one of the most valuable instruments of education in countries where some measure of democracy survives; and for that reason also what sort of instruction it offers seems to me to be a matter of supreme importance. In Scandinavian countries the solemn prolixity of university instruction seems to have called forth a reaction of spontaneous curiosity and alertness to issues of outstanding social importance; and adult education is a corner-stone of social progress. In England where professors do not take themselves quite so seriously, adult education is

[1] Lecture delivered at the London District Workers' Educational Association Rally, March 1937.

handicapped by a timid servility which aims, in words used by one of the leaders of the W.E.A., at "making the culture of our universities available *to the humblest worker.*" A sufficient prophylactic for sententious puerility of this sort is to ask what a university is, what is meant by the culture it confers, and what are the real needs of the worker.

What is a university is a question easy to answer if we put it in the more realistic form: What do people do in universities? The majority of students in our universities are registered in the faculties of Medicine, Science, Engineering, Agriculture, and Law. That is to say, they are serving an apprenticeship for certain skilled occupations which are an essential part of a complex modern community. So by far the more important part of a university's work is not essentially different from that of a polytechnic or a military college. The majority of students in a university are apprentices who receive scholarships from the State or allowances from their parents instead of wages during their apprenticeship.

A minority of students study theology or humanistic disciplines such as languages, history, philosophy, economics. The majority of those who study theology are destined to earn a livelihood as parsons. The majority of those who study the humanistic disciplines, like a certain proportion of individuals in the faculty of Science, are preparing to earn a livelihood as teachers. With the exception of Oxford and Cambridge, which account for a small fraction of university students in Britain, the overwhelming majority of university students may therefore be classified as persons who are learning to be practitioners, learning to be parsons, or learning to be pedagogues. Some of the adolescents who go to Oxford or Cambridge do not go there to learn anything. They therefore become politicians.

Our universities are a *necessary* part of social life because the majority of people in them are being trained to be experts. Most of them are acquiring knowledge which is essential to the conduct of a modern community. Some of them are preparing to specialize for activities whose usefulness is more debatable. The majority

of students are being trained to become physicians, surgeons, engineers, pathologists, agricultural advisers, soil analysts, industrial chemists, higher grade electrical technicians, and lawyers. Most students who take modern languages will eventually teach them in schools; and since the chief reason for teaching modern languages in schools is the existence of an international exchange economy, we must include modern languages along with medicine, science, engineering, agriculture, and law as part of the vocational activities of a university.

In some form or other universities must exist, because society cannot be run without expert knowledge. So much is clear. When we turn to ask what is meant by the culture of our universities, it is not so easy to be sure about what we are discussing. For instance, it is a paradoxical fact that specialization is carried furthest in those universities which pride themselves most on their cultural status. No university honours degree offers more scope for narrow specialization than the Oxford schools. Perhaps this explains why Oxford has produced distinguished Directors of Museums but few men of first rank in scientific discovery.

At the outset we must therefore dismiss an arrogant pretension which is in complete contradiction to the facts. The universities do *not* exist to provide more opportunities for general knowledge than those provided in other institutions for specialist training. If a man goes to Oxford to study history he may pick up a passing acquaintance with science from his friend on the same staircase. This does not happen often. In my opinion it is just as likely that a mathematician who is interested in ballistics will take to military or naval history, if he finds himself at an artillery college. The same time spent in Fleet Street would enlarge most men's general knowledge far more than three years' study at a university, and a journalist who works up from the reporters' room is more widely informed than the man who graduates from the lecture theatre. Speaking generally, the main difference between those who take to naturalistic and those who take to humanistic studies is this. The former remain ignorant of the

latter and regret it. The latter remain ignorant of the former and boast about it. I am always entertained by the note of proud humility with which one of my colleagues tells me, "Of course I don't know anything about science." The admission combines the privilege of being an authentic gentleman with the satisfaction of being a conscientious Christian.

Whatever we mean by the culture of our universities we certainly cannot mean breadth of knowledge and general information except in so far as they give students from rural areas or small communities access to larger libraries. Since England is very highly urbanized, this does not count for much. English universities, least of all the older universities, do not aim at encouraging breadth of study. Though the Scottish universities aim at doing so, they do not succeed. Their curricula have changed too little under the impact of changing social conditions during the last two centuries. Hence the studies prescribed exclude most kinds of information specially relevant to modern life. Speaking broadly, I think the best products of the British university system are Scots graduates who proceed by scholarship to Cambridge where their previous training lightens the pressure of specialized study and leaves them time to get a modern outlook if they are disposed to do so.

From personal experience I can say that I do not owe any general information which I myself possess to three years' study or twenty years of teaching in a university. I am glad I went to Cambridge, because I met first-rank biologists who taught me well. I am glad that I teach in a university, because I enjoy scientific research and believe that helping to make good doctors is a socially important job to take seriously. Apart from the fact that universities have good libraries with obliging librarians, and that my historical colleagues sometimes divulge useful information, I do not think that any university has done much to broaden my interests. My experience of university teaching has not led me to suspect that university teachers are either paid or promoted for broadening the minds or morals of their students. Speaking as one who has attempted to do so, I may say that the most

conspicuous effect of my efforts has been to irritate the Principal and Board of Governors of four of the six institutions which have had the good fortune to engage my services.

I went up to college in the first contingent of county schoolboys with scholarships. That helped me to take a rather detached view of what universities are like. The fact that I supplemented my scholarships by taking various vacational jobs, which included being a secretary to a member of Parliament and a reporter on a county newspaper, taught me a few lessons which most undergraduates do not learn. Since then I have learned a little more by living on three continents and getting paid for it. I have kept young by avoiding the company of professors, except when it is necessary to discuss academic policy, and that of their wives in all circumstances. It is my strong conviction that some of my humanistic colleagues would know more about the human race if they also spent more of their time in pubs and less in common-rooms. If I wanted to know more about human beings at second hand, I might question my friends who are journalists or railway guards or civil servants. The last person from whom I should expect to learn anything about human nature is a professor.

§ 2

Having decided what is *not meant* by the culture of our universities, let us now try to find what is. If we examine the writings of the self-appointed custodians of English culture, I think we shall be forced to put culture in the same class as gentleman, hero, martyr, and God. In his plea for a dictionary of sensible words, Sir William Petty included the latter in a list of words which, having too many meanings, have no meaning at all. Among other meanings which are quite distinct, two which crop up most have no very obvious connection. One is preparation for intelligent citizenship. A second is an enlarged capacity for personal enjoyment more or less compatible with that of others. Yet another is equipment for leadership in civic affairs. There is clearly no necessary connection between the first or third and the

second. Since only a small fraction of the population go to universities we need not draw a hard-and-fast distinction between the education of the citizen and leader in civic affairs. If the universities really provide the type of education which helps people to become intelligent citizens, its products will necessarily be leaders in civic affairs. So if we restrict ourselves to the two broad issues raised in the preceding remarks, the culture of our universities means what provision they make for enlarging our capacity for enjoyment and for training men and women who can give a lead in social affairs.

Let us first examine the claims of university instruction as a means to the enrichment of capacity for personal enjoyment, other than the enjoyment which comes from varied, skilful, and responsible work. From this point of view we may dismiss the natural sciences and their applications together with modern languages for reasons already stated, and we may defer discussion of historical and economic studies as ostensibly cultivated to promote intelligent grasp of social affairs. This leaves us with three main items of the curriculum: so-called moral philosophy, dead languages, and English.

Moral philosophy with its foster-child scholastic logic is merely a relic of the ecclesiastical foundations, and as such need not detain the attention of a twentieth-century audience. In Oxford it is properly treated as an appendage to the grammatical disabilities of defunct Mediterranean civilizations. In Scotland it still occupies an honourable position as the dutiful daughter which stayed at home to comfort religion in its declining years. Elsewhere in English-speaking countries the annual appointment of a Gifford lecturer is sufficient to raise a twitter from the headmistress of a high school.

In this context it is irrelevant to discuss various arguments put forward by those who advocate the need for classical studies, i.e. familiarity with the grammatical usages, military exploits, and political delusions of the slave-owning classes of Italy and Macedonia during a period of protracted mechanical stagnation. For the time being we are concerned only with what is customarily

called education for leisure. No one claims that it is impossible to enjoy Ibsen's or Strindberg's plays without first learning a Scandinavian tongue, and few who specialize in dead languages ever acquire enough proficiency to enjoy Euripides better than the rest of us can enjoy Gilbert Murray. So while we may be thankful that some people are able to translate Euripides, we can scarcely regard the enlargement of personal enjoyment as the main reason for teaching dead languages.

The only subject of university instruction justified unashamedly for its entertainment value is the pursuit of English literature. Since serious literature, including biography, polemics, or popular science, is relegated to history, political science, or philosophy, English literature of the last hundred years is commonly concerned with two topics. One is whether a sexually inexperienced young woman of a prosperous class will succeed in compelling a hard-working or handsome young man with insufficient knowledge of contraceptive devices to sign a legal contract of cohabitation. The other is whether a leisure-class wife with no serious profession can make her getaway from a legal arrangement which she would continue to tolerate if liberally supplied with oestrogenic preparations. One job of the English professor —there are honourable exceptions such as Richards of Cambridge—is to keep up the pretence that discussing these topics without medical knowledge is honest work. Literary criticism is the Siegfried line of sententiousness and the Maginot line of mendacity. The main difference between the Press critic and the professor is that the former is underpaid to tell lies in an amusing way, and the latter is overpaid for the privilege of being unprintably dull.

We do not write poems, novels, or plays about a poached egg. This is an interesting fact because Arctic explorers have been known to dream of poached eggs. It seems that the class of people who write novels are more successful in budgeting their food than their erotic requirements and that their books sell because the social regulation of the latter leaves a number of other people in the same predicament. If our social arrangements were better

adapted to ensure happy sexual union and if the sciences of human biology and psychology were sufficiently advanced to tell us how to make marriage a success or how to choose a satisfactory partner, the theme of Othello would give us no more excitement than a lament on an overdone poached egg. Professors of literature would then have to undertake the scientific business of planning the perfect instrument of rational discourse between men and women of all nations, or to seek employment in the departments of history and dead languages.

While no one in his senses would maintain that the thrill of reading *Hedda Gabler* is a satisfactory substitute for a happy marriage, few of us are sufficiently self-confident to follow out the obvious implication. Much of what is called art is simply living at second hand. Speaking as an individual I may say that my own capacity for personal enjoyment has enlarged since I ceased to be bullied by highbrows into the dreary routine of passive satisfactions which pass as culture in the Christmas competitions of the *New Statesman*. At forty I enjoy the sight of daffodils growing along the Teign valley in late March far more than I ever enjoyed an art gallery. I am a happier man because I am beginning to enjoy the experience of having grown-up children far more than I enjoyed four attempts to finish *The Brothers Karamazov*. I am a happier man at forty because I openly read P. G. Wodehouse on a train journey and no longer carry Virginia Woolf to impress the other people in the compartment. To adapt Dr. Johnson's remark, "I have tried hard to be a cultured man, but have always found cheerfulness creeping in." Of all sentiments expressed in verse none coincides more closely with my own than those of Chesterton's lines:

> But the song of beauty and art and love,
> I consider an utterly stinking song,
> To double you up and drag you down and damn your soul alive.

Having found (as Chesterton elsewhere says) "common things at last," the last insult which I would offer the worker is the culture of our universities. I would like to feel that every

worker could enjoy a ramble along country like the Teign valley in spring. I would like to see mechanical technology space our population so that the humblest worker could have his garden and have space to live and do things and enjoy living at first hand. I cherish a vision of England as it could be if biotechnology were used to plant our roadsides with trees bearing fruits throughout the seasons. I want to see science used to make a world too beautiful for the survival of passive satisfactions which multiply in the hypertrophied urban squalor of life as it now is for most people. If you look for vision, for imagination, for confidence in the human experiment to-day you will find it more frequently among men with scientific knowledge than among those who lack it. To those of us who know something of the present resources for beauty, for leisure, for material abundance, civic responsibilities resolve themselves into one theme—to make accessible to all the plenty which science has made available for all.

Contemporary cant about education for leisure is the newest sort of cant. Its more vocal advocates are usually dons with an understandable solicitude for advertising their own anaemic wares. The Press lords who help them to do so know, as you and I know, that few other human beings have more impoverished resources for spontaneous enjoyment except in so far as they are conspicuously addicted to orgies of over-eating and under-thinking in costumes designed to inhibit excessive cerebration. From the writings of Principal Jacks one might almost infer that ordinary people live in daily peril of the devastating monotony of being torn away from city offices and factories before four o'clock in the afternoon and kept out of them till eleven o'clock next day; or that unemployed locomotive engineers who cannot have lectures on landscape painting are being demoralized by lack of work as dons are demoralized by a sabbatical year on full pay. This curious pretence is naturally congenial to the Press lords, because it helps us to forget the simple truth that science has made it possible for us to organize our lives so that we could all of us have more of what we want most, and that we could collectively plan the

redistribution of population in surroundings where normally constituted people are rarely bored.

No normally constituted individual whose brains have not been sterilized by protracted adolescence in monastic institutions for the promotion of a mediaeval outlook needs to be told that for people who are prosperous enough to have a country cottage for the week-ends the only problem of leisure is the problem of using a railway time-table or driving a car. That is why no educationists whip themselves into a frenzy of evangelical zeal about teaching the right use of leisure to the rich. It is therefore plain as a pikestaff that the problem of leisure is partly the problem of how to do away with poverty and partly the problem of how to use mobile power as a basis of population planning in the hydroelectric age.

In every branch of education where this pestilential nonsense distracts attention from the compelling task of spreading knowledge which would show us how to make more leisure in congenial surroundings available to people who can enjoy themselves without the assistance of *declassé* dons and metropolitan misfits, its only effect is to prevent people from discovering for themselves means of enjoyment suited to their individual needs. The few who are not capable of doing so need the services of an expert psychiatrist. The reason why we tolerate the busybodies who claim to know what tunes we should be allowed to hum in our baths is that psychology is still a very young science. While it remains so, headmasters and principals of training colleges, if wholly devoid of constructive educational ideas, can cash in on public ignorance about the nature of human satisfactions by starting a hue and cry for teaching musical appreciation to boys and girls who cannot do their home lessons without the distraction of the radio set. Members of the governing board can then go off to their clubs and say that the twentieth century is the century of the child.

All of us have been victims of this right-use-of-leisure quackery at some stage in the educational process. As a boy, I had no difficulty in amusing myself when left to my own resources. I

enjoyed reading about the Sabellians in the Protestant dictionary, making a galvanometer out of a sardine tin, or sitting by a hedge with Bentham and Hooker's *British Flora*. Whenever I wanted to do any of these things there was usually some fool schoolmaster who believed that I should become a happier and better man if made to stand about in an east wind deafened by the simian cacophonies of other adolescents propelling an inflated pellicle of leather through a quagmire with little prospect of overtaking it. English education is infected with right-use-of-leisure quackery more than education on the Continent or in America. We do not choose teachers because they are first-rate biologists with expository gifts or because they are historians with a lively sense of topical relevance. The two indispensable talents are: (for a woman) chastity and (for a man) football. If a woman displays a natural aptitude for healthy enjoyment by committing matrimony she is dismissed by most educational authorities. If a male applicant reserves the right to recuperate from the nervous strain of continuous contact with children by seeking adult forms of enjoyment on half-holidays or during week-ends, he receives notice that an Oxford half-Blue whose father is a school inspector has been appointed to the job.

§ 3

What the humblest worker needs is not the enlargement of his capacity for enjoyment but the enlargement of his means for enjoyment. Think of any question which bears on this and ask whether the universities provide an answer. We shall then be able to assess the value of university culture in the second sense of the term defined above, that is to say, the usefulness of university instruction as a preparation for leadership in civic affairs, and as a guide to the intelligent exercise of our responsibilities as citizens.

No Minister for Defence could hold his job and neglect the advice of chemists trained in our universities. Can we say that no Chancellor of the Exchequer could hold down his job while

neglecting the advice of economists in our universities? The contrast is instructive, because genuine science thrives by its applications. Economics is at present wedded to a dialectic of scarcity. As such it is an obstruction to scientific knowledge. When the advance of science was obstructed by bishops, men of science conceived it their duty to state without any ambiguity that the first chapter of Genesis is not science. They did so whether professors of theology liked it or not. In the tradition of Thomas Henry Huxley it is my plain duty as a man of science to tell our Adult Educational Movement that the mediaeval rubbish taught as economics in British universities is the negation of science and that as long as no provision is made for naturalistic studies in the training of historians or students of sociology, the culture of the universities is not good enough for the civic task of the humblest worker.

As Disraeli said, it is easier to be critical than to be correct. I should not have launched this attack unless I had a constructive alternative to offer. Some of you may think that you know the conclusion to which I have been leading you. Perhaps you are thinking that like every other specialist I want to press the claims of my own subject and that I am making a plea for organizing more courses in Natural Science under the auspices of the W.E.A. Emphatically this is not my aim. It would not be consistent with what I have already said, and it would not be consistent with what I have laboured to do in two volumes of scientific popularization which are rather heavy to carry about. I have told you that the universities are valuable in so far as they are primarily institutions for specialists. The specialist in so-called humanistic studies is grossly ignorant of the impact of science on modern society, and no provision is made in the training of scientific workers for the study of science in its broadly humanistic applications. Hence W.E.A. courses based on the vocational teaching of science in universities can have little bearing on the civic education of the wage earner in the present social context.

At all great turning-points in the history of our social culture the recognition of a new social need has been the signal for the

birth of a new science and the birth of a new science has had the backing of a popular movement outside the established universities. Turning-points in cultural history are not times when men seek culture for the passive satisfaction of second-hand living. They are times when men recognize that knowledge brings the power to shape human destiny. In the present struggle between Dictatorship and Democracy the future of Democracy may once more depend on forging new instruments of culture. As I see it there is a worthier task for an organization like the W.E.A. than bringing the culture of the universities to the humblest worker. It can help to salvage Democracy by becoming the instrument of a *new* social culture. By fearless criticism of the shortcomings of our universities it can strengthen the hands of those who, like Babbage in his own time, realize what a university could be if it undertook the tasks worthy of its opportunities.

In England we have never regarded education as a bulwark of Democracy. We have always relied on the fact that the Scots and the Welsh value education more than we do. The belief that education is above politics is a peculiarly English delusion and the W.E.A. has been content to build on a foundation which has no historical reality except the class character of English higher education, and the snobbish belief that a rich man's education is necessarily a good one to have. An education which aims at enlarging the capacity for enjoyment in people who lack the means, an education which cultivates a vague broadmindedness about the burning questions of the moment without seeking knowledge as an instrument for power cannot salvage Democracy in its present hour of crisis and will not survive the perils which beset it. If we do not undertake the serious business of creating a new social culture, the song of beauty and art and love will double us up and drag us down and damn our souls alive.

Incompetence of democratic statesmanship in this country is the inescapable penalty of putting education above politics. The survival of Democracy depends on providing the kind of education which fits men to solve the problems of their own time.

While no such education exists it is futile to abuse or blame them for failing to do so and betraying their trust. If the British Adult Education Movement undertakes the task of demanding something more relevant to current social needs than the type of instruction which the universities provide, history, which tells how the Lunar Society of Birmingham was of vastly greater significance than the combined universities of Oxford and Cambridge in the year when the National Assembly made Dr. Priestley a citizen of France, will record its favourable verdict. In a period of social disillusionment and cultural decay, when the fate of Democracy seemed darkest, we shall recall men who with little recognition and little encouragement issued their challenge to Dictatorship in the English way.

15

The Theoretical Leadership of Scottish Science in the English Industrial Revolution[1]

THE EIGHTIES OF the sixteenth, seventeenth, eighteenth, and nineteenth centuries may be taken as foci of pivotal advances in the theory and practice of modern science. In 1581 a Wapping compass maker named Norman published the first printed work exclusively devoted to magnetic phenomena. Between 1684 and 1687 Newton wrote his *Principia*. Between 1782 and 1786 the Royal Society of Edinburgh received its charter and the first hydrogen balloon was constructed by an Englishman in Paris. Between 1881 and 1888 Herz confirmed Clerk Maxwell's theory, and Weismann forged a link between the new evolutionary doctrine and the study of cell structure. There is a wealth of material accessible to throw light on the social impetus to scientific discovery in the times of Newton and of Darwin. Much has already been said about the social background of Newtonian and Darwinian science in relation to contemporary invention and to prevailing ideologies. It is a curious fact that there is no connected study of theoretical science during the early stages of what is generally called the Industrial Revolution. Indeed the accessible materials for such a study are meagre.

I have chosen it as the subject of this address for several reasons. On an occasion such as this it is fitting to dwell on a topic of common interest to several disciplines. I hope to show that the paucity of materials bearing on the subject of my lecture offers a unique opportunity for co-operation between students of naturalistic and humanistic enquiries. It is also one

[1] Inaugural Lecture in the University of Aberdeen, April 1937.

for which there are special opportunities of study in a Scottish University. With one conspicuous exception all the leaders of British science at this period were graduates of Scottish Universities. The one exception was Cavendish whose work was somewhat insulated from the major currents of contemporary discovery and earned posthumous recognition in the light of later work. Although the major advances in theoretical science during the middle of the eighteenth century contributed most to the progress of physics and of chemistry, the men whose names I shall chiefly mention—John Roebuck, Joseph Black, Francis Home, James Keir, John Playfair, Hutton, and Murdock, were with two exceptions—Playfair and Murdock—graduates of medicine. Since the contributions of this group illustrate the impetus which physics and chemistry received from biological studies I hope to be forgiven if I seem to err from my proper beat. A personal reason reinforces my choice. You have paid me the honour of taking an Englishman to profess in a Scottish University. It is therefore proper that I should record a long neglected debt of English industry to Scottish science.

The half-century between the death of Newton and the erection of Boulton's factory in Soho was the most decadent period of English social culture between the times of Elizabeth and the present day. The grammar schools were in decline. The Royal Society which had nursed the engines of Savery and Newcomen had relinquished its original intention to produce, as its first historian Sprat, Lord Bishop of Rochester, tells us, "a continuous succession of inventors." The genteel trivialities of Addison and the bogus scholarship of Johnson enjoyed an eminence due to the flatness of the surrounding country. As we learn from Hamilton, whose admirable book on the history of Scottish industry documents the social background of my theme, Scottish industry was at this time in a phase of rapid expansion. Scotland telescoped into the three decades which followed the last Stuart Rebellion, a process analogous to what Nef calls the first Industrial Revolution of the early Stuart period in England.

Professor G. N. Clark refers to the social atmosphere in which

the Invisible College was born as the "adventurous hopefulness of early English capitalism." To recapture it you need only recall the writings of Bishop Wilkins or the title of the Marquis of Worcester's book. Like the English Royal Society, that of Edinburgh also had its Invisible College, the Philosophical Society of which David Hume was a Secretary. Like the Invisible College it commenced when adventurous hopefulness was the keynote of local industry, and its personnel was closely involved in the industrial efflorescence of the time. It would be interesting to trace its relations with *the Honourable the Society of Improvers in the Knowledge of Agriculture* founded in 1723 and with a society for the encouragement of the Arts and Manufactures which began its work about 1755. This will be a task of the first historian of the Royal Society of Edinburgh, when its first history is written, as I hope, by an Aberdeen graduate. I shall try to show you why the absence of such a history is a deplorable gap in the written record of British science.

§ 2

In the domain of industry the middle of the latter half of the eighteenth century witnessed the beginnings of power production and of chemical industry in the modern sense. In the domain of science the theoretical complement of the first was the discovery of latent heat and a nascent recognition of the conservation of energy. That of the second was the announcement of the modern view about the elements. The ascent of the first hydrogen balloon is the symbol of a rapid succession of discoveries concerned with the individuality of gases, the overthrow of the phlogiston doctrine, and the introduction of a new system of classification based on the sources and properties of chemical compounds. Before tracing the predominant role of Scottish science in both fields of discovery let me briefly indicate why men of biological training played the leading part.

The first fire engines of Savery and Newcomen were theoretical by-products of the new gas mechanics of Hooke and Boyle. At Hooke's suggestion Newcomen combined the principle of Savery's

design published in the *Philosophical Transactions* with that of van Guericke's piston demonstrated by its curator Papin at an early meeting of the Royal Society. The Newcomen engine was not designed on the basis of any theoretical knowledge of heat. Before Black's researches, which followed the introduction of Newcomen's steam pump in the Lothian coal fields, the study of heat was partly nursed by meteorological enquiries which derived their social impetus from the needs of navigation. It also received encouragement from the use of the thermometer as a new instrument of diagnosis. Hence we need not be surprised to learn that the theoretical principle which exposed the defects of Newcomen's design was made by a professor in the faculty of medicine at Glasgow.

The word chemist is still used ambiguously. So the relation of medicine to chemistry only calls for an explanation, because one aspect of the association is usually forgotten. By that I mean the influence of systematic biology on chemical classification. In the records of early academies we find many miscellanies of the animals, plants, and minerals of colonies such as Ceylon, Java, or Malabar. The key to these miscellanies is given in Hakluyt's references to Elizabeth's instructions to sea captains, in the New York colonial documents, and in the greatest of all the later seventeenth century Herbals, the *Hortus Malabaricus* produced by the Dutch Governor of Malabar. When Linnaeus divided the *Systema Naturae* into an animal, a vegetable, and a mineral kingdom, he merely followed the policy of English and Dutch colonial expansion. As its materials grew in this way Herbalism was forced to undertake a systematic revision of its terminology. Herbalism or *Materia Medica* was at once the Institutes of Medicine and the basis of any regular instruction in chemistry till the end of the eighteenth century. Inevitably chemistry was infected with the new fashion which Linnaeus set.

Scotsmen will scarcely need to be reminded of the part which their fellow countrymen played in the early theory of power production. The relevant materials are set forth in Smiles's *Lives of the Engineers Boulton and Watt*, in Dickinson's separate bio-

graphies of Boulton and of Watt, as also in Dr. Hamilton's book to which I have already referred. We all know the story of how Watt, then a technical assistant in Glasgow University, was set to repair a model of the Newcomen patent, how his thrifty disposition recoiled from its colossal wastage of fuel, and how the clue to an efficient engine came from conversations with Dr. Black, then Professor of Medicine in the University of Glasgow. We all know how Dr. Roebuck, who leased the Duke of Hamilton's coalfields to provide pit coal for the reduction of his ores in the Carron Iron Works, financed the first attempts to make an engine with a separate condenser. The way in which Watt obtained his clue is told by him in the following citation from Smiles:

> Among his other experiments, he constructed a boiler which showed by inspection the quantity of water evaporated in any given time, and the quantity of steam used in every stroke of the engine. He was astonished to discover that a small quantity of water in the form of steam heated a large quantity of cold water injected into the cylinder for the purpose of cooling it; and upon further examination he ascertained that steam heated six times its weight of cold water down to 212°, which was the temperature of the steam itself. "Being struck with this remarkable fact," says Watt, "and not understanding the reason of it, I mentioned it to my friend, Dr. Black, who then explained to me his doctrine of latent heat, which he had taught for some time before this period (the summer of 1764), but having myself been occupied by the pursuits of business, if I had heard of it I had not attended to it, when I thus stumbled upon one of the material facts by which that beautiful theory is supported." When Watt found that water, in its conversion into vapour, became such a reservoir of heat, he was more than ever bent on economizing it, for the great waste of heat, involving so heavy a consumption of fuel, was felt to be the principal obstacle to the extended employment of steam as a motive power. He accordingly endeavoured with the same quantity of fuel, at once to increase the production of steam, and to diminish its waste. He increased the heating surface of the boiler by making flues through it, he surrounded his boiler

> with wood, as being a worse conductor of heat than the brick-work which surrounds the common furnaces, and he cased the cylinders and all the conducting pipes in materials which conducted heat very slowly. But none of these contrivances were effectual, for it turned out that the chief expenditure of steam and consequently of fuel in the Newcomen engine was occasioned by the re-heating of the cylinder after the steam had been condensed by the cold water admitted into it. Nearly four-fifths of the whole steam employed was condensed on its first admission, before the surplus could act upon the piston.

Two features of Black's relation to Watt merit comment. One is emphasized by Dickinson, who dwells on the close friendship between Black and Roebuck in his recently published book on Boulton. Dickinson tells us that Black lent £1,000 to Watt for the conduct of his original experiments to make a working model of an engine to use full steam pressure. The other is that no account of his doctrine of latent heat announced in a paper to the Newtonian Society about the year 1763 was ever printed by the author. In a different social context we may wonder whether his contemporary, Hutton, would have referred to it with such eloquence in the opening chapter of his book, *The Theory of the Earth*. Hutton there anticipates the conservation of energy, when he says:

> In the abstract doctrine of latent heat the ingenuity of man has discovered a certain measure for the quantity of those commutable effects which are perceived.

The following citation from Prosser's book on Birmingham inventions discloses the direct influence of Watt on the subsequent development of Black's contributions to thermal equilibrium. Referring to John Southern, a Fellow of the Royal Society, at a time when the Soho firm numbered four such among its personnel, Prosser says:

> His researches on the elasticity, density and latent heat of steam which were undertaken *at Watt's request* in 1803, were for a long time the standard authority on the subject. They are printed in Brewster's edition of Robison's mechanical philosophy.

§ 3

The well-known association of Black with Watt and the fact that Boulton and Watt were both elected fellows of the Royal Society of Edinburgh does not exhaust all that may be said concerning Scottish influence on the theory of power production or of the unity of scientific theory and industrial practice in the latter half of the eighteenth century. What is implied in Hutton's words is not sufficiently realized. How the dead weight of the Newtonian tradition prevented physicists from accepting the Conservation of Energy when biologists and chemists had already assimilated it is a familiar theme. Indeed a Scottish resident, Robert Owen, had grasped the sociological significance of Watt's experiments on horses, which he discussed in the *Report on the County of New Lanark*. A biologist, Mayer, published the first substantial contribution to the physical exploration of the new theory in a chemical journal half a decade before the Royal Society refused to print in full the special contribution of James Joule. That Mayer's work was inspired by the experiments of Lavoisier is also a matter of common knowledge to those who are familiar with the history of science. It is less well known that Lavoisier's contribution was the repetition of an experiment carried out by a Scottish physician named Crawford, and that it was first announced in a letter to Black, confirming Crawford's experiments. Using Black's new units of heat measurement Crawford had shown that the heat output of a guinea-pig and of a candle are the same for corresponding quantities of carbon dioxide produced by them. Thus Black's discovery of fixed air was at once the foundation of the modern theory of respiration, the impetus to Beddoes' pneumatic chemistry which sponsored Davy's scientific career, and the first foundation-stone of thermo-dynamics.

The close association of Birmingham practice with Scottish theory is illustrated by comparing the laboratory scale enquiries of Crawford with the conditions under which the Boulton and Watt partnership exploited the new patent. The Watt models were originally sold on a premium basis which implicitly pre-

supposed the doctrine which was to revolutionize Newtonian physics. A premium was charged on the savings of fuel consumption affected by replacing Newcomen pumps. For this purpose a standard of fuel economy was adopted by Act of Parliament. Crawford's experiments were a laboratory model of the new task which industry had undertaken. Boulton, says Dickinson in his recent biography:

> states it succinctly towards the close of the partnership in a letter to James Watt, junior, thus (B. and W. Coll. 1796). One bushel (84 lb.) of Newcastle or Swansea coal will:
>
> (1) Raise 30 million lb. of water 1 foot high.
> (2) Grind and dress 10, or 11 or 12 bushels of wheat according to the state of it.
> (3) Turn 1,000 or more cotton spinning spindles per hour.
> (4) Roll and slit 4 cwt. of bar iron into small nailor rods.
> (5) Do as much work per hour as 10 horses.

One other aspect of the relation between English industrial problems and the new science of heat measurement in Scotland is revealed in Smiles' Life of *Josiah Wedgwood.* Wedgwood was elected a fellow of the Royal Society in the same year as Priestley, whose chemical researches were jointly financed by the Prince of Potters and by Boulton himself. He earned his election by inventing a high temperature thermometer in connection with heating clays for his products. Smiles tells us:

> Wedgwood sent his first paper to the Royal Society on the 9th of May, 1782. His paper was entitled, "An attempt to make a Thermometer for measuring the higher degrees of Heat, from a red heat to the strongest that vessels of clay can support." A few months after his paper had been read to the Royal Society Mr. William Playfair, an Edinburgh Professor, wrote to Mr. Wedgwood the following letter (London, 12th September, 1782):—"Sir, I had the pleasure of being present at the reading of your very ingenious paper on your newly invented Thermometer before the Royal Society last spring, and of joining in the general satisfaction that such an acquisition to Art gave all present. I have never conversed with anybody on the subject who

did not admire your thermometer, and considered it as being as perfect as the nature of things will admit of for great heat: but I have joined with several in wishing that the scale of your Thermometer were compared with that of Fahrenheit's (so universally used for small degrees of heat), that without learning a new signification, or affixing a new idea, to the term *Degree of Heat*, we might avail ourselves of your useful invention. The method proposed in the enclosed paper occurred to me as one applicable to this purpose, and I lay it before you with all deference to your better judgment of the subject. I should be glad to know where I could purchase some of your Thermometers, as I can get none here in town.—I am, sir, with much regard your most humble—William Playfair." Wedgwood followed Mr. Playfair's advice. In his next papers, sent to the Royal Society, he gave a reduction of the degrees of his Thermometer to Fahrenheit's scale, from which it appeared that the greatest heat he could generate in a small furnace coincided with many thousands of degrees Fahrenheit, the scale of heat which was registered by his Thermometer being about thirty-four times as extensive as that to which the common Thermometers could be applied.

The Playfair who is referred to in this passage was presumably the author of *An Enquiry into the Decline and Fall of Nations*. I believe that this was the first book in which graphical devices were employed in the treatment of sociological discussion. William Playfair was, one may say, the Sir William Petty of the Edinburgh group. His brother, who popularized Hutton's theory of sedimentation, was John Playfair, the well-known Professor of Mathematics at Edinburgh, and an original fellow of the Edinburgh Royal Society. John Playfair was rejected as a candidate for a chair at Aberdeen which had not at that time learned to recognize precocious talent.

§ 4

It is a commonplace of Economic History that the revolution in power production in the latter half of the eighteenth century was anticipated and accelerated by a new technique of metallurgy.

The part which Roebuck's Carron Works in Stirlingshire and Smeaton's inventions played in this is dealt with fully in Dr. Hamilton's treatise. The immediate impetus to improve metallurgy came from the exhaustion of charcoal. As the Hammonds put it, the forges had stripped the English woodlands bare. In his book on the *Rise of Coal Industry*, Nef points out that the ensuing impoverishment of an economy which relied so largely on the use of wood and of its by-products involved almost every industry of the time in one way or another. It is therefore odd that historians[1] have hitherto paid little attention to a comparatively sudden and rapid growth which accompanied the extension of steam-driven machinery from the mines and potteries to the textile and metallurgical industries. If less spectacular than the introduction of pit coal for reducing ores, another consequence of the exhaustion of supplies had equally far reaching and unforeseen effects. The rise of chemical industry in the modern sense was a distinctive feature of the second half of the eighteenth century, and made possible the enormous expansion of manufactured articles in the century which followed. The social impetus which resulted in the endowment of new institutions and fostered the great theoretical advances in the beginning of the nineteenth century is well illustrated by a sentence in one of Boulton's letters. Referring to his son he says:

> Matt is a tolerable good chemist . . . I shall be glad when the time arrives for him to assist me in the business.

In particular, the exhaustion of wood supplies diminished the available sources of alkali or "potashes" as the incinerated charcoal was then called. Potashes were used in the manufacture of soap and of glass as well as in the preparation of wool fibre for textiles. The search for a substitute for the crude natural product was a dominant theme of practical chemistry throughout the latter half of the eighteenth century. Black's name is immortalized in chemistry by his doctorate thesis on the nature of alkalis. According to the narrative given in the biographical sketches

[1] Vide especially Knowles' book on the Industrial Revolution.

which accompany Kay's caricatures Black was led to undertake the enquiry by the reward which Walpole paid for a fictitious cure for dropsy. The oedematous affliction from which the great Whig suffered does not supply a sufficient clue to the influence exercised by the obscure publication in which Black's discovery of carbon dioxide was announced. Its importance was recognized, because it was directly related to a pressing social need, and its author was not indifferent to its utility. Dickinson tells us that in 1765, Black and Roebuck jointly commissioned James Watt to undertake experiments in the hope of making alkali from lime and sea salt. During the next decade the Swedish apothecary Scheele and a group of French chemists were occupied in the same quest.

The neglect of this aspect of the Industrial Revolution forces me to be more explicit about what I mean by chemical industry in the *modern* sense. To the extent that ancient and mediaeval industry used what we ordinarily call chemicals, i.e. relatively pure substances, it relied on natural deposits or waste material, and employed no technique which could not be included under the general term, cookery. Thus alum used in the mediaeval dye industry was obtained from the Isle of Wight. The alkali used for cleaning wool fibre was incinerated charcoal. Lime was obtained for cement by heating chalk. Saltpetre was the white crust formed on insanitary deposits. During the seventeenth century some substantial advance had been made in refining sugar and saltpetre, and with these exceptions nature or the stove was the laboratory in which the basic chemical processes of manufacture were carried out. What distinguishes chemical manufacture in the modern sense is the deliberate search for substitutes based on discoveries made on a laboratory scale. In the first half of the eighteenth century this was restricted to the petty operations of pharmacy, then emerging from exclusive reliance on herbal recipes.

Synthetic operations in pharmacy were not exclusively directed by optimism and misconceptions about disease. For one ailment to which the human frame is heir Egyptian chemistry had already

discovered the use of calomel as a remedy. In the middle of the seventeenth century Glauber announced the efficacy of sodium sulphate, made by heating sea salt with sulphuric acid, in a tract called *Miraculo Mundi*. The name of the tract, that of the salt which enjoyed the sobriquet *sal mirabile*, and the text of Glauber's pamphlet recall an all too familiar advertisement. Glauber's researches illustrate the intimate relation of chemistry and biology at this period. In his book *The Prosperity of Germany* he dealt with the manufacture of saltpetre from excrement and disclosed the discovery that saltpetre is the "active principal of manure." In our own vernacular this is equivalent to saying that the value of manure as a fertilizer resides in its nitrate content. When we recall how Germany was able to delay defeat by making herself independent of South American nitrates in the late war, there is an element of prophetic irony in the title of Glauber's treatise. It exercised a profound effect on an energetic group of physicians among the early fellows of the English Royal Society, and stimulated Mayer among others to undertake investigations on the relation of salts to soil fertility. This class of enquiries is of special importance because it anticipates a new feature which make Black's researches memorable. The nature of the problem demanded careful and delicate weighing of the constituents.

Thereafter there was no progress for half a century, until Francis Home, an original fellow of the Society for encouraging the Arts and Sciences and of its offspring the Royal Society of Edinburgh, published in 1755 his *Principles of Agriculture*. In this book, which reflects a new drive to theoretical enquiry from the Scottish Agrarian movement, as described by Dr. Hamilton, the author announced the discovery of sulphate and potash fertilizers. These discoveries helped to stimulate the systematic soil surveys undertaken when the English Board of Agriculture was created by Pitt. They provided much of the substance of Davy's illustrious lectures on agricultural chemistry, and opened up new lines of enquiry in plant physiology. Home himself was Professor of Materia Medica at Edinburgh. In his direct contributions to nascent chemical industry his name is associated with another

medical graduate of Edinburgh. In 1758 Home was awarded a medal by *The Honourable Board of Trustees for the Improvement of Manufactures in North Britain* for an essay entitled Experiments on Bleaching. The biographical notes to Kay's *Portraits* tell us that "he received many testimonies from manufacturers whose art it had improved."

These remarks refer to the use of sulphuric acid for bleaching in the Scottish linen industry. As a boy I wondered, as many others must have wondered, why elementary text-books of chemistry always describe the manufacture of sulphuric acid in great detail. Indeed it is often the only substance whose commercial production is so described in an introductory course. The reason illustrates the rule that there usually are good reasons for the contents of a syllabus, though the painstaking efforts of pedagogues often prevent us from seeing them. Sulphuric acid was the first chemical product manufactured on a commercial scale. The fact that it was available in large quantities gave it priority as an ingredient in choosing alternative methods of making other substances. Thus Liebig remarks in his *Chemical Essays* that:

> We may judge with great accuracy the commercial prosperity of a country from the amount of sulphuric acid it consumes.

The first factory for the manufacture of sulphuric acid was therefore a portentous event in the industrial efflorescence of the eighteenth century. It was set up in Birmingham in 1746 by Dr. Roebuck in partnership with Mr. Garbett, three years before Roebuck started a larger manufactory at Prestonpans. Roebuck's return to the country in which he received his medical education was momentous. It is hardly too much to say that what Boulton was to England Roebuck was to Scotland. Boulton, Roebuck, and Wedgwood were the finest flower of a period when the entrepreneur still discharged a creative function, participating actively in the scientific discoveries which occur when prosperity is advancing and contributing to its further advance. Of his relation to the major theme of the Industrial Revolution we have a well-documented account in Dr. Hamilton's book. His unique

contribution to the rise of chemical industry has still to be recognized.

Unhappily there is no extant biography of Roebuck. Apart from a chapter by Dr. Hamilton, the materials in Dickinson's book on Boulton, and a short sketch in the *Dictionary of National Biography*, the only relevant sources that I have been able to discover are contained in Prosser's *Birmingham Inventors* and in a detailed obituary in the Transactions of the Royal Society of Edinburgh for 1796. Like Black and Home he was an original fellow. One fact about his early life is interesting, because of the light it throws on the cultural decadence of official education in England before the repeal of the Test Acts. His parents were prosperous dissenters of Sheffield. He was sent from Dr. Doddridge's Academy at Northampton to Edinburgh University and subsequently set up practice in Birmingham, long since famous for its smithies and for the coal it consumed. There he started private work on refining precious metals. This no doubt led him on to the sulphuric acid project. Prosser says that sulphuric acid was in great demand among Birmingham manufacturers. I suspect that this was because it was used to make nitric acid from saltpetre in connection with the process to which Roebuck first applied himself. Be that as it may, it was no accident that a physician met the demand. The popularity of sodium sulphate as an aperient had made the preparation of sulphuric acid essential to the practice of pharmacy. An English physician named Ward set up a small manufactory at Twickenham in 1740. Though it could hardly be called a factory, it reduced the price from 2s. 6d. an oz. to 2s. a lb. Judged by Roebuck's achievement the cost was still considerable on account of the expense of the large glass vessels employed. Roebuck made use of Glauber's discovery that sulphuric acid does not attack lead. So he built large lead chambers to make it. He seemed to have retreated to Scotland to avoid legal entanglements ensuing out of the Ward patent, and according to the writer of his obituary Ward contested his Scottish patent without success. The factory in Steelhouse Lane, Birmingham, passed into other hands after Roebuck set up his works at Preston-

pans. According to Prosser it continued to produce till 1825. A statement made by Knowles who says that Roebuck set up a factory in Manchester is wrong, and the entire section on chemical industry in her book is an argument for the claims of elementary chemistry as a prerequisite to humanistic studies.

The reaction of sulphuric acid with sea salt for the production of sodium sulphate leads us at once to two other chemical industries in which Scotsmen played a leading role in the latter half of the eighteenth century. Students of chemistry will not need to be reminded of the fact that this reaction is the first stage in the Leblanc process for making synthetic alkali, and that hydrochloric acid is also a product of it. The Leblanc method, which began in France in 1793, was the culmination of numerous efforts by French and British chemists. Of these one was James Keir, a graduate of medicine in the University of Edinburgh. Keir was at one time in partnership with Boulton in Birmingham. He was elected a fellow of the English Royal Society in 1785, though curiously enough his name does not appear with that of Boulton, Watt, Black, Home, Wedgwood, or Roebuck in the roll of the Edinburgh Society. He produced an alloy substantially similar to Muntz metal, and set up a factory for making alkali in Staffordshire in 1780.

His biographer describes the process in terms which are worth quoting, because they illustrate how the problem of mass equilibrium arose at an early stage in the practice of chemical manufacture. Referring to Keir's partnership with Blair, Amelia Moilliet in her *Sketch of the Life of James Keir, F.R.S.*, states:

> They established works at Tipton, near Dudley, for the manufacture of alkali for the use of soapmakers from the sulphates of potash and soda. The method of extraction proceeded on a discovery of Mr. Keir's contradicting a point in the doctrine of elective affinities held by the chemists of the day. Their experiments seemed to show a stronger affinity of sulphuric acid for either of the two alkalis than for lime. Mr. Keir found that—by presenting the salts in an exceedingly weak solution, and by calling the aid of a chemical agent (for which he always professed

the highest respect, and the function of which in natural operations were greatly underrated) *Time*—the rule of election was reversed. By passing the weak solution *slowly* through the thick body of lime, the sulphates were decomposed, the sulphuric acid uniting with lime, and leaving the alkalis disengaged. The liberated alkali had then only to be brought into a concentrated form for sale. After a time it was considered that much labour would be saved by using the products on the spot, and the *Chemical Works* became *Soap Works* also. For many years, whilst Chemistry slowly made its way into the arts, the sulphates neglected refuse of other manufactories were at a *low* price in the market; and the secret of the decomposition by lime remained so long exceedingly profitable. On the same ground was carried on the manufacture of red lead, for glass-houses of litharge and on a principle which was patented later (1806), of white lead for the *Staffordshire Potteries*, the lead being first converted into a muriatic, then displaced by the carbonic acid gas for this purpose. Whether there were any business relations between Keir and Mr. Wedgwood in the matter of white lead is not known, but it is clear that Keir had for many years been acquainted with him. In Miss Meteyard's *Life of Wedgwood* it is said that Dr. Darwin introduced them to each other by a letter dated 8th November, 1767.

As these concluding remarks hint, Keir was a prominent member of the Lunar Society which included Darwin, Wedgwood, Boulton, Watt, and Priestley. The absorbing common interest of this group was the problems of chemical manufacture. By the joint efforts of Wedgwood and Boulton, Priestley had been induced to join the Soho group. Smiles tells us that Wedgwood and Boulton jointly raised a fund administered by Erasmus Darwin to finance Priestley's researches on the site of Roebuck's pioneer venture. Like Faraday, Davy, Dalton, and Joule, Dr. Priestley was not a University man. He was an English dissenter of comparatively humble origin. Scotsmen may therefore congratulate themselves on the fact that Edinburgh rewarded his theological deviations with a doctorate. This was a century before Oxford had sufficiently recovered from its tractarian obsessions to recognize that the discovery of oxygen was an important event.

Out of the discussions of the Lunar Society two other chemical industries came to birth before the eighteenth century closed. One which had momentous effects was coal gas. The study of coal gas had been part of the English Royal Society's original programme to enquire into matters affecting the health and accidents of miners. Clayton had prepared it in 1691. Twenty years after that Stephen Hales had estimated the coal gas produced from a pound of Newcastle coal. In the new social context of Scottish coal mining Black had demonstrated the ascent of toy balloons filled with it. To Murdock is due sole credit for bringing coal gas as an illuminant into social practice. Part of the Soho establishment was regularly lit with gas in 1798. Prosser says that he subsequently "read a paper to the Royal Society giving an account of his investigations on the subject, for which he received the Rumford Gold Medal."

I do not know whether this distinguished Scotsman was a fellow of the Edinburgh Society. Of his early life we have little information. One incident reminds us that an Industrial Revolution needs and knows how to value its cranks. "The story goes," says Prosser:

> That Boulton's attention was attracted by a curious hat which a young man had—a *wooden* hat—turned on a wee bit lathey of my own making, as Murdock said in answer to his future master's enquiry. . . .

The origin of another industry indirectly related to the Scotsmen of the Soho group is also mentioned in Smiles' biography of Boulton and Watt. From hydrochloric acid produced as a by-product in the manufacture of sodium sulphate, the Swedish apothecary Scheele had produced the new elementary gas chlorine. Apparently through correspondence between Berthollet and Priestley, Boulton and Watt became interested in its remarkable bleaching powers which Berthollet had studied. James Watt made a special visit to Paris, to witness Berthollet's experiments. On his return he instructed MacGregor of Glasgow to undertake similar experiments on bleaching. This led to the discovery of bleaching powder. In the last year of the century Tennant of

Glasgow held the secret of a new process which superseded the work of Roebuck and Francis Home.

In speaking of the contribution of Scottish science to this aspect of the Industrial Revolution of the late eighteenth century, it would be unjust to omit any reference to the father of modern Geology. The first work in which the modern view of the origin of sedimentary rocks was set forth has for its social background the mining operations in which Roebuck played a conspicuous part and the "canal mania" which directly initiated the first large scale geological surveys. Like Roebuck, Hutton was a medical graduate of Edinburgh and an early fellow of the Edinburgh Society. The fact that he started a manufactory for sal-ammoniac is an interesting footnote on Scotland's contribution to the beginnings of chemical manufacture.

The outburst of fruitful speculation which signalized the first two decades of the nineteenth century somewhat overshadows the substantial advances of chemistry which occurred between 1750 and 1800. It had been the achievement of the seventeenth century to establish the existence of the third state of matter. The spirits of the retort materialized as ponderable bodies. The distinction between earthly bodies which being of the earth fall to it and celestial bodies which being of heaven ascend to it was relegated by Galileo's solution of the paradox of buoyancy to devotional usage. The amiable habit of burning witches lost its popularity when their examination was entrusted to the secular practitioners of medicine. The achievement of the nineteenth century was to codify the qualitative rules which apply to the combination of matter in the gaseous state. Before this task could be undertaken it was first necessary to recognize the qualitative multiformity of matter in the gaseous state. In the two decades which followed Black's work on fixed air, the individuality and properties of no less then ten gases was established. This was what eighteenth-century chemistry pre-eminently accomplished. Its accomplishment was contingent on the new social demands which nascent chemical industry made and on the materials which it supplied.

The mere fact that Roebuck made sulphuric acid readily procurable and relatively cheap is not irrelevant to the discovery of hydrogen. It was the indispensable condition of a secular miracle to which the historians of science rarely refer. The ascent of the first hydrogen balloon in 1785 invested chemistry with the virtues which had departed from witchcraft, and made the individuality of gases a spectacle of common imaginative appeal. In Scotland, Black carried out experiments on the use of coal gas as a substitute for hydrogen. Priestley shares with Cavendish the honour of discovering that hydrogen is an essential constituent of water, and Watt was keenly interested in this experiment. The recognition of the properties of sulphur dioxide and hydrochloric acid gas by Priestley and the discovery of chlorine contributed to problems directly arising out of emergent chemical industry. The death-blow to phlogiston was its failure to supply the guidance which the conduct of industry required.

§ 5

Like the story of Frankie and Johnnie an inaugural lecture should have a moral. The part played by Scottish men of science in the industrial expansion of England at the end of the eighteenth century is instructive for several reasons. Like the English Royal Society the Edinburgh body began its labours in a period of close collaboration between theoretical enquiry and pressing social needs. Since then Scottish science experienced one episode of equal lustre. That was when Kelvin was actively involved in the Atlantic cable venture. In the first history of the English Society Spratt says:

> I shall only mention one great man who had the true imagination of the whole extent of the enterprise as it is now set on foot, and that is Lord Bacon.

The short sketch which I have given shows that the Edinburgh Society was also founded by a group of men who took as their motto Bacon's words "the true and lawful goal of science is that

human life be endowed with new powers and inventions." Great formative periods in the record of science have occurred when scientific investigators have been interested in the social uses to which their discoveries are put. In the social context of their own labours the men who made Scottish science illustrious were doing what Sir John Orr is now doing. If there is any lesson to be learnt from the history of modern science it is this. Professional exaltation of theory to the detriment of practice is the hall-mark of cultural decay.

The scientific efflorescence of the late eighteenth century draws attention to another intimation of decadence, when we are told that too many people are being educated. The restricted class basis of English education could not supply the theoretical leadership which its industrial expansion demanded. It had to rely largely on a fund of personnel from Scotland. Scotland was able to supply it, because John Knox believed in education for the people. Knox believed in education because education was part of the serious business of founding the Kingdom of God in Edinburgh. We may best honour his memory by striving to mould the provisions of educational instruction in accordance with an objective equally intelligible and equally relevant to the social needs of an age in which science can offer the prospect of plenty.

It is natural to ask why Scottish science failed to maintain its pre-eminence during the first few decades of the nineteenth century when Dalton, Davy, Faraday, and Joule built on the foundations which Black, Home, and Roebuck had laid. The truth, as Oscar Wilde remarks, is never simple and rarely pure. So it would be rash to attempt a complete answer to this question. One feature of the decline of Scottish leadership is noteworthy. In the closing years of the eighteenth century the Scottish universities became the last stronghold of the phlogiston doctrine. Hutton himself applied his exceptionally subtle powers to its defence. When events demanded men of flexible outlook to face new problems in a new way, the old Adam of Aristotelian logic was too deeply rooted in the tradition of the universities to

encourage the initiative needed for a drastic revision of scientific theory. Perhaps the position of sociology is much the same to-day. English economics has still to learn that a distrust of mere logic is the alpha and omega of the scientific outlook. I am not suggesting that Scottish universities should give up teaching logic. What I do suggest is that the logic of science can be a profitable discipline only when it is related to a study of how knowledge grows. Faced with an unprecedented potential of welfare and of destruction, the world of to-day stands in need of a new orientation of science and social values. By tracing the relations of scientific theory to social practice the study of scientific method can remedy some of the defects of over specialization.

14

Science in the School[1]

ENGLAND WILL BE a really civilized country when the school teacher enjoys the prestige now allotted to generals, film stars, and newspaper proprietors. If you wish to achieve this, two reforms are urgent. One is to get more teachers elected to Parliament. The other is the abolition of morning prayers. The daily accompaniments of school assembly and the annual ritual of prize-giving give head teachers the maximum temptation and the maximum opportunity for exercising a form of self-indulgence which normal people secretly despise. When pressing social needs demand concise and vigorous statement, the teacher is therefore liable to carry his aptitude for ambiguous and sentimental exhortation into public affairs. So he (or she) becomes identified with sanctimonious earnestness about trivial matters and vague broad-mindedness on decisive issues. An illustration is contained in the recent Interim Report of the Science Masters Association on the teaching of General Science. The Committee recommended the claims of science in the cultural curriculum because no one

> can now be considered truly cultured, no one can be considered as having felt the European spirit at its best, if he has never had his imagination stirred by that great adventure of ideas on which we are engaged: the scientific exploration of natural phenomena.

Ever since the Reformation we have sterilized the teaching of mathematics by adopting Plato's plea for the pursuit of geometry as an aid to spiritual refinement. The world now stands in need of another Reformation and our Committee propose to sterilize the teaching of science by using it to cultivate the European

[1] An address delivered to the National Union of Teachers, December 1936.

spirit. As a plain citizen I must confess that I do not know what the European *spirit* is, and I am not very excited about the prospect of finding out. I do know what are the outstanding *achievements* of civilization in modern Europe and modern America, and I do know something about how these achievements have affected and have been effected by scientific discoveries. If that is what the Committee are talking about they should say so, and if I have misinterpreted them they have only themselves to thank. If they wish to convert me they cannot expect me to penetrate a smoke screen of earnest and equivocal phrasemaking. It is their business to state a plain case in plain terms which I, as a plain citizen, can understand. • •

As a plain citizen with no interest in watching the antics of the European spirit in the nebulous realm of ideas, the claims of science in education seem to me to rest on very simple and impelling considerations which are easy to grasp and easy to state, if your powers of lucid exposition have not been permanently impaired by usurping the curate's function. In three sentences they are these. The scientific knowledge which is now at the disposal of civilization in modern Europe and America could rid us of war, poverty, and disease. If European civilization does not use science to rid itself of them, war will probably destroy our Anglo-American civilization and destroy it irreparably. Knowing how science can be used to advance civilized living and knowing how it may be misused to destroy European civilization is therefore necessary and useful knowledge for a citizen to possess.

The special characteristic which distinguishes modern civilization is the extent of its dependence on an organized body of scientific knowledge. The potential of social welfare is vastly greater than it has ever been; and rational organization of technical knowledge which private enterprise has failed to exploit could now guarantee health, leisure, and comfort for all. The potential of sheer destruction is also vastly greater than it has ever been; and it is difficult to imagine what could survive the wreckage of another world war. If greater poverty has existed in the past, there has never been a greater gulf between the poverty which

exists and the plenty which lies within reach. If there have always been wars and rumours of wars, there has never been the possibility of such material havoc and cultural disintegration. This being so, there has never been a greater need for intelligent understanding of the social forces which will decide the fate of Western civilization, and intelligent understanding implies some knowledge of the new powers which science has placed at our disposal.

In Britain the claims of science in the education of the citizen have been repeatedly stated during the last three centuries with little effect. This is not surprising. Rooted in classical scholarship, British educational theory has never abandoned an outlook which dates from the City State tradition of slave ownership. We still follow Plato in a fatuous antithesis between vocational training or useful knowledge and cultural education which is *ipso facto* useless and at the same time superior, because its very uselessness is the ornament of a leisured class. We have not yet orientated our ideas about education to the needs of a society in which every citizen is expected to make a pretence of performing useful work and every citizen is entitled to a minimum of leisure guaranteed by law. When we wish to press the cultural claims of science our first anxiety is to prove that it is just as useless as Greek or theology. By doing so we feel ourselves to be members of a leisured class. So it is very easy to succumb to the temptation. The strength of it is attested by the popularity of A. S. Neill, and others who believe that children should decide for themselves what is good for them. This confusion between pedagogy and pediatrics diverts attention from the serious business of education to issues which have no special relevance to contemporary needs. Whether the promotion of child welfare is or is not a worthy calling, our compelling task in an age of potential plenty is to equip citizens with prevision of the constructive possibilities which lie within reach and with power to surmount the new perils which beset us.

Great educational reforms are brought about only in response to pressing social needs. In periods when great educational

reforms are carried through those who accomplish them are not afraid to call what they want useful knowledge. They are not afraid of stating the only rational arguments for their claims, because they would be called tendentious if they did so. If you had asked John Knox why he encouraged classical scholarship, he would not have told you that Greek is worth studying for its own sake. He would not have told you that Greek is a good training for the mind. He would have taken it for granted that a good education was part of the business of founding the Kingdom of God in Edinburgh. Founding the Kingdom of God then meant, among other things, bringing the Bible to the common people and scouring the earliest authentic texts for evidence of Popish innovations. If we are to give science its rightful place in the education of a citizen we must abandon earnest trivialities about the European spirit and state its claims with the moral vigour of John Knox and a corresponding relevance to the conditions of our time.

§ 2

The social task of modern education is not to found the Kingdom of God in Edinburgh. It is to implement the age of plenty. To do it we have to make the record of scientific discovery an open Bible. Only when we have stated our aim in terms which are socially relevant to our age shall we find any basis for agreement about a curriculum. Discussions about the contents of a curriculum of general science generally end in the same deadlock. Each expert wishes to see that his own special province is fairly represented, and each expert has his own views about what are and what are not important principles of science. If you start with a plainly stated social objective there is little room for disagreement about what is important and what is not important. Principles of science are more or less important because they have affected the social practice of mankind directly or indirectly to a greater or less extent.

For instance, the principle of self-induction is important

because we could not have had transatlantic cables without it. The principle of the pendulum is important because of its pivotal role in the romance of the clock. The principle of the inclined plane is not important unless you think it is the best way of introducing a beginner to the principle of the pendulum. You can toboggan down a hill successfully without knowing the principle of the inclined plane, but you cannot arrive in New York on time unless sea captains have seaworthy clocks for finding longitude.

Judged from this standpoint most proposals for a general course in science betray a narrow appreciation of the needs of citizenship. The words I have quoted draw special attention to a common and, in my view, deplorable limitation. Undue veneration for the European spirit divides the field into three main themes, physics, chemistry, and biology, excluding the oldest of the sciences. The neglect of astronomy is a serious defect in a course intended either as an introduction to science or as an introduction to citizenship.[1]

As regards training in science *per se* it is sufficient to say that 50 per cent of the intellectual difficulties which beset the teaching of dynamics, of optics, of electricity, and of magnetism arise because the concepts and methods of these sciences were borrowed from astronomy at a stage when astronomy was still the science which most closely affected the social life of mankind and the earliest of all the sciences to be subsidized by the State as the basis of maritime supremacy. Let me illustrate this in the crudest possible way. Every child's first reaction to the path of a bullet or to the law of centrifugal force is to feel a certain artificiality in dissecting a continuous simple motion into two separate ones. It is not made less artificial by bringing in a boatman rowing in a current, because few town-bred children have any experience of river currents. So the boat's course is just as much an exploit of faith as the parallelogram of forces. On the

[1] For that reason I should like to take this opportunity of expressing appreciation of Parsons's *Everyday Science*, in the same series as another admirable text-book, Hadley's *Everyday Physics*.

other hand they do sometimes see the sun. They could therefore see why there was nothing artificial about the resolution of motion in a complicated path to the generation of Galileo and Huyghens. Galileo and his followers were only doing what the calendar priests of the Mediterranean world had done several thousand years earlier, when they first began to think of the continuous apparent motion of the sun over the horizon as a diurnal rotation in the plane of the equator and an annual retreat in the plane of the ecliptic.

Aside from this, understanding of what European science owes to earlier civilizations is an essential part of the culture of citizens in the age of potential plenty. The cultural task of the science teacher is not to ventilate the virtues of the European spirit. We have an object-lesson of the dangers of doing so before our eyes. If German boys and girls had been brought up to realize what we owe to the astronomical discoveries of the Babylonians and Alexandrians the racial mythology of Houston Chamberlain and Aristotle would not have paralysed the constructive will of a great nation.

A course in general science designed to meet the needs of citizenship must reinstate confidence in the human reason, reinforce constructive social effort, and give the citizens of tomorrow a vision of what human life could be if the treasury of scientific knowledge were dedicated to the satisfaction of common human needs. If it is to do this we must lay aside our preoccupations as specialists and find a common ground of agreement in our common needs as citizens. Recognizing that the treasure of Athena is not for the building of the Parthenon, that the Sabbath was made for man and not man for the Sabbath, we must ask ourselves how each of the great constructive achievements of mankind demands its special foundation of theoretical knowledge, and how the circumstances of man's social life have conspired to advance theoretical knowledge or hinder its useful application. The present divisions between specialist disciplines would then disappear against a background of man's developing social needs.

We should start naturally with man's first great cultural task, the construction of a calendar to regulate the seasonal pursuits of settled agriculture in the dawn of city life. We should see it giving birth to a map of the heavens and learn how the needs of navigation adapted the principles of calendar practice to the survey of the habitable globe. We should discover new needs imposed on the practice of timekeeping and navigation by the grey skies of a northern climate when the Nordic savages were drawn into the pale of civilization. We should learn how the study of motion became at once a possibility and a necessity where the sun-dial could no longer compete with the mechanical clock. Approaching the end of man's search by land and sea for the ready-made bounties of Nature we should watch the new conception of a pure substance emerging from the search for material substitutes. We should trace the recognition of a third state of matter growing out of the practice of deep-shaft mining in conditions of labour shortage and the exhaustion of fuel supplies. We should see how the disappearance of slave labour quickened human ingenuity to devise new sources of power, and how the purchase of power demanded new principles of measurement for costing man's reserves of power. We should learn how the control of plagues and the exhaustion of the soil set man seeking for the knowledge which has doubled the expectation of life in two centuries and flooded modern commerce with a vast surplus of wheat.

If at each stage in the drama of human achievement we asked, "Did this or that principle, this or that theory help mankind to lift this or that stone in the building of the temple of plenty?" you who are a chemist could forget your personal enthusiasm for the mercaptan compounds, and I who am a biologist could forget the fact that I am sometimes enthralled by the reproductive habits of the parasitic Hymenoptera.

Whether Universities, Departments of Education, and Training Colleges will undertake the necessary reforms in higher education preliminary to such a radical revision of the teaching of science will depend upon whether there is an active demand, or at least

a ready response, from the teachers. Two questions will properly be raised by the teacher who has to teach science with primary emphasis on its vocational use and is constantly preoccupied with the demands of examinations designed by specialists without regard to the requirements of intelligent citizenship. He or she will naturally ask whether the approach to science as a social venture is possible within the framework of the existing examination system and whether a preliminary course of this type would be better or worse for the pupil who will eventually specialize. In matters of education we have to accept the inevitability of gradualness with a stiff, if unsealed, upper lip. So these questions must be faced frankly and sympathetically.

You may be inclined to think that examinations are a subject on which a university professor can speak lightheartedly because he is often free to set his own. This is not always so. During a large part of my twenty years' experience of university teaching I have had to prepare students for examinations prescribed by the General Medical Council. The syllabus of such examinations has had little affinity with my own views about the best way to introduce the beginner to biology. So my difficulties have not been so very different from those of the teacher who groans and travails under the demands of the School Certificate. My own experience has been that however badly a syllabus is designed it pays to spend 75 per cent of the time allotted in getting the students keenly interested in the subject and helping them to remember the really important facts or the really fruitful generalizations. This done, the unpleasant necessity of drilling them in the answers expected to the fool questions they may be asked can be undertaken with cheerfulness and confidence. I can honestly say that I have found genuine enjoyment in giving a course with the grim determination that an examining body would neither defeat my intention of teaching what I thought was important nor make capital out of the failure of my students. I would even go further and say that bad examinations may provide the best test of good teaching, and that no good teacher would make a bad examination system an excuse for defeatism.

There is nothing paradoxical in this. Important facts are ones which call attention to fruitful generalizations. Fruitful generalizations are ones which co-ordinate a large variety of facts, and hence help in memorizing them. The pupil or student who is expected to remember facts which are trivial or principles which have only a limited application needs a scaffolding of important facts and comprehensive principles to quicken his interest and give him his bearings.

Let me illustrate this from my own experience of preparing first-year medical students for an examination in which they were expected to remember the bones and foramina of the skulls of the rabbit and frog. Taken by themselves a more meaningless collection of tedious trivialities could hardly be demanded as a sheer feat of memory. I soon found that the only way in which I could make students remember what they were expected to know was to tell them much more. Bones are interesting because we know as much about the skeletons of many animals which died off several millions of years ago as we do about that of any living vertebrate. Bones are therefore the alphabet of the written record of the rocks. All that we know, or almost all we know, of the evolutionary panorama of vertebrate history is based on them. So, although the examination did not demand a knowledge of a single fossil, I devoted the greater part of the allotted time to a rapid kaleidoscopic survey of the recorded history of vertebrates in the rocks. Then, enlivened with a little community singing, we memorized the skull of the first known land vertebrate, a common ancestor of the rabbit and the frog. A few simple rules of evolutionary history make it easy to remember how each differs from their common ancestor. In this way I found it possible to take my students into the valley of dry bones and, like Ezekiel, make the dry bones live. After ten years of it, I would even conduct a lecture on the skulls of the rabbit and the frog with something of the zest of a Four Square Gospel.

In this my task was not very different from that of the teacher who has to prepare pupils for a School Certificate examination in mechanics. The principles of mechanics discovered in the

seventeenth century had little relevance to the sort of machinery with which boys and girls of the twentieth century are familiar. In so far as the principles of classical dynamics have any bearing on familiar problems of practical interest, such as clock design or marksmanship, they lead to gross discrepancies unless supplemented by considerations which lie outside the curriculum of an elementary course. Unless these limitations are intelligently grasped, the teaching of elementary mechanics must promote an attitude more akin to scholasticism than to the scientific outlook. This explains why some people think that economics is a science.

While school examinations prescribe the use of formulae for the suppositious eccentricities of perfectly smooth balls slipping down frictionless slopes or indefinitely small objects swinging in vacuo from weightless cords through immeasurably small arcs, school mechanics is as lifeless and inhuman as memorizing the bones of the frog. The teacher who has no voice on the committees which perpetuate this practice can bring the dead bones to life only if he (or she) is able to unearth the fossil history of the subject, and, by so doing, relate what the pupil is learning to known facts about geography or mediaeval warfare. The pupil who now understands why the principles were important at the time when they were first discussed will have no difficulty in recognizing the circumstances in which it is appropriate to apply them. Only when the pupil can do so, can the teaching of mechanics give any insight into the methods of genuine scientific investigation. The teacher, who recognizes that five units of interesting information are more easy to memorize than one unit of irrelevant and unpalatable material, can equip himself for his task by browsing in the pages of Professor Wolf's *History of Science and Technology in the Seventeenth Century*.[1]

When long-distance westerly navigation first began, the problem of longitude at sea made the perfection of the clock a pivotal issue in the technology of the sixteenth and seventeenth centuries. The existence of the clock itself provided the means of studying motion in an age when piratical expeditions and

[1] George Allen & Unwin Ltd.

rising Protestant democracy owed their success to artillery. It was then that the new technique of marksmanship first demanded a close-up view of motion. In their own social context the principles of Newtonian mechanics were concerned with two main themes, how to make a seaworthy clock and how to calculate the path of the comparatively slow-moving cannon-ball of the time. The Galilean principles which neglected friction were tolerably successful so long as they were applied to slow-moving mechanisms like a clock or slow-moving projectiles when gunpowder was the only known explosive. They were brilliantly successful when applied to the frictionless motion of planets moving through empty space. The movements of planets bring us back to the same pivotal problem of navigation when sea pilots still relied on planetary conjunctions to determine longitude at sea.

However deplorable an examination syllabus may be, I believe that you get the best results by telling your pupils much more than they are expected to know. Of course, I assume that the extra knowledge is of the sort which helps them to remember and grasp what they are expected to know. There is, after all, some comfort in this reflection. If it were not true, cheap textbooks could replace good teachers as ticket machines replace booking clerks, and unemployment in the educational profession would rise rapidly.

§ 3

Neither the exigencies of the examination system nor the vocational needs of the pupil who will eventually specialize in science will suffer if the social background of scientific discovery is emphasized. The pupil who will specialize in science is not helped if you let him believe that mechanical principles of elementary courses apply to situations to which they are irrelevant. He will not become a better technician if he fails to understand the situations to which they do apply or the limitations within which they can provide a useful guide to conduct. On the contrary, the present teaching of science puts a premium on docility. It discourages the adventurous and matter-of-fact attitude which is essential to creative or highly competent work in science.

Taken out of its social context it is difficult to conceive that anything could be more dull than the principle of the inclined plane. Seen as a step in the theory of the pendulum in the social context of clock-making it could be made an exciting incident in a breathless saga of how man has explored the world he lives in and the universe of space. The teacher who brings into his teaching that sense of social achievement will be helping to make citizens able to salvage democracy in an age of potential plenty. He will be helping to maintain confidence in the power of the human reason. He will also be making better scientists and more successful examinees.

The barren scholasticism of most elementary courses and syllabuses in mechanics draws attention to a criticism which is commonly, and in my view unfairly, made against examinations in science. In the words of a report circulated at this Conference, "an examination in general elementary science should aim at testing knowledge and appreciation of general principles." The fashion of saying that children should not be crammed with facts has very grave dangers. Comprehensive general principles emerge from a comprehensive survey of facts, and one way of deciding whether an individual understands a principle is whether it enables him to recall facts which are easily forgotten unless their significance is grasped. Too great insistence on memory work may well have its perils. In my view a far greater one in teaching science is the presentation of principles without regard to a sufficient background of relevant information.

The present teaching of electricity and magnetism furnishes a monstrous illustration of this danger. Till the problem of self-induction was made a matter of urgent social importance by the failure of the first transatlantic cable the experimental principles of electricity and magnetism progressed with little or no reliance on sophisticated mathematics. In all his works Faraday never uses an algebraic formula or relies on any device of calculation beyond the rule of three. Kelvin's successful achievement in adapting Newtonian mathematics to the cable problem opened up a new territory for mathematical ingenuity. A luxurious

overgrowth of field strength and potential derived by analogy from the theory of gravitation then took root. This spread rapidly into university courses, and finally extended its tendrils into the schools, where children sitting for School Certificate are taught the A position and the B position of Gauss, or Cavendish's theorem. As it happens, the mathematical theory of self-induction lies outside the scope of school science, and can be elaborated from the experimental data by using the more fruitful principles of energetics. The child who leaves at the School Certificate stage learns how to measure the moment of a magnet without realizing that it has any connection with measuring the inductance of a radio set, and drops the study of electricity before he has learned the meaning of a kilowatt.

This blind worship of principle is the negation of science. Science is the unity of theory and practice, and excessive intellectualism is a far greater peril to science than excessive cramming with facts. At the School Certificate stage an examination based on a much wider factual knowledge of electrical and magnetic phenomena would be more useful to the child who will pursue no further study in the subject. What is called "teaching the principles of electricity and magnetism" means teaching principles that have no relevance to facts of which the child has experience and illustrating them by facts which do not help the child to understand how discoveries are really made. Consequently it is equally bad for the child who is going to continue his studies.

The proof of the inverse square law in magnetism for the School Certificate Examination is worth examining in detail from this standpoint. The child who may or may not as yet have learnt anything about the mechanics of rotation is first introduced to the couple exerted by the horizontal component of the earth's field and the couple exerted by a bar magnet on a compass needle. At a stage at which he may not yet have learnt any trigonometry he is taught that the ratio of the field strength of the magnet and the earth is the tangent of the angle of deflection. A second excursion into algebra then discloses the conclusion that if the law of inverse square is true the resultant

force acting on a unit magnetic pole is inversely proportional to the cube of the distance between it and a bar magnet. While the pupil is recovering from the effort of imagining how a unit pole can exist by itself in Nature, a magnetometer is produced to demonstrate the conclusion that the cube of the distance is inversely proportional to the tangent of deflection. What effect can this be expected to have on the intellectual development of the child? As far as the child is concerned there is no more reason to *explore* whether the inverse square law is true than to explore whether any one of a million other possible laws is true. To the child, therefore, the experiment is not the testing out of the most likely hypothesis. Its success is merely a reward for inspired guesswork or mathematical industry; when he has derived the law he does not learn how it is applied to achieve any useful result.

While I deplore the introduction of the theory of attractions in the teaching of science until a very advanced stage, it provides me with a further illustration of the principle that the successful teacher will always go beyond his syllabus. The teacher who wishes to rescue his pupils from complete mystification by the silly demands of the present syllabus will only do so by giving the historical setting of the problem. The child has never previously met the law of inverse squares in the theory of attractions and cannot be expected to understand why he should endure such agonies to find out whether it is true. Physicists trained in the Newtonian tradition only knew of one law of attraction. They could command an armoury of ready-made mathematical devices which suggested experiments to test it. They naturally turned their attention to the type of law which they knew best how to handle. (Actually Cavendish's theorem is given as a hypothetical case in Newton's *Principia*.[1]) By a stupendous stroke of luck it was the right one, and there is nothing miraculous or surprising about the fact that they set about their problem in this way if you know how gravitation dominated the physical

[1] The theorem that the charge on the inside of a hollow spherical conductor is zero is formally identical with Newton's proposition on the paradox of the hollow planet.

thought of the eighteenth century or that Kepler had likened gravitation to the earth's terrestrial magnetism.

§ 4

In the early training of a child who may become a scientific worker there are two great dangers which beset an undue stress on general principles. Both would be more readily corrected if the social background were brought into prominence. One is that principles are too often used to illustrate the rules of mathematics rather than the process of scientific discovery. This is specially true of the theory of attractions. When it is included in elementary courses it is not used to solve any problems which commonly arise in the class of electrical or magnetic phenomena included in the rest of the curriculum. It is used for working algebraic examples and then dropped like a hot brick. The psychological effect is that the docile pupil fails to grasp that a scientific principle is a rule of conduct, and the adventurous one may acquire an unduly suspicious attitude to the use of generalizations.

A second danger lies in the ubiquitous neglect of the relativity of scientific laws whether they are stated verbally or mathematically. A scientific law only becomes a useful guide to conduct when we state with what kind of conduct it is concerned. This means stating when it is valid and when it breaks down. The conditions which limit its validity depend on the circumstances of observation, and the delicacy of the instruments used. The significance attached to its connection with other known laws also depends on the validity of mathematical approximations introduced into its final statement.

This fundamental relativity of scientific laws is constantly flouted in the elementary teaching of science. When boys and girls of thirteen are instructed to perform experiments to test Snell's law of refraction, the apparatus supplied rarely allows them to demonstrate whether the law of refraction as given by Snell, or by Kepler, or by Ptolemy is the correct one. As far as

they are concerned Snell's law is one of several equally true laws. The only reason for preferring Snell's is that is gives better results in the hands of more practised investigators with better instruments than the ones which school children handle. In the circumstances it will be more convincing, as well as more honest, if the teacher tells the pupils that they are going to test a simple rule for making calculations about images with as much consistency as they are likely to achieve. That, after all, is what a scientific law really is.

The relativity of scientific laws is neglected too often, when the mathematical connection between one law and another is exposed. In almost every elementary textbook of physics you will find an exposition of the pendulum with the necessary qualification that the principle is only true if the angle of swing is small. As far as I know, no book yet written tells you what a small angle is. The qualification depends on the identities $\sin A = A$ radians or $\cos A = 1$ in the limit. I do not know of the existence of any school text-book which tabulates the error involved. I have even met teachers of mathematics who did not know that the error involved in taking the sine of an angle as its circular measure is less than 1 per cent on angles as large as 10°. In one context or another such approximations are constantly made without the slightest indication of the order of smallness. The result is a totally unnecessary element of mystification. The teacher who is anxious to show his pupils how the principles of science are used in regulating social life will not fall into this trap. Before you can use a rule as an instrument of conduct, it is necessary to find out the limits within which an approximate statement holds good.

At the beginning of this address I said that the problems of educational reconstruction in our own time are as urgent and as singular as those of the Protestant Reformation. One material circumstance which contributed to the great intellectual enlightenment of that time was the invention of a new instrument for diffusing human knowledge. In our own task of making the world outlook of science an open Bible we have at our disposal

instruments which transcend the power of the written word as the printing press transcended the limitations of oral discourse. Though it is commonplace to say that the cinema has placed new powers in the hands of the educationist, few educationists have really grasped what its new powers are. So far the cinema has largely been canvassed as a way of stimulating interest or of conveying in a more vivid and palatable form information which is less attractive when communicated through the medium of print. What we have still to realize is that it can explain many things which many people can *never* understand at all if they have to rely on the printed word.

Many teachers think that the great obstacle to the understanding of science is its reliance on mathematical symbolism. I do not believe that this is true. Dynamics and astronomy are not difficult because they make use of difficult branches of mathematics. To the person who finds them difficult they are equally difficult when the mathematics used is of the simplest kind. It is my view that the greatest difficulties both in mathematics and in those branches of science which rely on mathematics do not reside in failure to assimilate the rules of symbolism. More often they reside in failure to visualize the physical construction, model or process which the symbols describe. *The cinema can bridge the gulf which now separates people who have a good visual imagination from those who have not.*

The limitation imposed upon the communication of knowledge by the printing press is easiest to see if we consider the implications of a well-known class of optical illusions. All of you know (and if you do not you can test it at the end for yourselves) what happens if you draw a cube in perspective with twelve straight lines and then stare at it for some time. After a little while it seems to turn inside out, and this happens repeatedly if you go on staring at it. Although this class of optical illusions is commonly mentioned in text-books of physiology and experimental psychology, little if anything has been said about its bearing on education. Every teacher knows perfectly well that many children who can acquit themselves passably in plain geometry experience very

great difficulty when they come to solid geometry. This fact is not surprising in the light of the experiment I have cited. There is an inherent ambiguity in flat representations of three-dimensional objects. The longer you go on looking at them the more perplexed you get.

Of course, the experienced teacher knows that a little play with plasticine and knitting needles will often surmount the first difficulties of visualization of this level. What the model does for the three-dimensional object the cinema would do for the four-dimensional process. Simple harmonic motion, the precession of the equinoxes, the relation of celestial and terrestrial co-ordinates of a star, wave motions, the trajectory of a body projected in space, are themes which present insuperable difficulties to a large number of people. They bristle with problems for the teacher, even if he has to deal with pupils who have a tolerable aptitude for naturalistic studies. With all the resources of stereoscopic cinematography, I believe that a few hours would suffice to overcome visual difficulties which now defeat the ingenuity of the teacher and at best absorb weeks and months of time and effort.

Bacon said that it is unwise to exalt the powers of the human mind when we should seek out its true helps. There are many to-day who would have us exalt the minds of leaders with supposedly superior gifts. The task of educationists must be to emphasize the new helps which science has brought to the understanding of the common man. Distrust of education and a pessimistic attitude towards the powers of the average citizen in our generation are the seeds of despotism and war. If the cost of one cruiser were applied to providing projectors for our schools and the expense of two battleships were devoted to the production of films for the teaching of science this generation could witness a greater advance of human enlightenment than the world has yet seen. This is rational ground for hopefulness in the dark hours through which Europe is now passing.

15

The Theology of Violence

NO CONTEMPORARY MAN of science writes with an English style at the same time more personal and more engaging than that of J. B. S. Haldane. One of the several merits of his writing is a translucent simplicity which always makes it easy to decide whether one does or does not agree with him. He rarely, if ever, makes use of rhetoric, and his best effects are accomplished by a whimsical gift for mentioning obvious things which clever people overlook. This is another way of saying that he is one of the few really original writers of our time.

Haldane exercised this gift in full measure when he gave us an essay good enough to dispose of a library of unreadable books in the series he started. The hopes roused by *Daedalus* were also justified in *Possible Worlds*. Since then he has been less inclined to tell us something new than to testify to a doctrine with which we were familiar in our undergraduatude; and one suspects that fewer people read his books. A recent statement of his personal creed begins "my philosophy is the philosophy of Marx and Engels. It is a living philosophy all right. Millions of men live for it, and when need arises, die for it." I am more impressed by a creed for which a man of Haldane's international calibre will live than by any of the innumerable shoddy dogmas for which thousands will die. So I read with particular interest the concluding sentences in which he said:

> I believe that there are peoples which will take the third path, the difficult path of reason. Such peoples will be able to carry what is best in their old culture into a new economic system. But they will only do so by clear thinking and brave action.

I have said that Haldane produces his best literary effects without recourse to mere rhetoric and that the supreme merit of his earlier style was its transparent honesty. I have said also that one of Haldane's many gifts which have placed him in the front rank as a writer and a thinker is that he does not overlook the obvious. Least of all is he likely to overlook two obvious facts of some social significance. One is that adolescence needs no encouragement to explore any alternative to the *difficult path of reason*. The other is that what has hitherto been called the Great War has left a shortage of men of Haldane's age to impress on adolescents the need to follow it and to show them how to find it. So the words I have quoted puzzled me. I have read Haldane's book on Marxism and science, and am unable to discover any indication of why he believes in the possibility of achieving social progress by the difficult path of reason or in what circumstances he would advise us to pursue it.

The book has several merits which are lacking in other contemporary contributions to what is now orthodox Marxism. Haldane's controversial manners are unexceptionable, and unlike most Marxists he can disagree with an opponent without exhausting a Freudian vocabulary of moral invective. What disappointed me about his exposition of the Marxist doctrine was that he paid special attention to Marx as a theologian and relatively little to Marx as a naturalist. He is more concerned to expound Marxism as a philosophy of violence than to emphasize what Marx contributed to a reasonable interpretation of social movements.

Marxism has three aspects, each of which can stand or fall on its own merits without affecting the plausibility of the others. As I understand it the Labour Theory of Value anticipates at unnecessary length everything which is sensible in the doctrine now called technocracy. As a theory of social change Marxism rightly emphasizes the truth that the technique of production is continually changing and continually calling forth new types of human association which react upon the legal, cultural, and political superstructures. As I see it, the only reasonable criticism of Marxism in this sense is a *caveat* against underrating the forces

of inertia arising from language, climate, religion, and other circumstances which cannot originate but may powerfully obstruct social innovation. A third feature of Marxism is the doctrine of class struggle. This emphasizes the hostilities arising from changes in the personnel controlling production.

What is called the materialist conception of history is a combination of the Marxist doctrine of the impact of advancing technology on the social superstructures and the Marxist doctrine of the class struggle. In reality the two have no necessary connection. It is possible to study how changing methods of satisfying man's material needs influence his social habits in preliterate societies which are not divided into social classes or in periods when conflicts between classes affect the subsequent course of events far less than conflicts between neighbouring communities. It is also possible to recognize how social institutions respond to new material inventions without arranging the personnel of a particular society in the social classes prescribed by Marxist literature. In all this one may remain a consistent materialist in the modern sense, i.e. a behaviourist. The importance of conflict between social classes raises other issues.

The doctrine of the class struggle is difficult to state in simple terms, because a clear definition of social classes is compromised by local circumstances. The barriers which separate groups of individuals who pursue different occupations or inherit wealth differ greatly in different communities, and the part played by group loyalties is a matter for examination in the light of such local differences. The theory that class conflict is the midwife of social progress is attractive in Germany or in France where the several *estates* were at one time castes which did not intermarry. It has never been popular in Norway where it is obvious that substantial social progress has been accomplished by the "difficult path of reason"; and in Britain, where Dick Whittington and his cat are the symbols of class collaboration which has continued since the beginning of the wool trade with Flanders, scarcely anybody of outstanding intelligence took it seriously till Hitler stimulated our native chivalry by attacking it because the author

had the same racial antecedents as Einstein and most scientific men of genuine distinction in pre-Hitler Germany.

The meaning of the class struggle, as Guizot discussed it, is easy to recognize, because Guizot wrote about France. If we try to extend the conception to Sweden or to the United States the outlines are not so clear and the *differentiae* are not so easy to define. In Britain the town clerk with a thousand a year and the dustman with three pounds a week are both municipal employees. The piano tuner with two pounds a week and the K.C. with a retainer of ten thousand a year are both independent workers. A skilled engineer who gets ten pounds a week when times are propitious may look down on the scullery maid who is paid by the month like a professor.

This does not necessarily imply that when we speak of people belonging to the same or to different social classes we mean nothing at all. People who are not zoologists recognize the difference between a sparrow and a starling without being able to give a definition which a zoologist could not pick to pieces. Certain kinds and conditions of work can be associated in a statistical sense with certain levels of security and prosperity; and on this basis we can roughly assign certain limits beyond which intermarriage does not usually occur. The recognition of these levels and limits is a matter of painstaking research. Such research has been undertaken by students of population in connection with the study of differential fertility, and much remains to be done before those who study social institutions can speak about social classes with the confidence of a zoologist, when he defines the difference between sparrows and starlings. In so far as realistic social studies draw attention to social diatheses comparable to the estates of France at the time of the Revolution, they do not encourage us to simplify the problem along the lines suggested in the ensuing quotation from a recent exposition of Marxism:

> We turn therefore to a study of the qualities of employers as a class. It will be remembered that for us in the first place they represented a uniform group in their relationship to workers, also as a class. In their relations to each other, on the other hand, this

> unity is immediately seen to be transformed into diversity. They compete with each other. In any changing market situation, each employer or each group will strive to squeeze the maximum of advantage for his own side. Accordingly while there is a characteristic quality in the relation between employers and employees of the form we have discussed, a totally different quality exists between employer and employer. . . . As the frequencies of bankruptcies and industrial collapse increases, so the inconsistency between the existence of masses of commodities and the millions of workers in acute distress who are excluded from the means of obtaining them becomes more and more glaring. . . . Finally it passes to organized destruction. The State makes legislation restricting production but at the same time guaranteeing profits. As the stress, that is to say as the class struggle, intensifies and human distress rises, repressions, legal restrictions on free speech, are introduced, and so what has to be called Fascism acts as a delaying factor in order, by force of arms and organized brutality, to prevent the situation from boiling over, and passing into the *next socially necessary phase*.[1] (Italics inserted.)

The reader will have no difficulty in seeing that Professor Levy does not rely on the slow empiric methods of scientific observation and statistical analysis to arrive at the conclusions stated or at the distinctions implied in this passage. Nowhere in his book from which it is taken does he produce figures of the various categories of employees who are to act in unison in the final phase of this drama; and nowhere does he make clear whether the employer he is talking about is a shareholder, an unpaid director, a managing director with a salary, a highly paid manager of a large trust, or the single owner of a small concern. He does not take us apart and say that a minute study of all the relevant statistical, psychological, and historical information bearing on present conditions leads him to believe that *one* of *several possible* events will happen, and that intelligent social effort must therefore be specially alert to a particular contingency while prepared for more than one course of action. What will happen is "the next socially *necessary* phase."

[1] *Philosophy of a Modern Man*, pp. 211–13.

Clearly this is not *necessary* in the sense that a high wind necessarily blows out an exposed and lighted match. Judgments about what necessarily happens in this sense are based upon observations of simple situations which have occurred repeatedly. In contradistinction to what the dialectical theologians of the Comintern call mere empiricism of this sort, Professor Levy believes in the necessity of *the dialectic*. This dialectic which lifts the discussion of the class struggle above the level of statistical, demographic, or psychological research is derived from an early nineteenth-century philosopher who might have made less impression on his contemporaries if he had been forced to state his views in the lucid idiom of Bacon or Faraday. Authors who use a language which allows them to put the nouns on the first page of their works and collect the verbs in the final chapter of the last volume have an unfair advantage over the rest of us. Intellectually timid readers are prone to assume that they may be missing something really important.

The doctrine of the class struggle stands or falls with the Hegelian philosophy of which it is the offspring. So to form a just estimate of the relation of Marxism to modern science we have to examine Hegel's teaching. The first thing to be clear about is that it was hostile to the naturalistic movement of his time. Of all philosophers since Plato none has presented a world view more diametrically opposed to the world view of natural science. In the year when Piazzi discovered Ceres Hegel wrote upbraiding scientists for their neglect of philosophy; and unluckily illustrated his disapproval by citing the time which astronomers waste in looking for a new planet. Philosophy clearly showed that there could only be seven. But for Piazzi there would still have been seven at the end of the year.

This sort of number magic runs through all Hegel's philosophy. Its chief accomplishment was to reinstate the occult properties of the number three for which public respect had been weakened by the engaging flippancy of Mr. Gibbon. In his metaphysics, as in the ancient Pythagorean cult of magic number, reason, or unity was the source of all. So the secret of the universe

lies in finding how the reason works. Hegel did not waste time like astronomers who make thousands of observations on stars, or like modern psychologists who make thousands of observations on school-children, lunatics, or the files of advertising firms. As is the way with mystics, he found the truth in his own nature.

According to Hegel this is how the reason works. Discourse is like the proceedings of an impanelled jury, fated to be locked up until they find a verdict in favour of the Absolute, which is the Pythagorean unity, or source of all. The weather is sultry. Tempers are jaded. Every statement which one juror makes is contradicted by somebody else. Eventually nothing is left but the unity of the contradictions themselves. For philosophical purposes the apex of this vanishing triangle is spelt "the Absolute," for political use "the Prussian State" (now "der Führer"), in theology "God." Every argument which arises in the successive series which lead to the Absolute consists of three parts. The first step, which Hegel never succeeded in taking, is a plain statement. It is called the thesis. The second step is usually translated in English as the "negation" or "contradiction." Unhappily a defect of our tongue makes it quite impossible to signify the rich content of the Hegelian equivalent with less circumlocution than the Shakespearean catalogue, which begins with the retort courteous and ends with the lie direct. Finally comes the negation of the negation. This combines the higher truth in both the preceding steps. The only single English word for it is "compromise." As is often the fate of compromise, it is only the beginning of a new argument.

Whether people really do argue in this way, whether they are entitled to, or whether they get very far by doing so has no obvious connection with the class struggle if you are a materialist or a practical person. Hegel was not. He was an idealist. He believed that the universe was mind and that history is a sort of soliloquy which goes on in it according to the rules of reasoning laid down in the dialectic. Since the Absolute, alias the Deity, alias the orders of the leader, is also reason or unity, the source

of all, history itself, is nothing but a succession of triangular arguments. The hereditary properties of successive series explain what happens. Hence civilization naturally divides itself into three episodes: the *Oriental* stage ("thesis"), the *Classical* ("antithesis"), leading up to the higher synthesis of the *Teutonic* or, as we now say, Nordic civilization. This has all that is best and brightest in both. The cogency of the sequence has been amply confirmed by recent events which have shown us how many virile characteristics of the earliest Oriental civilizations can be incorporated in the higher synthesis.

Theologians and politicians, who have reinforced their argumentative technique by a training in the intricate phallic symbolism of argument conducted on these lines, are equal to most emergencies. The dialectic gathers into its own higher synthesis the principal advantage of every preceding variety of mysticism. Once you have convinced yourself that the universe is wound up by the Absolute, you can enjoy the advantage of believing that your mistakes are inevitable and that everything will turn out for the best in spite of all the ineptitudes avoided by painstaking study of how we behave like human beings. Besides this you need not have the decency to apologize to those you have abused when you find that you have been wrong.

According to the Hegelian view every social unity inevitably brings forth its own "contradiction" in a process of endless change. Since Hegel himself was a Conservative, and the social unities which he expounded in his lectures on world history were races or nations, we can well imagine the relish with which his rebellious pupils might, in the words of Marx who was one of them, "coquette" with a metaphor so well adapted to dramatize revolution; and we need not suppose that Marx was not aware of what he was doing. The inner *necessity* of the dialectic which supposedly guarantees the overthrow of the employing class rests on the *identification of history with the reasoning process as a corollary of the belief that ultimate reality is mental.* In other words the dialectic is a purely idealistic device which has no relevance to any creed which is essentially behaviouristic, as are the views which Marx sets forth

in his notes on Feuerbach. Hence dialectical materialism is a confusion of terms.

Possibly a tactical reason which encouraged Marx to "coquette" with the jargon of contradictions, interpenetration of opposites, and passing of quantity into quality was the delusion that German social democracy was destined to lead the world's workers into the Promised Land. Belief in the ultimate salvation of humanity through the spiritual precocity of Nordic Man was also shared by many Fabians and English Marxists who followed the late Mr. Hyndman till he made the spontaneous discovery that killing Germans would establish liberty, democracy, and the rights of smaller nationalities. Before they took to denouncing as pro-German those who had resisted the Germanization of English political thought and realized that dead Germans might be more dangerous than living ones, the English Marxists were never tired of telling us that the German workers would rise as one man when the hour struck. Mr. Chesterton replied that the clock, being a German clock, did not strike. That was before the war. To-day he might have added that it was a cuckoo clock.

As a student of Hegel, who had turned away from Hegel's idealism and Hegel's conservatism, Marx may have enjoyed the facility with which he could apply the metaphor of contradiction to revolutionary propaganda as atheists with a severe evangelical upbringing enjoy quoting Holy Writ. The inner necessity of the dialectic cannot be reconciled with his own statement that "all the mysteries which seduce speculative thought find their solution in human practice and in concepts of this practice." Marx himself never attempted to do so; and the epithet dialectical materialism was not of his own making. It seems to be due to Joseph Dietzgen, whose essays first appeared as articles in the social democratic journals *Volksstaat* and *Vorwaerts* between 1870 and 1884. Writing under the pseudonym "A Manual Worker," Dietzgen ingratiated himself by the disclosure "the comrades know that I am not an academician but a simple tanner who learned philosophy by himself."

Tanner, comrade, or philosopher, Dietzgen was at heart a

German nationalist. "Because the idealist perversity in its last representatives, namely, Kant, Fichte, Schelling, and Hegel, was thoroughly German," he writes in the *Philosophic Essays*, "its issue, *dialectical materialism*, is also pre-eminently a German product. . . ." Elsewhere he speaks of "this specifically German, or if you like, social democratic materialism"; and contrasts English and French materialism with Marxist "materialists trained in German idealism." No writer who found favour in the Marxist camp did more to perpetuate the Hegelian obsession; and it is only fair to say that he appreciated some of the difficulties of his self-imposed task. "It may appear contradictory," he remarks, "to make the Hegelian system of philosophy with its pronounced idealism the starting-point of the materialist conception of history. Yet the Hegelian *Idea* is striving for realization; it is indeed a materialism in disguise."

In 1872 Marx had introduced Dietzgen to the International Congress at The Hague as "our philosopher." In his essay on Feuerbach Engels remarks "this *materialistic* dialectic which for years has been our best tool and our sharpest *weapon* was discovered not by us alone but by a German workman, Joseph Dietzgen." Later his expositor Pannakoek refers to him as a "socialist artisan." So the legend of the working-man philosopher grew. Dietzgen seems to have hidden his identity from his patrons and expositors with remarkable success. The actual details of his career, now disclosed in a biographical sketch by his son, reveal the "artisan" philosopher as a clear-sighted and prosperous American business man of prodigious reading in the works of orthodox philosophers, untainted with any sympathy for the natural sciences and unscathed by any acquaintance with their pursuit.

He was the son of a master tanner, of a highly respected burgher family at Blackenberg, near Cologne, and received a good high-school education. Before he left school to work in his father's business he had acquired a tolerable fluency in classical and modern languages. At twenty years of age he became involved in the enthusiasms of the "mad year"; and emigrated to America

in 1849. Here he married a devout Catholic. In conformity with the Hegelian *accouplement* of thesis and antithesis they lived "in rare harmony." Dietzgen founded a flourishing business, and left America to manage the Government tannery in St. Petersburg at "a higher salary." In 1869 he returned to the Rhineland where "he had inherited a tannery from one of his uncles." In this capacity he published his pseudonymous articles in the social democratic Press.

Lenin states that Marx himself regarded "our philosopher" as a "muddlehead," and it is probable that no one would have taken any notice of the proletarian dialectic if the contradiction between the Hegelian metaphor and the materialistic teaching of Marx had not generated its own negation. Marx was attacked by Duehring, and the criticism of Duehring brought forth dialectical materialism as its own contradiction. *Anti-Duehring*, a polemic defence of Marx by Engels, contains the essential articles of the creed expounded in Levy's *Philosophy for a Modern Man* and in Haldane's *The Marxist Philosophy and the Sciences*. Much which Engels wrote in *Anti-Duehring* was sound sense and well worth saying at the time. In a chapter devoted to the criticism of Duehring's "apriorism," Engels accepts the necessary empiricism of any consistently materialistic view of nature in all its implications.

> Principles are not the starting-point of investigation but the conclusion of it, they are not to be applied to nature and history but are derived from them. Nature and Humanity are not steered by principles but principles are, on the other hand, only correct in so far as they correspond with nature and history. . . . In pure mathematics the mind is not by any means engaged with its own creations and imaginings. The concepts of number and form have only come to us by way of the real world. The ten fingers on which men count are anything but a free creation of the mind. . . . Logic itself is more than anything else a method for the discovery of new results.

Hume himself might have written

> If we derive the scheme of the universe not from our own brains but merely by means of our own brains we need no philosophy,

> but simply knowledge of the world and what occurs in it, and the results of this knowledge likewise do not constitute a philosophy but positive science. . . . Further, if no philosophy as such is longer required, there is no longer the necessity of any philosophy of nature. . . . An exact thought picture of the universe in which we live remains not only for us but for all time an impossibility.

When he is engaged in the unwelcome task of defending Marx against the charge of inconsistency Engels writes at a different level. Duehring, who rejected the Hegelian apparatus of contradiction, had maintained that Marx could prove the necessity of social revolution only by "reliance on Hegel's negation of negation." Duehring's charge involved two issues. One is whether the dialectic of Hegel is consistent with the materialism professed by Marx. The other is whether the Marxist doctrine of class struggles is capable of standing on its own legs as a scientific generalization when deprived of the Hegelian imagery with which Marx had upholstered it. Engels evades the second issue and stakes his defence on whether Hegel's terminology is or is not an effective expository device.

Thus the fact that a grain of barley germinates and becomes no longer a grain of barley but a plant which in turn gives rise to other grains is the negation of negation in botany. That the square of a negative number is a positive number is the negation of negation in algebra. The destruction of the old and the formation of new rock formations is the negation of negation in geology. The word negation is not used consistently, even when Engels confines himself to a single example of the dialectic formula. One example is the following:

> Let us take an ordinary algebraic quantity *a*. Let us negate it. Then we have minus *a*. Let us negate this negation, that is let us multiply minus *a* by minus *a*, and we have plus *a* squared, that is the original quantity but in a higher form, that is to the second power.

In defending Marx for coquetting with the highly emotive phraseology of Hegel's pseudo-rationalism, Engels rejected the

suggestion that the dialectic is an instrument for discovering new truths. He states explicitly:

> If I say that all these processes constitute negation of the negation, I embrace them all under this one law of progress and leave the distinctive features of each process without particular notice. . . . With the mere knowledge that the stalk of barley and infinitesimal calculation fall under the principle of the negation of the negation, I cannot cultivate more barley nor can I differentiate and integrate.

If we interpret these words in the light of what he had said about logic and principles in an earlier chapter, it is difficult to escape from the suspicion that Engel's defence of the dialectic is ironical. The substance of his well-thumbed brief is that if you agree to torture the words negation or opposite out of all recognition, you can hide the simplest and most familiar truths of everyday life in the husk of a Hegelian triad. The function of the dialectic was, and remains, *emotive* like Sorel's social myth. To apply it is to permeate the world of discourse with the implicit conviction that progress can only be achieved through violent opposition. Hence it is equally well adapted to the propaganda of militarism and of any form of insurrectionary violence. It is inconsistent with the outlook of those who intend to persevere along the difficult path of reason.

Since the dialectic has no time-scale with which to weigh the last straw which breaks the camel's back, it cannot squeeze the unbeliever through the needle-eye of conviction. When the believer seeks to make it plausible he merely succeeds in reducing it to the level of ordinary common sense. If it is a useful instrument of reason, it must contain within itself a recipe for the circumstances in which it is appropriate to apply it and more explicit information about the level at which it operates. For expository purposes the dialectic has two defects. One is that those who adopt or adapt it find their powers of persuasion cramped by the belief that truth only emerges as the result of flat contradiction; and Marxist propaganda in the past has provided an experimental demonstration of the futility of discussion conducted on this

assumption. An additional defect of the Hegelian recipe is that it makes the job of the cartoonist too simple. An obvious gambit for good caricature is: thesis Lenin, antithesis Mussolini, with Mr. Stanley Baldwin and his pipe as the negation of the negation. We are entitled to deal with any of the dialectic formulae in the same way. The passing of quantity into quality may signify that steadily increasing enthusiasm for democracy among Popular Front Marxists since Hitler came into power will reach a level at which the whole doctrine of insurrectionary violence will be thrown overboard by the Comintern. Stranger things have happened.

Although the explicit content of the dialectic furnishes no clue to the fascination which it exercises on people who are intelligent enough to see through this farrago of nonsense, the fact that it does so is not surprising. Napier spent far more time in numerical calculations to identify the Pope as the apocalyptic Antichrist than in preparing his system of natural logarithms; and in all past periods of large-scale social change intelligent people have got themselves entangled in controversies about issues which had a symbolic appeal out of all proportion to their intelligibility.

Few people with any scientific training would now waste time discussing whether the sacrament should be administered in one or in both kinds. Whether Christ is present in the hearts of the believers who participate in the feast of commemoration or whether the consecrated wafer partakes of the divine essence are issues which have now lost interest for us. From a rational point of view it is just as difficult to prove or disprove one assertion as to prove or disprove the other; and the task of doing so was not easier when the issue was one which engaged the combined efforts of the most nimble intellects in Europe. In so far as we disregard the fact that a plausible justification for the priestly miracle once rested on whether it did mean anything, the distinction between the divine *substance* and the divine *essence*, the *accidens* and the *differentiae*, is altogether meaningless. In so far as we are able to see it in its own historic context, we can understand why it mattered to men and women for whom the priestly miracle was the divine endorsement of the priestly authority and the token

of celestial approval for a predatory system of property rights in real estate.

From this point of view it is not so difficult to see why the Hegelian metaphor of Marx eventually outwitted the shrewd and illuminating judgment he brought to bear on the way in which technical innovations were transforming the society in which he lived, or why it has outlasted the impulse to examine later events in relation to the impact of technology on social superstructures. At a time when Liberalism countenanced child labour in the factory there was everything to suggest that fundamental social changes could be achieved only by violent methods. So a philosophy which infused the tempo of contradiction into the fabric of the reasoning process offered an attractive antidote to the complacency of liberal rationalism. When the esoteric nature of the dialectic is thus laid bare the essential issue is whether Socialism can or cannot be achieved by mobilizing the forces of persuasion. A consistent Marxist must examine this possibility in relation to the technology of his own time. In this sense Alfred Bingham[1] is the only consistent Marxist of to-day. Unless his figures are shown to be incorrect, the doctrine of social progress through insurrectionary violence must be relegated to the status of a Victorian superstitution of which the dialectic is the apple-pie sauce.

I have met Marxists who would accept the arguments of the last few paragraphs. They concede that the esoteric and implicit content of the dialectic is more significant than its explicit claims to rational assent, and take refuge in the consolation that human beings have always invented intricate rationalizations to accommodate the simple necessity of social change. This seems to me to be just as valid as arguments of those who once disposed of Methodists and Quakers by correctly asserting that a high level of culture had always been contingent on the coexistence of chattel slavery. As I see it, the value of historical study lies in warning us against repeating the imbecilities of our ancestors. Even if I did not think so, I should doubt the evangelical vitality

[1] *Insurgent America.*

of an ideology which its advocates do not really believe. This business of preparing for the Age of Plenty is so serious and compelling that we cannot afford to befuddle our brains with an unnecessary infusion of metaphors.

The dialectic is attractive because the path of reason really is a difficult one, and if Haldane wishes to show us how to take the difficult path of reason, he could put his outstanding ability to better use than by giving us plausible examples of the dialectical formulae. The history of Marxism is a record of repeated mistakes which could have been avoided if Marxists relied more on research which would reveal a variety of possible contingencies and less on reasoning from insufficient data to seemingly inevitable conclusions. At one time Marxists were confident that unemployment resulting from overproduction would inevitably lead to revolution. They failed to reckon with the possibility that the prosperous classes might find it more convenient to undertake large-scale projects of outdoor relief. To-day Marxists reject Federal Union because imperialist powers will "inevitably" refuse to give up their colonies. They cannot reckon with the fact that technical advances have now made warfare a menace to industrial capital and threaten to impose a troglodyte existence on rich and poor alike. The inevitable is invariably a sufficient excuse for refraining from constructive action and for pursuing a consistent policy of opposition. The inner necessity of the dialectic is the mirror image of the *anti*-mind; and the repudiation of constructive hopefulness which a scientific outlook can bring to bear on social questions.

Perhaps one reason why the dialectic exercises such a curious fascination for minds as nimble as those of Haldane and Levy is that some Socialists lightheartedly assume that the substitution of a collectivist for a capitalist economy will necessarily lead to a better society. While all Socialists agree that private enterprise conducted for profit has become an obstacle to human enlightenment and to technical progress, as chattel slavery proved to be an obstruction to science and advancing prosperity in the civilizations of classical antiquity, some Socialists also recognize that the abolition of chattel slavery was accompanied by many setbacks;

and that the seizure of power by a ruthless bureaucracy may be, like the rapacity of Church landlordism, the signal of Dark Ages ahead of us. Whether we choose the spectacular path of revolution in accordance with the dialectical theology of violence, or whether we strive to follow the difficult path of reason may therefore decide whether the emergence of a collectivist economy is or is not a step towards a better social order.

Those who believe that collectivism is a *necessary* rather than a *sufficient*[1] condition of further social progress will feel the imperative need to preserve the intellectual gains of our own civilization in the society which succeeds it; and will doubt the value of emotional short-cuts which may achieve the material conditions of further advancement in the process of destroying the intellectual freedom which could take advantage of them. In the present tempo of dissolving loyalties they are not afraid that capitalism will survive. Of collectivism in some form or another we may now say with St. Augustine *petant aut non petant venire habet*. Whether it is better or worse than what preceded it will depend on whether the aggrandizement of a bureaucratic caste replaces the self-interest of the shareholder or whether education for a potential age of plenty keeps in step with the necessary changes of administrative machinery. If such is the choice before us a great responsibility rests on those who have the intellectual gifts which would strengthen us in our resolve to pursue the difficult path of reason. Among those who possess such gifts no one is better equipped than Haldane to show us how research into current changes in population could throw light on the perplexing problems of social stratification; and thus help us to set about the task of mobilizing social effort to realize the age of plenty.

Intellectuals who recognize their social responsibilities need no pressure to divert them from excessive and unimaginative empiricism. What Bacon calls man's inveterate habit of dwelling on abstractions sometimes asserts itself in its most retrograde form,

[1] A distinction made by Bertrand Russell in his new and penetrating study, *Power*. George Allen & Unwin.

when individuals equipped with the subtlety essential to fruitful abstraction in fields where the relevant facts are well exposed, exercise judgment without the discipline of professional *amour propre*. That is why most *voluntary* social research is bound to be unsatisfactory. Einstein has put his finger on our greatest weakness when he declares in a letter to Freud on war:

> How is it possible to control man's mental evolution so as to make him proof against the psychoses of hate and destructiveness? Here I am thinking by no means only of the so-called uncultured masses. Experience proves that it is rather the so-called 'Intelligentzia' that is most apt to yield to these disastrous collective suggestions, since the intellectual has no direct contact with life in the raw but encounters it in its easiest synthetic form—the printed page.

Epilogue

AT LAST we have got the war against Hitlerism, the war for which the Labour Party has been clamouring during five years of frustration and the extinction of any vigorous constructive policy of domestic reform. Even the Popular Front intellectuals have gained their point. Mr. Winston Churchill is now in the Cabinet. So everyone is pleased; and Miss Ellen Wilkinson has tried to say what we all felt about it at the outbreak:

> "On Saturday night M.P.s went home with grim unhappy faces. Yet the next day, crammed in our air-raid shelters, the war declared, *we were happy*. The fight to stop aggression had begun."[1]

What would have been a plea for the Federal Union of the democratic nations with a common and enlightened policy for their colonies will not be the concluding essay of this volume. Written before hostilities began, it set forth how Labour Party bellicosity and Popular Front opportunism paved the way for the consummation which confers so much happiness on Miss Wilkinson. It would have explained how the parties of the Left in Britain and in France neglected every opportunity of bringing forward constructive remedies, as the inherent defects of the League were successively and dramatically exposed. It would have told the story of how Labour rallied round the Empire and it would have described the somersaults of the flying young men of the Popular Front trapeze with Mr. Gollancz at the piano.

Any federal union which does not provide for a common system of colonial administration to educate backward peoples for self-government will merely prepare the means of war on a larger scale than the present one. So it is useless to discuss such

[1] *Time and Tide*, Sept. 9, 1939.

a project without discussing the future of the Empire. Though it is still legal to say that Britain is involved in a life and death struggle for her Empire, it is only legal to say so if you have taken the precaution of joining the Conservative Party. Since I belong to no political party, I am not a free agent. The row of asterisks below stand for the Empire.

* * * * *

If we could still hope that there is time and will for setting up a Federation of Atlantic States including the Scandinavian nations, we might also hope that the movement towards Federal Union would be a focus for progressive thought and resolute action to promote a planned economy of abundance, and to furnish a remedy for social disillusionment which has followed the Russian as it followed the French Revolution. Capitalism is everywhere in process of dissolution. Having sunk their moral capital in the Nazi leadership the owners of industry and credit monopolists are no longer blind to what Left Wing apologists of the banker's balance sheet still refuse to see. While Left intellectuals continue to bleat the formula that fascism is capitalism showing its teeth, large-scale investors have learned to their cost that the barter system has stormed the last citadel of privilege. They are now compelled to choose between graceful abdication within the framework of democracy and strangulation by the Totalitarian State. Perhaps we may still hope that they will choose the former.

To whom could we then turn for leadership? The mentality which is capable of planning the use of science for the benefit of mankind is not the *anti*-mind of the perpetual Opposition front bencher or of the dialectical theologians. The present personnel of Left Wing politics has shown itself to be incapable of prosecuting a vigorous programme of domestic reform, consistently wrong in its remedies for international misunderstanding, and incorrigibly wrong-headed in its analysis of current trends in social policy. The leaders of the Left parties are utterly and irremediably discredited by events which have occurred since this

essay was sent to the Press in its original form. The party programme of the Age of Plenty will not be drafted by men united in a common impulse to oppose, to contradict, and to destroy. It will be the work of men united in the impulse to *create* a new order.

Anyone who ventures to write with hope for the future in present circumstances does so like Condorcet under the shadow of the guillotine, facing the same dilemma as Wilkins and hundreds of others who make up the class of premature moral births. All considerations of worldly wisdom point to Ragnarok and the twilight of western civilization in Europe. Only the sheer need to keep alive constructive hopefulness can keep a parent from insanity in these days. Those whose only stake in immortality lies in the immortality of the germ plasm *must needs hold fast to the hope of a new international order*

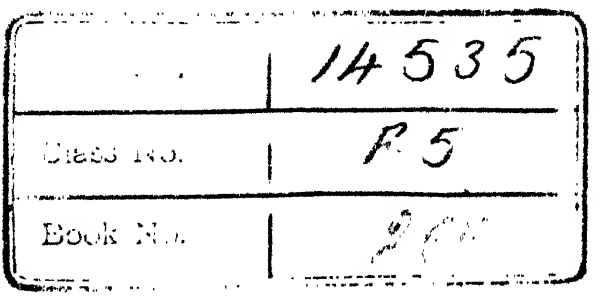
. . . till Hope creates
From its own wreck the thing it contemplates.

That these essays are redolent with hope does not signify that the writer claims special knowledge of what possibilities, for good or evil, the future may hold. To sneer at hope is the cloak of snobbery with which outworn scholarship conceals its own mediocrity. If the intellectual liberty of the last three centuries disappears in the havoc of imperialist wars and post-revolutionary disillusionment, its destruction will be a just penalty for the cynicism with which so-called intellectuals cherish the prerogative of pessimism as the hallmark of a privileged caste. Meanwhile scientific humanism cannot give us the dogmatic and apocalyptic certainty of the Hegelian dialectic. All we can ask from it is a constructive anticipation of possibilities inspired by such exploits of social usefulness as the drama of tropical medicine records. Freda Utley has said all that we are entitled to expect in the present tempo of dissolving loyalties:

> National Socialism, Red or Brown, may be the new society which we cannot escape. The fact that it is so different from the Socialism we have worked and hoped for does not mean that it is not the coming social system. Capitalism did not turn out to

be at all what those who inspired and led the mighty forces released by the French Revolution envisaged as the society to follow the destruction of feudal privilege and serfdom. The degree to which democratic rights and liberties, and all those values which we call civilization, can be preserved, will depend upon how and in what circumstances the transition from our outworn social system to a national planned economy is made.

Without such safeguards against the arbitrary use of power as we presume when we speak of democratic rights, bureaucracy may prove to be a harder taskmaster than the privileged classes of the past century. One necessary condition of an economy of abundance is therefore the preservation of intellectual liberty. If the events of the past generation can teach us anything, they show that we cannot hope to preserve intellectual liberty in the chaos and disillusionment which will result from protracted hostilities, or in the armament race which will inevitably follow a patched-up peace which does not lead to a new international order.



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