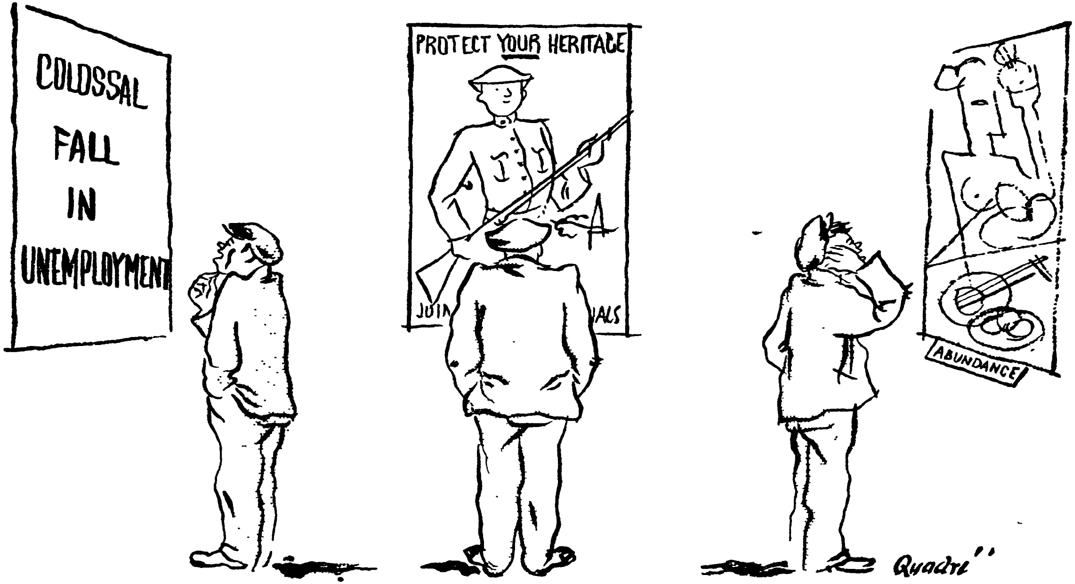
A PHILOSOPHY FOR A MODERN MAN



THIS MYSTERIOUS UNIVERSE

A PHILOSOPHY FOR A MODERN MAN

by

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The Universe of Science, Science in an Irrational Society,
The Web of Thought and Action,
etc.

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ILLUSTRATIONS

WHAT THIS BOOK IS ABOUT

He who works for the Socialist movement is a Socialist. Such a movement in history is made by men and women freeing themselves from the bonds of the past, and building their future. In this there is born an outlook on life that explains how the movement has arisen, what shapes it, what it is becoming, and your part in it. This book is about that philosophy.

Such a movement is one of many in history and in nature, where groups of people linked together, or groups of things or of ideas, interweave and interact. What kind of changes do such groups undergo, what settles their nature and their order? When it is a group of things (planets or atoms), scientists study it: when of human beings (social movements), it is important to scientific Socialists.

Here we study how the cause of change passes from outside the group to inside, and back; and the remarkable changes that follow. Social changes in history are then seen to occur in definite order. We see whither men in the mass were in the past unconsciously driven, and with what travail they reached their goal. We can see where men's actions are unconsciously leading to-day, and what travails await them if they act without understanding. This gives us a scientific view of our relations to others, why some changes seem important and others not, and how we can become aware of our power to direct history intelligently. That gives us a practical philosophy.

CHAPTER I

WHAT MEN DEMAND OF A PHILOSOPHY

For ordinary men and women, a philosophy will have meaning and importance when it is based on the assumptions the material world forces them to make in their practice of life, when it illuminates their relation to the world and to society, and so acts as a guide to conduct.

BRINGING PHILOSOPHY TO EARTH

PHILOSOPHERS are not commonly regarded as men of affairs. During a crisis politicians do not turn to them with eagerness for guidance on matters of high policy. In undertaking large-scale ventures business men do not call them in as men of clear vision and understanding to submit schemes to their judgment. Even scientific men pay scant heed to the interpretations philosophers offer of their findings. The man in the street is the only person who will treat them with due respect, with the respect he will give to any rare incomprehensible specimen.

There are of course good reasons why these estimates of the importance of the philosopher should have arisen. His speculations, thoughts, and word spinning, appear to have no significant outcome, and to make no evident contact at any point with the life and actions of ordinary people. The test is a practical one and to that extent is valid. If philosophers are never called in to advise, as architects, consulting engineers, geologists and lawyers are called in, then it can only mean at the best that in the social and individual aspects of life, their philosophy plays no conscious part.

In this book we profess to attempt a complete break with this tradition. If a philosophy does not illuminate the practice of ordinary life, we maintain it fails in its function. It must be something drawn from the world of human affairs and guiding it. To lead a philosophy in this way from the barren wilderness of speculation into the rough and tumble of action is more than to violate the traditional meaning of philosophy. To suggest that its truth be consciously and deliberately tested by human beings in the fire of practice is to demand that, like science, it stand or fall by its active meaning for man.

For we are born and cradled in struggle. Our power of understanding is a vital matter in our efforts to safeguard ourselves against the uncertainties of the world about us. We have to know our world, to understand and piece together its behaviour, so accurately, that we can anticipate its next move. We have to rise above this: we have so to alter circumstances, so to change the world in the present, that as far as possible it will move according to our desires in the future. For man is also a creature of hopes, ideals and aspirations, dreaming of a world in which the finer things he values can be his to practise and enjoy. These ideals also we have to understand, whence they arise, how they have to be transformed to make them capable of realisation. They have to be separated into true and false, those that are potentially true because capable of being brought to fruition, and those essentially false because they cannot correspond to any attainable state of affairs. In short, if a philosophy is to be a real living guide to man, it must illuminate the part he has to play in reshaping the world so that his ideals may finally be achieved.

These are heavy demands to make on a philosophy, but they are nothing more than human demands. They will not be attained unless once and for all we break with the past, by dismissing the idea that philosophy is contaminated when it addresses itself to the mundane matters of life, when it enters into the hurly-burly of political controversy, and when it accepts as valid certain dictates of common sense that are valid because tested by the ordinary man in his handling of the world. If it is to be a philosophy for a real human being, it cannot wait to question whether the universe exists, but must pass to a study of the nature of that existence. We know the truth, you and I. It will be futile to argue moreover that the matters we have touched on, fall properly under other headings, sociology, science, ethics, religion or politics, and are not therefore the concern of philosophers. If our problems are human problems we cannot ignore those things that are vital to human beings, by withdrawing ourselves from the immediate and practical task of using our science, our sociology, our history, and our politics to shape the world according to our needs. We must not fight with hands tied. If it is a fact that life is a ceaseless struggle from which knowledge and wisdom are distilled, and living thereby transformed, then only in wrestling consciously and fully armed with the forces of nature, and with the crudities and obstructions of mankind itself, can a human philosophy be created that will clarify that struggle and bring its objective into consciousness. Within its circle, therefore, it must encompass science and art and all other human activities. A philosophy must simultaneously be an avenue to understanding, and a spur to action, not an escape into inactive contemplation.

PHILOSOPHY AT WORK

Compared with our continental brothers, Englishmen appear highly reluctant to set out their social philosophy in measured terms, and to strive for its application in practice. Except during the past few years, the dead calm of the British Universities has always contrasted strangely with the fervid political atmosphere in which the University life of Germany, France and Russia has been steeped. There have been critical occasions, as during the French Revolutionary period when individual scholars and scientists have broken down their academic aloofness and challenged the forces of reaction, but these have been special occasions.

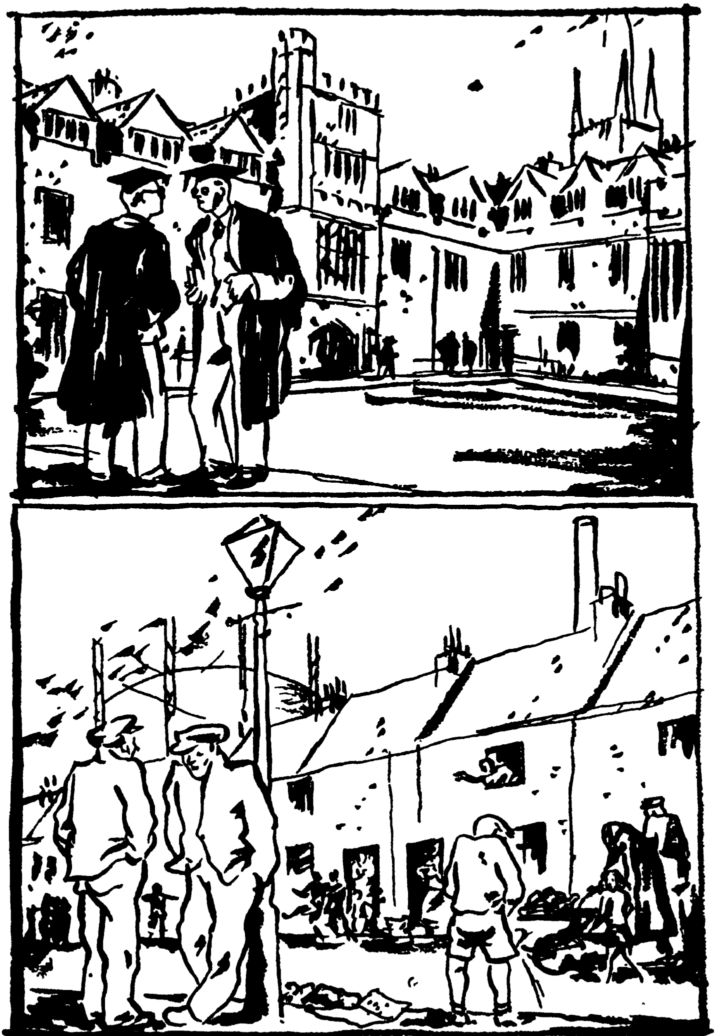
There is no counterpart in England for example of the struggle for a liberal constitution waged by students and professors alike in the German Universities during the post-Napoleonic years of 1813–1820; the rise of the *Burschenschaft* groups, the mass demonstrations of students and professors in 1817, the winning of constitutions for *Bavaria, Baden and Wurtemberg, the newspaper campaigns*, the pamphleteering, and the philosophical disquisitions that led to the assassination of the poet Kotzebue in 1819; the dissolution of the Burschenschaften, the governmental supervision of University teaching, the exclusion of teachers and students suspected of liberal views, and their imprisonment, the censorship of books and newspapers. It was a period of ferment among the bourgeois class in their joint struggle for Nationalism and State power. Even when the campaign broadened and reached the mass of the people after the introduction of repressive measures, the Universities still played their part. In the parliament that was elected in 1848, a repercussion from the corresponding movements in France, out of the 500 deputies elected there were 150 professors. The history of how philosophy was used as a weapon of attack or of defence by the one side or the other in this struggle is itself illuminating. I need here refer only to Fichte (1762–1814), expelled from his professorship at Jena because of the suspicion that he was an atheist, who more than any other contributed to arouse in the student youth the great surge of national sentiment in 1813. Of Hegel (1770–1830) we need hardly speak. The way in which his idealist philosophy of dialectical change was applied to justify the reactionary policy of the Prussian State is too well known. It has since then been resurrected on behalf of Fascist ideology. In 1832 Feuerbach was deprived of his chair: four years later he was an outspoken critic of religion. By 1841 he had become a materialist. In 1842 the left Hegelian, Bruno Bauer, was also forbidden to lecture. It was in this atmosphere of political ferment, intermingled with philosophical controversy, that the young Marx grew up. By 1843 he has already removed to Paris in order the more freely to carry on the attack. What is remarkable about this period is not that there was political ferment, but rather the prominent rôle played by University professors in that movement and the extent to which their various philosophies were applied, in their social context, to justify the one side or the other. There was no sense of philosophical aloofness from the world of affairs, no call for detached calm and preservation from the political struggle in order to attain a balanced judgment. On the contrary, philosophy was a weapon of attack. Marx himself was driven from pillar to post. At the age of 25 he is an exile in Paris. Two years later he is banished to Belgium at the instigation of the Prussian Government. In 1848 at the age of 30 he is thrown back to Paris: next year he is in Cologne during the Prussian insurrection, banished again from Germany and finally settles in London. A student of philosophy, a political pamphleteer and writer of newspaper articles, an active fighter in working-class organisations, struggling to distribute in secret his material throughout Germany, a critic of orthodox philosophy, a victim of repressive measures in country after country and a prodigious worker, it was little wonder that his writings exposed a pungency in analysis, that rings strange in the quiet atmosphere of the English drawing-room or within the cloistered quadrangle of a British University. His social bias does not require to be disinterred. It suffuses the whole of his writings.

THE NEW TEMPO

In Britain the history of its social struggle has, outwardly at least, been separated sharply from the history of its philosophy. The Chartist Movement, the persecution of the Tolpuddle Martyrs in their early struggle for Trade Union rights, the Rochdale pioneers of the Co-operative Movement, the long succession of strikes and lock-outs in the mining industry, these are only a few of the outstanding features of a century of industrial strife, at times rising to an intense pitch of bitterness. Side by side with this, the official philosophical schools have pursued their studies in the isolation of the classroom. With few exceptions the industrial struggle has meant nothing for them; and the reasons for this are patent. The individuals who peopled the Universities of Germany at the end of the eighteenth and the beginning of the nineteenth centuries were drawn from the same class as those who filled the Universities of England, the sons of merchants and small landed gentry. The social problems with which Germany was struggling were those of that same class. They plunged into the fight. In England on the other hand that struggle had been fought out nearly a century before. With the rise to power of a commercial class in England came also the conception of a liberal education for its leisured or student sons. Britain then established her position in the markets of the world, the proud possessor of a colonial Empire that was the envy of the whole world. The sons of this powerful class ✓ were "born" administrators capable, by nature, of dispensing even-handed justice between commercial agents and ungrateful natives. They peopled the Civil Service, Home and Colonial. Their interests were across the seas.

There was no hurry. Philosophical questions could be examined in the abstract, rights and justice analysed in detached calmness. After all, was one sure that the world really existed? There was no urgent or incessant drive, no call to meddle in these tiresome disputes between factory workers and their employers. Certainly give the workers freedom, equal liberty to both, to accept or refuse terms, but individual liberty. If the worker could not afford to refuse, that had nothing to do with the matter. Let him also show his initiative and individual capacity as his employer had done. Shut the door, it does not concern us.

Behind it all lay this solidly established order of society, unquestioned, unassailable, permanent, the natural home of a liberal tradition of an individualist liberal philosophy. And so after all, the focus of interest of official English philosophy is not so divorced as one might imagine at first sight from the social setting of its professors.



ACADEMIC ISOLATION FROM THE SOCIAL STRUGGLE

A change has set in. The offspring of a new class has begun to elbow its way into the Universities. During the past ten years, in a period of international instability, the old sense of permanence and respectable well-being has given way to a sudden feeling of insecurity. A new mood, a new outlook has made itself apparent. In the effort to appreciate and control the forces that are moulding this changing situation there is a call that philosophy must help to provide understanding, and that understanding must offer guidance. It is to the readjustment in the economic sphere of Britain's relation to other nations, to the new wave of uncertainty and to the increasing awareness of the British people that the outlook and philosophy of security, isolation and unchallenged supremacy no longer reflects the modern *tempo* of wars and revolutions, that one must trace the new philosophic awakening.

THE PROPER MOOD OF APPROACH

No new standpoint can be understood unless it be approached in a sympathetic spirit. This means neither discarding one's critical sense nor accepting as dogma what may be only theory or suggestion. To be sympathetic implies two things: first a clear desire to understand exactly what the particular philosophy seeks to contribute; and secondly some realisation of the limitations from which the student himself may suffer, that may prevent him from sensing or appreciating it. The historical circumstances that have separated English philosophy from the social struggle of the working class, have produced also a similar isolation in other fields. Religious leaders for example preach doctrines that, in principle, are supposed to stand above the mere sordid issues of the contemporary wage struggle. A man or a woman can lead a Christian life at any social level; and religion as such, concerning itself with spiritual truths that are asserted to be eternal, is not necessarily circumscribed by social relations. It impinges only incidentally on material problems. Yet such an outlook cannot long remain the view of suffering humanity. Even in the present period of crisis, any observer can see that Church membership is reft between those who would stand before all else for its spiritual message, and those who feel that its moral mission is being defeated by the circumstances in which people live. The present scale of this division is a comparatively new feature, in spite of the fact that in the past there are many cases of individual members of the church who have taken their stand in denunciation of social injustice, child labour, sweating, negro slavery, etc. Nevertheless, every Church leader recognises, consciously or unconsciously, that to take sides *officially* in this human struggle would precipitate a crisis within the Church itself and bring it into conflict with the State – an intolerable situation for an official State institution. Unless an adherent of the Church can have the courage to face this possibility, fairly and deliberately, he is not likely to approach this study in a sympathetic spirit. He will have begun with reservations.

A similar situation arises in the scientific world. The scientific method is essentially an effort to deal with the problems of nature in an objective dispassionate mood. Every detail of the scientific process is hedged round with safeguards that exclude the personal influence or bias of the experimenter from affecting the results. This procedure breeds in him a fictitious sense of detachment. It is not what he likes or dislikes that is of importance, but what is in fact objectively true; and what is objectively true is what his instruments show when so safeguarded. So deeply does he treasure this sense of detachment that he would fain believe that all problems encountered by man can likewise be handled in their entirety, by this process of self-effacement. It may be true that he likes or dislikes the use to which his science is put in social practice, but the mere fact that such things arouse feeling and emotion, bias and prejudice, prompts him to turn his back on such matters. For him they are a dangerous diversion from the proper mood in which to pursue scientific work. However much we may admire the standard he sets himself in this way, the attitude is nothing less than a refusal to face an objectionable situation. If the preservation of the scientific environment is to him an essential of his practice, and if it cannot be applied to the problems, undoubtedly serious, that arise from the social misuse of his work, for example the pounding to pieces of the town and inhabitants of Guernica, then his method has broken down when faced with a real situation of profound importance. That some unexpressed philosophy, some system of valuations unconsciously applied, have made themselves apparent in the social and industrial turn given to his work, cannot be denied. That he will not be able to appreciate the full implications of his own practice, and of its social effects, without, at least, a detached examination of this underlying philosophy, in order to bring it to the level of consciousness seems self-evident. For these are precisely the types of problem with which we are concerned. Sceptical as he may be of the nature of the evidence from which philosophical conclusions are drawn, yet playing his part in human social practice, he cannot afford, even as a scientific man, to ignore the fact that in some way he is working out and applying some underlying social theory. To become conscious of what this is, is to revolutionise the interpretation of his own activity.

What is true of the scientist is equally valid for the artist, but his difficulty is even greater. While both the scientist and the artist tend to regard their work as free and individual, inspired by a pure effort of the imagination, the scientist, in the last resort, regards his conclusions as an external, in a sense, impersonal truth. It is forced on him by nature. The artist on the other hand cannot divorce the significant part of his work from himself. While the scientist can easily verify the fact that many of the problems with which he has to deal are thrown up by society, that the solutions to these problems might equally well be discovered by other scientific men, and that the results, when used, change and direct the way of life and the thoughts of masses of people, the artist may not so easily appreciate the social conditioning of his work, its influence on other human beings, or the extent to which the ideas and valuations of the period, the energy of the society in which he lives, are being poured out through his own creations. Precisely because his work seems to present itself as such an individual creation, and because it must at the same time have meaning and significance to others, it is necessary for him to examine exactly in what sense it is individual, and in what sense the expression of a social or even a class mood that speaks through him. Unless such matters have importance for him, he also will not be facing this study in the appropriate mood.

To plead for a sympathetic approach on these grounds is to ask for no more than a recognition of the truth of one of the essential factors in this philosophy, the need for each individual to become conscious of the direct and indirect social conditioning of his thoughts, his feeling and his actions, and of the precise nature of his inter-connectedness in these matters with the groups of human beings among whom his life is spent.

ASSUMPTIONS

We begin then with quite elementary considerations.

(*i*) *The universe exists;* this we state as a truism that we shall not question. If it does not exist, its problems disappear with it. Those who question this need not proceed further with this book.

To say that the universe exists is to make too bald, too simple a statement, because even as soon as we look at the world, we begin to realise that actual existence is something different from mere *being*, which implies a sort of permanent, unchanging, static condition.

(*ii*) *The universe is a changing entity*, and the divorce that we easily make between the fact of change and the fact of mere existence as if the latter implied only *being* is one into which language encourages us to slip. It is possible that in his effort to build up an environment on which he could rely and which he could control, man has striven always for permanence, to find and to use unchanging elements in a changing world. On these he has attempted to build up a solid basis for his life. And so it is not surprising that his language is honeycombed with words that suggest fixed, static, unalterable things – *tables*, *mountains*, *I*. We, who have grown up in a scientific age, and can look back on the history of man, cabined and confined within a language that links him up with his primitive state, can begin to sense a few of the difficulties that have to be faced if language is to fit the actual world of change. For, not only is language to express at once object and changing object, process and changing process, it has to describe our impression of these things, the pictures and ideas that flash into our minds, and the flow of feeling that surges through us as we encounter them.

(*iii*) *Language is the liaison officer between the physical world about us, the actions, feelings and thoughts about that world that flow within us, and the interpretations we pass on to each other.*

Recognising this, we can attain a clearer appreciation of the function of language, we can become conscious of, and therefore evade, some of the confusions that obsess us in our efforts to use language to help make thoughts and ideas of the world accurately mirror the world itself.

The first difficulty, therefore, of which we have to become conscious is the danger of assuming that when we talk of existence we are talking of mere existence, a world that simply *is*. If the word is to describe the universe as it is found, then *change is inseparable from it*.

Let us therefore examine more closely the use to which we are putting this word *change*. We think immediately of the movement of things, of tables and chairs and vehicles, of planets and particles of dust. Change of this nature is an easy concept; it occurs visually before our eyes, and scientific men make this exact by referring to it as motion, speed, or velocity. But change is not confined to mere shifting of objects, not at least in this simple direct way. A leaf of a tree undergoes change as it passes to the sere and yellow stage. True, a microscopic examination of its surface would show that particles composing it have themselves undergone changes, changes of position and of composition. If this is so, then what indeed is a leaf, to what does the term refer? We use the word to represent a *collection* of such particles at some point of time, but the content of the collection is in a ceaseless state of change. Thus permanence, the condition of being static, can no longer be attributed by us to the detailed arrangements of the little parts of the leaf, but is already thrown back a stage, to the fact of a collection. That fact is of a group, or, as we shall call it, a *statistical* nature, even when the group consists of as few as two members. It is a legitimate use of the term, since *statistics*, in the ordinary sense, is what we use for representing groups or collections of facts.

(*iv*) *Detailed changes show themselves within relatively permanent groups or collections.* If words could fit process, we could follow that change in process by a sort of process-change in name, but language is unfortunately not constructed to do this. Even were process to occur continuously, words must change in jumps. In practice, words persist and tend to petrify or fix our idea of the object to which they refer long beyond its legitimate physical stage. Thus again the inertia of speech and the way in which our thoughts and ideas are entangled within its framework make us slip easily into false beliefs in permanence and unchange, in the object also.

In discussing change in this way, however, we have still restricted ourselves to the movement of material things, even if they be groups. Ideas change, opinions change, our likes and dislikes, our valuations, our understanding, our very natures change. These are all aspects, or, as we shall call them, *qualities* of material things. Sometimes we know how to describe their size or amount. Not all qualities, however, can easily be dealt with in this way. Is there an easy method of measuring the intensity of our feeling, or the degree of our mental concentration, or the vividness of a picture? And yet all these terms, intensity, degree, vividness, do represent an effort to express quantity in association with quality. Intensity and vividness come and go, they fluctuate. A change may take place in the strength of the quality. Again quality may change its type, as when love passes to hatred, or bravado to fear, or mental fuzziness to mental clarity. When, therefore, we talk of change and movement, we shall be circumscribing the meaning of these terms unduly if we restrict them to change and movement of material objects only. When we say in hackneyed terms " the changing world is a restless universe of flux," we do not merely mean that the universe contains within it material objects that move among themselves, showing alterations in relative position.

(*v*) *The universe contains also human beings with a changing consciousness of the material world about them, changing thoughts, feelings, perceptions and actions.*

I have referred to the very obvious fact that human beings, with all their qualities, think, feel and work within the universe. This would not merit remark were it not for another quality, a habit, we might almost call it, which we human beings have acquired. We see the universe existing " out there," apart from us, passing through its changes independently of our likes and dislikes, independently of our thoughts of it, independently of the meaning it has for us. There is danger in this apparent independence. We cannot say that we are part of the changing universe and at the same time assert that its process is *quite* independent of us. In some sense it is different for our presence; the world is changed by our being here from what we may *imagine* it would have been without us. The thought is, of course, a mere fictitious idea; we are part of the universe in the sense that we are one of the cogs in its vast complicated machinery.

If the phrase " We, our thoughts, feelings and actions exist within the universe " is to be properly appreciated we have to examine very carefully our relation and our interaction with this " rest of the universe." We must not confuse the latter with the " whole of the universe." If we do so we will slip into the error of making the relation between us and it a fixed one, of becoming mere onlookers in an affair that does not concern us, instead of participants in it. There is an active quality in this relation. We work on it, it works on us. It affects us, we affect it. It is this characteristic that is of greatest importance to us here. A philosophy that hinges on this feature of the universe is one that is sharply distinguished from the philosophy of a mere onlooker. For us that would not correspond with a reality. It is through this active quality that our desires and our ideals link up with the world. They link up in two ways. They are stimulated into being by our conscious appreciation of that world, what it does with us, and what may be done with it. That is to say, we change and alter under the impact of our environment; the environment is changed and altered under our impact. We are its environment. Again our ideals, values, and judgments are not produced once and for all in this way but are themselves continually undergoing change with the change in the world about us. There is a *movement* in ideas and in feeling. Change is to be found in every aspect of the universe.

MAN AND HIS THINKING ABOUT THE UNIVERSE

The universe, then, is a changing reality. This embraces all its aspects, objects, collections, parts of objects, colours, ideas, feelings. They are all aspects of material parts of the universe. The most abstract idea, the most imaginative concept, the most fantastic effort of thought, are all the work of real beings. They show what the brain of man can do. They are signs of brain activity. We experience pain, pleasure, fear, love, hate, and a variety of other emotions. They are all perfectly real feelings. Real human beings have them. There are no degrees of reality about them. They are simply different forms of reality. The idea of infinity, a brontosaurus, a primitive man, an angel, a ghost, an end or a beginning to space or to time, these are all real ideas. Whether there are or have ever been real things or real situations to which these could be fairly applied is quite another matter. That depends on whether statements that embody these ideas correspond to, or reflect actual parts or aspects of the universe. This leads us to our next point.

One of the problems to which all philosophies direct a great deal of attention is the relation of mind to matter, as it is usually stated, the relation of man's thinking about the universe to the universe about which he is thinking. It is a very important relation. In what sense can we say that the idea we obtain of the universe is a *true* one ? If it is approximate, how approximate is it ? If false, how do they arise and wherein do the falsehoods lie ?

THINKING WITH ACTION

Now, such problems, as we have already stated, are not solved by mere thinking alone. We, or our fellow members of society, actively partake in the study and practice of living and doing, in order to acquire knowledge about the world, and to shape it to our needs. We may live and work in a perpetual fog, but as we become accustomed to feel our way about the world, to acquire a more intimate knowledge of its behaviour, a more certain anticipation of what it will do and what will be the outcome of our actions, the effect of the fog gradually becomes less and less important. We are always testing our thinking in our actions and in the results. In early savage days, man may start up at every shadow, or fear the devil that he imagines resides in every stone; but as society develops, these fogs that have darkened his mind and confused his understanding, gradually melt away. All this corresponds to a rising level of practical understanding. Man is thinking more accurately.

When we say that the universe exists objectively now, what we say also is that the past experience of mankind, as it is summated in the speech, writings, libraries and institutions of modern society with all our sharpened thinking, also exist objectively now. To think truly about the universe, then, we must bring to bear on the problem, not merely our direct personal experience, but all that vast experience of the race. We have consciously to assimilate in personal experience, that of the species Man.

Now there are certain elementary truths which can be drawn out from this storehouse of knowledge, that we can use immediately for this purpose. They have been discovered by experimental interference with the world. All scientists are agreed that in the past history of the universe, and in particular in the past history of this earth, there was a period during which the globe was itself part of a much larger gaseous mass—the sun—at an intensely high temperature. There is some doubt about its exact manner of birth. Some have maintained that as an enormous droplet it was splashed off during a time of rapid rotation of the sun; others that yet another enormous sun, passing in close proximity, so disturbed the equilibrium that a long pear-shaped portion was drawn out from the heart of our sun to circulate about it as the planet Earth. All this has emerged out of a detailed and elaborate study of the temperatures, sizes and internal constitution of the stars and nebulæ in the heavens; and from the numerous celestial bodies at various stages of evolution and development. Whatever the nature of these theories, one point at any rate stands out clearly and distinctly and is accepted by all sides, that the early temperature of the earth was such as to make the presence of living organisms upon it an impossibility. What we call life can persist only within a narrow range of temperature.

THE PRIORITY OF MATTER TO LIVING AND THINKING

Two facts then stand in opposition. First, that many millions of years ago there were no living organisms on the earth; and secondly, that to-day highly developed, *highly organised pieces of matter, ourselves, showing* mental qualities, exist.

Need the gap between these two stages be filled before we can draw inferences? Let it be admitted at once that the history of the earth in the early stages after its birth can be sketched only in broad outline on the basis of such scientific experiment and inference as have only during the past three hundred years come within our compass. We know little of the early stages of cooling, the passage through the liquid state, the forming of a crust on the outer surface and the changing forms through which the elements of matter and their compounds passed during that period.

If we proceed to the opposite end of the scale, and trace back the history of man from the present day to more primitive times and then bring to bear all the knowledge that has been gained, we can fill in with some measure of fullness a certain portion only, of this gap. The vast number of fossils that have been dug up at various depths, the estimated intervals of time that must have elapsed for the surface material to have been deposited or overlaid to this depth, and a whole mass of indirect evidence, all point to the fact that gradually the present complex forms of living animal and vegetable matter have emerged from simpler forms that link on through almost countless ages back to more and more elementary forms. The gap between the simplest cell that is the most elementary living organism, and the most intricate chemical substance known to be still inanimate is great, but not nearly so great as it was a few years ago.

QUALITIES OF MATTER FORMED IN NATURE AND CREATED BY MAN

In itself, however, the mere fact that we can assert with certainty that a situation did exist when material forms were so elementary that living organisms had not manifested themselves must be taken as indicating that as the *temperature of the earth fell, a stage was reached at which* this new form of matter became a possibility. Within a certain range of temperature, the passage from inanimate to animate qualities was effected. The successive stages in this process and the necessary material conditions for its occurrence are clearly matters for careful examination, but the fact that they have not yet been explored in minute detail is of no consequence to us here. All we are concerned with, is that the new qualities that matter continually manifests as it changes, on this occasion took the form of what we call " living "; qualities of matter that were to become crucial in the later emergence of man. Let us remark, however, that there is nothing mysterious or non-material about this course of events, as we shall see. That scientists cannot yet lead inanimate matter through the stages that will change it into the animate form must be set side by side with the fact that there are also in existence innumerable complicated substances in the so-called natural state that have not yet been produced in the laboratory. No one argues that a mysterious agency brought about the " creation " of these. On the other hand, the history of chemistry includes the successful production of a whole series of natural products from elementary substances with precisely the correct qualities. More than this, it includes the " creation " of innumerable composite substances with new properties never yet found in the natural state. Not only are chemists pointing out the route that nature went, but their experimental experience with it has led to such accurate understanding, that they are deliberately leading nature along new paths, predicting in advance characteristics of the things that will be discovered. In these fields man is a creator who predicts what he is going to create. The emergence of living properties in matter was indeed a very distinctive step in the natural process, but it was a natural process. It was not in any other sense unique, for every time a synthesis or an analysis takes place new properties emerge. We shall deal with such matters in greater detail in later chapters.

(*vi*) *Science establishes the prior existence of matter to mind, prior in time; and here we accept this point of view.* It follows, therefore, that we will very seriously misread the world and its meaning for us, if we fail to realise that in interpreting that world it is

(*vii*) *Mind, a quality of that matter, that manifests itself in the interpreter and so also in the interpretation.*

To erect a philosophy on the priority of matter over mind in this sense is to build a materialist philosophy, a philosophy of nature.

To assert that mind and matter are distinct and separate entities, or that matter is a quality of mind is to violate this basic fact and to adopt the attitude of a philosophical idealist. We do not propose to discuss these standpoints. They are part of the groundwork of any philosophy of contemplation, but it may be worth while noting one or two dilemmas into which such a viewpoint forces its holders.

Taking the view that mind and matter are distinct entities, each with its own independent existence, how, they ask, does mind act on matter? The action of mind on mind, or of matter on matter appeals to them as simple and direct, but with two totally different "stuffs" like mind and matter, what is the exact mechanism of the operation of the immaterial on the material?

The confusion arises in the first place from the image that is called up by the use of the word *Mind.* It falsely suggests a something, that although not an object is yet composed of something else,—mindstuff. The word serves to imply that there exists somewhere a vague kind of materiality, separate and distinct from the brain, and that its function is to think, to co-ordinate experience, to probe, to infer. But in fact the word *mind* simply serves to group together a series of aspects of the composite activity we call thinking. If the word, by its mere existence, is taken to imply more than this we involve ourselves in a verbal fiction. To enquire how mind makes the brain work is as sensible as enquiring how sight makes the eyes see, or, to use a static parallel, how green-ness makes the grass green.

The problem as we have said is a fictitious one and arises because the philosophical system in which it can be raised, has dropped out of its content the primary factor of *activity*, or active participation, to which we have referred. In this process the activity of brain is thinking, an active changing quality of the world.

The same type of confusion showed itself in older philosophies. One of the primary qualities to which we have attached great importance in nature is change. In the scientific sense, then, motion is a fundamental quality. Had we begun otherwise, and conceived existence as static, unchanging being, then we would have been compelled to invent a new quality of a general nature called motion to account for change. We might then have found ourselves asking questions such as: " How does motion acting on this body make it move ? "

Or again " How did the world come *into* existence ? " Not, be it noticed, " From what previous state of change did the present state of change emerge," but " From what state of nothingness did the present state of somethingness spring ? "—a meaningless question.

MATTER—OUT OF DATE?

One final point. It is sometimes maintained that matter is out of date, that it belongs to the pre-scientific days of " substance "; with the modern discovery that what seems so solid and ponderous is in reality groups of tiny electric charges, moving at high speeds, so small that the intervals between them are relatively vast open spaces, it is futile to maintain the old fiction of solid matter. It is mostly space. So it is argued.

The word matter is used here for what we pick up as pieces and objects everywhere. Common sense refuses to be violated by false interpretations of simple scientific discoveries. As science progresses, it tells us more and more concerning the structure and make-up of these pieces of matter. It may break it up into its constituent parts, and even finally dissipate it into light, heat and electrical energy. But if dissipation is taken to mean sending it out of existence, then a false idea will have been created. It is no more dissipated than a piece of paper goes out of existence when burnt. It changes its form. It does not vanish, it passes from one changing form to another. The relations of the parts are altered, and they no longer exhibit themselves as what they were. To suggest that for this reason matter is now a useless pre-scientific concept, is to deny common-sense by maintaining that the more one knows of it, the less does one understand. To-day we know more of matter and its behaviour than we ever did.

It is probably correct in one sense to say that the space between the particles of a solid body is very much greater than that of the particles themselves, but that does not deny the solidity of the body. Test it. What indeed is the " space " between particles of a group all of which are in a violent state of agitation? Is it not the fact, that the particles pass across some of the space all of the time, and all of the space some of the time, that makes the solidity of matter apparent? It is a characteristic of a group in movement. The movement is an essential quality of the particles, and as a group they manifest solidity.

CHAPTER II

HOW A QUALITY IS MODIFIED

Every aspect of nature is a group-aspect, and exists or changes within a wider group. It is in the relations of groups to groups, or of a group to its constituent parts, that qualities show themselves. Here we discuss various forms of activity, the qualities that are displayed, how they are deepened or intensified, and in what way they may be measured. Probability is shown to be the appropriate method of measuring certain types of objectively changing qualities.

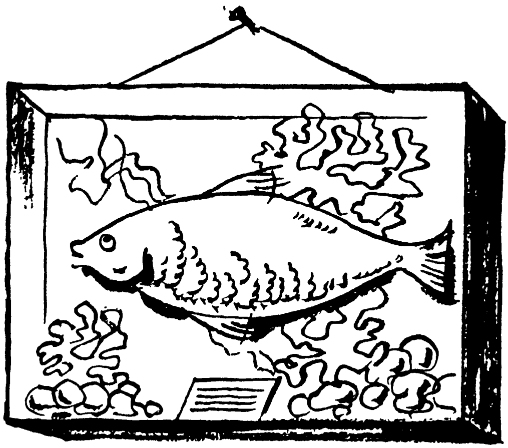
HOW A QUALITY IS MODIFIED

THE UNIVERSE shows itself alternating and changing in appearance, each part moving relatively to every other, each appearance different from what it was a moment previously. A piece of coal burns; it is no longer coal, but smoke particles and radiant heat; it is no longer a black shining mass, but distributed particles moving through new positions in space. Every change appears in the first instance as a movement of some *thing* or of a group of things. With that movement certain aspects of that thing, and its relations to other things, also alter. Such relations to other things we call the qualities of the situation or group. For example there are certain qualities that we are showing even at this moment. We are showing a need for understanding, for studying, for analysing. That is a characteristic, a property, a quality of human beings in relation to some problem. That need again has certain qualities, certain essentials by means of which we recognise it when it is in operation. We are compelled, for instance, to focus our attention on restricted aspects of any situation we are studying, and to ignore a whole variety of other aspects. In studying the paper on which this is written we concentrate only on a certain limited number of its qualities, its shape, size, texture, its smoothness, thickness, its flexibility, and so on. We ignore its past history, the size of the sheet from which it was cut, the conditions under which it was made, its chemical composition, what is going to happen to it, perhaps even what is written on it. There appears to be no end to the particular aspects we might select for examination from out of the wide background of relations this sheet of paper has with the rest of the universe; but we always select one or two qualities at a time. In our mind's eye, we isolate one or more qualities for examination, and the particular one we select for study depends on the purpose for which the investigation is being carried out. It is what characterises the thing for us at the moment.

Take a bee-hive for example. If we seek to know something about its make-up we ignore its local situation, or the position of the hive in relation to the beds of flowers from which the bees derive their honey. We forget whose bee-hive it is, what is going to happen to the honey that is stored in it, or what the present owner will do with the hive at the end of the season. If we are asked about these matters, we say that they are immaterial or irrelevant to the problem in which we are interested – the bee-hive " in itself " as it were.

DEFINITION OF AN ISOLATE

We are always interested in a *bit* of a wider situation, that is one of our characteristics in thinking; and yet at the same time we are well aware that the *situation* is itself a *bit* of the universe. We are always mentally isolating bits of bits from a universe in which *each thing or group exists always within a wider group*. Even when we take the bee-hive *as a whole*, we may concentrate our attention on the shape of the cells, or on the habits of the workers, or the drones, or the queen bee. We may even be concerned only with the *relations* of each of these groups of insects to each other or to the general functioning of the hive as a unit. We may concentrate on the bits or on the relations of the bits. Anything that in this way becomes the inescapable centre of our analysis we will call an *isolate*, and we recognise an isolate by the qualities with which it is associated. An isolate has at once an internal structure with internal relations between the elements of which it is composed, and it has external relations in virtue of the fact that it is itself an element in a larger isolate.



A fish out of water—isolated from its environment—becomes an anatomical specimen.

It is very important to appreciate the extent to which the internal structure and make-up depend on these external relations. Suppose the bee-hive is so placed that its workers always collect their honey from a particular field of flowers. There is then a definite relation between that hive and its environment. That relation will show itself in the colour and flavour of the honey. For example if the flowers are heather the honey is dark, while if it is collected from apple blossom it is light. The tastes are quite distinctive, that is to say, there is a distinctive qualitative relation to ourselves in each case. Again the relation will show itself in the fact that the bees direct their activity and their to-and-fro flights mainly to and from this spot. There is an active economic relation between the two, and that relation has a dual aspect. As the bee collects the honey by withdrawing it from the flower it also transfers the pollen from the stamen of one flower to the stigma of another, thereby fertilising it. The bee-hive survives in virtue of the practical meaning this joint relationship has for it; so also do the fertilised plants. Whereas for bee-hive and flowers as a group this is an internal relationship, a quality of the whole that illuminates the dependence of each part on the other, and a quality that indeed justifies it in being regarded as an isolate for study, to the hive or to the flower-bed itself it is an external relation.

RELATION BETWEEN EXTERNAL AND INTERNAL QUALITIES

The external qualities of an isolate, those that relate the latter to its environment, naturally also undergo change when the environment changes. Take a family as an isolate and suppose the environment in which it dwells is that of a congested slum. All we are asserting is that with a slow or a drastic alteration in the nature of this environment will follow also a slow or drastic change in the attitude of the family to that environment. The internal qualities on the other hand refer to elements within the isolate and to the relations among or between these elements. Thus in a slum household there are internal relations between the various members of the family, in addition to the external relation of the whole household to its slum environment.

In general a change in the external qualities is reflected in a change in the internal qualities. Change the environment by repairing and enlarging the slum dwelling and by beautifying the area, or by increasing the income of the family, and the relations between its members change. They are no longer irritated by having to scrape and pinch for each meal or by having too little elbow-room or by lack of privacy.

It is not always so easy to change the relational quality of an isolate to the external environment by changing the internal qualities, but it does happen. A family happy in a certain environment may lose an important member by death. The environment with all its associations may become intolerable. Again the difference of approach between two types of reformer stands out clearly in this way, viz. those who maintain that by changing the environment the internal qualities in family life and human relations generally may be improved and those who maintain that by individual regeneration and by individual salvation alone can social problems be resolved. The point at issue is the relative importance of these two factors as causal agents for change in the whole situation. Yet there are clearly cases in which changes in the internal qualities may be as important as changes in the external ones. For example, a fountain pen is an isolate whose significant environment is the writer and the paper on which the writing has to take place. The internal qualities refer to the nib and the ink reservoir. Cross the nib or let the ink reservoir be badly adjusted and the functioning qualities of the pen in its environment may be reduced to naught. Change the environment by using too coarse paper or by pressing too hard and the internal qualities, say the condition of the nib, may be drastically altered. Here the two processes, internal and external, are closely and directly interlocked. Later on when we come to discuss the way in which qualities undergo drastic change we shall appreciate more clearly what this implies, particularly when we consider how qualities can be changed by the " interference " of human beings with the material conditions in nature.

REPLACING THE ISOLATE

An isolate is separated out in this way only for purposes of analysis. As soon as its examination has reached a certain stage it is then replaced, as it were, into its background, into the situation from which it has been mentally plucked, and something like a synthesis is performed in thought. With the newer knowledge we have acquired from an examination of the isolate, therefore, we direct our attention to the wider situation from which it was derived, reinterpret it and thereby acquire a deeper understanding of the external relations of the isolate.

We can see this process at work in popular detective fiction. First the detective assembles the facts in so far as they seem to have any bearing at all to the crime. Isolated in this way from their context, that is from their environment, these facts are pieced together to see how they can be related. He is searching for the qualities that bind or unite them internally. Then with these tentative relationships he takes the facts and these supposed relations back into the environment from which they were extracted, and examines the whole situation again in the light that has so far been thrown on the crime. This enables him to broaden the isolate under examination by bringing in new relevant facts, but at the same time it enables him to narrow the issues by eliminating all those that are of no special significance. Every piece of logical analysis fits into this framework; mentally forming isolates, examining the internal qualities they expose, and then fitting them back into the old situation.

Take a fundamental scientific illustration. When we say that the speed of a ship is half that of a train, or when we talk of the speed of sound or of the speed of light, we are always mentally isolating the motion from the object moving. We are interested in the motion *itself*, we say. We find it exceedingly useful to do this. While no one has ever experienced a disembodied motion, we can see a meaning in motion nevertheless without having to worry about the object that shows this *quality*. The object that does the moving becomes, for the moment, part of the irrelevant background.

Every isolate is associated with one or more qualities by which we recognise it, and on which we fasten our attention, colour and shape of an apple, for example. If we are interested in an apple, it becomes the isolate, and the colour and shape become the qualities that enable us to recognise it. They are related to us and the apple. A quality can, therefore, be regarded as a sub-isolate. Again an apple has a taste; it is edible; so there are qualities in relation to activities of our own, as when we say that it is

Here is a hiker in a hurry. The picture is an isolate torn out of its context. If the isolate be replaced into its environment . .

. . . We can understand the hiker's hurry.

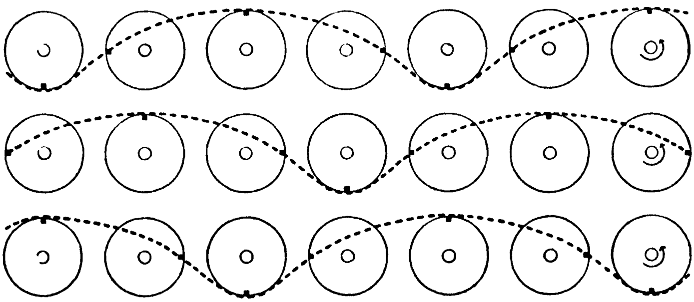
sweet or sour to the taste. In this sense, then, there are as we see, no disembodied qualities. There is no shape without there being something with a shape, no colour without a coloured object. So we can pass to the next step where the shape and the colour are themselves taken as isolates if the purpose of our study and of our action is primarily concerned with these qualities alone.

MOTION AS AN ISOLATE

Let us return to *motion.* Once we have fixed our attention on motion itself, so that it becomes the isolate for us, we can begin to see a distinction between various kinds of motion, and relations between these kinds. For instance, the scientist is primarily concerned with the *measurement* of motion, of steady motion, of unsteady motion or of accelerated motion. Thus from motion he acquires the idea of rate of change of position, i.e. speed, and therefrom, rate of change of speed, i.e. acceleration. He compares speeds with one, selected as a standard; he compares accelerations. They have a certain magnitude or measure. They are for him the magnitudes of measure of the quality he has isolated. The quality, he would say, is present in a certain *quantity*, and one of his first problems is to discover a useful and convenient way of describing this quantity.

WIDENING THE NATURE OF THE ISOLATE – GROUP QUALITIES

Once the scientist has isolated this quality of motion, it becomes an instrument of thought. He sees the quality showing itself in situations not previously suspected. The isolate is formed for just such a purpose. Thus he proceeds to apply his conclusions about speed to wider isolates that are other than simple bodies, e.g. he applies them to waves in water which he can see, and to waves in air which he cannot see, but can sometimes feel. He applies them even



The set of wheels rotate counter-clockwise on fixed axles. Spots are marked on the wheels, each spot ⅛ turn ahead of its right neighbour. The dotted line through them in the bottom row traces a wave form. As the wheels turn, the wave form moves to the right as shown in the two upper rows. This is a quality of the *group* of wheels.

to what he calls electromagnetic waves, the shapes of which he can neither see nor feel, but whose existence he can infer indirectly. For instance, he may watch a number of passengers seated on the spring cushions of a bus and bobbing up and down with the jolting of the bus. The tops of their heads will together form a sort of wave-motion that passes across the passengers. They do not pass across the bus by bobbing up and down, they merely create the wave-motion. Such a motion begins to acquire for the scientist an individual reality apart from the detailed parts that contribute to it. Thus we are led to consider a wider type of change, the motion of a larger isolate, viz. the passengers *as a group*. In very much the same way, the particles of water in the sea do not move *with the wave;* a wave is not composed of a single moving mass of water. The particles merely execute a circular movement in a vertical plane so that as they come to the surface they change its shape and produce a *wave form* that passes along the surface. This form is itself a quality shown by the sea, its temporary changing shape; and the forward motion of the wave, of this shape, is again another such quality. While the individual particles of water have their own movements, the sea exhibits through them other large-scale or *group* qualities.

LEVELS OF QUALITIES

This distinction between the qualities associated with an isolate, and those of the group which includes that isolate, is a very important one to grasp, as it is vital to our further discussion. Let us therefore illustrate this with a number of further examples before we enter into a more detailed study of the nature and relations between these qualities at different levels.

A crowd surges through the streets. The speed of the crowd is a very different matter from the speeds of the various individuals constituting that crowd. They are like a swarm of bees in which the single members may be buzzing backwards and forwards, and round and round, while the swarm as a whole may be moving with comparative slowness. The swarm may even be at rest in a hive while the individual bees may be very active indeed.

The bawling of an excited supporter at a football match is a very different thing from the noisy hum of the totality of shouts, no single one of which can necessarily be distinguished in itself; just as the patter of hail betrays a distinctive quality that is not to be confused with the special sound of a single particle.

The shape of a curve is a different matter from the successive points from which it is formed.

The collection of numbers

1, 3, 5, 7, 9, 11, 13, 15, 17, 19, 21

must not be confused with the individual numbers into which it can be decomposed. For example they have a special order, associated with the fact that they increase steadily by 2. The collection has a *sum*, viz. 121, and the operation of summing would have no meaning for individual numbers. The order and magnitude of the individual members involve qualitative relations that show themselves in the group as a group. For example the sum of any set starting from the left is always a squared number.

The effect of the consumption of ten pints of beer in close succession is certain to be very different from the consumption of single pints on ten successive days. No more than a certain maximum time must elapse between the drinking of the successive pints, in order that they may have the distinctive quality of a collection rather than of ten isolated pints. Persistent consumption of beer at this pace over an extended period produces again another qualitative situation.

A series of pictures on a screen, when the image is thrown up more than sixteen times per second, appears to be a continuous process, has a different qualitative relation to the onlooker, from what is produced when the images, thrown up less frequently, appear in flickering form.

A set of dots can be arranged as a pattern on a sheet of paper where the pattern exists in virtue of the *arrangement* and not simply in virtue of the *existence* of the dots.[1] The dots may be small squares or small circles, in which case the pattern, even if the arrangement is similar, will show differences. Nevertheless when seen from afar where the

[1] See pp. 55 *et seq.*

distinction between the dots and the squares may not be so apparent, the two patterns begin to exhibit the same quality. From afar it is the *arrangement* of the isolates in the group that is significant: close up, the shape of the elementary isolates also begin to become of importance.

The speech of a member of the upper or of the working class can hardly be confused, and yet the individual mannerisms of the separate people in each class are also not likely to be confused.

The appearance of a town as seen from the air shows characteristics different in quality from that of the individual houses that compose them.

In spite of this distinction between the qualities at different levels, however, it is clear that they are nevertheless bound up together in some way. We turn therefore to a brief examination of the way in which these different levels pass into one another.

RELATION BETWEEN QUALITATIVE LEVELS

Most people are familiar with an ordinary crystal, and the varieties of form and shape in which these beautiful structures show themselves. It is not so well known that most solid substances with which we come into contact are also of crystalline structure, all steels for example; and that in many ways the gradation from liquid to solid is more apparent than real. Even liquids show a certain type of pattern to which we shall later refer.

ORDERLY QUALITIES

A crystal has certain very definite qualities; regular formation, smooth surface, cleavage along certain particular planes, hardness. The qualities of steels and of all alloys depend very closely on the exact nature of the crystals of which they are composed. There is a technology for the examination of their strength qualities, drawn from a *surface study of the crystalline structure of such composite substances.*

Now one can also study the crystal itself in detail to discover its make-up. For this purpose a beam of X-rays is passed through it and the transmitted ray photographed. It is then found that the beam has been stopped at a series of regular positions distributed throughout the body of the crystal. These are the positions of the atoms of which it is composed. All crystals of the same substance show the same atomic formation. This is what we mean when we say that the crystal as an isolate has an orderly structure. For example, it may be that the atoms are all situated at the corners of a pyramid, or of a cube, the whole system forming a symmetrical and very stable configuration. Thus the atomic arrangement within the crystal implies (involves, corresponds to) a definite systematic shape to the crystal itself. Moreover, because of the way the molecules are grouped, certain parts of the crystal attract molecules more strongly than others. New molecules link on at these points, taking again the old arrangement under their mutual influence and so form new crystals of the same nature, built on to the previous ones to form a larger whole with new group qualities.

The arrangement of these groups, now recognised as crystals that form the solid steel, imply (involve, correspond to) certain properties of the metal mass that has this crystalline structure. Here, then, we can see where the properties at higher levels, viz. those of the steel, can be related to those at lower, viz. those of the crystal, and indeed numerically measured in terms of each other. The subject of crystal structure has been developed to an extraordinary extent during the past few years, and has provided one of the most fertile fields in its application to metallurgy and the production of all manner of synthetic substances. From the present standpoint, that of scientific method, it teems with illustrations of qualities at successive levels of aggregation and complexity, that arise from the ordered arrangement of the elementary particles making up the structure of the simple crystal. At each higher level we deal with the qualities of a *group* of elements at the lower level in orderly formation.

DISORDERLY QUALITIES

There are other qualities that are associated with substances, not because the elements have a regular periodic and orderly arrangement, but rather because they do not possess this. We take a large crystal, which as we have indicated is itself composed of a large number of small crystals arranged in orderly fashion. We crush or pound the crystal into a powder. Any small sample if separated out and examined under the microscope will be seen still to retain its crystalline shape, but the whole is now a powder with new qualities of its own, graininess, colour and so on. Whereas the large crystal possessed its distinctive qualities because it was composed of tiny crystals showing a systematic orderly periodic arrangement, the powder shows its special qualities because the tiny crystals are distributed higgledy-piggledy, without law or order.

COEXISTENCE OF QUALITIES OF ORDER AND DISORDER

A liquid is in some respects rather like a powder in which the individual elementary crystals float about and move their relative positions. At any one localised position the molecules cluster together into an approximate pattern, but the clusters are not evenly spaced nor similarly arranged with respect to each other. Nor are they at relative rest. The groups move about varying their distances from each other, but each group retains approximately the same internal pattern. Here then, with a liquid, we have a stage intermediate between orderly arrangement in detail, and complete higgledy-piggledyness. Nevertheless the combination produces *in toto* an effect of uniformity that corresponds to the distinctive qualities we associate with a liquid.

STATISTICAL QUALITIES

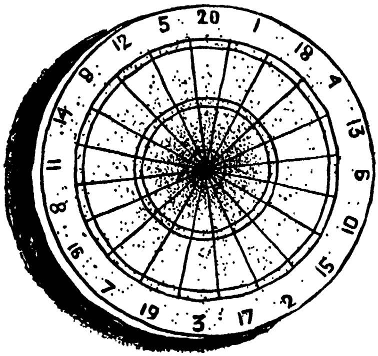
In the case of a gas the localised order has vanished. The disruption of the detailed pattern is complete, but in its place a new type of uniformity makes itself apparent. We will study this case in some detail, for it brings out very clearly what we will mean by qualities of a statistical nature. Here the particles of gas are supposed to be shooting about in all directions.

The first point we note is that the resulting effect of the rapid impacts on the walls of the containing vessel, shows itself as a pressure. This uniform force exerted on each unit area of the vessel is a quality of the gas in that vessel. It is a group quality, at a different level from those of the separate molecules, but it exists nevertheless in virtue of the impact of these particles. Its relation to the individual is clear if we imagine a person rushing around a room, so fast, that every time the door is opened slightly he strikes himself against it. The effect will be that of a jostling crowd in the room.

Now let us turn to the actual speeds of the molecules as they fly about, in all directions. There is no special direction that can be indicated as that followed by even a largish fraction of the particles. We say that they are flying about " at random," which is simply a short phrase for what has just been stated. Nevertheless this is not the case for the actual speeds of the particles. One cannot assert that there are as many particles flying about in different directions at a speed of, say, one hundred miles per second as at five feet or five inches per second. At each temperature of the gas, there is one outstanding speed, and more particles are flying about with a speed of approximately this value than any other. A few are flying very much slower, and a few very much faster. In fact we say that the speeds range about this outstanding value according to a definite law. There is a "pattern" in the distribution of speed. It is a peculiar one, very closely associated with this " randomness " to which we have referred.

SHOTS AT A TARGET—ORDER OUT OF DISORDER

Let us suppose that shots are being fired at a target and as each bullet hits the target it leaves a black spot. Some of the shots will fall actually on the bull's eye, some above, some below, some to one side, some to the other, some near, some far away. This, we can assume, will arise if the dis-



STATISTICAL ORDER

The perforations due to the darts are most closely packed near the bull's eye, and fall off according to a definite law as the distance from the bull's eye increases.

turbing factors that deflect the aim of the marksman are acting " at random." Just as the particles of the gas were flying about equally in all directions, so the disturbing factors on the shots act equally in all directions. The result is interesting. The distribution of dots on the target takes on a characteristic appearance. Most dense at the centre, they fade off gradually in a very definite and distinctive manner. The density of the dots, that is the number of dots per square inch, has a definite relation to the distance from the bull's eye. Out of the randomness of the disturbances, coupled with the general centralisation of the shot, the " dot distribution " shows a definite quality, a quality of the group that cannot be matched with any quality of the individual elements because it arises in the *grouping* of these elements.

And now we can illustrate a further development of this by returning to the particles of gas rushing about at random in their container. Assuming that the speeds are distributed about a certain outstanding one, the average speed, just as the dots were distributed about the centre, it is possible to connect up all sorts of qualities of the gas as a whole, with the speed-grouping of the particles, its temperature, its viscosity, the rate at which the pressure on the containing walls increases with temperature and so on. These are all qualities of the gas as a group-entity and have no meaning if interpreted in terms of the motion of any individual particle.

What we are endeavouring to appreciate is the way in which qualities at two different levels of complexity are related. The regularity at the lower level out of which the quality of the group at the higher level may be seen to originate may be either *systematic* or *orderly* as in the case of crystal structure, or *random* or *disorderly* as in the case of the mass of gas, or of stages embodying both features as in the case of a liquid. When we come to a study of scientific laws we shall see that one characteristic of a law lies in the fact that it states quantitative relations between qualities of the materials under consideration. It is clear therefore that such relations and therefore such laws must concern themselves frequently with qualities of a statistical nature, and thus we must expect to find within the logical make-up of any science, many laws that must also be of a statistical nature.[1] Such laws have been much bruited about in scientific quarters during the past few years as if they were not really to be accorded the full status of laws in the sense of, say, the law of gravitation or the laws for the reflection of light from polished surfaces. But that attitude has arisen merely because scientists have frequently not themselves appreciated that such relative levels of qualities have equal status in reality, and that laws must be sought in all such quarters.

[1] Cf. also p. 23, where the word "statistical" is defined in a sense that embraces the above use.

FROM HIGHER TO LOWER LEVELS

It may be necessary to say a word about yet another source of confusion that arises in this connection. Once it becomes clear that any law involving, for example, the pressure of a gas is to that extent a statistical law, and once it is evident that the nature of that law has to be traced to a " random " element in the collection of isolates at the lower level (in this case the molecules of gas flying about within the confines of the containing vessel), it may not necessarily be possible to discern the characteristics of the *individual* elements that together as a group are responsible for the statistical quality.

UNIFORMITY WITH DIVERSITY

The trouble arises in this way. Supposing we say that the pressure of hydrogen as a gas on its containing vessel arises from the impact of the individual molecules. Are we to suppose that only the features we have considered, that distinguish one molecule from another, are the only ones in which they do differ ? We say they have a range of speeds, and are shooting about in different directions, and that may suffice for appreciating how pressure arises. But are the molecules of hydrogen all alike in other respects ? Are the various elementary electrical isolates of

UNIFORMITY AND DIVERSITY
All are members of the working class, each is an individual and yet each is also a type.

which the molecules are composed exactly duplicated from one molecule to the next ? Actually what is tacitly assumed is that the differences (and it is certain that differences must exist) are immaterial for *the purpose in hand*, and only when experiment shows that this assumption does not suffice will theory proceed to examine whether such differences are likely to show themselves in other respects. The very phrase " a molecule of something " asserts an objective statistical uniformity and an implied but hidden diversity from one molecule to the next. If therefore we are unable to account for the individual idiosyncrasies of the individual molecules from the statistical behaviour at the higher level, we must in such circumstances beware of falling into the elementary fallacy of asserting that therefore the individual differences in their behaviour represent some form of " free-will." That would indeed be pandering to mysticism in science.

COEXISTENCE OF QUALITIES AT THE SAME LEVEL

Once we recognise the distinction we have drawn between qualities at different levels, as when we compare the movement of the particles of water with the wave-form that passes over the surface, we are in a position to recognise also numerous other qualities at each of these levels.

Very much the same distinction is brought out when we detect such properties as smoothness, hardness, rigidity and flexibility in solid bodies. Certain qualities in the individual atoms exhibit themselves *in the mass* differently from their individual manifestations when alone. Or we may reverse the statement by saying that certain qualities in the rigid body can be analysed down to an interlocking series of constituent qualities of a different nature on a " lower " level.

It is apparent, then, that since isolates are recognised by the qualities associated with them, levels of qualities correspond to levels of isolates, a group quality to a group isolate. We shall deal later with the problem of causality and determinism, but here it is worth while noting that a *certain "dependence" necessarily must exist, not only between qualities at the same level but between the* qualities at different levels. We can say for example that the existence of the quality at the lower level is necessary to the existence of that at the higher. We can say that the latter can be analysed into atomic qualities, at a lower level. We can say that the quality at the higher level arises from the " combination " of the lower level qualities, but combination in a sense different from mere juxtaposition. To understand how the passage is effected from the lower to the higher we have to discover precisely how " atomic " qualities interact and combine, how in fact they behave in each other's presence.

We see it in the process of thinking. Each feels that his is distinct and individual, quite different from that of his neighbour. We become sceptical whether others mean the same as we by the words they use. When I say grass is green do you really know what I mean by green ? The difficulty comes from a false isolation. All thinking is collective : all words, images, phrases, thoughts and meanings require a social context. Without a group to agree with us, we are queer, cranky, or mad. We see this at work in a collective discussion or decision, a process very different in its course and interpretation from that followed by the individuals who have contributed to it. They *combine* to produce the collective process : the latter colours the thinking of the individuals. There are two levels of process, each with its distinctive but interdependent qualities, the atomic level of the individual thinkers, and the statistical level of the group in the collective discussion and decision

QUALITIES SHOW THEMSELVES THROUGH BEHAVIOUR

Again let us realise that a quality is not something fixed and eternal, an unchanging property tacked on to the object in question. We discover the quality or qualities by *studying the behaviour of the object in a variety of situations; by using the object or acting upon it or by* controlling the environment in which it is. For example, in all scientific work there are usually systematic tests to discover the qualities displayed by steels and alloys generally. We are in this way really studying behaviour, and certain groups or forms of behaviour are referred to as originating from certain qualities. Every scientist knows that in the process of testing, the actual qualities of the thing tested have changed. In testing a liquid to discover how cold it is, by plunging a thermometer into it, we do in fact warm it up by means of the thermometer, just as we analyse a chemical substance by changing it into something else. We do not so much examine the qualities that are present as examine what they are becoming or have become, and draw an inference from the result. Qualities are changing features of changing situations, and we, in the process of examining them, change them also.

FORMING NEW QUALITIES FROM OLD

In a sense every change that takes place (and it is continually taking place) in the universe brings into being something new. This is simply another way of stating that it is a changing universe. It is not the same from one instant to another. Every breath I draw alters the composition of the atmosphere of the room in which I am working, and involves or corresponds to a readjustment of the breathing of every other occupant of the room. New qualities are aroused. I crumple a piece of paper in my hand. I have given rise to new qualities; I have altered old ones. I place a screen in front of the fire. I have established new qualities or I have altered the way in which old ones operate. In bringing the screen close to the fire I have established new relationships. The fire and the screen as a group operate *for me* in a different way from their operation prior to my action. I have brought something new into existence. They have new group qualities. In assembling a wireless set, a motor bicycle, a motor car, a building, new qualities have been brought into being. Such cases can of course be multiplied indefinitely, and particularly are they apparent when one deals with living beings. A cat in one room and a red-herring in the next are a very different matter from a red-herring in front of a cat. A group of workers will behave very differently *as a group* from what the same individuals will do when scattered *as individuals*. A new quality, we might call it morale, comes into existence. When human labour is applied to raw material and the latter thereby becomes socially useful, new qualities have been created by that labour. The same thing applies when an artist paints a picture, or a sculptor moulds or carves his material. He has placed the material in a new qualitative relation to human society.

A patrol of soldiers will put up a better fight than the same number of soldiers individually. Soldiers used to march into battle in close formation for this very reason. The new quality in the situation comes into existence as soon as there are two soldiers.

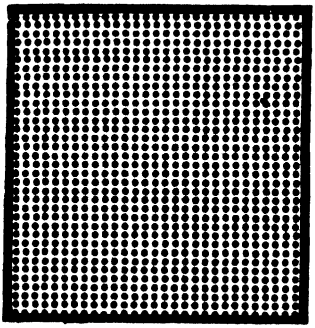
Again, as soon as rifles had reached such a pitch of accuracy and range as to make close formation a disadvantage, the quality of the situation underwent a change and the morale of the group was then to be found in open formation. The morale would have been destroyed by close formation in such circumstances. Quite a different quality would have emerged—probably group panic.

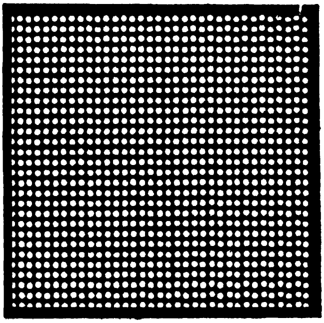
The patter of hail on a corrugated iron roof produces a distinctive hum that is quite different from the separate blows of each particle of hail. While we can talk of the temperature of a gas and measure it by means of a thermometer there is no meaning to the temperature of an individual molecule of the gas. C, E flat and G played separately on the piano, or played in succession, is a very different matter from the minor chord produced when they are struck together. Every harmony corresponds to a new quality stirred into existence by the combination of the

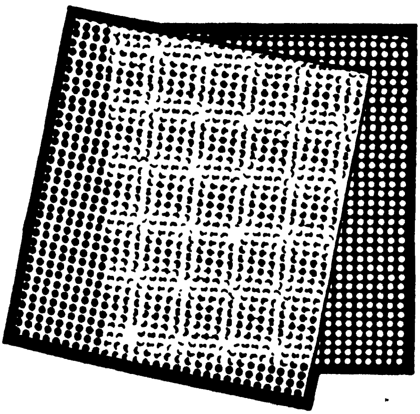
[*Continue on page 61*

FORMING NEW QUALITIES. Produce two simple dot patterns on transparent paper or on a photograph plate. Place the one over the other, and hold them up to the light. A totally new, composite, group-pattern will be formed. As the one plate slides over the other the group patterns are continually transformed. The two basic patterns (they may be identical) are the *atomic isolates*. When they are brought into relation with each other as a pair, a group, a collection, they show different qualities. Together they form a *statistical isolate*. The new patterns are qualities of the latter, that is, they are statistical qualities.

Notice, however, that each basic pattern, the atomic isolate in this operation, is itself a pattern of dots. Hence the basic pattern





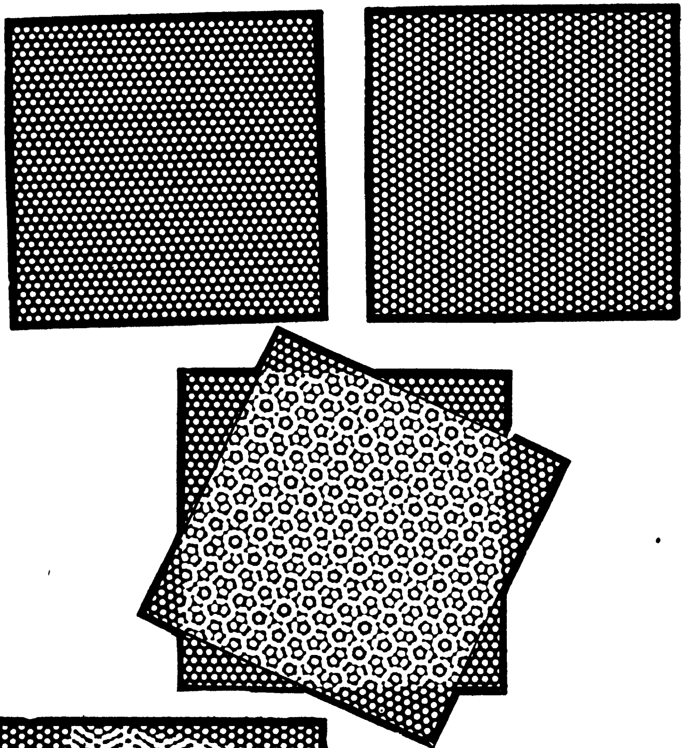


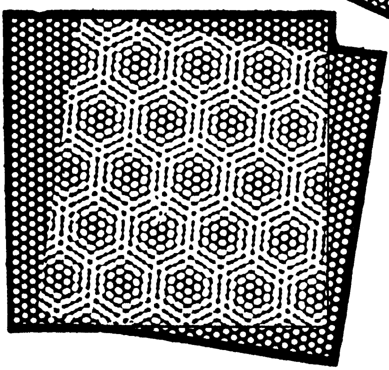
can be seen as a statistical isolate of which each dot is an atomic isolate.

Note. For purposes of contrast the basic pattern has here been made darker than the composite. In reality this is, of course, reversed.

These effects are easily produced by

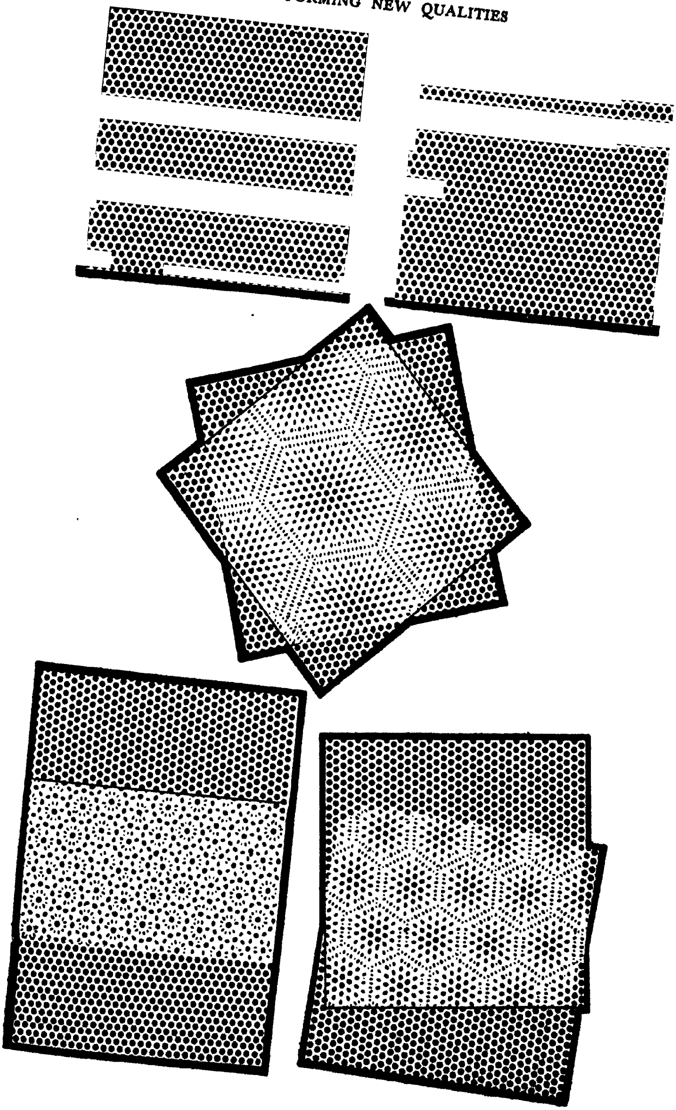
FORMING NEW QUALITIES



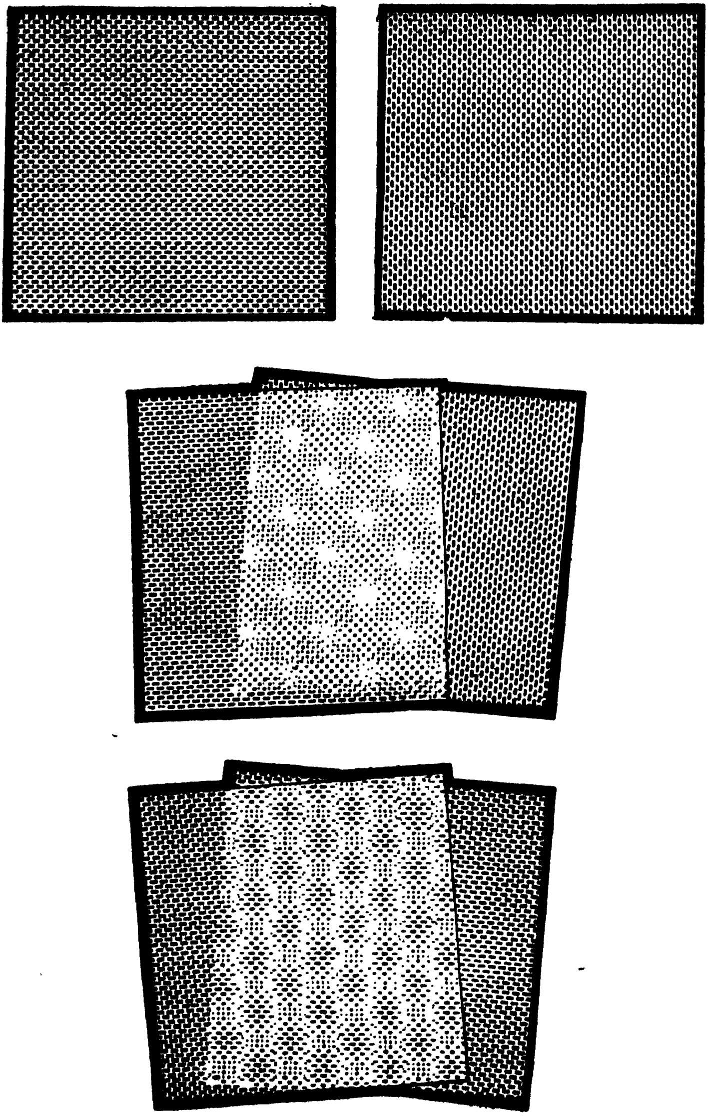


typing dots, dashes or colons on two pieces of transparent paper of the kind that is found round packets of cigarettes.

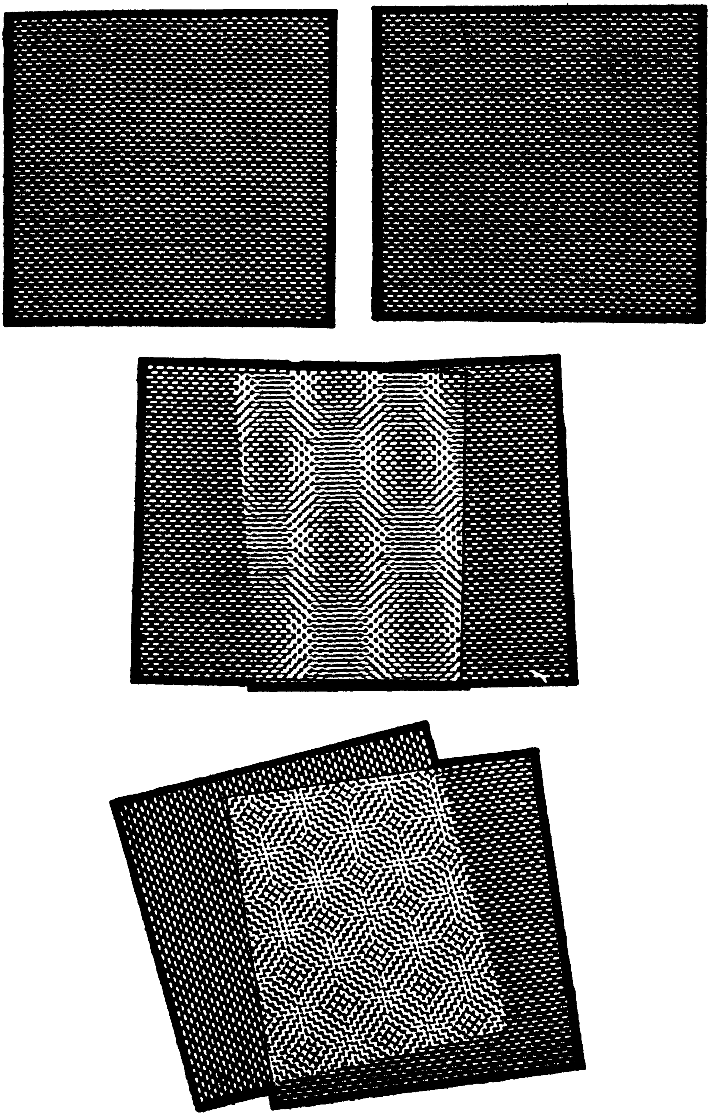
FORMING NEW QUALITIES



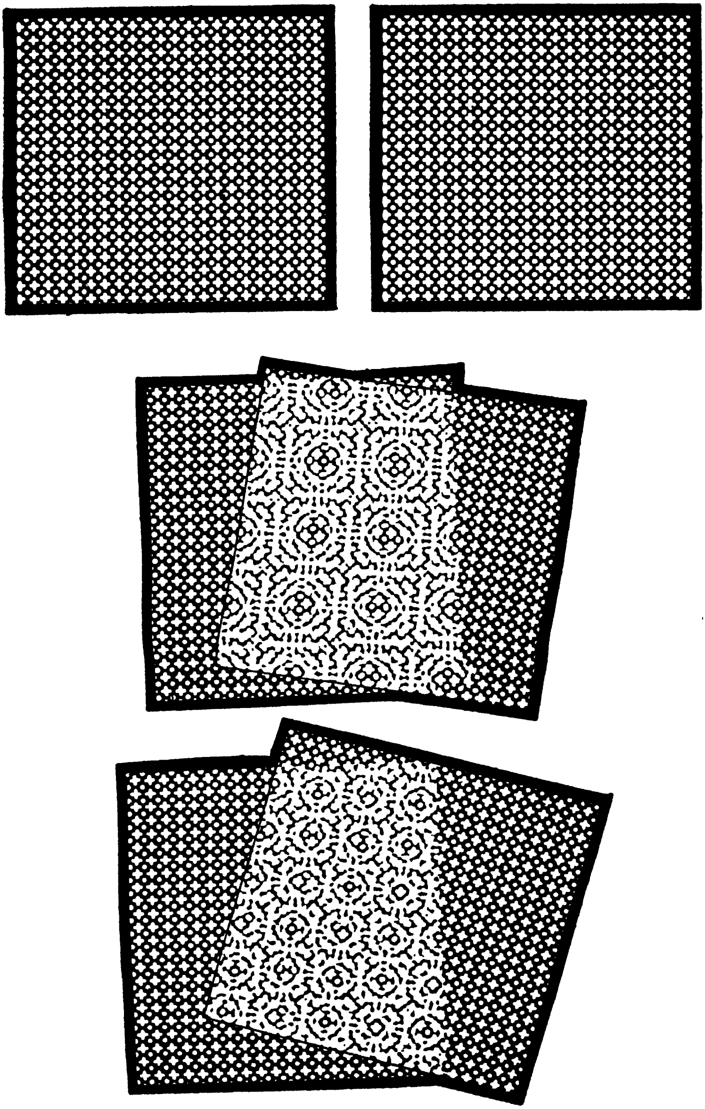
FORMING NEW QUALITIES



FORMING NEW QUALITIES



FORMING NEW QUALITIES



separate elements when brought together; every musical theme to a new succession of harmonies, every fugue to a new succession of theme variations.

Because in a sense this is all so commonplace, a matter of everyday experience, we do not suppose that anything mystical is involved. Yet how often has it been asserted that when two atoms of hydrogen become bound up intimately with one of oxygen into a group isolate to form water, an element of "creativeness" has entered into the proceedings, for the result is something with totally different qualities from those of the constituents. So of course are those shown in the behaviour of individual students from those of the group; so are those of a brick wall from those of the individual bricks. So also are the qualities associated with the paper, after I have written on it. I have "created" new qualities simply because I have *acted*; because in acting I change something and therefore change a *relationship*.

It is this inability to recognise that a *changing universe implies a universe whose qualities are changing*, sometimes apparently as a gradual change of one quality (as when I slowly alter the smoothness of the paper by crumpling it), sometimes by changing relationships drastically (as when a chord is struck), that the theories of *creative evolution* and *emergent evolution* have been pushed into the foreground. If evolution is creative, so in the same sense is every detailed action and event in the universe. But to term this creative in some mystical sense is to destroy a good word to no purpose. It would therefore be more accurate to say that evolution is a particular change-making process, and that any theory concerning that process is in the first instance a logical analysis of the factors that have acted most cogently towards effecting these changes.

The confusion involved is indeed very similar to that already referred to in connection with motion. Suppose we mark the position of a moving body at successive seconds. When space and time are thus taken as basic isolates, "motion" (as distinguished from measuring of speed) seems non-existent and a continuous series of creations and destructions has to be invented in order to meet the evidence of common sense that bodies do, in fact, move. Here again we tend to think of things as having fixed qualities tacked on to them, like labels. Two elements come together, interact in some mysterious way, the labels vanish and with them the qualities to which they referred; a new label is required to tack on, again in a fixed way, to the newly created entity that has suddenly emerged from nowhere. This static conception, while it may be a convenience in certain circumstances for analysing down, may definitely lead to a false picture in the sense that it will not synthesise up. It describes *states* rather than *processes*, the qualitative connecting link has been altered and a special theory has to be invented in order to effect the passage from *state* to *process*, from a static to a dynamic picture. It is an invention to rectify an initial false step. From the standpoint of materialist explanation, however, it introduces a very serious error. In thus introducing "*creativeness*" as if it were something extra-human that operates in a purposive way in association with activity or change that is not conscious, as in the *creation* of water from hydrogen and oxygen, a special assumption is made regarding the nature of existence that, as we have seen, is not only inessential and confusing but stands outside the whole range of human experience. It is a name without an objective referent. It is an unnecessary *ad hoc* assumption. It is a *teleology*, an appeal to something essentially unverifiable to explain something material. Such a procedure violates all the canons of scientific method as mankind has been compelled to develop it. In attempting to explain the known in terms of the unknown, it denies the meaning of explanation.

PURPOSIVE ACTION

The nature of the confusion involved in an explanation of the actions of inanimate matter in terms of purpose can be seen again if it be examined from the standpoint of levels. We can say that the quality of the behaviour of a piece of wood or of a simple chemical substance is different from that of the behaviour of a living human being. If we say that the latter exhibits conscious behaviour we all know roughly, if not exactly, what we mean. We are describing a special qualitative relation between the human being and his environment. When we say that the human being associates a purpose with his action we can appreciate in a subjective way at any rate what is being conveyed. And because there is this subjective aspect, these qualities are peculiar to what we call human action; they are qualities that are not only not shared with inanimate matter but that actually serve to assist us in distinguishing between inanimate and human bodies. For purposive consciousness is something quite distinctive. Moreover, if we accept what seems obvious on scientific and historical grounds that living beings have been evolved at a later and more complex stage from simple inanimate matter, we are justified in saying that conscious and purposive behaviour is a characteristic of a more complex level of existence. But conscious purposive behaviour involves, as we all know from personal experience, bringing together a whole mass of diverse considerations and experiences, that were previously separate and distinct. The very act of bringing them into each other's sphere of action as it were, the very act of seeing each fact and each experience in association with or in the environment of each of the other's and of all the other's, is to bring at that very moment new group qualities into consciousness. In this sense also, it would appear, is conscious purposive behaviour a quality of a higher and more complex level than the simple activity of inanimate matter. To say this is not to express any judgment of the nature of a valuation. It is simply that we are concerned with a higher level of isolate in the sense in which we have used that word before. A teleological explanation can now be seen to involve a confusion of ideas. It may involve using a quality of one level of isolate as a means of explaining one at a lower level. To assert that there is purposiveness at work among inanimate objects in their mutual behaviour is to transfer to one set of circumstances a quality that comes into play *only* in another. It is just as if we were to explain the occurrence of the white coat of the Arctic fox in terms of the conscious relation of that animal to a hunter who pursues it. It is a form of animism. It projects characteristics from a higher level to a lower. It transfers to a stone the hatred of an enemy and converts a meteorological storm into the wrath of a god.

Even to present purpose as we have done, however, is to introduce a teleology.

THE QUALITY LINKING ENDS TO MEANS

Apparently it links up ends with means, the means to be adopted now in order to achieve a certain objective in the future. It is like action at a distance across time, and therein does its seeming mystery lie. Note, however, that consciousness is not a passive state, but a phase of activity, the doing of something in the face of a situation, and it implies the quality of being aware and responding to the situation. Thus the consciousness of the situation does not consist simply in perceiving in a static sense what is there present, but in perceiving, estimating, anticipating the outcome of present change. *Within the field perceived, lies one's behaviour, capacity and activity.* Thus the purposive quality involves an estimate *now* of what the future can bring forth, if one's own activity *now* be taken in conjunction with the changing processes otherwise external to oneself. It involves a recognition *now* of the necessities of one's own activities, if a desire *now* is to be satisfied. Everything is in the present, including one's estimate of the future outcome. The leap across time that seems to involve the teleology in purposive behaviour becomes then fictitious. It is nothing more than conscious behaviour *now*, based on an analysis *now* to decide what part of the future appears to be potentially contained in the present circumscribed situation. Once purpose is seen in this light as a quality of conscious behaviour, the confusion involved in attempts to explain activity in the inanimate world in terms of purposive or creative concepts becomes immediately apparent.

We shall see later that if " purpose " is seen from this angle, the whole problem of causality in relation to human beings is completely transformed.

MARKING THE NEW LEVEL OF UNDERSTANDING

It is desirable at this stage to summarise our conclusions by making the terms we have been using more specific.

1. Existence implies existence in groups, or existence of groups within greater groups.

It follows that the thought of a *completely* isolated part of the universe is a thought about a fiction.

2. A particular change implies a change within a group of changes.

3. A particular change makes manifest a joint quality or a mutual quality between two or more parts of the universe. Hence it is by the study of changes in behaviour that we infer changes in qualitative relations.

4. We examine the structure of a group by concentrating on the part, and the qualitative relation of the part to the group.

5. Any part of the universe that is the subject of examination we call an isolate.

6. Thinking about any isolate involves a qualitative connection between the thinker, the isolate of which he thinks, and the social context. This quality shows characteristics of " being aware, conscious, purposive."

7. In general any isolate can be analysed down into *atomic isolates* and qualities relating them.

8. When a set of atomic isolates are seen to be grouped together as a recognisable isolate the latter will be called

a *statistical isolate*, e.g. husband and wife, a crowd, a heap of stones, the patter of rain, a musical chord, a leaf (cf. p. 23).

9. A statistical isolate is recognised by one or more statistical qualities which exist and change in virtue of the changing grouping of the atomic isolates or of its changing relations to other statistical isolates.

It is important to recognise that we are here using the word statistical with a wider meaning than is usually given to it. For any collection of two or more isolates has a statistical character. A group of two isolates as we have seen is qualitatively different from two separate ungrouped isolates. It follows, since existence always involves existence in groups in some way, that

10. Every isolate is simultaneously both atomic and statistical. It is atomic with respect to wider isolates with which it links through relational qualities, and every isolate is somehow linked in this way, while it is statistical with reference to the atomic elements into which it can be decomposed.

DAWN OF STATISTICS

11. To say that the universe is in a state of change is to say that at any moment new statistical isolates are being formed out of old ones or by the grouping of atomic isolates, and so old ones are being transformed or decomposed.

12. The relation between atomic and statistical isolates is a relative one of levels, with their corresponding levels of qualities. Thus the formation of a statistical isolate from a set of atomic ones involves passage *from a lower to a higher level* with new qualitative features.

It will be recognised, therefore, that *we are here adopting a general statistical view of nature*, in which the qualities constitute the binding factors. Changing nature is then to be interpreted in terms of changing statistical isolates and their formation or disruption, and the interconnectedness of nature in terms of these binding but changing qualities.

QUANTITIES AND QUALITIES

Our discussion so far has concerned itself solely with isolates of various kinds and their qualitative relations. We have seen that a quality may deepen as when a friendship becomes stronger or a colour becomes intensified, or a noise grows louder. We recognise it still as the same quality but a subsidiary aspect of it undergoes a change. For many purposes it is possible to set out a measure of this intensification, and to this measure we refer as the quantity of the quality. In many ways it is a misleading or obscure phrase for, as we shall see, the number will also show itself as a new quality of an operation that can be performed with the original quality that it is proposed to measure. At the present juncture we shall deal only with a part of this problem, a very vital one for us, and later when we discuss causality and determinism we shall examine its further significance. At this stage therefore let us turn to the field of physical science again, within which region the greatest success has attended efforts to express the measure of qualities in terms of numbers.

NUMBER—AS ATOMIC AND AS GROUP ISOLATES

First a word about number itself, the very basis of measurement. We are not concerned here with the historical process by means of which the number system developed or through which our conception of number became generalised from integers, i.e. whole numbers, to fractions, then to irrational numbers like $\sqrt{2}$ and $\sqrt{3}$, to numbers that cannot be expressed in terms of these such as π. Let us see rather how the idea of number, and how the operation of enumerating, fits into the qualitative outlook concerning isolates that we have developed.

If existence implies existence in groups, the basic isolate with which we must commence is the "collection," a

Bottle with attached label, showing bottle with attached label, and so on *ad infinitum*. Each bottle or label is a statistical isolate with respect to all it contains, and an atomic isolate with respect to all of which it is a part. The endless sequence implied in this can be defined without using the idea of infinity. Try it.

statistical isolate with individual members, objects of any kind. Here the collection is itself isolated from the differences exhibited by the various objects. Accordingly they are the " same " kinds of objects for our purpose. A whole variety of smaller isolates or smaller collections can be formed from this parent collection. An exception stands out. The quality of a collection vanishes with 1. One object becomes our atomic isolate. We can now apply a process of matching or pairing members of collections, or of forming statistical collections by starting with 1 (which is not a collection), then *adding* 1 which is not a collection, but which with the previous 1, now forms a group. Adding one again and again we can now arrange our collections in an *order* of such a nature that each collection can be subdivided into two isolates, one of which is the previous collection, and the other is 1. By giving the names one, two, three, etc., to these, this provides us with the natural numbers, the integers, but finite in extent. As an isolated concept we can imagine this set extended by supposing the operation of "adding one in succession" conducted incessantly. Thus we imagine the idea of an infinite succession of whole numbers. An infinite range of numbers does not exist as an isolate of any real group of entities, but the *idea* exists and it is a composite of ideas of real operations. The idea of endless addition of 1 is an idea extracted from a real practice in human operation.

THE HIGHER LEVELS OF NUMBER

We will not pursue the way in which the notion of number at a higher level than that simply of *whole* numbers, fractions, irrationals, and incommensurables has been derived. That would take us beyond the range of our present discussion. It suffices to notice that a mere succession of whole numbers necessarily describes a process that proceeds by jumps, each step involving a discontinuous leap to the next number. The next step, using whole numbers to form fractions, i.e. other numbers with new qualities, seemed at first sight to overcome this, until it became clear that if number were to be taken as a measure of length, itself a continuously varying quality, then there would be lengths that could not be represented exactly either by whole numbers or by fractions. Bring together two unit lengths in a new qualitative relation as the sides of a square. The diagonal of a square, for example, having sides of unit length, cannot be exactly expressed in whole numbers or in fractions. No degree of finite subdivision of a scale with its units equal to the length of the side of the square would bring two marks simultaneously opposite the ends of the diagonal when the scale is placed along it. While number was thus on the one view necessarily continuous, attempts to express all numbers by integers or fractions led only to discontinuous jumps no matter how small these were. A new quality had shown itself in number. From this angle the gap could be bridged only by an *unending* process of subdivision, a process equivalent to the representation of certain types of numbers like $\sqrt{2}$ in terms of unending decimals. Thus in order to reconcile the coexistence of the real whole numbers with equally real numbers like $\sqrt{2}$ and $\sqrt{3}$ mathematicians have had to content themselves with an internal contradiction, the conception of a *completed* infinite process of subdivision.

From the standpoint of the present chapter we can see how these contradictions can be reconciled. Number as a changing entity is a statistical isolate with an internal quality of continuity. If the whole numbers be extracted from it, the qualitative connection is broken. The whole cannot then be reconstructed from these atomic isolates, the integers, any more than it could be reconstructed from any other class of number. For example, even if we take whole numbers, fractions and irrational numbers like $\sqrt{2}$, $\sqrt{3}$, $\sqrt{5}$, etc., as the basic set we cannot derive the so-called incommensurable numbers like π by manipulating them in the ordinary processes of multiplication, addition and division. π is simply the name for the number of times the length of the circumference of a circle includes the length of the diameter. It is, therefore, a number, part of the continuum of numbers, but it cannot be obtained by any simple qualitative connection of atomic elements of the type we have mentioned, unless we conceive also of a finished infinite process. Thus the continuity of number is basic, but discontinuity as we see can be found in it by atomisation, by forming isolates.

Discontinuity is inherent in the enumeration of discrete objects. We say there are either 4 or 5 objects present, and no intermediate amount. The process of measurement of isolates involves both continuous and discontinuous aspects.

We return therefore to our fundamental *collection*. The basic process there was that of enumeration. Matching one collection against another, atomic isolate against atomic isolate, is the most primitive and fundamental form of measurement. It corresponds to the production of the tally stick of early times. It is in effect also what the scientific man does when he sets out to represent a quality numerically.

MEASUREMENT AND QUALITIES

Let us see then how the scientist succeeds in doing this. For this purpose take *change* again, so fundamental to our discussion. Two special characteristics of the universe command our notice. Certain pieces of matter appear to be solid, i.e. they appear to maintain their shape unchanged. We have seen this and its meaning for different levels when we took the leaf as a collection—as permanent—although its parts were in a state of change. A thing then is relatively solid, relatively fixed in shape. In taking one of these solid pieces of matter as his yardstick, his standard yard, the scientist has isolated the quality of length for practica purposes, i.e. he can now express other lengths in terms of so many of these, as a unit. He does this by the process of matching and enumeration. However, all lengths do not even *appear* to remain unchanged; moreover the purpose in choosing a unit of length is above all to be able to express change, i.e. for the moment, changing lengths. Merely to isolate length from a changing entity does not make it possible to describe adequately this essential quality. Where then can one find a persistent change that can serve if necessary as a unit for the measurement of other changes? Put in this form, the answer is not far to seek. The constellations of the stars periodically appear to return to the same situation; the seasons come and go; they recur systematically, night follows day, and day night; a pendulum of fixed length swings to and fro steadily. Here are a series of changing isolates *any* one of which may be used to provide another unit for the description of change. For example by means of the yardstick we measure the length of a shadow; but it is a changing shadow so we measure it *just at the moment when* the pendulum is at the end of a swing. It beats out a hundred strokes and *at that moment* we measure the shadow again. In attempting to describe change we find ourselves compelled in the first instance to separate out length, and then to express the change as so many units of length produced in so many beats of the pendulum; but the language in which it is expressed is always one involving the conception of duration, an interval of duration expressed in terms of the unit interval beaten out by the pendulum. It also involves simultaneity—" at that moment." We are at once involved in the concept of time, and this has arisen because we have been trying to analyse the fundamental quality, *change*, by first separating out from it the subsidiary quality, length. Time and extension are essential aspects of change; it is in their unity that the quality of change resides. They can never be completely disentangled. To express a change in length we appeal to time; to express a change in time we appeal to a length, as when we describe it in terms of the *distance* travelled by the hand of the clock from an allotted position (XII on the dial). Let us note in passing that all this has arisen historically because of the human need for measuring change—growth of crops, rising and falling tides, changing position at sea and on land. Motion, as we have already pointed out, is not formed out of these two measures length and time, but these are derived from it. Motion is primary; the others are isolates of motion.

SUBJECTIVE SENSE OF CHANGE

We must distinguish the nature of time arrived at in this way from the subjective feeling of duration, or passage of events that we all experience. The coursing of our blood, the systematic application of stimuli like daylight and darkness, summer and winter and so on, produce in us corresponding reactions almost of a mechanical nature that are also periodic. These are naturally interpreted subjectively and emotionally so that the flow of our changing feelings marks off rough forms of units of time. They are an emotional interpretation of the passage of such events as crowd in upon us so that we will only confuse the issue if the term *time* is used uncritically to represent both modes of analysis.

IS MOTION AN ILLUSION?

The fact that change and motion encourage us to isolate time and space in this apparently rigid way as if the latter were inescapables has induced many thinkers to commence their analysis of the universe with these as absolutes. Hence arises for them the utterly fictitious problem whether motion is not after all merely an illusion. If a body at a certain instant in its motion, it is argued, occupies a particular place, how can it be in course of occupying yet another place without at the same time leaving the place it is occupying? If it is leaving the place it is occupying, has it not already left it? Does not this imply that it is in two places at once?

The confusion, and therefore the apparent paradox, arises from a failure to realise that the primary quality in nature is change, and therefore motion. This is a datum and we cannot argue it out of existence. In attempting to find a measure for change we have naturally to express it in terms of isolates like itself. To do this we have taken two extreme cases, a length whose measure does not change in time and an interval of time whose measure does not change in space. These are the two *idealised* forms of "unchange," idealised because they imply a fixity in length, and a simultaneity in time. In an absolute sense they are both fictions, but the success of science testifies to the fact of their approximate realisation. In isolating position and time from the more general isolate change or motion we must not imagine that merely by associating the two together again (or rather by associating the derived measures) we can reconstruct the prior changing situation. This, as we have seen, would mark the static occupation of a series of positions at a series of times. Such a set of isolates are derived from the motion merely for the sake of expressing its measure. To do this we subdivide the route into a number of elementary distances and take the time interval that elapses during the passage *through* these points of subdivision. If we talk of the body *occupying* the positions that separate the intervals we do not do so in any static sense. After falling into this error of confusing the process, the actual motion, with the sub-isolates that have to be formed for the purpose of effecting its measure, thinkers have not been wanting with sufficient logical courage to assert that as a consequence motion is itself an illusion, a fiction, and that in fact the body really disappears at one position and reappears at the neighbouring one. Thus, as we might expect, with the disappearance of motion, goes also the reality of continued existence of matter, and in its place come a series of miracles of creation and destruction. Given sufficient courage, one might almost say sufficient stupidity, there is almost no limit of phantasy to which such a false approach can lead. We must beware of confusing the measure of the quality with the quality itself. We must distinguish between the quality and what we are for the moment calling the quantity of the quality under consideration.

MEASUREMENT, A QUALITY OF A SOCIAL OPERATION

All this is in reality a gross over-simplification. We have been talking about measuring a length. What is a length, a quality or a quantity ? Does length refer to the fact of extension or to the number of times we carry through a certain operation with a footrule, the operation of laying the standard footrule alongside the quality in question and enumerating how often we have to step it out ? If the number we get refers to *this* operation in what sense can it be taken to refer to the quality of extension of the object ? If we say there is a numerical relation between the extension of our footrule and that of a piece of paper, is that numerical relation also a quality? Let us examine the process of measurement again.

Let us suppose we have such a footrule and we propose to measure the length of a field.

I measure it to-day, to-morrow, and the next day. I get all my friends to measure it. We all take the greatest of care in setting down the rule so that there is no slipping or false adjustment of any kind, and yet when we finally examine the group of measurements, the numbers are not all identical. Many are of course repeated, but as a group they are distributed over a range of numbers. The larger the number of people who try it out the more closely packed will these numbers be, those about the middle of the range appearing much more frequently than those near the ends of the range. We are not concerned for the moment to decide which of this mass of numbers we may propose to term the *actual* measure of the length. All we can say is that the relation between measurers and measured is described for our purpose by this group of numbers. That relation is a statistical one. The measurement of the quality of extension, as a mutual one between objects and the rest of society, is a complex statistical isolate. By taking, say, the average of these measures and defining this as *the* length for future work we may treat this statistical isolate as an atomic one and proceed to examine the relational qualities exhibited between this and other isolates in nature. It is in that sense that we may perhaps talk of the field having a unique length.

PROBABILITY – A MEASURE OF SOMETHING OBJECTIVE

The relational quality to which we have here referred is an objective one. If we ask " what number will someone obtain who endeavours to measure the length of the field? " we will say that *the probability that he will find* a number lying between *a* and *b* is say *P*, a figure derived from an examination of the proportions of the numbers already found to lie between *a* and *b*. We do not necessarily say that *the probability that the length of the field lies between a and b is P.* Nor is there any question of subjective uncertainty in the statement. There is no doubt about what we have found, viz. this set of numbers. It is precise. It is simply the appropriate method of expressing the quality involved in carrying through operations and using them in an inductive way, that is, for forecasting the result of yet another operation. Induction is forecasting in science and in ordinary life, whatever logicians may say about it.

Now let us compare this treatment of the measurement of a length with a different case. In Ancient Greece there was a regular rate of insurance against loss occasioned by the escape of a slave. We can imagine that every year a certain number of slaves succeeded in gaining their freedom in this way. These escapes represented a definite objective process that had qualitative relations to brokers and slave owners. How is such a real social quality to be measured? It is not described numerically by giving a single number such as might be given for the number of people in a room at any moment. Looking back on the records of escapes, if such records existed, the insurance broker could study the trend of the figures. They might fluctuate for example between 100 and 120 per year without any special pattern showing itself, but the numbers in the neighbourhood of 100, say, might occur more frequently than those at the extremities of the range. The totality of numbers in the range and particularly the frequency with which each occurs is the measurable description of the event in question. We can express this again in probability form by saying that the odds that the number will lie, say, between 108 and 112 are 10 to 1, meaning thereby that out of a set of 11 years for which data exist, in 10 of them the figures will be found to lie approximately within that range. This is then a mode of representing the measure of an objective process that has social meaning like the measuring of the length of the field. In this case, however, it is not the process of counting to which the probability is attached but the "rate of escape of slaves." A probability or "the odds" is in this case the appropriate measure for the isolate under consideration; for that reason we say that *probability measures an actual objective statistical isolate.*

Finally, we turn to the simplest case—that of enumerating the number of objects in a group. With that we have already dealt. All the observers find the same answer, say five. There is not a set of results that differ among themselves. The answer is unique—the process of enumeration is independent, in its outcome, of the individuals who perform it. It does not therefore involve any internal structural quality of the process of arriving at the result. It measures a quality of the group. Like the probability measure for the escape of slaves it is a representation of a truly objective feature of nature. Both unique numbers and probability numbers have their appropriate status as measurements of natural qualities.

I have emphasised this because there is a general impression that when a measurement is expressed in terms of a probability there is necessarily present an element of ignorance, a lack of knowledge. This is far from the case. *A measurement is always exact.* It is the number found by the operator. The confusion arises with reference to the quality which the measure expresses. All the different numbers found by different observers dealing with the same isolate are all exact. It is simply an obvious truism to say they are exactly what is found. As a group they exactly specify a numerical aspect of the relation or operational quality that exists between the measurers and the object measured. That set of numbers, as a group-isolate, enables us to make a certain kind of prediction concerning the measure that will be found by the next person who applies the footrule to the object.

THE LIMITS OF SIMPLE ENUMERATION

This is a very important distinction, but there will be no confusion once it is realised that the measures refer to the operation of measuring and not necessarily solely to the isolate to which the operation is directed. *When the measures so found are independent of or, as it is called, invariant to the actual measurers*, we are dealing with a process which in that respect is definitely *reproducible*. The counting can be repeated over and over again always with the same result as in simple enumeration. This has its limitations, however. A group of expert counters will not necessarily arrive at the same result when finding the number of grains of sand in a sand heap. Even expert counters err, but then a heap of sand is a statistical isolate. After a certain stage or size of heap the results of measurement are not unique. The relation of the counters to the counting and the objects counted, is also a statistical one. Even this is however reproducible, in the sense that if the heap is recounted by the experts they will again get a similar *group* of numbers to those already found. The process passes to a *new level of reproducibility*. As we shall see, reproducibility in an experiment is an essential part of ordinary physical science. This will be dealt with in the chapter on Causality and Determinism, but for the moment we must recognise that reproducibility in the process of measurement may imply either the repetition of the same numbers or the same group of numbers. In the latter case it is the qualities of the group that have to be the same, not the individual members of the group.

THE GENERALISATION OF THE FOOTRULE

We can deal in corresponding fashion with the measurement of illumination, the strength of a current, pitch and intensity of a note, noise, the fluctuations of unemployed, etc. The operation of adding or enumerating units of any standard quality, however, depends on the nature of the quality. One does not take a standard current and lay it alongside another current to be measured as if it were a footrule. The quality involved simply does not admit of this. A current like every isolate exhibits its qualities in relation to some group; it is a mutual quality. Accordingly the scientist seeks in the first place to establish a standard reproducible environment and then compares the behaviour of some feature of that environment in two circumstances, first when the unit current, say, is present and secondly when it is replaced by the current under study. The environment may be simply a magnetic needle a foot distant from the wire along which the current flows—the whole isolated from any other disturbance. (A disturbance is a non-reproducible feature of the environment.) A unit current then deflects the tip of the needle by a definite amount measured as a length: two currents of this nature, as far as possible coincident, deflect the needle by a different amount and so on for three, four, five, six units of current. On this basis then a new type of footrule is built up, rather more complex, but essentially on the same principle as the footrule for length. In such an experiment then we are exploring the numerical relations of the mutual quality that exists between a current and the magnetic needle. We can produce a chart showing how the deflection of the needle varies with the number of unit currents. The dial of an ammeter is just such a chart. It is the law that describes how the relational quality in the statistical isolate formed out of the current and magnetic needle changes with a variation in one of the atomic isolates.

MEASURABLE AND NON-MEASURABLE QUALITIES

Many of the qualities to which we have directed attention are drawn from the field of physical science, but they are not necessarily those to which most people will attach the greatest importance. They have been chosen merely to clarify a general thesis. What is significant about the qualities studied in physical science is the fact that they can be expressed in measurable form in a comparatively simple way. Indeed that is one of the reasons, although not necessarily the most cogent one, why so much attention has been devoted to them by scientific men, but it is the principal reason why a tradition has grown up that science consists wholly of measurement; and why those "things" that cannot be expressed in measurable form in this simple way are considered either not knowledge at all, or only "a kind of knowledge." This assertion, as we shall see, is very far from the truth. It grew up during a period of rapid advance in mechanisation and in industrial development when accurate and precise measurement was of first importance for industrial and technical processes, and for the type of science that fed them.

Moreover, there are qualities of the situation, even in a factory or in an industry, that have found an adequate measure and that are not seen for the measures they are. Every executive officer in a producing industry knows precisely what is meant by the level of production in his factory. By that he does not mean only the total output, although that is undoubtedly one of the factors. He means also what he would call the quality of the production. He means that the goods will pass certain prescribed tests. He does not mean that he can assert in advance that every article produced will be able to face that test satisfactorily, or will attain that standard, but that approximately no more than a certain percentage of the output will fail. The measure is an average measure, and the quality of the whole output to which he refers is a group or statistical one. Some of the set will fall below the average, some rise above it, but as a collection they will be represented by certain measures.

Again, in every industry there is a certain quality in the relation of the workers to their employers. No one would say, for instance, that in the coal industry conditions were anything but "unhappy." Because it is impossible or not easy to give a precise measurement to the sense of injustice felt by the individual miner, or the condition of dis-ease of the individual mine-owner, or the state of indifference of the individual shareholder, it would be ridiculous to assert that there is not a decisive and distinct quality in this relationship. Some aspects of it might possibly be measured in terms of the average wage of miners during a lengthy period, in terms of the frequency of disputes that have occurred in that industry, or the number of hours lost by industrial disputes, or the number of deaths by accident or by negligence and so on. All these are measures of aspects of a complex quality in the relationship between two industrial groups. Each aspect is an isolate or sub-quality in the more general qualitative situation that is somewhat clarified in the whole collection of group average measurements to which we have referred. The quality, however, is something more, embraces a higher level of relationship than any one of these factors.

FORMING SOCIAL ISOLATES

In directing attention to such social features we are also mentally seeing social isolates, and in any given epoch they could be multiplied almost indefinitely. Unemployment figures, cost of living index figures, death rates, birth rates, deaths by accident on the roads, traffic census figures, maternal mortality rates, figures for overcrowding, criminal returns, suicide figures, bank deposits, number of people travelling abroad for holidays per year, meat consumption, milk consumption, etc., etc., all these, and hundreds more, separately and together provide statistical measures of certain sub-qualities in the whole social situation. The fact that these figures fluctuate from year to year is not evidence that the qualities in question are unreal, but real and changing like every other quality in nature. One function of science, indeed, is to link these qualities up in a logical way; that is, in such a way as to bring out their mutual influences on each other and so to expose what appears chaotic, as rational and orderly. In this way only will it ever be possible to control them, to direct nature in accordance with human desires and ideals. Again, we shall deal more fully with these matters in the chapter on Causality and Determinism.

SOCIAL QUALITIES DISTINCTIVE OF AN EPOCH

All the illustrations of social qualities and social isolates to which we have referred are drawn from the present epoch. That there is something distinctive in this epoch, a group quality that justifies us in marking it off as a large-scale social isolate itself, is evident from the fact that two hundred years ago it would have been impossible to provide any of these statistical figures. This is not only because the state machinery for their collection was non-existent—that is itself a significant fact in this connection—but simply because many of the qualities which they seek to express had themselves not yet emerged. Standardised production had not come into being; indeed it was not even dreamt of. There was no large-scale coal industry. Trade Unionism and Employers' Federations had not yet been formed, for there were no large masses of proletarianised workers, no large cities as industrial centres, no large groups of shareholders with financial stakes in industry at home or in the colonies. Suicide and unemployment figures had not reached their present height, the roads were not congested with motor-cars, the internal combustion engine had not yet been invented. Even the simpler possibilities of the steam engine were hardly imagined. Thus it seems clear that something drastic happened about a century and a half ago that as a consequence transformed many qualities of social life, something just as drastic as when a chemist brings hydrogen and oxygen together and so forms water. The quality of society two hundred years ago was clearly that of a different epoch. As we shall see in a later chapter, this is precisely what has happened over and over again in history. For our purpose, however, all we have to remember at the moment is simply that these successive epochs are real and distinctive phases, to some of the sub-qualities of which, if necessary, we can apply a method of measurement of a statistical nature.

All qualities are not necessarily reducible to numerical terms, however. A Gaelic tune has a quality that distinguishes it at once from a German, a Russian or a Hebrew melody. They could not be confused. It is not easy for a sensitive ear to confuse a Welsh, an Irish or a Scottish melody. The qualities of a Beethoven symphony and of one by Franck are quite distinctive. So are those of a tune in the major or in the minor mode. A close game at chess is different in quality from an open game. Lasker stands on a different level from Morphy as a chess master. They played at different periods with different techniques, tactics and strategy, and manifested quite different qualities in their play. What are we to measure in the qualities people discern in a poem by Keats or Blake, or a play by Shakespeare or a novel by Tolstoy? Certainly there are features in each of these and in our reactions to them that could be reduced to measurement, but he would be a bold man who would assert that these measure the complex totality, undoubtedly real, that we call the quality. Yet there is no reason to suppose that in the last resort some group measure linking together a large number of constituent qualities even in these cases might not be found, adequate as a measure for certain restricted purposes; some measure similar to that which psychologists have evolved for estimating general ability. General ability is undoubtedly a composite isolate embodying a large number of sub-isolates, and men in their dealings with each other have had to give special consideration to this quality. The rather complicated tests that are being evolved to determine some kind of measure for it, are simply evidence that although it is a real enough feature it is nevertheless, when analysed, a very complicated grouping of more elementary ones. Thus the measures that are found for each individual sub-quality have again to be combined together in a rather intricate fashion in order to find a representative measure of the group totality; just as the fighting strength of a platoon of soldiers will be measured by a complex combination of their numbers, the range of their weapons, their period of past service, their physique, their power of mutual assistance and defence and so on. It is a statistical entity none the less real because its measure is expressed in this composite way, and it is an entity at a more complex level than any one of the simple elements that it may be seen to embody. The grouping of the measures in combination has to reflect also the active grouping of the sub-qualities in joint operation.

MAN-MADE ISOLATES

From the standpoint developed in this chapter we have to see the Universe as an interconnected network of wider and wider isolates linked together by qualities that in changing behaviour express the changing nature of the isolates. In recognising these linkages, where they are static and where they are dynamic, men establish laws of nature, setting out to discover them where such knowledge is necessary to satisfy his needs and using this knowledge again to establish control over nature. In doing so man becomes an active agent in the formation of new objective groupings of matter, of people and of ideas and therefore in the creation of new isolates. To say this is simply to assert that the width and depth of the field of knowledge is enlarged step by step with man's needs, desires and interests, or at least the interests of those of the groups of individuals who exercise directive control over his activities. Now in the selection and forming of isolates for a human purpose there is a certain active quality in operation, the three constituent atomic elements of which are:

i. The human group concerned.

ii. The purpose or future use to which the isolates are to be put.

iii. *The actual isolates formed or selected.*

Let us illustrate this with two contrasting cases. In the effort to form an employers' federation (a statistical isolate) in a group of allied industries (each atomic), the functions of such a federation will express the purpose (or one stage of the purpose) of the individuals desirous of forming the federation. Further, the actual qualities selected for examination will depend on this particular purpose. These would include, for example, such matters as the mutual interests, jealousies, and possible collective working of the firms that are to be encouraged to join the federation. Furthermore they would be concerned with exploring the various ways in which the federation, once established, might be worked to the financial advantage of its members.

Quite a different set of isolates would require study and active formation if the group in question were a set of workmen anxious to establish a trade union. Even if they also select some of the same qualities as do the employers' federation, they view them in a different setting, see a different side to their meaning since their purpose is to handle or use the isolates in a very different way. Each group selects the isolates and qualities instrumentally relevant to the purpose and desires it has to express in action. This is the case with all social isolates. There are in fact three distinct steps in the process:

i. Deciding on the facts that have to be got at.

ii. Getting at the facts.

iii. Using the facts.

Section i above depends on the purpose implied in iii, and so we can see how the direction in which knowledge is sought by man is related to his needs and his active purposes. After all, no human being, other than a crank, simply collects facts as if he were an encyclopædia. There is either an immediate or an ultimate purpose in it. He is either conscious of the purpose or he is simply an unconscious instrument, an executive officer, for some other group. Once the facts have been got, they may of course be used for purposes other than those for which they were originally intended. Hence arises the belief in the abstract notion of acquiring knowledge for the " purpose " of " extending the boundaries of knowledge," science for its own sake.

In using and grouping the facts new qualities are brought into being, new relationships are exposed, and these express the valuations, desires, and strivings of the group that uses them. A social group with common desires, using facts to bring new relations into being that express these desires, is a social class. The isolates they form to attain their class satisfactions are the Class Isolates.

CHAPTER III

HOW A QUALITY IS TRANSFORMED

Group-qualities at various levels may be transformed into new qualities either continuously or discontinuously. Such transformations are here discussed in the realm of material and social practice and in the realm of ideas. The nature and circumstances of such changes are examined, and the conclusions formulated as a very general law. Tests of its validity are applied in a wide variety of circumstances.

DISCONTINUITY IMPLIES CONTINUITY

IN THE PREVIOUS SECTION we have dealt with the qualities by means of which we identify particular isolates, but we have emphasised that these qualities, existing in a changing world, must themselves also undergo change. To say that the qualities of an isolate undergo change is not at the same time to assert that this happens to the same extent to all of them. Were this so it would be impossible to identify the isolate in the altered condition. A human being does not become transformed into something totally different, say a number. In spite of the variety of qualities that change completely during his life, he remains recognisable as a human being. In the process of identification, therefore, there are at least two qualities, one of which, recognisably constant, serves to provide continuity between the two states, while the other marks the discontinuity. In this section then we propose to discuss this passage from one qualitative phase, as we shall call it, to another. Two successive phases in time are recognised as such when they belong to the same wider isolate, and when the earlier one shows some qualities common to the later one, and others that have been transformed to new qualities in the later one.

We have tried to distinguish between atomic and statistical qualities. In the process of change, therefore, we equally recognise atomic and statistical phases. The successive changes in speed and position of the Earth in its passage along its orbit round the Sun are changes in two qualities of the Earth which for the purpose is regarded as a unit or atom of the whole planetary system. We recognise it, say, by its relatively unchanging orbit, while its changing qualities are those of its relative speeds and positions. Here we do not regard the Earth as something composite, but as a unit, an atom. The study of the variation in road accidents on the other hand, formed by grouping the actual individuals who are killed or hurt as a totality, would be the study of a statistical phase. What remains unchanged is the fact of human death or injury on the roads. What alters is the totality of material considered.

DEVELOPING PROCESSES

When we talk of the sequence of phases, therefore, we are concerned with the following types of movement:

(1) From one atomic phase to another atomic phase.

(2) From one statistical phase to another statistical phase.
These two might be called horizontal development, in the sense that the successive phases remain of the same type.

(3) From atomic phase to statistical.
This we might term development upwards, or integration.

(4) From statistical phase to atomic.
This would correspond to downward development, disintegration or differentiation.

The emergence of new qualities by bringing together a series of elements would be included under (3), whereas under (4) would fall the destruction of a quality by tearing a composite thing into its constituent parts.

Let us illustrate these.

(1) *From atomic to atomic.* The seven ages of man as described by Shakespeare in *As You Like It.*

At first the infant...
And then the whining schoolboy...
And then the lover...
Then the soldier...
And then the justice...
The sixth age shifts into the lean and slippered pantaloon . . .
Last scene of all . . . is second childishness.

We can identify the individual, throughout, as the same. He always has the same father and mother. In the last resort the methods of identification are social; others accept his identity. Social recognition remains unchanged.

A piece of metal, the same metal when melted, the molten metal cast as a frying pan, each of these stages consists of the same material and yet each of them displays characteristic qualities that may appear discontinuously from the one stage to the next. The " use-quality " of the frying pan, a social quality, comes into existence suddenly. Such illustrations can be multiplied indefinitely merely by selecting any object and watching its history over a long enough space of time. If its qualities are " use-qualities " they are conferred on it by human labour that links it up with a social need.

Another form of this can be seen if the relation of a piece of land now situated in the centre of a large town like London be traced back in history; many of the new phases into which this relation passed arose not necessarily from any internal change in the land, but by social environmental changes. The ground remained the same, the social need changed.

(2) *From one statistical phase to another.* At one stage a pair of rabbits, no more than two, it is said, male and female, was taken to Australia. This was the smallest possible statistical set, with internal qualities or relations between its members, and with a group relationship to their environment. To-day, rabbits in Australia, regarded as a group or population, have a series of totally new qualities in relation to their environment. Multiplying in numbers they have

spread over thousands of square miles of crop lands and forced the farming population to readjust themselves to a new and serious menace in their struggle with nature. Rabbits have become a large-scale pest. They are still rabbits.

Physical science teems with illustrations of successive phases. For example, there are the various transformations through which water vapour passes in the atmosphere . . . mist or clouds to rain or snow or hail and sleet; or again, when a steady fall of snow leads to a snowdrift.

(3) *From atomic to statistical phase.* Notice how a cigarette-maker, rolling his cigarettes by hand, produces first one, then two, three, four . . . a heap . . . then a group of heaps . . . and finally sells them by weight: five pounds by weight of rolled cigarettes, more or less. The very method adopted in measuring the quantity indicates that the quality of the situation is now of a group-statistical nature. Take again the grouping of dots to form a pattern, p. 57. The dots are the atoms. Not until a certain number of these appear can one assert that the pattern shows itself. It is a statistical entity formed by the aggregation of the individual dots. Or another weather illustration—a sunny day, a series of sunny days, a dry spell (which is now something different from the individual days out of which it has been formed), a drought, i.e. something much more drastic than a mere dry spell. Here, the continual addition of sunny days forces or involves the passage through a series of statistical phases.

Two atoms of hydrogen uniting with one of oxygen form a new group of a statistical nature, the molecule of water. [Contrast this, however, with the following case—If two cubic feet of hydrogen, a statistical mass of molecules, be exploded in the presence of one cubic foot of oxygen, another statistical mass of molecules, they combine completely to form water in steam or in liquid form, another statistical mass of molecules. Here statistical phases—cubic feet of hydrogen and oxygen which have developed from atomic phases—the atoms of hydrogen and oxygen pass to a statistical phase with different qualities—water.]

PHASE CHANGE IN PRODUCTION

When we compare production under factory conditions with the previous phase, that of the craft worker, we notice the same thing. An individual bootmaker made his wares to order for an individual client, just as the individual tailor made suits for special customers whom he knew individually. Under the factory system, a later stage of production, boots and suits are made *en masse* irrespective of the identity of the actual person who may finally be wearing them. In this respect production has passed from the individual or atomic phase to the mass or statistical phase. The extent to which this has happened can be seen by examining the objects in your room and deciding how many of these were made specially for you; and even where this appears to be the case, *how much* of it was made specially for you. Was the material not perhaps statistically produced before the final personal touch was given? Actually all factory production, involving the making of a series of constituent parts and finally the assembling of them to a finished product, is an illustration of passage from the atomic to the statistical stage.

(4) *From statistical to atomic.* This, as we have pointed out, corresponds to analysis, disintegration or differentiation. A family with its mutual adjustments and maladjustments, its own jokes, its music and its discussion, its internal joys and troubles, has a special quality that exists in virtue of the fact that it is a group unit. The members of the family grow up in this changing atmosphere and finally disperse: it is disintegrated. The old quality lingers on only as a memory. The family has passed from the statistical to the atomic phase. Notice, however, that it is quite arbitrary to stop at this point. When the disintegration occurs each individual bears with him the experience and memories of that group association, and seeks to build up a new group unit. The disintegration of the previous group is a necessary condition for the formation of the next.

On a wider scale, history relates how certain social groups have collapsed in the past. A study of the remains of ancient villages and industries associated with the tin mines in Devon, for example, presents a moving picture of the life of a complex community and how it must have completely disintegrated.

The present industrial crisis with the devastation it has wrought in what are called the "depressed areas," the breaking up of homes in the search for work, witnesses also the shattering or atomisation of a complicated social life.

Again, during the Fascist rebellion in Spain many works of art have been destroyed. Paintings, carvings and pieces of sculpture, whose qualities resided in the juxtaposition and mutual balance of the parts and in the meaning this combination of elements had to groups in society, have been shattered. When smashed to pieces, and the parts dispersed, a work of art irretrievably loses its distinctive qualities. It has been atomised. It becomes a set of discrete bits of stone or pieces of torn canvas. Every work of art is a statistical entity. Its qualities emerge from the grouping of the various parts in such a way that emotional and intellectual meaning to others is thereby aroused and expressed. Its qualities, therefore, are also social qualities that manifest themselves in communal life. It is a social statistical entity.

When we write of the sequence of phases, therefore, we have in mind all such modes of successive change. One further point must be stressed. Since every isolate can be seen to be an atomic element from one point of view and a statistical group from another, it is to be expected that when a change of one type appears there will simultaneously occur changes of the other types. All the illustrations showing changes from one to another atomic phase, for example, can, from another point of view, be seen as changes from one statistical state to another. It is not that we *may* so regard them: it is not a matter of choice. We must so regard them. In a particular discussion we need not necessarily take them into account: that will depend on whether they are relevant to the isolates we require to form. Nevertheless both types of variation in qualities coexist.

SUCCESSION OF STATIC PHASES

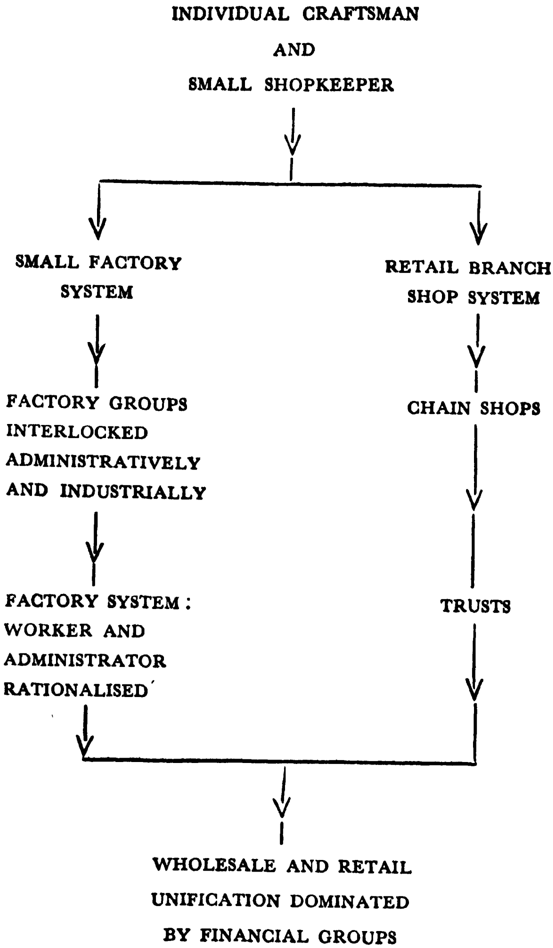
In these illustrations what we have called successive stages are successive in time. This is not really necessary to our discussion. As we pass geographically from an agricultural area, for example, to an industrial district the quality of life led by the population undergoes a distinct change. This geometrical, or geographical, or spatial method of examination is valuable in certain types of problem of a static nature, as in questions of classification, in patterns, or in static logic. Here for the moment however we are concerned with change in the temporal sense, variation of qualities with time.

NON-CAUSAL NATURE OF TIME OR SPACE

The method of setting out such processes along the axis of history enables the successive phases to stand out sharply. It does not in any case offer an explanation why the transition occurs. When we say that there are causes at work forcing a change in phase, we do not include time among these causes, no more than we explain how certain things come to be where they are merely by pointing out their location in space. Causality involves interaction, and time does not interact. Nor does space. Changes occur in space and time and the latter are therefore the media through which interaction must be seen to take place. By examining a process historically however we can prepare the way for such a dynamic explanation, for it is a method of laying out the problem demanding explanation. In that sense, like all preliminary thinking, it corresponds to the static part of the analysis. It shows up the phases as static sections.

THE STATIC PHASES IN PRODUCTION

In illustration, the successive stages in production and distribution during the past 150 years when seen along the axis of time look like this:



Each of these stages can be quite clearly recognised by its distinctive qualities—the later stages never completely supplanting the earlier ones. Some individual craftsmen and small shopkeepers continue to exist side by side with factories working under the Bedaux system and with large chain stores. We must not see these stages therefore as corresponding to sharp alterations in the modes of production and distribution but as phases in which quite definite new modes of social activity have been introduced, phases of a whole developing process in which the newer ones develop side by side with and partially only at the expense of the older ones. Setting it out in this way does not explain *why* the changes occur, but throws into relief what is the real problem. We are induced to ask—what qualities of the productive and distributive process in society encourage, or direct, or canalise, the activities of men so that these successive phases manifest themselves?

Or again, take a problem on a much more extended time scale, the various phases of social life and social organisation generally in Western Europe, the Tribal Stage, the Feudal System, the Mercantile Period, the Industrial Period. To each of these corresponds a special quality of social life, a distinctive technical mode of production, a distinctive legalised system of sharing the proceeds, and a set of cultural customs and beliefs. These enable us to recognise and distinguish the various stages of group or statistical development. They are not sharply cut off one from the other. Even in England to this day traces of the Feudal System and of the Mercantile Period (Merchant Companies generally, Freemen of Cities) still persist. In England, moreover, the transitions from one stage to the next occurred at different times from those, say, in France. The successive stages fade one into the other, although it is possible to mark points where decisive struggles occurred. It is in these crises that the replacement of the one phase by the next was most clearly seen. If such a process is to be subjected to scientific analysis we have to disentangle the *compelling factors* that forced the change from one qualitative stage to the next. If we are to succeed in asking and answering sensible questions about such changes we can begin by turning again to the world of experimental science where the circumstances are largely controllable and examine the corresponding processes that show themselves there.

SCIENTIFIC CONTROL OVER PROCESS

What does "controllable" signify? For the present purpose we may explain it in this way. Given two different stages of the same material, we may say that the scientist has control over a process when he can so arrange circumstances as to lead or guide the material from the one stage to the other and repeat the operation. Sugar may be led from the crystalline state to one of solution in water. Again a sugar solution may be led back to the crystalline state. Here the process is what is termed a reversible one; it may be forced to go either way. It would seem therefore that no useful purpose is served by seeing the stages set out along the time-scale—along the axis of history.

DOES THE SCIENTIST SNAP HIS FINGERS AT HISTORY?

The scientist by exercising his control over the situation seems to set history at naught. He forces history to repeat itself. The same can be said of processes such as the transformation of steam into water, and then into ice—or back from ice through water to steam, or the transformation of one form of energy into another, e.g. chemical energy into electrical energy and thence into light or heat or kinetic energy of a machine. All these are reversible in process and quality. It would appear therefore that in physical science a profound difference exists between those natural processes that are the subject matter of its study and experiment and those that correspond to some of the illustrations previously taken. In considering the evolution of man, for example, we could scarcely contemplate the idea of the process being reversible, and man passing back to the early primitive and ape stage. The natural historical process is not a reversible one. Natural history does not repeat itself.

NO

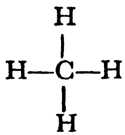
Is a scientific process then not a truly historical one? The difference is more apparent than real. No scientific process, rigorously speaking, is ever in fact repeated. What happens is that a series of phases is passed through and by so arranging or controlling the circumstances the scientist can contrive to reproduce, at a later date, certain characteristics that, *for his purpose*, can be regarded as identical with those of an earlier phase. The universe has changed in innumerable ways during the process. The *steam* during its wanderings in the guise of water and ice may have finally returned to steam again, heat through electrical changes back to heat, but in order to ensure this, in order to bring this about the scientist has himself had to alter the universe in a multitude of ways. He has redistributed much of its energy. He has made apparatus, or ordered its making. He has consumed food. He has interfered with the production and consumption of the community and he has altered the geographical position of parts, perhaps only small parts, of the Earth. He himself has changed. He has gained in experience. All this may be unimportant to him if the purpose in hand is merely to study the various forms in which water may manifest itself. In this sense he may claim that the process is a reversible one, that time and history are irrelevant to it, but if once he turns his gaze away from the actual part-process, the historical isolate with which he is concerned, he is immediately confronted with the fact that in its wider setting there has never been a process that is reversible. The traffic of the universe flows in one direction only.

Science, even physical science, does not restrict its study simply to artificial reversible processes. The fact that there is such a generalisation as the Second Law of Thermodynamics, a generalisation concerning irreversible processes in their relation to the utilisation and the squandering of heat, is evidence of this. Nevertheless much of what may be called Mechanistic Science, the study of machine-like processes, is in a restricted sense of a reversible nature. We shall have occasion to deal with this subject later in greater detail. For the moment it is important for us to see where this particular restriction that is applied in mechanistic science can assist us. It helps us in this way. Since the actual historical order of the processes may not be important to the scientist because of his peculiar method of exercising control, the other factor in the situation, his mode of forcing the change in phase, stands out all the more distinctly. Thus it enables him to show that when such processes occur in nature without his intervention such and such are the driving factors responsible for the changes of phase.

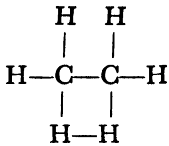
THE SCIENTIST DEEPENS A QUALITY

How does a scientific man lead a process through its successive phases ? He fixes his attention in the first place on some one of its various qualities and devises a method of accentuating it. He takes a solid, for example, and, concentrating on its temperature, increases it by the application of heat until presently, at a critical stage, the solid melts and becomes a liquid ; further increase of temperature and the liquid evaporates as a gas. Thus he deepens one quality and remarks how the others change. Not all the others undergo change, however, otherwise he would not know that he was dealing with the same isolate. His experimental skill shows itself in his success in keeping the distinguishing qualities unchanged.

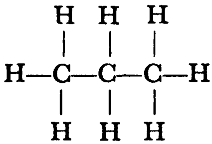
But the temperature is not the only quality that might be selected. That depends on the phases through which it is proposed to drive the substance. For example, the characteristic that may be accentuated may be one of the material constituents in the substance. Thus take the class of substances known in chemistry as the paraffins. He begins with a gas represented by the formula

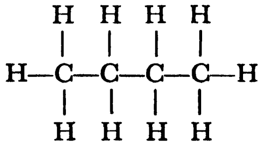


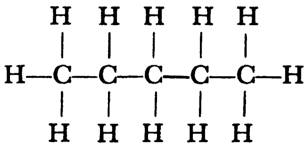
one atom of carbon (C) united with four of hydrogen (H). This gas is known as methane or marsh gas. By suitable and rather elaborate means he replaces one atom of hydrogen by a group consisting of a carbon attached to three hydrogen atoms and so he obtains ethane, a heavier gas than methane with certain of its chemical properties very similar but rather more accentuated. Its formula is:



He repeats the process, deriving in succession:

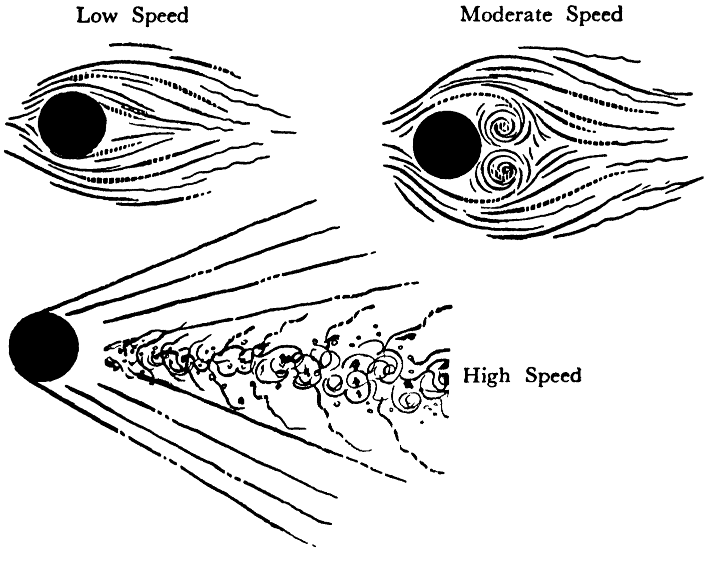






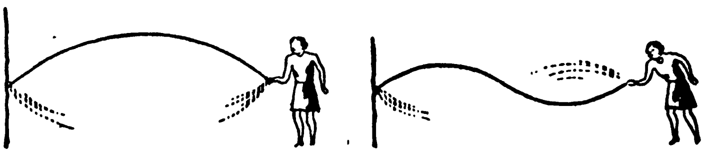
As each additional group is added, the substance becomes heavier and heavier, and more and more sticky, these qualities changing until, at a certain stage, at normal temperatures, a liquid is produced and then, at a later stage, a solid; and so, by this process of accentuating the carbon characteristic in the original substance, a series of successive phases is passed through, within the group of paraffins, each phase showing its characteristic series of qualities, corresponding qualities showing discontinuous changes from stage to stage. They represent passage—discontinuous passage—from one statistical phase to a more complex one. The science of chemistry is honeycombed with just such illustrations.

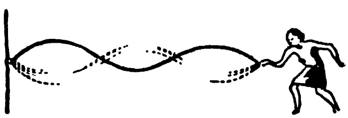
In the study of aerodynamics again where we are dealing with the steady motion of a solid body through air or through a liquid, we may take the motion of the body as the particular quality to accentuate. At very slow speeds of the body, the fluid stream-lines past the solid, following its contour closely. As the speed is increased a critical



PHASES IN THE MOTION OF A BODY THROUGH A FLUID

point is reached where the movement in the liquid undergoes a rapid change in appearance. Eddies or whirlpools begin to form in the rear of the moving body and place themselves in a systematic order. These arrange themselves in two parallel rows in the rear or wake of the moving body. This then represents a new phase for the whole nature of the motion. Another quality, the force impeding the body in its forward movement for example is found to follow a totally different law from that of the previous phase. If the speed of the body is still further increased the appearance changes again and the movement in the fluid becomes generally chaotic and *turbulent* and the systematic pattern formed by the whirlpools disappears. The law of resistance to forward motion is again altered. If the motion of the body be still further accentuated it cleaves through the gas or through the water so rapidly that to all intents and purposes a hollow vacuous space is left immediately behind it and a wave pattern begins to show itself in front; a new phase has again been entered, called the cavitation phase. If the body is moving through the air instead of water, sound waves are produced.





If a skipping rope be turned with increasing rapidity, the same changes in outline of the rope appear in succession as in the case of the spinning shaft described below.

The flight of a bullet or a shell is a case in point, and the whistling accompanying it arises from these sound waves as they reach the ear.

Here then we have a situation in which a variety of qualities are present, the motion of the solid body, the state of motion within the liquid, the density and stickiness of the latter, the shape and size of the body. One only of these qualities—the forward movement of the solid body—has been deliberately increased. Certain of the others have changed with it, notably the general state of motion within the liquid.

Again, if a long metal shaft supported freely at its ends, a shaft such as those that have driving belts attached to them in factories, be spun, at first at low speeds, the shaft remains straight between its bearings. As the speed is increased, at a certain critical speed the shaft begins to deflect or whip outwards in the form of a single spinning arc. If the speed be rapidly increased the shaft passes beyond this phase and straightens out again. Accentuating the speed further, a second critical stage is soon reached where it begins to whip outwards again, but now in the form of two arcs shaped like an S, and at successive higher rotational speeds, successive phases of the same nature are passed through with an increasing number of bends of snake-like form. Thus, by constantly intensifying the particular quality—rotational motion—the bar passing through a series of phases in shape, each occurring at a critical value of the quality—rotational motion—that is being accentuated. Other qualities, for example the stresses and strains in the material, also change while others, for instance the weight of the shaft or the position of the bearings, are maintained unaltered.

PHASE CHANGES IN NATURE

These illustrations are all drawn from the sciences of physics, engineering and chemistry, but they could equally well be matched from any other of the exact sciences. Certain drugs, for instance, are beneficial in small doses; beyond a critical dose they are lethal. They bring out a general and accepted scientific feature about scientific method and natural process. They illustrate the procedure scientific men adopt in forcing one qualitative state into another. In spite of this however all these processes may be seen to occur as it were " in nature." By that we mean that they need not necessarily be led into being by the deliberate action of man. He did not cool the Earth from the gaseous to the solid stage. Whirlpools occurred in nature before man began to experiment with them. Trees collapsed under the force of a gale before man had any knowledge whatsoever of bending moments or buckling loads of beams.

Vegetation was transformed into coal before man stood on the Earth.

Scientific study covers two classes of event. To begin with, it sweeps within its ambit all those experiments that nature has itself performed, all those occurrences that have arisen from " natural causes " as they are called. The motion of the planets is a case in point. So are earthquakes. In these he sees events pass through successive phases of the type we have just considered, but usually so muddled up with other and simultaneously occurring changes that they are difficult to isolate—to discern as a sequence. The function of the scientist is to disentangle them.

SCIENCE = DELIBERATE INTERFERENCE WITH NATURE

In the second place scientists deliberately interfere in nature. Science is not an objective study if by that is meant that scientists merely look at what is happening around them. *Scientific method is a precise plan for practising systematic interference*, and it is largely from an examination of the results of this interference that they are able to disentangle what has been happening in circumstances in which they have not interfered. This plan for positive interference, as is to be expected, shows itself in the attempt to exclude all such events as occurring at the same time as the process under study tends to obscure the succession of phases with which the scientist seems to be concerned. Accordingly circumstances are deliberately chosen or created in such a way as to eliminate these interferences, or at least to reduce them to a minimum, and therefore at the same time to throw into relief the sharpness of the successive phases. In such experiments therefore the scientist becomes the agent that leads the material on its journeys. He is the agent who heats the water to convert it into steam. He it is who fixes on the particular quality—in this case its temperature—actively forces it to change, and by that means drags the material through its successive phases. He is a causal agent in the process. And so also with the other illustrations.

Not so, however, with a natural physical process over which he exercises no control. When dealing with causality and determinism we shall discuss this matter in greater detail. Here it may suffice to cover both cases by stating that we reserve the word causal agent for that quality (or those qualities) in a partial process which, by becoming accentuated, drag the latter through its successive phases. This definition has a certain vagueness and it will later be necessary for us to refine it, but it does correspond to an actual scientific practice. It would imply for the moment that the intensifying motion of the body passing through the liquid was the immediate *cause* of the changes in phase through which the general motion of the liquid passed. The intensifying rotational speed of the shaft was the immediate *cause* of the changes in snake-like form shown by that particular shaft. On this view we would appear to regard the cause of a physical change as residing in the objective materials and in other circumstances associated with the change. When saying this however we consider the process as isolated at some level from certain other of the attendant circumstances. If it is a laboratory experiment, for scientific purposes we may ignore the experimenter and make the responsible cause external to him as we have done above. If, on the other hand, we include him in the experiment we may legitimately assert that he is the cause of the changes that have occurred. On this view it becomes, not an isolated scientific experiment, concerning itself with changes completely external to the scientist, but an experiment in which he is one of the actual pieces of apparatus, exercising an active quality. It becomes a social experiment, something performed by a fragment of society.

IMMEDIATE AND REMOTE CAUSES

It is important to bear this distinction in mind, for it brings out what one can term *levels of causality*. For example, we may say that what is happening in a certain part of our apparatus is " caused " by certain features or qualities of an interconnected neighbouring part. We may say that both these are caused by the electrical system in the laboratory to which the apparatus is connected. We may say that the whole experiment, including the connection to the electrical system, is caused by certain actions on the part of the experimenter and that this again owes its origin to or is caused by the desire of certain groups of individuals who employ him to acquire further information on the subject of the experiment. Thus as we pass outwards in ever widening circles from certain details of the experimental process we refer each stage in turn to a cause or causes always one stage more remote from our starting point but leading in this case inevitably from physically impersonal causes to human ones. We have then a sort of causal hierarchy that unites the experiment with its social background. This is inevitable because in the end each such experiment has been deliberately called into being by an individual and some human group.

From the present standpoint therefore we can attach the term causal agents generally to those qualities of a restricted process, they may be human relationships, that by their persistence or intensification lead or drive the system through one phase to the next.

SCIENTISTS EXAMINE SINGLE PHASES

The study of phases through which qualities pass is not necessarily the central occupation of the scientist, but rather the examination of each phase in detail in order to discover how each quality varies in its strength as the process moves on. The increase in strength of the causal quality is held responsible for this onward movement. We need not concern ourselves with the special methods the physical scientist adopts to decide on a unit in terms of which he may express each quality. We have already discussed this to some extent and will return to it later. What are usually called physical laws in science when written in mathematical or symbolical form tell us two things about changes within a single phase.

1. The particular qualities that are brought into play in the phase to which the law applies.

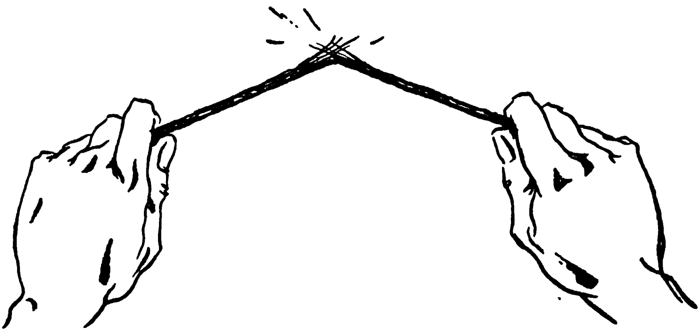
2. The numerical relations between the measures of these qualities.

For example, if a beam of wood is bent by force into a circular form a law of the type we are considering would relate the quality of stress in the wood to the qualities (elasticity, density, etc.) of the material and to the curvature of the arc into which it has been bent. This relation would be a numerical one. If we take numbers that measure the elasticity and density of the wood, assumed unchanging during this process, and a measure like the radius of the arc to represent the curvature, the law in question would tell us exactly the amount of the stress at each point of the beam. Thus in general a scientific law is both qualitative and quantitative.

DANGERS OF SCIENTIFIC ISOLATION

Now there is a serious danger latent in the uncritical use of such laws. We have to remember that in stating the law there are, in addition to its mere statement, also the circumstances defining the limits of the phase to which it can apply. In the case in point, we have in mind a beam isolated *in toto* from the rest of the universe, except in one particular. This resides in what is called the external force required to bend the beam into the shape of the circular arc. This isolation is precisely what is always assumed, or approximately striven for, in scientific work. Unless we recognise it as a temporary expedient for the single phase, our wider interpretations are likely to be, to that extent, deficient. We shall cut ourselves off, for example, from the social or technological qualities of the beam and its bending, from the ways in which the results of the analysis and the investigation are applied in communal life. We shall falsely imagine that science is a thing in itself, operating and developing in a social vacuum. Just as soon as the isolated scientific conclusions are drawn they have to be reinterpreted in their social setting. That is the first factor in the " assumed " circumstances of which we have to be conscious.

The second factor appears at first to be something much more specifically scientific. In assuming that the beam is *given*, we are also assuming that certain other qualities of it remain unchanged, its elasticity, for example, as the beam is bent from the straight position into the bent. In real life



The law relating the stress in a rod to the amount of bending breaks down when the fibres snap. A new phase has been entered.

this must finally be false. It can mean only that for a certain degree of bending into a circular arc the elastic qualities of the beam remain *substantially* unchanged, and for the purposes in hand, changes that do occur are too small to be taken into account. That this is not always the case is obvious. Suppose the beam were made of lead; then, after the release of the bending force, the beam, unlike a wooden one, does not spring back to its original position. It is " set " in the bent form. Suppose the beam is wooden but the circular arc into which it is bent is of such small radius that the beam cracks, is broken. What then? We have carried the process through to a new phase. The previous law no longer applies. The qualities that specified the previous phase no longer have the same significance in the new situation.

What has happened is that, as the bending is increased, the internal stress that is called into being becomes itself a causal agent transforming the internal make-up of the phase structure by tearing the fibres of the wood. We shall see that this illustration is typical of a very wide class of phenomena: many examples of the same feature have already been offered.

The general qualitative discussion we have given serves to bring out the succession of phases, marked off from each other, sometimes sharply, sometimes continuously, at a series of critical points. The physical scientist concerns himself as far as possible with the numerical relations that are exhibited in each phase, statistical or atomic. These are his statistical or atomic laws. In addition he endeavours to discover the critical measures, either of the causal agent that was forcing the process through its phase, or of the secondary and internal causal agent that is brought into being in the process and so effects a change of phase. He does not produce general laws that cover a succession of phases, and this because, in isolating a process, he always requires " given " conditions to remain unchanged. The characteristic of a true change of phase is that it corresponds to a freeing from the restrictions by a destruction of the given conditions.

Before we attempt to draw more general conclusions let us consider another case in detail. There is a certain phenomenon known to science as Brownian Movements. Very tiny particles of matter are kept in suspension in a fluid, and the latter left to stand for a long time in a situation as far as possible free from disturbance. When the liquid is judged to be at rest, it is examined under a microscope. The small particles will then be seen moving about in jerks, zig-zag fashion. It can be shown that the magnitude of the speeds they acquire and the indiscriminate directions in which they move are consistent with their being struck by the ceaselessly moving molecules of the liquid itself. These motions of the particles are known as Brownian Movements, and it is clearly one of the crucial pieces of evidence on which rests the molecular theory of liquids. Thus while the statistical isolate " liquid " is at relative rest, the particles of which it is composed are in continual agitation. At one and the same time there is united in it, like an ant-heap, the two opposite qualities *rest* and *movement*, statistical rest, atomic movement. Now if the liquid be raised to a higher temperature but still maintained generally at rest, this agitational motion grows. We say its internal energy has been increased by absorbing more heat. All that happens is that the body that communicates the heat to it, is itself, as regards its molecules, in a more violent state of agitation, and these, by impinging on the molecules of the liquid, communicate to them a more rapid state of movement. Here the statistical isolate is *heat*, the atomic isolate is *molecular energy*. Now, as this process continues, the range of movement between successive impacts of the molecules with each other increases, just as a crowd of closely wedged people might gradually shake themselves loose if they started oscillating backwards and forwards, not in unison, but with increased power behind their oscillations. They would begin to spread out. As a crowd they would expand. So also with the liquid. As the quality of heat is accentuated so the quality of volume increases. The two statistical qualities interlock or interact. All schoolboys are aware of the simple numerical law that relates these two qualities. Presently a new situation emerges. As the jostling among the molecules increases, a larger and larger number every second succeed in breaking loose from the general body of the fluid and escape into the atmosphere above the liquid, until at a critical stage (it would correspond to some number of molecules per second being discharged into the atmosphere) boiling, as it is called, takes place and the liquid phase passes into the gas phase.

CAUSAL AGENCY IN CHANGE IS AROUSED INTERNALLY

Compare this with the previous case of the bending of the beam into the form of a circular arc of smaller and smaller radius. In the one case the phase is that of the liquid state, in the other that of a continuous beam. The external activating quality in the one case is in the increased application of heat, and in the other the increased bending force. This shows itself in the intensified agitational energy of the molecules of the liquid in the one case, and in the increased stretching of the wood fibres in the other. (Actually increased stretching of this nature can be traced down to forced displacement of the molecules of the fibres, and this is called potential energy.) In both cases the external activating causes have given rise to secondary causes within the actual detailed material of the medium. Finally, these get the upper hand, and become themselves primary causal agents forcing the passage over to the next phase, by the water boiling in the one case and by the binding fibres bursting in the other.

This is a description in terms of qualities; physical and mathematical science is concerned with its quantitative examination. Nevertheless what stands out even from a qualitative study of these processes is the peculiar way in which the *causal responsibility for the change shifts from what was the primary cause of the mere sharpening in quality, to a secondary internal cause which is itself brought into being by that primary cause.* An intensification of the statistical quality of the statistical phase is met by a persistent readjustment of the internal atomic qualities until finally the latter become incompatible with the maintenance of the statistical phase. This illustrates a *general qualitative law of change,* but of course its quantitative expression is dependent on the nature of the phases. The law in question is usually referred to, in Hegelian terminology, as the " Passage of Quantity into Quality." We need not quarrel about its suitability. What is most important is that we should understand accurately the actual process. For what we are seeking is a generalisation that will have meaning for a succession of qualitative states usually regarded as outside the confines of orthodox science, particularly in the field of sociological and human action. We are trying to find a generalised Law of Movement and we are doing so by following as closely as possible the method adopted in physical science. For this purpose, therefore, we propose to set out this description in a form divorced, or isolated, from the special examples by means of which we have illustrated it, in order if possible to find the form in which it is valid also in other fields. All that is sought for the moment is a recognition of its meaning as a law in terms of the content and general nature of the various sciences if indeed what we are stating is a general qualitative law. If it is, then the law becomes of vital importance to the methodology and philosophy of science, and not less important for the study of communal life. Certain matters of this latter type will be dealt with in Chapter V.

STATEMENT OF LAW OF QUALITATIVE CHANGE IN PHASE

As a first step then towards this more general standpoint we remark that all problems in physical science that involve changes in phase can apparently be represented in this way. Processes that involve simple limiting factors are of this type. For a particular design of aeroplane, for example, there is a limiting size beyond which it would collapse under its own weight. As the scale is increased the growing weight of the whole system exerts internal stresses on the parts that bind it together and ultimately bends these parts to breaking point. This is true of any structure made of material that will ultimately yield under stress. It is this process that, it has been suggested, was responsible for the extinction of mammoths and other " over-grown " animals of prehistoric days, and for certain types of deer whose antler weight became too great for their strength.

Their increase in scale and weight finally made it impossible for them to move sufficiently far afield and with sufficient agility to collect the necessary food or to escape attack from agile enemies.

Again, a body of any shape when falling through the air will rapidly increase its speed. During this accelerating phase there is aroused, by air friction, a growing resistance to its motion until this resistance reaches such an intensity (equal to the weight of the body) that the motion no longer accelerates and a phase of steady and constant motion is begun. This is called the limiting speed. This principle is used in the design of parachutes. It is responsible for the fact that if an insect falls from a great height it simply floats down gently; a mouse also is so light in comparison to its surface area that it quickly reaches its limiting speed and is little the worse for the fall, no matter from what height: on the other hand a horse, in a fall of a few hundred feet, would be smashed to pieces, so great is its "limiting speed."

These examples are all illustrative of the same principle that the change in phase is always brought about directly by a secondary causal factor arising in the inter-relation of the parts during the actual phase, and indirectly by the operation of the primary causal agent. Let us now state this in very general terms for future use. Consider a *given* state or situation S, in which there resides a certain quality Q which is undergoing intensification. S has an internal structure or composition, of such a nature that the intensification of Q arouses in it or intensifies in it a structural quality q. The quality q is recognised by the fact that its intensification is inimical to the continued existence of the given state S. Accordingly at a critical stage of q, the state S is transformed by it into a new qualitative state T. The transformation is made manifest by the fact that what was *given* for the state S no longer has relevance. The immediate cause of this intensification of q to its critical value is Q; the immediate cause of the transformation is q. A change-over brought into being by an internally aroused agency such as q is referred to as a *dialectical change.* As we have already remarked, the actual quantitative point of q at which the dialectical change occurs is referred to by Dialectical Materialists as the point at which " Quantity passes into Quality," or more shortly as the *dialectical point.* A statistical isolate involving the coexistence of Q and q prior to the dialectical change is considered as possessing a *contradiction.* The quality q is said to *negate* the state S, and reaches its climax when it is itself transformed in the new situation and plays a new rôle therein.

All this Hegelian terminology seems to have originated from an examination of the corresponding process as it manifests itself in dialectical or verbal argument. As a discussion is pressed forward a tentative conclusion gradually emerges. This is seen to shed a new light on certain aspects of the initially assumed data, and leads to additional data being derived as a result of further examination. The discussion is again pressed forward. The tentative conclusion becomes unable to accommodate the new data. An internal contradiction is involved. As soon as this is perceived the next stage or next phase becomes imminent and must involve a reconsideration of this tentative conclusion in a wider form, in order to reconcile the conflicting viewpoints. It is not that a compromise is reached, but that a more generalised standpoint sees both in a wider perspective. This, taken as a new tentative conclusion, leads again on to the next stage of the discussion. It seems abundantly clear that if people could be made to realise that this is indeed approximately the process through which they do wander in argument towards a conclusion, discussion would take on much more of a consciously planned appearance, and less of accidental and blind groping. A discussion conducted on these lines can become sensible and well knit logically. It does itself undergo a dialectical change.

Are we correct in saying that this process takes place also in the transformation of ideas ? So far we have sought to establish it for changing processes in materials. That this is to be expected follows in some degree from the qualitative linkage we have persistently underlined between mental and material changes.

PHASE CHANGES IN SCIENTIFIC UNDERSTANDING

What we have suggested above, can be seen to have occurred in the history of scientific theories. Periodically during this process the generalisations arrived at have acted as pointers for further experiment, and therefore further accumulation of data. This appeal to the world of matter has then gradually made it apparent that it was not possible to reconcile certain of these results with the existing laws. Under the gathering pressure of these contradictions a stage arrives when the old form of statement can be seen finally to be incapable of accommodating the new content. Further attempts at explanations on these lines merely hinder development, so cumbersome do the *ad hoc* assumptions become.

The time is ripe then for the entry into a new scientific phase. New generalisations of a basic nature are forced into being and a new level of understanding is reached. By analogy we might regard the obsolete theory and the new data as two sets of elements which, by their interaction or unity, bring a more complex statistical quality into being. That new level is attained not only with the formulation of wider laws, but with a clearer appreciation of the restricted part played in them by those that have been replaced, and a better understanding of why they were unable to accommodate the new data. In illustration we need refer only to the Periodic Law for chemical elements as marking a generalisation that led on immediately to the study of radio-active substances, and then, at the end of that phase, to attempts at formulating the Quantum Theory that brings us to a new level of understanding of the constitution of matter. Or again we may note the passage from the Newtonian Law of Gravitation that had stood the test of experience for more than 200 years to the Theory of Relativity with its generalised Law of Gravitation, after it became impossible to reconcile the new astronomical facts with the older law.

All these successive phases fit in with the qualitative law of change we have set out. The phase S is marked by the set of generalisations of the historical period. The quality Q is the activity of scientific men and the accumulated experience of others in contact with relevant natural process. The logical implications translated into practical predictions are represented by *q*. It is finally the contradictions between these predictions, and the actual immediate practical outcome of the activity Q, that transforms the generalisations S to a new level, and at the same time opens up new avenues to the activity Q.

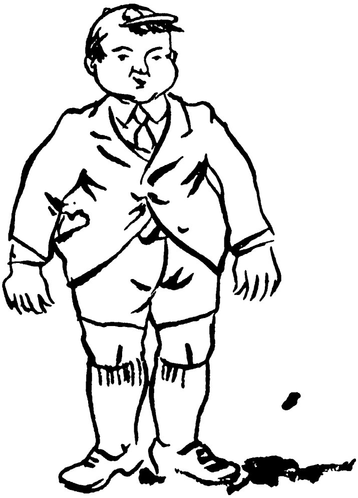
PHASE CHANGES IN LOGICAL PROCESS

This same process can be seen at work very clearly in the development of any logically well-knit science. When we say " If A and B are given then C follows " we have passed from viewing A and B as separate isolates, to A and B as a statistical group whose binding quality is seen in C. We say that we see the connection. At that stage we find that for further discussion we need usually refer only to C, in association with which we now bring forward a new isolate D and once more pass on to a new statistical isolate E relating C and D. The isolates A and B can be set into the background, and we are released from the burden of continually keeping them in the limelight of thought. They are present in the background in the shadows. At each stage C, E . . . we reach successive and rising pinnacles of understanding. We pass from phase to phase.

If it is proposed to establish a complex proposition in geometry for example, or indeed in any other branch of mathematics, the conclusion is arrived at by bringing to bear, in association, a series of lesser propositions. Each of these in its turn, if it is to be established, requires a series of still lesser propositions to be quoted. In this way we retrace our steps until finally we arrive at the initial assumptions and definitions that were originally brought into association, and that, therefore, manifested certain qualities as a group. At each stage it is the summated experiences of all the preceding stages that are dealt with as units with qualitative relations. In passage upwards towards the more complex propositions, these units are made to act as atomic propositions; when analysed down they are seen to be statistical with reference to the lesser atomic propositions from which they have emerged. At the higher statistical flights we throw off the burden of remembering the atomic propositions two places or more removed. We bear only the immediate ones in mind.

Now in describing the logical development in this way we must remark on two points. First we can see easily how a well-arranged treatment passes from one level to the next by building up wider and wider statistical isolates into which the lesser ones fit in orderly fashion. In the second place, however, it is not so obvious where the internal features enter that are responsible for the dialectical change. Where is the quality *q*? This point is being obscured by the fact that we have indeed only described the final structure and not really the details as a process of active discovery.

If I ask " given the assumptions *a*, *b*, *c*, *d*, *e*, *f*, then what follows? " I find it impossible to answer. The mind strives to cope with all the factors at once, boggles at their number and many-sidedness, and fails. If I reduce the demands on my imagination by asking " given *a*, *b*, *c*, only, then what follows? " I may still be unable to master the situation, although I may feel myself on the threshold of discovery. When, however, I reach the critical stage " given *a*, *b*, what then? " the implications become at once clear. I answer—" It is obvious that . . ." and I can then associate with the conclusion the next part of the material I am offered, say *c* or *d*, and I begin to see where the internally related qualities of *a* and *b* are partially or wholly contradicted by *c* or *d*. The mental stress is a quality of thinking associated with the struggle to find the greatest amount of material I can succeed in bringing together at one step, so that their mutual implications can be immediately grasped. In such matters then there is a critical stage at which the data can be dialectically transformed and from which something new—a conclusion—can emerge. Given more than a certain quantity of data at each phase, our thinking is slowed up and becomes confused. The phase has to be transformed by a process of ruthless scrapping



The struggle between content and form shows itself in the effort to express material changes by ideas, ideas by words; to accommodate a growing complexity in detail within organisational practice. It presents the first problem in artistic expression.

of such encumbrances in data as hold up the necessary advance in clear thinking.

Step by step then, the law we have stated is seen to fit the actual nature of the growth of theories and ideas as enunciated by human beings. Notice, however, in this case, that since the ideas are qualities of human beings, the change in phase has to come about by the formulation of a new set of ideas *by these human beings*. Thus in the end they become the causal agent that forces the phase over to the next stage. It is on this understanding that we would be entitled to refer to q, the data and its interpretation in this case, as the immediate cause of the change-over. We must not isolate ideas from human beings who carry them in their heads. What we are discussing at one level of isolation is a battle of ideas; but they are ideas held by human beings and they are stimulated into existence by the activities men undertake with the material world about them.

CONTENT AND FORM

We have just discussed what we have termed the battle of ideas. It might more appropriately be described as the struggle between *content* and *form*, the attempt to retain the old form of statement in the face of a too vigorously growing content of fact, very much after the manner in which a developing chicken has to break its way through the shell structure that surrounds it after the latter has fulfilled its function of enclosing and protecting the yolk and albumen during the embryonic stage. This is itself in fact a case of the qualitative change in phase to which we have been directing attention. The struggle of content with form is one aspect of this, but the phraseology serves to direct attention to a special feature. It indicates how the severity of the struggles for a change of form, or the deepening stress that leads to a transformation in phase, will depend also on the strength of the form that has been created in the past to hold the now obsolete content. Particularly when the phase is a human one, either atomic or statistical, does this show itself, for efforts can then be consciously directed to retaining the old form as long as possible. In such circumstances, as we shall see, other qualities than q are also brought into play, oppositional qualities that work in a secondary way to conserve the phase intact as long as possible. We can refer to these as *inertial or conservative qualities.*

ORGANISATIONAL CHANGES IN PHASE

We can see this struggle of content with form in the internal organisation of any large institution such as a school, a university, or a large business undertaking. When the institution is small the administration can all be handled by one leading individual in close association with his immediate colleagues. As the size of the institution increases so that its internal and external affairs (qualities) become more complex the struggle to hold the threads all in one hand grows more intense until finally, at a critical stage in size, and therefore in internal complexity, it simply becomes physically impossible to carry on. Work falls into arrears in spite of increasing efforts to cope with it, even by working longer and longer hours, and so confusion grows. If the institution must be carried on, then the next stage, a change in form of direction, that of delegating some of the functions to others, becomes inevitable and is forced into being. On that basis expansion proceeds again with renewed vigour. Control is passed on departmentally to various heads of departments, each of whom maintains contact with the original chief. For a time this new form is again successful. As each department becomes more complex, however, the respective heads find themselves unable to cope with the increasing mass of detail and they also proceed as before to delegate certain of their functions. Gradually the original chief and the heads of the various departments find themselves more and more aloof and isolated from the detailed features of the institution, and from the actual personnel who carry through the more subsidiary tasks; confusion, misunderstanding, and personal friction arise, individual and group grievances are ignored, and the time becomes ripe for a more thorough transformation of the whole machinery of administration of the institution, if it is to survive and develop.

Such are the changes through which the internal structure of most expanding sociological isolates pass. Under the steady pressure of its social functions—the remote causal agent Q—the internal administrative qualities and relations q are intensified or strained almost to breaking point, and reorganisation and overhaul of the form of the functioning isolate becomes inescapable. The history of any large school, or of any large business or factory or of any large government department will on examination be seen to have followed this course. A wise chief of staff or intelligent head of department who recognises that this process of change and of transformation is natural and inevitable, will remain consciously on the alert for the approach of the critical stage, and consciously take steps in advance to facilitate the new order. Those who cannot rise to the conscious level of appreciating and anticipating the necessity for such changes are forced almost mechanically by the internal pressure to carry through the transformation " against their better judgment," but their better judgment is in that case merely ignorance of a law of nature, a prejudice built up during a phase that has already passed away. It is a drag on necessary and inevitable change.

ILLUSTRATIVE EXAMPLES OF A BIOLOGICAL NATURE

Before we ourselves pass to the next phase of this discussion let us clinch our argument for the generality of the main proposition by some examples of a more biological nature.

Take the nature of the vegetation that is found in any area. Forest vegetation may embrace trees, shrubs, herbs, mosses, fungi, lichens. Marsh vegetation also shows its distinctive structure, bulrushes, cat-tails and so on; while desert vegetation covers cacti, palms and a variety of other plants. The vegetation of an area is a clear illustration of a statistical isolate. Take a forest for example. The trees have a very far-reaching effect on the other plant life that may develop. They modify the action of sun and wind on the earth beneath them and on the vegetation that may arise there ; and by depositing successive layers of leaves on the ground they affect the moisture content in the soil by preventing it from evaporating. In this way they are largely responsible for a special type of ground preparation and so encourage the growth of special forms of vegetation.

Thus the trees exercise a very distinctive quality in their relation to the remainder of the isolate. Again they are not independent of each other; if closely packed they grow up tall and slender, the lower branches remaining stunted, so that only particular types of trees can survive in such circumstances. Here, then, is a large-scale isolate possessing a great number of remarkable internal and external qualities, the growth and development of one part affecting the growth and development of every other. Vegetation, as we shall see, transforms the environment, and the environment in its turn the vegetation. It is almost like a society of human beings. We may expect, therefore, to find in the growth of vegetation dialectical changes manifesting themselves over and over again, whereby the whole isolate passes from phase to phase.

Any given region of vegetation at any period of its history has a very obvious structure. First there is a dominant species that is largely determined by the prevailing climatic conditions of the area. Thus in open forests there may be yellow pine and bur oak. With such trees sufficient light penetrates through to lower levels to admit of the growth of shrubs. The dominant trees themselves largely settle which of these secondary features will develop. Below the shrubs grow grasses and herbs, and below these again such mosses and lichens as can survive in the shade. Here, then, is the temporary structure of a statistical isolate and the interplay of these various forms of plant life should show the general features we have been discussing. What we have described is roughly typical of an open forest, but we have to remember that for other regions other isolates of this nature would have a different structure. Moreover seasonal changes also manifest themselves within the one isolate. It will be periodic besides dialectical in its changes.

Let us begin with a simple illustration. Suppose we have a region covered with shrubs. Trees whose seeds are carried by the winds gradually grow up under the shelter of the shrubs which protect them. Once these have established themselves they draw the nourishment from the soil away from these shrubs, slowly overshadow them and presently starve them out altogether. A new phase, that of woodland, will have emerged. Or again, take a stretch of prairie grassland. Trees will succeed repeatedly in sowing themselves, their seeds borne along by the prevailing winds, only to be as often burned out during prairie fires. Finally, a long enough period of immunity from fires occurs for them to become established and in doing so they shade the grasses so effectively that the latter die out and the prairie fires cease altogether. The invasion is complete, for the trees have then succeeded in driving the previous population completely from the scene.

Now consider how a forest itself may be transformed. Suppose, for example, the climate is wet so that the forest floor is moist with decayed leaves. During the dry season this moisture may be largely evaporated. Presently sphagnum moss, encouraged in such an environment to establish itself, begins to invade the forest floor, particularly where there are any springs or seepage water. Under such conditions it will grow and expand its territory steadily, holding the water just like a sponge. Finally the whole area becomes waterlogged, the roots of the trees rot, and the forest gradually begins to disappear. A new phase has supervened. The dialectical transformation has been carried forward yet one further stage.

Finally, let us consider briefly how a forest becomes established over a region previously covered by deep water, a process that must have occurred on innumerable occasions in pre-history. The first step points to the accumulation of bacteria and decaying organisms on the bed of the sea or lake. Slowly on these there arise submerged plants that grow and die, steadily raising the level of the bottom. Presently floating plants begin to form on the surface, connecting up with the bottom that now is just below the surface. The lake has at last been transformed into a swamp, usually a reed swamp. The roots cause the ground to firm up and soon it is a sedge meadow. The next stage we have already described. Trees begin to seed themselves, and as they become established the grass disappears. A woodland has now taken its place and finally a forest with all its usual variety of secondary vegetation. The transformation is complete. It should now be clear that in all these illustrations precisely the same general process has been gone through ; an active causal agent Q driving the process forward, an internal quality *q* aroused in this process that acts as a negating factor to that stage of the process, and finally a new phase forced into existence by the canalising influence of *q*.

One last example from the animal world that brings out the dangers into which one might slip by an uncritical application of this law. It has been remarked that the Red Deer of Scotland are lower in body weight and in antlers than in any other part of the continent. In some districts of Scotland their weight is as low as 75 kilograms, and rarely exceeds 125 kilograms anywhere in that country. Also their antlers may have only six to twelve points whereas in the Carpathians, for example, they may have as many as twenty to twenty-five points with about twice the body weight. Now in the peat bogs of Scotland skeletons of deer have been found rivalling the largest existing European specimens in size and number of antler points. Julian Huxley (*Problems of Relative Growth*, p. 205) points out that while it would be natural to suppose that the low size and slight antler development of the Scottish deer implied a true geographical sub-species it would be difficult to imagine that a true evolutionary (genetic) change, reducing the body weight by half, could have occurred in such a short time. To what is this drastic change due ? What process has been at work that has transformed the animal in such a short time? It has been surmised that in some way this may be associated with the fact that so many Scottish forests have been cut down and converted into agricultural land and in this connection we must bear in mind the fact that the Red Deer is by nature a forest animal.

Now during the last hundred years a number of Red Deer have been imported into New Zealand from Scotland,

and liberated. In the new environment, profusely covered with forest, the Scottish animals attained weights of over 200 kilograms with antlers of twenty points and more. As Huxley remarks, they bridged the gap between the Scottish and the Carpathian strains in one generation ! So much for the effect of the causal environment Q in arousing *q*, the vigour of these animals.

In this propitious environment the deer multiplied rapidly, especially in the absence of natural enemies. The numerous herds began to destroy the forests they fed on, and so to transform the very environment that had been responsible for their development. Almost immediately degeneration set in, so that the body weight and point numbers of the antlers rapidly slipped back to what it had been a few decades ago.

WHAT IS THE TEST OF A PHASE CHANGE?

This last illustration raises a point of great importance for us. What indeed is a change in phase ? If a beam is bent until it breaks it is obvious that the phase has altered drastically, but the crucial test is that, by relaxing the force that has given rise to the bending, the beam does *not* return to the original condition. The mere withdrawal of the causal agent does not reinstitute the original set of circumstances. An irreversible historical event has taken place. [Under highly controlled conditions the scientist can sometimes obscure the historical nature of the event and reverse the phase, as when he changes water to steam and back again, in a closed vessel. How he appears to set history at naught we have already discussed on p. 97.] Here we notice that in the case of the Red Deer no such change had apparently taken place in the animals as a species, if indeed the statement is correct that they had returned to their original condition after the destruction of the New Zealand forests. The changing of the environment was then accompanied by a deepening (or a weakening) of certain qualities in the deer; the relaxation of the environment, even when it was occasioned by the deer themselves, enabled the latter to return along their qualitative path. Unless the animals had bred true to the larger type in some way there would not be a true phase change. This then is the statement equivalent to what the geneticist asserts when he would say that the smaller deer did not constitute a special sub-species. This immediately suggests a difficulty, a contradiction in the data as presented. If the removal of the forests in Scotland were responsible for the decrease in the weights of the deer, and if when transplanted to an environment where forests were plentiful the deer themselves multiplied so that *they* destroyed the forests, why then did these deer not likewise destroy the forests in Scotland prior to their being removed for agricultural purposes? What kind of equilibrium conditions had been established in Scotland that could not be established in New Zealand between deer and forest? The answer appears to be that in Scotland there are natural enemies (including man as a sportsman!) that were absent in New Zealand. Thus the situations in the two countries were not comparable. There were in Scotland constraints on survival that did not operate in the other country.

ARTIFICIAL DELAY IN PHASE CHANGE – MECHANICAL FASCISM

The phase change can be delayed by the introduction of artificial constraints. This conception, as we shall see, is very important indeed when we come to consider the nature of the resistance that is offered to social and political change, but we can illustrate it more directly in the first instance from some of the scientific examples we have already given.

(*a*) Consider the case of the body moving through a liquid. It will be remembered that the two initial phases referred to were those corresponding first to very slow motion of the body, in which case the liquid moved smoothly and easily along its outline, and secondly to much quicker motion, in which case whirlpools were formed in the wake or rear of the moving body. Now it can be shown that these whirlpools grow out of the layer of the liquid in immediate contact with the body. Along this layer the fluid is being dragged forward by the body, while a short distance outwards from its surface the liquid is being dragged relatively backwards. It is being left behind. This gives rise to a sort of rolling motion in this narrow layer; these rolling elements move down towards the rear of the body, and collect there. When this reaches a critical amount, the whole collection discharges itself as a whirlpool. This is itself an illustration of how a change in phase originates. The whirlpool is a statistical unit of which the rollers are its atomic elements. Accordingly it becomes clear that the unruly section of the liquid that is the immediate cause of the trouble, the quality q as we have called it, is this layer close to the body, where the fluid is most sharply sheared. If therefore instead of taking a solid body we take a hollow one, and bore very small holes through it at a series of points on its surface, and if we arrange in some simple way to suck the boundary fluid through these holes and incarcerate it inside the hollow body (just as if it were a concentration camp for radicals) it is possible to increase the speed of the body very far beyond the previous stage without producing the whirlpools, and the general turbulence which would otherwise have appeared at the increased speed. Finally, of course, in spite of this artifice, turbulence is set up by those fluid layers further removed from the boundary of the body. The artifice merely postpones an inevitable process.

(*b*) In the case of the whirling shaft that is thrown into a snake-like form and finally bursts asunder, if the motion be allowed to persist, this also may be delayed by imposing external constraints that will prevent it from whipping outwards. This can be done by imposing on the shaft a larger and larger number of intermediate bearings. Finally, however, if the speed of rotation be great enough, in spite of these constraints, the stress in the interior of the metal will reach the critical breaking point by centrifugal action alone.

(*c*) In the case of the liquid that passes to the gaseous state by being heated, if the atmosphere above the liquid be kept under pressure, or if the vessel containing the liquid is closed so that none of the gas escapes, the temperature to which the liquid will require to be heated before boiling occurs will be very much higher. Finally, however, it must boil or burst.

(*d*) Artificial preservatives can be used to delay the transformation of food-stuffs and fruits from the nutritional to the poisonous stage.

In the next section we propose to discuss the form in which these processes show themselves in sociological problems. There, however, features enter without parallel in the sphere of experimental science. In the first place social development is an historical process. It is not controlled or reversible in the simple scientific sense. There is no superhuman being who decides how history shall unroll itself, in what order the phases shall occur. Man is himself part of the process and he is one of the agents, if not the crucial agent, in forcing the passage from phase to phase. Man is a conscious being, but he may not be conscious of the rôle he plays in this process. Moreover the kind of material with which we shall be concerned, the behaviour of large groups of human beings, sets the problem on a different plane from any simple scientific question. The characteristic qualities lie at a different level of complexity. The law exhibited by their changing forms will differ from those of a simple scientific nature, for example, a whirling shaft or a mass of gas. Yet if due allowance is made for the nature of the qualities at work we shall see that the difference is not so great as might appear at first sight.

CHAPTER IV

WHAT CAUSES CHANGE

Here we discuss the meaning of causality and determinism in relation to the various levels of group activity and in the light of the generalised law of change. The dangers inherent in a merely mechanical use of determinism are exposed, and its appropriate form and correct use in prediction carefully explained. The belief in the objective existence of causal process is justified, and the part played by human beings as causal, i.e. "free" agents within restricted social circumstances expounded.

GENERAL AND HISTORICAL

THE terms Cause, Causality, Causation have themselves been the occasion, one might almost say the cause, of endless confusion. To discover the cause of things has been put forward as the task of philosophy since the time of the Greeks, as if knowledge of cause stood on a different footing from any other kind of understanding. So also with Francis Bacon (1561–1626) when he writes "Vere scire esse per causas scire." To Mill a knowledge of the Laws of Causation meant the power of accurate prediction in every detail. Both physically and logically the present was involved in the past, and the future involved in the present. To a particular event, a particular cause; and all that was apparently required in order to forecast the event in every detail was the necessary and invariable conditions under which the cause acts. We shall see presently what an excessive over-simplification of the true situation this is. The mediæval scholars appeared to accept this view. Each cause is the effect of a previous cause, they argued, and so they found themselves ultimately driven to admit the existence of a First Cause that stands behind all other causes. This they identified with God; an argument that is still presented to-day by theologians as if it were an inescapable conclusion. The argument might have proceeded otherwise. If, instead of asserting that each cause is the effect of a previous single cause, we say it is preceded by a group of causes, then we are led to the prior existence of a whole hierarchy of causes that diverge or branch out like the twigs of a tree. Mill's view, that of the early nineteenth century, we say is an over-simplification. It suggests that the universe in all its manifestations acts not merely as a large machine but as a mass of self-contained small ones. Our knowledge of the world is limited in time and space to a tiny compass of the world about us; our understanding of the so-called invariable conditions under which causes are presumed to operate is necessarily equally restricted. Causality, therefore, in this mechanical sense, if it is to be operative at all, must be completely valid even in the limited compass of small regions. This view moreover makes no allowance for the nature of causes being dependent on the nature of the materials with which they are concerned. Are possibly some causes passive and others active ? Are we always to expect causation to act quantitatively or are there circumstances in which its action is confined to qualitative change ?

The word cause itself has been defined in a variety of ways. Hobbes tells us that " A cause is the sum or aggregate of all such accidents both in the agents and the patients as concur in the producing of the effect propounded: all which existing together it cannot be understood but that the effect existeth with them: or that it can possibly exist if any of them be absent."

Others have defined it as the object or event that immediately precedes a change and which existing again in similar circumstances will be always immediately followed by a similar change. Jevons points out the latitude that is used in the things or events to which the term cause is applied. For example, even the absence or removal of a thing may be a cause, as when we say that the absence of moisture in the Egyptian climate is the cause of the preservation of mummies, the cause of a mountain elevation may be the denudation of the surrounding regions, and hence the formation of valleys.

Prior to the middle of the seventeenth century the conception of cause was essentially a combined philosophical and theological one, and it is not until the scientific renaissance of the early Newtonian period with its attempts at exact mathematical predictions of natural process that a distinct change begins to set in. With it came also a readjustment in the conception of determinism. In the theological sense causality and determinism were not necessarily associated. Indeed side by side with God as the First Cause stood two doctrines. One doctrine maintained that Man was the possessor of Free Will, having a free moral choice in his actions, albeit a will that was in fact only free economically and socially when it operated to fulfil the dictates of the catholic church. Like Galileo one was free if one handed oneself over mentally and spiritually trussed to the all-powerful church. The other doctrine maintained the principle of predestination in spite of the charge that, if God had predestined everything, it implied that " God was the author of sin, God really sins, God is the only sinner, there is no sin at all " (Cardinal Bellarmin). These were the dilemmas into which the contending schools were thrusting each other in their battle of words. Beneath the surface, however, this struggle was something much more significant than mere verbal argument. It was the form in which two warring classes were contending for the hegemony of society. It was the challenge of the rising bourgeoisie eager to inherit social power predestined for them, a challenge rallying to its aid serf and peasant against the feudal church.

From this background of theological philosophy disturbed by a rapidly growing accumulation of mercantile, commercial and astronomical data there emerged the scientific renaissance. Kepler, analysing masses of astronomical data, from a welter of arithmetical detail isolated the regularities of planetary motion only to maintain that the heavenly bodies were urged along their courses by angels. Newton, whose private life was devoted to a close study of the dates and prophecies in Daniel, devoted his public life to the erection of a mathematical and mechanical framework to enable man to become his own prophet in the world about him. It was essentially a period midway between science and mysticism. The body and soul of man was being released from the thraldom of mediæval feudalism. And so the seventeenth century saw mechanical determinism beginning to push its way to the front while God the First Cause was silently bowed to his new place in the background; the Great Engineer, who in some remote beginning wound up the colossal machine, released the lever and set it going. From now on, determinism became a calculable process, involving the numerical prediction of future events. These referred to mundane events, mere movements of lumps of matter. No moral issues were involved. Causality also began to move out of the theological field. It became a force in nature that guided these lumps of matter irrevocably along their predestined grooves. It was a non-spiritual force whose operation made things determinate. Behind it all, however, stood God the Creator, the First Cause, the Cause of Causes, remote, austere.

With such a past history before us we have to beware of importing into our analysis of the problems of causality and determinism, ideas and words that have no other justification than that they have held an historic place in a controversy that was not so much concerned with discovering the nature of objective processes as providing a justification for religious beliefs of a past epoch, of offering a sanction for the continuation of the social supremacy of the feudal church, or of justifying the inevitability of the overthrow of the power of that church by a new social class.

DIFFICULTIES OF CAUSALITY

The idea that causality may be at work in nature raises a series of difficulties in the minds of most people. There is the suspicion that it implies the existence of a human or personal activity " out there," independent of human actions, and that it is therefore a transference to inanimate matter of something only human beings exert or apply, a form of anthropomorphism. While we can think of ourselves and others as causes, can we imagine a piece of dead matter acting as a causal agent ? Again, we can see a piece of material, a colour, we can " see " an argument, a piece of logic, but can we see a cause ? How can we get to know and verify the existence of a cause ? Is it not the case that all we ever see are objects in motion or at relative rest ? Do we ever really see a cause, and, if not, on what basis of evidence is it justifiable to assert that it exists ?

There is another difficulty. Are we not generalising too rashly from physical science ? It may be justifiable to say that the deeper science penetrates in its analysis of objective nature the clearer does it become that natural processes of that type can be fitted into the form of systematic law so that the behaviour of objects and groups of objects can be predicted with varying degrees of accuracy. It may consequently be justifiable to assert that causality and determinism manifest themselves continually in the field of objective nature. The actions of individuals and of groups of individuals in society, however, can hardly be predicted in just this way. Dare we say then that causality and determinism are operative in the field of human affairs even if it be granted that they manifest themselves in the scientific laboratory ? Here, be it noticed, we have turned full circle. We began by querying whether we are not dragging human characteristics into inanimate matter in our effort to interpret nature, and now we are questioning whether we are not guilty of an undue extension of the scope of causality and determinism from this field back into that of living matter.

May it not be that causality is imported into nature by man and that it shows itself in the laboratory simply because the scientist " causes " things to happen by the control he exercises over the arrangement of his material ?

Is it possible that scientific laws are man-made in a very real sense? Perhaps it is the case that there are no laws in nature but that they are simply created by man in his effort to understand it. Perhaps they are implied in his method of analysis.

Finally there is a very old difficulty; how can there possibly be causality in nature side by side with the human conviction that man is a free agent? Does causality not mean that every aspect of nature is determinate, our actions, our feelings, and our inmost thoughts? Then in what sense are we free at all? How could this sense of freedom survive if it were not an objective fact? What would be the meaning of this contradiction? And what, moreover, would be the good of doing anything if it is in this way determinate? We would be merely a collection of marionettes making clockwork gestures, but having a mechanically acquired feeling that we were making these movements because we *wanted* to make them; thinking and feeling erroneously that we could *if we cared* have done quite otherwise. Apart from this what can be meant by the statement that our thoughts are determined? What is this causality that can pass so easily from the field of matter to that of mind producing its result with infallible precision?

These are a variety of the puzzles that spring up as soon as the question of causality is raised in general form. And now we turn to a difficulty of a different order. Surely if causality exists as an actual objective something—shall we call it a force?—this would imply the possibility of repetition of an effect by the causal agent if, again and again, it is directed to operate in the same circumstances. After all in what other way could causality be exposed to view? Yet nowhere and never does history repeat itself exactly in every particular. If we admit the existence of a causal agent at any moment its operation, by definition, changes the circumstances. How then can we call it the *same* causal agent in the next moment? Does this indeed mean that we must not regard it as a causal agent but as a causal process at work, and, if so, what is the constant background against which this process can be viewed and isolated for examination ?

We are already getting into deep water, so deep in fact that we may feel ourselves induced to give up causality simply as a complicated and complicating fiction. If this is indeed the case, if the introduction of the notion of causality is no simplification but rather the contrary, what is the alternative ? Have we to fall back on the admission that anything may happen at any moment, that the universe is an irrational chaos, that order and understanding are non-existent, a mere human fiction. All these queries and the difficulties they appear to expose must be set out for careful scrutiny and examination in the light that is shed upon them by the whole history of science, of our accumulated knowledge, of rational understanding, and of control over nature. If causality appears to have shown itself in the restricted field of physical science can that help us, we must ask, to discern its further play in more extended regions of study.

SCOPE OF LAWS

Let us begin by summarising in a general way the scope of scientific laws as they have been formulated in the field of physical science. By this means we may be enabled to see more clearly the restricted nature of the field to which such laws apply; and indeed the restricted nature of their application in these fields. If we can in this way become aware of the limitations that are implicit in physical science we may then be in a position to recognise how law might be extended outside this region, what is to be expected of such an extended type of law, and whether, if the restricted scientific law depicts some restricted form of causality at work, the extended law depicts some extended form of causality also at work.

Now a scientific law is usually presented in the form of a general assertion. Thus:

"Every particle in the universe attracts every other particle with a force that is directed along the line joining the two particles and varies inversely as the square of the distance between them."

Such a statement tells us what something does and the circumstances in which it does it. It describes a process. It can be regarded as an isolate. It is statistical in the sense that it summates a mass of experimental data and inference. These are all qualitatively related and it is this relationship which is the essence of the final statement. The conditions under which the experiments are successful, the actual data found, and the process of inference, are the atomic isolates. When therefore we come to enquire what a law is we shall have to direct attention to the relation of the law to each of these constituents from which it finally emerges.

But a law may itself be an atomic isolate of a larger statistical unit. For example it can be viewed as a statement having a relation to the group of scientific workers who have pursued its study, or to those forces in society that have required the pursuit of these enquiries by scientific men. Here then we are thinking particularly of the activities of men, the process they conduct as they struggle to understand, control, and shape nature to fulfil their needs. Scientific laws and their formulation, then, play a part in this scheme of things. They become the tools of men and are forged out of the raw material that nature offers or that more primitive tools enable men to unearth. The law is, then, merely an atomic isolate in this more-embracing human process.

Again it is a statement that has to fit into the logical structure, the whole logical development of science. It is always possible to set out the content of any science in abstract logical form. The process is one both of collection of data and the drawing of inferences. In the logical exposition, the data become assumptions and the rest reduces to logical exposition and inference. In this process the successive stages in the sequence—data, inference—

further data, wider inference—are marked by the formulation of scientific laws of greater and greater power and generality. In this sense the law is an element in a complex logical process.

All these aspects of a scientific law must be taken into consideration when we come to analyse its qualities.

A LAW AS A STATISTICAL ISOLATE

We begin then by regarding a law as a statistical isolate. There are then always at least two elements or atomic isolates involved in its statement, one of which draws our attention to the essential feature of the process and thereby classifies it: the other is a relational quality in this process. Here are three specimen laws:

(*a*) All gases *of equal volumes under the same conditions of pressure and temperature* have the same number of molecules.

(*b*) All bodies *immersed and at rest in a liquid* will appear to lose weight equal in amount to the weight of the liquid they displace.

(*c*) All bodies *falling in a vacuum* will every second gain in speed by 32 feet per second.

In each of these a certain set of conditions (italics) is specified and the law states the form of behaviour of a class of object, gases and bodies, in these *given* circumstances. The given circumstances define a class of circumstances. Thus:

(1) *It is a statement that, defining a process in one way, points to the necessary existence in that process of a quality not used in the definition.* The definition of the process is also a definition of a class of objects that can carry through this process. It is therefore a method of classification.

The quality pointed out, also defines a class, viz. those objects or processes that can possess this quality. Hence the law sets out a relation between the two classes.

Thus a scientific law directs attention to the way in which a particular uniformity of behaviour in nature may be made to show itself. It shows how one uniformity follows on another. Make the circumstances in which a series of experiments are done the same in certain respects, then the result is the same. For this to have value and meaning, however, it has to point to a *uniformity in the presence of diversity*. For example (*a*) asserts that the gases may be different in all respects other than those mentioned in the given circumstances. Again, (*b*) asserts that we can ignore the composition or the colour of the body or of the liquid. They have simply to belong to the classes solid and liquid. The same things applies to (*c*). The solid can have any shape, can start off with any initial speed, it can be as hot as we like and any colour. The various members of the class can be as diverse as we care in their other qualities. All that is necessary is that they possess the one set of uniformities, viz. that they be bodies falling in a vacuum; in that case the law states that they will possess the other uniformity. Accordingly we can say that a law in the sense (1) points out a linkage between two uniformities, in spite of other diversities, a physically necessary linkage.

It does more than link qualities. It does not say simply that all bodies fall in a vacuum with increasing speed. It says that these increases are regular in amount and tells quantitatively what they are. It is both qualitative and quantitative.

Turning now to the relation which the law expresses between the data from which it is derived, and those further data to which it is to be applied, we state:

(2) *A scientific law is an induction.* An induction is a general statement that outstrips the restricted data from which it has been formed. It forecasts. If we recollect the nature of isolation, it is not difficult to see that a general statement is one that confines itself to certain isolates common to this data. In becoming particular it becomes general, a unity of two opposite conceptions. The importance of an induction consequently lies in the fact that it provides at one and the same time an avenue for the collection of further *relevant* data (relevance being determined by

whether they possess the isolates in question) and a test to determine whether the *form* of the induction can still be maintained unchanged in the face of the new *content* it has to include. From this standpoint therefore a scientific law can be seen to be a statement embodying the cream of past experience but stated in such a form as to point to the next experimental step with its possibility of a more searching, even a more general law.

Such laws enable us to make predictions. In accepting the generality of the law, implied in the word *all* for instance, we would be accepting the validity of the prediction. To put the matter in this way, however, would be to give a false description of what actually occurs in practice. It is to make it static rather than dynamic. We can see this best from a third statement of what we can mean by a scientific law.

(3) *It is a statement that, leading us to anticipate uniformity in behaviour of parts of nature, acts as a guide to human action.* This is to direct attention to the fact that human beings alone frame laws, and that they do so for some specific purpose. Were it not for the urge to satisfy some such need, uniformities would be of no interest to them. Nature might as well be a chaos, where at any moment anything might happen. Man's need in the first place is to anticipate events, to see into the future, in order to make preparations to meet it. He can remember the past and through that memory know the future. A scientific law is a unity of past and future. It is necessary in order to survive. Thus out of this there emerges also the need and the possibility of planning. For this he must exercise control over the future, bring certain events into being. To this end he needs natural law, not simply with reference to events that can be predicted but to events that will be made to happen if circumstances occur whose nature he can specify to himself in advance. These circumstances he can sometimes bring about in the present. And so the qualities of a scientific law that are of vital importance to him are those associated with the *given*. circumstances. If he can arrange and control these the anticipated event will occur. Planning is thus to know and

to also *give* himself these circumstances. When we make our third statement therefore of the nature of a scientific law we are really directing attention to the circumstances in which the law can be made to apply rather than to the isolated content of the law as an idea. This is no trivial matter. For example, if it is suggested that a decrease of the rate of interest to *x* per cent will be followed in certain circumstances by a fall in unemployment of *y* per cent and if, in point of fact, the particular circumstances about the rate of interest can never be realised even approximately, the statement tends to lose its status as a real law. Here the actual application of the so-called law demands human action by those apparently in a position to arrange the circumstances; but if the result is also to decrease their income derived from interest they may not be prepared to plan the circumstances of the experiment. The *given* circumstances become then fictitious, and with this also the so-called law. This touches one of the crucial differences between socio-economic laws and scientific laws in the restricted sense. It introduces the part played by man in making the law come true.

A scientific law embodies all these characteristics:

It describes *a linkage in an objectively changing situation.*

It is couched in such a form as to arouse a legitimate sense of *anticipation regarding the outcome of future events.*

It indicates *what has to be done in order to bring certain events to fruition in the future.*

The inner significance of the last statement in its relation to the problem of this chapter must be underlined. It shows that a scientific law enables a *linkage* to be brought into being between a process carried through by ourselves in the present and a natural process in the future.

In the one case the law points out a linkage between one set of objective circumstances and another, in the other case it points out a linkage between our own actions and a certain objective process. Unless this point be fully appreciated we may later be led to imagine that to use a word like causality is to introduce a teleology or a form of animism.

Now involved in all three aspects of law that we have enumerated is the idea of prediction. But prediction may be of two kinds:

(i) We may say that such and such a thing will happen by a certain amount in certain specified circumstances, as for example when we predict that next year at least so many miners will be killed in mines, or that at least so many people will be killed on the roads in England next week. We are pointing to a regularity in our social life, itself a part of nature. The possibility that it may be temporary is beside the point. All laws are not unchanging and eternal. In such circumstances the prediction can be verified, after the fact. Moreover it professes to be accurate. It is accurate even although it merely says "at least." It is accurate when the facts are found to be consistent with the statement as made. Again, we may predict that the maximum speed of a certain car is 60 miles per hour and we may do this either from an examination of the way in which the various parts of the car link together, or from a knowledge of the maximum speed of a large number of other cars similarly constructed. In the one case we seem to be making a deduction and in the other an induction, but on closer examination it will become apparent that both involve deductive and inductive processes. For the behaviour of parts of the car is derived inductively from the behaviour of similar parts in similar circumstances, and these inductive conclusions are used for *deducing* its maximum speed. On the other hand the statement—an induction—that this car will behave like the large number of other cars is one based on a deduction concerning the actual cars that have been tested in the past. The distinction between the two processes is more apparent than real.

All the predictions we have mentioned are qualitative although not always quantitative in nature. Thus:

(ii) We may say that in certain circumstances dark lines will appear in a spectrum, a solid will change into a liquid, a harmony will change into a discord, a click will be heard, an object will fall, love will change into hatred, an idea will be proved false, and so on. These are all qualitative changes, for which there may or may not be an easy method of measurement. The prediction may be quite significant for its human purpose without the measurable characteristic. In fact it is precisely a law of this nature that we have already discussed in very great detail, the law of dialectical change as we have called it. A qualitative prediction is by far the most common form, but for various reasons we fail to recognise this. So much so indeed that it is sometimes asserted that there can be no science without measurement, but this is in fact an unwarranted generalisation from a certain aspect of physical science.

A scientific study of nature is concerned with the search for regularities. Each class of regularity is described in its own way. This may range from mainly qualitative to mainly quantitative forms. For instance there are æsthetic emotions of human beings whose significance lies in their quality. There are features of mathematics and of arithmetic whose significance lies in their numerical aspects. Are we to say that there is a rational way of describing the latter and not the former? For all these aspects of law to which we have referred are simply aspects of our search for rational questions to ask of nature in order to ensure that we receive rational answers. To each qualitative level its own type of rational question. The answers received give to each of these its own type of law. To each type of law its own special form of prediction. From *a qualitative law a change in quality only will be predicted*, and used in its appropriate way by human beings. From a quantitative law a prediction concerning the relative strength of a quality is to be expected.

EVERY LAW BOTH STATISTICAL AND ATOMIC IN ITS NATURE

It has been part of the general theme of this book that every element of the universe exhibits at one and the same time a form of atomic and of statistical behaviour. In

Chapter II we have seen, for example, that even such a simple matter as the measurement of a length shows this twofold aspect. The numbers obtained by a group of people express, in the diversity of the measures found, the relation of this group to the object measured. That is a statistical quality. On the other hand if we lay the stress on the object measured rather than on the process of measurement or on the group that is doing the measurement, we take the average, say, as the *approximation* to the true length. The latter then represents an atomic element. It is then regarded as a *property* of the object. The different measures, by different people, of the true length are then said to be due to "errors of measurement." With the atomic concept, goes a *true* value, and therefore "errors of observation." With the statistical concept, goes a group of numbers that are true in the sense that these are exactly what have been found. They can then be regarded as a *property* of the group. Thus there is a two-end relationship between the object and the measurers. The one approach stresses the object, and the other the group of measurers. Each has a true measure relative to that stress. If we can see this clearly and realise that what we have said about the measurement of such a comparatively simple thing as a length applies with equal force to every type of measurement other than simple enumeration of small groups of objects, a new light begins to be shed on the numerical side of scientific laws. The law giving the time of swing of an ordinary pendulum, for example, would appear to tell us the *true* time taken to complete exactly 100 swings of a pendulum with a certain *true* length at an *exact* position where the pull of the Earth on the bob of the pendulum had a certain *true* value. This is to regard the law as a summation of atomic elements. On the other hand if we regard the symbol for the length, and for the pull of the Earth at that position, and for the time of a swing, as they appear in this law, as representative each of a group of measures as they would be found by a group of measurers, the law begins to wear a very different aspect. It is a law for a statistical grouping of statistical isolates rather than for a statistical grouping of atomic isolates. As will presently become apparent the kind of determinism that is exposed by it relates in the one case to the movement of matter without regard to human intervention, and in the other case it relates to the behaviour of groups of human beings handling objects in which they are interested.

PROBABILITY IN NATURE

Now we have already referred to the fact that in predicting the behaviour of groups of individuals in such a qualitative situation, the appropriate mode of measurement is a probability, and this would appear to be inescapable now that we are involved in the statistical approach. In the minds of most people and indeed even in the minds of most scientific men there is a series of deep confusions regarding the precise meaning and function of probability in relation to science. It is desirable, therefore, at once to clear the ground by spending some time over this.

The practice of probability encompasses a wide and extensive field: vital statistics and all forms of insurance; actuarial calculations involving industrial, commercial, and social forecasting; social statistics in relation to legislative action; standardisation in production and engineering practice; sampling in biological and chemical assays; designing experiments in agriculture; the control and balancing of errors in experimental processes; statistical methods in mechanics and in the mathematical examination of mass actions; the application of the laws of chance to gaming; and the testing of the significance of general conclusions drawn from statistics such, for example, as those associated with intelligence tests. Finally, there is its use as a guide in personal decisions, the nature of the estimates we make as individuals that arouse in us a subjective sense of expectation. Each region of application has its own particular series of theoretical developments, and in laying the foundations soundly and logically, its own set of basic assumptions. Broadly, the whole field can be subdivided into mathematical probability, statistical probability, and probability as a branch of formal logic. From the present standpoint these must all be regarded as cross-sections of a greater unity, viz. probability as a reflection of objective processes in nature, as an instrument of discovery and as a guide to human action. Thus, from this point of view, probability is an indispensable part of scientific method and plays its rôle in the making of predictions and the determination of causal relations. The crucial methodological problem is to define the circumstances in which any particular aspect of probability, and the degree of that probability, is a sufficient and necessary description of an objective process, and a sufficient and necessary basis for purposive action.

Now the difficulty experienced by most people in relation to this topic is associated with this idea that probability can, in any sense, be a "reflection of nature." Educated as they have been in a tradition that tends to regard the universe as composed of "objects," each with its own characteristic "properties," and acted on by various forces, they are led to see each element of the universe follow a deterministic course whether scientific men can trace the detailed path or not; this, they feel, must apply no matter how "elementary" the object may be. In this way they are driven to the conclusion that if probability enters at all it does so only from lack of detailed knowledge on their part. While this would make probability, as a theory of errors, a part of the scientist's apparatus of prediction, it would not necessarily make it a reflection of any actual happening in objective nature, other than in the brain of the scientist. This standpoint, of course, leads to mechanistic determinism, since it would take no account of group or statistical activity, and the new qualities displayed by a group—as a group—distinguished from the elementary atomic elements of which it is composed.

The difficulty then arises from a simple limitation in outlook. It arises from an inability to distinguish between, or even to recognise, the varieties of isolates and their levels with which we have to deal. From one standpoint, science is the search for uniformities in nature, and their use by man, as causal agent in constructing artificial uniformities and in discovering new natural ones. An object that persists is of course a uniformity; a scientific law describes a uniformity in behaviour. A gas and its laws are uniformities, although there may be little evidence to enable us to assert that the constituent molecules are uniform as between one and the other. The variation in numbers of people who travel by Underground in London to and from their work at various times of the day is a uniformity in mass behaviour, an accurate knowledge of which is required by the appropriate authorities in order to cope with their transport. There is a variation from day to day of the actual people who travel; the individuals who do so may be exercising their " free will " in deciding to travel, but the net outcome of these decisions is to create a certain law of behaviour for the mass isolate. It is the law of their free-will behaviour. The mass law describes a " higher " level of behaviour, and it is used by the transport authorities to create a corresponding uniformity in the running of trains.

There is yet another level that may be seen, and is in a vague way used. Once the relation between individual behaviour and that of the group is understood and clearly formulated, the group eventually becomes conscious of the laws it manifested when it was not consciously creating laws, and it can organise its group behaviour according to plan, making its own laws with deliberateness. This occurs when workers in an industry, having up to a certain stage established regularity in attendance at their work, decide to go on strike. Here they are consciously creating a new group law of behaviour and using it for a specific purpose, just as an industrialist utilises a chemical or engineering law in the process of production. But this level of behaviour is distinctive of human groups. A gas does not change its laws in virtue of the fact that its molecules have become conscious of how their individual motions and impacts aggregate together to a new statistical isolate—pressure on the walls of the containing vessels.

Let us then restate these levels for further discussion here:

1. *Atomic Isolate.* Here the unit is recognised by a certain quality treated as if it were isolated from the rest of nature, and its numerical behaviour predicted in a deterministic way experimentally or using some mathematical theory. By contrast, probability emphasises the fact that the isolation is in reality fictitious. Indeed, it is precisely through the so-called " theory of errors " of experiment that allowance is made for the linkage between the supposed isolate and the rest of nature.

2. *Group or Statistical Isolate.* Here the quality is also a definitely objective event or process, like the hum of a city, the pressure of a gas, the morale of a regiment, the shape of a water-wave, the attendance at a football match, the density of population in a certain area. Prediction may move in two ways. First, as in the case of the atomic isolate, we may attempt to predict the future magnitude of a selected quality of the group by a study of its laws of variation just as if it were an individual isolate, and the prediction will take on the same form. Secondly, the prediction may proceed downward to the lower level. This is done only when we have some knowledge of the constitution of the higher isolate, when we know that a gas is composed of molecules shooting about in a variety of directions with a variety of speeds, when we know that the grey colour of a substance arises from the presence in it of equal numbers of black and white pellets, or when we have evidence that a beam of light is composed of a stream of charged particles. Downward prediction then attempts to formulate what can be stated about an individual presumed to be one of the constituent elements of the group isolate, from a knowledge of the action of the latter. What is the probability, for example, that Jack Jones, known to be a member of a

certain crowd, is in this or that part of the crowd, where it is dense or where it is diffuse ? This is the type of question that we are able to answer. This is the type of question that is answered by every insurance company when it is deciding on the annual premium to be charged, from an examination of a Life Table. But one must not conclude that the fact that there are " illegitimate " questions we cannot answer, implies any barrier to knowledge. An illegitimate question would be " Where exactly is Jack Jones ? " or from a study of an insurance company's Life Table " When exactly will Mr. A. die ? "

All this is perfectly direct and straightforward, but unfortunately not too well understood. The confusion arises as soon as interpretations are made of wider issues on the basis of imperfectly understood ideas of the relation of probability and prediction to the appropriate isolates and their data. Take for instance the case of a beam of electrons sent, as far as can be initially judged, in a thin straight line through an aperture. Because of the conditions under which the beam is produced it is legitimate to suppose (*a*) that it is composed of electrons, (*b*) that there is no initial reason to assume that any one electron differs from any other.

The second of these assumptions is not usually explicitly stated, but lies in the background. The stream is now directed on to a surface; certain electrons are reflected, and others penetrate. Are we to say that each electron has a will of its own; and since an electron's will is not accessible to observation must we perforce, through ignorance, resort to probability in stating whether a particular electron will be reflected or refracted ? What an individual electron will do is not a legitimate question on the data. What is a legitimate question depends on the data: what data are required will depend on the question. Certain data may be objectively inaccessible in detail although we may have evidence that behaviour is actually occurring. The nature of the reflection and refraction is, be it noted, additional data which now enables us to conclude that the implied assumption (*b*) above was invalid. The action of the surface has been of the nature of a sieve that has separated the original electrons into two types. It is similar to the studies of Aston when he showed how chlorine, whose atoms were previously regarded as all identical, one with the other, was in fact capable of sub-classification into different chlorines. The previously assumed uniformity was consistent with an unobserved diversity. The earlier properties of chlorine were statistical compared with those later to be isolated. This does not affect the operational fact that for many, indeed for most, human purposes statistical chlorine is still a uniformity. For other purposes it is the diversity that is humanly important; they could not persist in both being humanly important without both being objectively present, but their presence as isolates has to be seen existing at their appropriate levels.

3. *The Conscious Group Isolate.* What is significant about the conscious group isolate is simply that it is now *the statistical isolate itself that predicts its own behaviour*, and by its actions furthers the fulfilment of its prediction. A prediction concerning itself, made by a conscious group isolate, results in a group plan of action. " Freewill " and " Determinism " are united.

These brief remarks concerning the nature of the problems to which probability can legitimately be applied have been inserted in order that the survey of the historical development of the subject in Chapter V may be interpreted against the appropriate background, viz. the conditions which necessitated the development of the theories suitable to the peculiarities of the three levels of isolates. Thus, probability is not something that men have fallen back upon when they have been ignorant of the true facts. On the contrary, the facts themselves have compelled men to consider and use probability as the appropriate means for predicting and planning. The isolates with which they were concerned were real objective processes of a statistical nature.

IGNORANCE, ACCIDENTS, AND REGULARITIES OF ACCIDENTS

That is not to say that we are not ignorant of facts or that in circumstances of ignorance we do not introduce also the notion of probability. The field of human practice and the possibilities that it opens up of acquiring detailed knowledge is restricted in many ways, and being restricted many events that take place must be strange to us. Whether they are important is another matter. The region within which we live, and act, and see, and understand is bounded in space to lie between the range of our greatest telescopes and that of our finest microscopes; in time, between to-day and a not very remote past. Even within those bounds, our knowledge is scanty and fragmentary. Who will ever know what is happening at this moment under the cobblestones outside my window? Events regarded as trivial now, may later attain an apparent importance that, if viewed in one way, may astound us. It is asserted that had a particular signaller at the Dardanelles been seen, on a particular occasion during an attack in the Great War, victory would immediately have been assured to the British troops there, and not only would many lives have been saved but Constantinople would have been occupied by the Russians; the Revolution would never have taken place; there would have been no U.S.S.R.; and the whole course of world history would have been altered. What are we to say to this Accidental Theory of History? If not plausible it sounds at least possible. But even so it would have meant not that the course of events was a chaotic irrational accidental process but that what we might imagine were the controlling factors in a situation were in reality unimportant while others, that we might have been inclined to ignore as trivial, were in fact profoundly significant. For even this description of the part played by the army signaller and by those who ignored his message is rational. Now we are far from asserting that so-called accidental factors may not be significant. If our knowledge of any situation is restricted and bounded in the way we have pointed out, there must be many events that occur during a process that must be labelled accidental. Nevertheless to leave it like that would merely be to adopt an attitude of futility; it would attempt to justify a chaotic view of the world; it would deny the possibility of any kind of science at all, and would assert the impossibility of seeing any orderly pattern in life. The evidence is so far all against this. We have already discussed several cases where accidental factors taken together manifest a trend or pattern. Even in the case cited we have to remember that the Russia that entered the 1914 war was a non-industrialised feudal state against whose weakness in men, morale, and materials, the might of a modern mechanised army was brought to bear. The collapse of Russia was almost inevitable. The detailed way in which it would collapse was perhaps decided by accident, in the sense that we are unable to judge the situation *in detail* at that level. To demand predictions of a more detailed level than the available data permit is to demand the answer to an unscientific question. On the basis of the state of Europe then and at present, on the basis of the industrialised level of the various countries that entered so lightheartedly into the war, on the basis of the internal structure of these countries and the state of satisfaction or dissatisfaction of the populations, who would assert that the kind of Russia that has now developed and is still developing, is very different from what was more or less inevitable, army signaller or no army signaller. If that is indeed the case, then the enormous mass of " accidents," each of which is so easily presumed to bear the brunt for the whole future of history, have to be grouped together, balanced one against the other in the face of the broader and more compelling factors that shape the bolder outline of events. For in spite of these would-be critics that argue for an obscurantist attitude, man has had a long and understanding experience of how to handle such accidentals. Statistical isolates when taken as a composite of accidentals, find their place wherever secure knowledge has at last replaced ignorance and defeatism. Science treats accidents as a group, and these are also historical accidents at a particular level, the level of careful experimental work. Disturbances or " errors " are accidents. They enter uncalled, from outside the field of control. At another level their handling can be seen in the methods that have been applied in insurance of all varieties to cover accidents. Their group effect is estimated in advance. Future accidental effects become then, as a group, a matter of present knowledge. The relation of this to the examination of historical process on a broader basis we shall leave to the next chapter.

From the present standpoint, as we shall see in the treatment of that chapter, the interesting feature about this view of levels of " accidents " and their appropriate expression in measurable form lies in the fact that precisely these methods have almost unconsciously been adopted and applied at various stages in history, just as practice has demanded, and it has been only within comparatively recent years, in the attempt to piece together the theory that was implicit in historical practice, that difficulties of a logical and interpretative nature have been encountered. Subjectively these difficulties are little more than are to be expected from scientific men nurtured in a mechanistic philosophical tradition, to whom the summation of " accidents " were not to be easily seen as itself a group-causal agent in a restricted process.

We may summarise all this shortly by saying that statistical regularities, no matter at what level of complexity, are appropriately measured in terms of probability, whether they be groups of material particles, or groups of human beings. In principle we thereby do nothing more outrageous than is done when a simple length is measured in feet or a time in seconds. It is the appropriate measure for an objective process. The accompanying human sense of expectation is simply the reflection in our minds and feelings of this objective statistical process.

HOW CAUSALITY IS EXPOSED

Accordingly, now that this unification has been settled, let us turn to the experimenter in his laboratory, to study how laws are exposed to view, what is meant by determinism in his practice and what justification there is, if any, for the assertion we propose to make that cause exists objectively as a distinctive quality in a process of change.

Let us recollect the case we have already described, that in which a current passing through a wire is accompanied by a deflection of a magnet placed a short distance from it. It will be remembered that we examined how a " foot-rule " for such a situation could be produced so that finally the " law " relating the strength of the current with the deflection of the magnet was shown on a chart as in the case of an ammeter.

DETERMINISM AND REPETITIVE PROCESSES

The law states that if the circumstances of this experiment are repeated, then it is possible, from the numerical relation found, to settle or predict exactly what the deflection of the needle will be. We say that in these circumstances the deflection is determinate. This asserts that from a finite set of measures of the " given " circumstances it is possible to predict the measure of the " effect." When we say that this represents determinism at work it is clear that the statement amounts to no more than that circumstances can be detailed for which the same experiment can be repeated again and again to give the same result.

Now the deflection of a needle is not the only relational quality into which a current enters to produce a measurable change in the behaviour. An electric fire is yet another illustration. Thus of the multitude of qualities into which a current can enter, that between it and a magnetic needle is only one. That between a current and a thermometer or something else with a qualitative relation to heat is another.

In all these possible isolated environments the current in the wire is a constant atomic isolate of the statistical isolates within which the mûtual quality is exhibited. There are many such statistical isolates. For example the current may be made to pass through water. The water will thereby be broken up into hydrogen and oxygen, two gases that can be collected. We could then use as our footrule the volume of hydrogen liberated per hundred beats of a pendulum of unit length. The current could have been made to pass through a zinc plate immersed in a solution of silver nitrate and as the current persisted it would be found that the plate gradually became covered with a deposit of silver. The rate of deposition of this silver layer could have been taken as our footrule. The current could have been made to pass through a carbon filament in a glass bulb evacuated of air and the filament thereby heated to luminescence. The intensity of the light could then have been taken as our footrule. *The deterministic process, in the first place, consists in developing "footrules" for all such statistical situations and in expressing or relating the various footrules so found in a numerically determinate way.* Such a process leads again to a scientific law. For example we discover that the heat evolved per second when a current of strength C passes along a wire is proportional to C^2. This means that if C is measured by means of its footrule derived from the deflection of the magnetic needle (a length) and if the heat is similarly measured by means of a length, say the expansion of a metal bar such as a thread of mercury, then when the latter measurement shows that there is four times the heat passing out, the former measurement shows that there is twice the current passing, and so on. In the final statement the "footrules," both length measurers, are switched out of the story altogether and the relation stated as one between Rate of Heat Production and Current.

These are all laboratory experiments conducted under conditions that allow of their being repeated over and over again with the same result.

CAUSAL QUALITIES

In the relation between current and deflection of the magnetic needle, or rate of heat produced, or rate of production of hydrogen from water, or rate of deposition of silver from silver nitrate, we say that a deterministic relation is exposed. This then is equivalent to the statement that certain processes can be repeated again and again. Does this type of uniformity imply that determinism has meaning for causality? In this connection we note that *such a repetitive process is itself a complex changing isolate whose measurable or deterministic qualities are exposed in the law.*

Once a process has been set going in certain circumstances its passage along a unique path is physically implied. A changing quality in the situation proceeds to express itself in changing behaviour. Now the assumption that there is no physical qualitative linkage throughout such a process, no *unique* quality in operation, would involve no *unique* prediction, would lead us to conclude that anything may happen at any moment. Such a chaotic state of affairs does not manifest itself. The fact that certain classes of isolate are measurably expressed in terms of probability, as we have seen, has no bearing on this question. It is simply the appropriate form of measure for certain types of isolate. The existence of a causal quality in such processes then is at least a reasonable tentative inference.

JUSTIFICATION OF CAUSAL CLASSIFICATION, BY REPLACEMENT

We turn again to our magnetic needle, deflected in a deterministic way in relation to the current that is made to pass through the neighbouring wire. We note that a certain current deflects the needle by a certain amount. That current is sufficient but not necessary to ensure this deflection for with no current along the wire *I* can deflect the needle to the amount required for the whole current.

As far as the deflection only is concerned *I* can replace the current. With any part of the current *I* can deflect the needle by the remainder. If I am concerned only with the deflection of the needle, not with the relational quality binding it to the current, I can effectively take the place of the latter. If I should say there is a causal quality relating myself and the deflection of the needle I am using the word causal in a reasonable way. It stands for an active relationship, and I and anyone else can feel it in the same way as we can all feel the texture of this paper. I use the word *cause* in the first place for that active relationship. The causal qualitative relation between myself and the needle is, of course, different from the qualitative relation between current and needle. Now suppose that instead of my pressing the needle directly I make it deflect to the various requisite amounts by tying a thread to it, passing the thread over a pulley to a scale pan and placing weights in the pan. If I am concerned only with the group isolate *needle*, *weights*, *scale pan* and *thread* I can with equal validity classify the weights in the scale pan as the effective cause of the deflection. In both these cases the mode of operation of the effective cause is clear. The qualitative causal relation is different. In both cases, as far as this behaviour is concerned, the current can be completely replaced by other qualities to which the word cause can be legitimately attached. In that sense we can classify the current as the cause of the deflection. It does effectively replace ourselves.

ELIMINATING THE EXPERIMENTER

Now it may be argued that in replacing ourselves by the thread and weights we have merely avoided the issue by removing ourselves one stage further from the immediate field of operation. I am the cause of the thread and weights acting in this way and I have merely pretended to ignore myself, *the* cause, and transferred the title to my handiwork. But supposing that a wind had sprung up at the correct moment and so deflected the compass needle. Here circumstances over which I have no control have come into operation. Shall we not say that, as far as the deflection is concerned, the wind has replaced a current in the wire? How can we reasonably say that I or the wind has an active causal relation to the needle while the current has not? If one is bold enough to say so it is surely because in the latter case the detailed nature of the linkage is more obscure.

Again, on this basis we might ask how the current came to be running along the wire. If I arrange this, again I am the cause: but a current may run along a wire during a lightning storm. I do not initiate lightning storms. It is then with equal reasonableness the cause of the current. *I* am not essential to any of the immediate conclusions from these experiments. I and the storm stand behind the scenes. We have a causal relation to a *wider isolate.*

HIERARCHY OF CAUSES

Using the term cause for the quality in the partial or isolated situation as we have defined it, it is clear that there exists, as it were, a hierarchy of causes, each one stage further remote from the effect than the previous, each corresponding to a wider isolate. If we take needle and current, the latter has a causal relation to the deflection. Taking needle, current, and experimenter, the latter is the cause of the current-needle relationship. The first isolate current-needle, if split into two, divides into current and its causal quality on the one hand, and needle deflection on the other. The second isolate, experimenter-current-needle, if split into two, divides into current and needle deflection on the one hand, and experimenter and his causal quality on the other. Again this isolate may be widened and a causal quality shown to manifest itself between experimenter-needle-current, and finally society. We need not pursue this. It is simply an expression of the fact that experimental science can be traced back causally to its social source. The chain of causes is, of course, not unique.

It is relative to the particular levels and sequences of isolates: in the case of a laboratory experiment it exposes the interconnectedness of physical nature with social life.

The presence of the experimenter is, therefore, irrelevant to our problem. He has entered because the operations we have been considering have been conducted under controlled conditions in a laboratory. When we state that in certain conditions, or " if so and so," a particular effect will be produced, we are saying that these are the conditions set up by the experimenter. By doing so he discovers how to exhaust all the classes of case that may arise in nature, that is, when processes occur in circumstances not in any sense laid down by him. In this way he eliminates himself from the process altogether. His laws do not directly involve himself. He states them in a form, invariant to the observer. He seeks conclusions that any observer, any scientist, can use and can verify for himself. The whole relativist position is in reality an extension of this.

LIMITATIONS OF MECHANICAL DETERMINISM

We turn now to examine certain unexpressed restrictions that are implied in the assumption that the same experiment always emerges in the same result. The same experiment for this purpose may be regarded either as one in which the *same* apparatus and the *same* material is used again for re-conducting the experiment, or in which *similar* apparatus and *similar* material is so used. I need not here define what I mean by these terms, but the distinction between them can be made clear. If, for example, the problem under review is that of the heat emitted from a wire through which a current is flowing, the conditions of the experiment may be repeated many times with the same wire provided the current, in this case the causal agent, is not allowed to exceed a certain critical value, otherwise the wire will melt and the whole quality of the situation will undergo a change. If it does melt, the experiment, including the actual melting, may be repeated in the other sense provided the wire be replaced by a *similar* wire. If by the word "same" in our previous discussion we are always to suppose that no isolate in the experiments is to be replaced in this way, then it will not be possible for us to repeat the conditions for determinism if we pass outside the limits of a single qualitative phase. There is, of course, a qualification here. Even if we do repeat the phase with the same wire we cannot repeat it with the same current! But this would involve us in fine distinctions that need not detain us.

The problem we raise, then, is this: assuming a causal quality in operation within a given process, to what state of affairs does the continued operation of this causal quality ultimately lead? The answer to this question can only be found from actual experience. The illustration of the wire that finally fuses as the current is increased is a case in point. A gap forms in the wire, the course of the current is interrupted and, if the causal agent, the current, be increased enough, the gap between the two burnt-out ends will be bridged by a spark. One qualitative situation will have passed into another. This we have called a change of phase. There is no *same* wire to repeat the experiment.

This description, as we have seen in Chapters II and III, has a wide validity. The isolates are generally of a complex statistical nature and the defining statistical "footrules" have in most cases not yet been explored.

It is in directing attention to this particular characteristic of historic processes that we raise the problem of determinism at a new level. We are no longer concentrating our attention on simple laboratory science, in which within any given phase, circumstances are so given as to make the process repeat itself; we are dealing with history in the more usual sense as produced in the laboratory of social life, on human material under the influence of causes that include human activity, and we are attempting to isolate the features that give rise to these changes in phase. Let us examine this.

Now the illustrations already given here and in the previous chapter suffice in themselves to expose the manner in which these qualitative phases come into being. The current in the wire, for reasons into which I need not enter, sets the molecules into a state of increased agitation. As the current is intensified the agitational quality intensifies until finally the molecules shake themselves sufficiently loose to pass into the liquid phase; the wire has fused. Here the intensification of the current is the external cause, the rising agitation of the molecules is the secondary, or internal, cause of the change in phase.

This is a general description of the process of qualitative phase change. In the ordinary laboratory experiment we usually deal with a deepening of the same quality. The isolates may have undergone changes but, in as far as it was possible, *by a relaxation of the causal agent, effectively to reproduce the initial circumstances*, we have considered that we were dealing always with the same isolates. In the present part of the discussion we are witnessing the formation of new isolates from old, and we can now see in a general way how such transformations are effected by agents external to the isolate but possessing a causal qualitative relationship to it, and especially to its atomic qualities.

What we have been describing is the causal quality that brings more developed isolates into being.

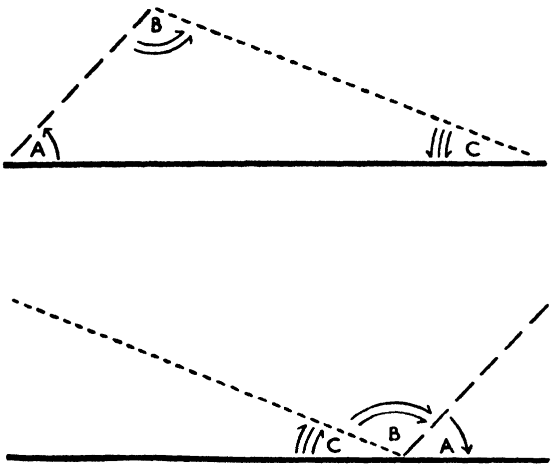
ACTIVE AND PASSIVE CAUSAL QUALITIES

At this juncture it is desirable to draw a distinction between two types of quality that manifest themselves. In a changing isolate, the change has a direction indicated by the successive stages in time. In general the process is irreversible whether it is repetitive in the scientific sense or not. The process that leads a piece of coal from the black stage to its final dispersion after burning, cannot be reversed so as to give us back the piece of coal, nor can a human being who has passed through some experience go back over his history and arrive at the stage again prior to the experience. As we have seen, such processes display the operation of a causal quality. That quality therefore has a direction. That is actually what we mean when, isolating the causal quality and the final state of the process, we say "this cause *gave rise* to that effect." Accordingly we can separate the two ends of the causal relation into: one, the agent; the other, the effect. In this sense therefore we see how within any isolate that includes a human being actively carrying through a process, we come to regard him as the causal agent. The same thing applies to a group of human beings actively performing some group task. In the case of human beings, as we have seen, the causal agent may either be conscious or unconscious of the task carried through. The causal relationship will be specific to each of these cases.

LOGICAL CAUSALITY OR LOGICAL NECESSITY

Now whether the causal agent is conscious of the activity or not, it is always possible after the action is completed to set out the successive steps in the process of change in a logical form. By that we mean that an objective study of the process can be carried through, just as is always done in physical science, the physical necessities of the circumstances recognised, and the final outcome seen thereafter to emerge as if it were a logical necessity. When we say that a person has done an illogical thing we do not mean that it is impossible to discover how he came to do it. There always is a logic of the process. No part of the universe has ever been found to be irrational in that sense. Once then the logic of any process already carried through is exposed to view the completed process can be viewed in a static way. The whole thing can be set out before us as a sort of pattern in which, what were dynamic or active qualities, that gave rise to the change and urged the process on its way, become simply qualitative relations of a passive or geometrical nature. The cogency of action is replaced by the cogency of logical necessity. The latter we call *passive causal qualities*, and they manifest themselves in any closely knit logical network like a piece of mathematics.

There, certain assumptions are made, the logical implications of these are followed through, and finally certain qualities deduced. These latter qualities are, as it were, the effects of the causal logical process carried through on the original assumptions. We can see it in a simple case. We make certain assumptions about the meaning of points,



If the base of the triangle be swung round A through the angle A, then round B through the angle B, then round C through the angle C, while it has swept out the three angles of the triangle, the equivalent lines in the lower figure will have swept out the three angles on the straight line.

straight lines and angles. We settle the process we propose to carry through, viz. take any three points and join them with straight lines. We then deduce logically that the sum of the three angles of the triangle always makes up two right angles. That is a new quality in the situation that was not part of our definition of points, lines, and angles, but it was an inescapable conclusion once the points, lines, and angles were compelled to adopt the kind of relation demanded of them when they were made to form a triangle. Now in mathematical work we always tend to treat the whole matter as a static issue, one in which the logic is causal or cogent in the passive sense. But if we imagine the logic of that process being conducted by an actual series of practical motions by a human being, fixing the points, joining the lines and measuring the angles or *demonstrating*, i.e. showing to the eye of any observer by imagined movements that the three angles, when brought together, exactly fill up all the " angle " on a straight line, we are actually seeing the dynamic or active process being conducted that is usually traced through logically after the active process is completed. The obverse side of the logic of any mathematical proposition is always the logic of an active process, although it may appear to be obscured by masses of symbols, and by delicate inferences. Nor is the practical process always a comparatively simple one of drawing straight lines and points. It may be several stages removed from this.

SLIPPING INTO IDEALISM

I have stressed this distinction between active and passive causal qualities in order to show how they are themselves linked in a logical analysis. It has a particular importance however in relation to certain developments in modern mathematical physics. Many scientific men would assert that a belief in causality as an objective quality in an objective situation is an old-fashioned belief; that modern science, particularly since the introduction of four-dimensional geometry as a mode of representing space-time so that world events can be traced as a network, has found it possible to dispense with causality. In its place they have geometrical and logical necessity, thus imagining that when conclusions are deduced as logical necessities from certain assumptions they have shown also that the active causal quality has dropped out of the picture. It will of course appear to have done so if they refrain from realising the twofold nature of their activity and from reinterpreting their findings into the world of active reality. In using time as an imaginary space component, and treating logical causality, not for the reflection it is of the active quality of change, in the mental habits of men, but as a self-constituted independent disembodied mental necessity, they ignore the qualitative linkage between themselves and the world in which they are intimately involved, and give a changing process the appearance of a static pattern. In dropping the materialist pilot, they find themselves foundering on the rocks of idealism.

SCIENTISTS AT THE PHILOSOPHICAL CROSS-ROADS

This however is not the principal reason why most scientific theorists have tended to dismiss causality from the status of a factual quality. In their minds it has been reinforced by certain other ideas. In the first place there is a traditional disinclination to accord to laws that express the behaviour of statistical regularities rather than of individual particles, anything but a fictitious standing as laws. This is a very peculiar species of conservatism, especially at the present epoch in science. Out of the Newtonian method of approach to natural change, where motion is always regarded as particle motion, and therefore where measurements and calculations were always simply methods for approximating to the *true* value and speed of the " particles," arose the belief in a " true " and " isolated " value to such relative qualities as position and motion. Hence came the notion of determinism as something applicable to, and only applicable to, every particle in the universe, as a particle. It had to be a particle. Causality was thus a *mechanical causality*, however difficult it was to see how this had detailed validity when the subject matter became that of human action. Individual scientific men thus divided into two camps, those who were whole-hoggers, and asserted that once we knew sufficient about the make-up of human beings, determinism of the particle type would still be found to hold sway, and those, including the great majority of scientists, who were content to ignore these issues altogether, classifying them as "philosophy" or "metaphysics," disinclined to be diverted from pursuing their voyage of discovery along the apparently simple and direct line. They did not even ask themselves whether that line was itself in any way determined by factors other than their own desires. Had they done so they might have seen the scientific movement as itself conditioned and driven forward under causal agents of an interesting sociological nature. The important point for us to realise, however, is that causality and determinism for both groups of scientists implied causality and determinism for particles only or larger things that could be regarded as particles. Finally under the pressure of experimental fact came two violent blows to this naïve position, the discovery of the quantum of action, and the behaviour of electrons sometimes as if they were particles and sometimes as if they were waves. We shall examine this a little more closely in a moment. For our purpose the significant feature of these new discoveries was this. It became at once clear that within the very inmost structure of matter there existed elements whose detailed movements could not individually be predicted by the "particle" methods based on the old Newtonian approach. From "true" values of the qualities of these sub-atomic particles as the object of his enquiry, the scientist found himself compelled to pass to "probable" values. Uncertainty in prediction was translated into uncertainty in behaviour of the individual particles, and so the previously accepted rigorous laws of behaviour of bits of matter appeared to stand out as fictitious regularities that emerged from the fact that they were in reality simply huge collections of chaotically moving sub-atomic particles. To those who saw the choice only as a rigid particle determinism in every detail of the universe, with its mechanical causality or with no causality at all, there was apparently no option. Their choice was determined! They chose the latter. It was to them either mechanical determinism at all levels, or nothing but chaos at the very foundations of matter. And so the flood gates of pre-scientific obscurantism and irrational mysticism were thrown wide open. The leaders of scientific thought, the men who were producing the very technique that might help to usher in a society in which man might at last use nature in a rational, reasonable way, sallied forth to tell the world in terms of a pre-scientific philosophy that all was vanity, unreason was triumphant, unreality lay at the very basis of nature. With all the weight of their eminence in the world of science we were assured that the world was a mere symbol of irrationalism in the mind of a mathematical God. For those of us with a social conscience, who hoped to see the scientific achievements of man turned to the elimination of the real and concrete miseries of poverty, unemployment, and world-wide preparation for war, it was a bitter moment; but it constituted a challenge which could not be ignored.

In what is called classical science it was always tacitly assumed that the objective world could be studied without changing it. If a disturbance did arise from the actual process of measurement, it was an " error " that could be allowed for by a careful study of such errors. The view we have here expressed of course denies this point blank. It denies it in the fact that we recognise the qualitative, indeed the active qualitative, relations that exist between human beings and their environment. From that older assumption modern science has emancipated itself, but not completely. Let us trace what effects this new standpoint has had.

Two problems now emerge. One is to attempt still to give an objective picture of the universe in the large, at the grand level, in which allowance is made for the intrusion of human beings on that scale. This intrusion shows itself there simply in the partial view which each of us gets of the same large-scale universe. This was the approach associated with the name of Einstein, and with Relativity. Basing his analysis on the observed fact that all measurements of the speed of light, whether one is moving towards the source or away from the source or across the direction of the beam at the moment of measurement, always lead to the same result—Michelson's classical experiment—he devised a form of description that would apply to any observer irrespective of his position in space or his state of motion. To achieve this however involved a denial of any universal meaning to the words "simultaneous events." This implied simply that space and time were not separately the absolutes of classical science, and in the last resort could not be dissociated. This is implicit in our view as here expressed, that change is the essential first quality we encounter and that our time and our space are our slices of the unity which change involves.

From the constancy of the speed of light it follows that two observers moving with different speeds will see successive events differently spaced, although their succession will not be altered; each will have his slice of space and time. This has no practical significance for individuals like ourselves on the same Earth: its importance rests on the fact that it forces scientific description on the grand scale into a new logical framework. From this new view Einstein followed out the geometrical necessities of his space-time world, as a static four-dimensional world picture, and concluded that it must show a behaviour in the movement of bodies, identical with that exhibited by gravitation. What we would regard as a causal quality became a geometrical necessity. We have already seen how this is consistent with our present analysis. The experimental basis for this standpoint is very slight, but that need not detain us. Nor the later generalisations that succeeded in unifying a series of other large-scale phenomena into a coherent and logically satisfactory system. What is important for us to realise is that here is an isolate of the universe on such a scale that the part played in it by human action fades into the background, and manifests itself only in this, that the picture is actually drawn by human beings. Even that aspect is then itself reduced to the extent that the final outline is one that is relevant to every human being. Each individual can find his picture in the general scheme if we can state the angle from which he is viewing it.

The second type of isolate must then be very much nearer ourselves. It must treat of the way in which human beings are related to the changes that take place in the rest of the universe. It would concern itself with the interaction between man and his environment. For the scientific man nurtured in the old tradition that imagined everything could be studied without interference, this is by far the most puzzling field. It includes the whole of social and individual activity. Within this field falls science itself. We have already discussed the procedure that is adopted, viz. to attempt to plan each experiment in such a way as to isolate the process under consideration from the effects of extraneous disturbances including, of course, the experimenter. This is according to the old tradition. That, however, was only the attempted method. In practice after a certain stage of detail had been reached it failed, as we would expect it to fail, because of the necessary qualitative relation between the experimenter, including his measuring apparatus, and the process measured. The fact that when this occurred it created consternation in the ranks of physicists is a sign of the strength of the old tradition that their activities could be carried out in complete independence of the rest of the universe. Let us see how this occurred and examine the nature of the reaction it produced among scientific men. That reaction will best be seen not alone in their astonishment, but in the type of rationalisations they found themselves compelled to adopt to explain this unprecedented experience.

The trouble begins with the nature of light. Until less than forty years ago light was firmly believed to be a pure wave motion, the evidence for which rested on an elaborate series of experiments. These showed that it was possible to produce *interference patterns*, as they are called, an effect characteristic of all other wave motions, such as the criss-cross pattern seen on the surface of a pond when two sets of waves pass one over the other. According to the standpoint of this book a train of waves would be a statistical phenomenon, of which each wave in itself would be the atomic element. The wave could also be a statistical isolate of which each moving particle that assisted in forming the shape, as a totality of particles, was again an atomic isolate. A train of waves passing across the surface of a pond would appear statistically as a continuous process. The waves as they reached the shore and broke there would appear to do so discontinuously. In such a system therefore one might expect to discover both continuous and discontinuous effects if seen at different levels.

It was in 1900 that Planck pointed to the existence of discontinuous increments in energy in the heat radiated from a hot body. Later, in 1905, Einstein showed that the electrified particles shot from a sensitive plate when a beam of light fell upon it, implied that light had a corpuscular constitution. These corpuscles are called photons.

To the physicists the idea that a shower of particles could also at the same time be regarded as a train of waves came as a shock. Suddenly called upon, as they were, to reconcile two totally diverse conceptions in one and the same physical entity, the conception of a particle with a specific velocity, moving in space in a definite way, and the conception of a continuous wave extended throughout a region of space, they accepted the strange view with considerable misgivings. Planck's Law connecting the two modes of description is that the kinetic energy of the particles is a definite number of times the number of vibrations per second of the wave. That definite number is called Planck's constant. While Bohr pointed out that this principle of Planck introduced an irrational feature into the description of nature, it was not contended that nature itself was in any sense irrational in its behaviour. The inconsistency existed solely in the mode of description. Planck's law from our standpoint links up the measures of two types of isolate.

A further measure in this connection links up the two processes, but it does so by introducing *probability*, which manifestly ought to have been introduced from the beginning when dealing with a statistical isolate. It states that the intensity of the wave in any small region of the shower of corpuscles is proportional to the probability that a particle is present in that region. The shower of photons at one level, as a stream, produces the effect of a wave system; at another level it is a stream of particles whose appropriate measure is a probability, viz. the probability that through a given region of space at any moment a particle will be found to be passing.

Now it is important to note that we are not here referring to any particular photon. Nothing is known about the special behaviour of individual photons except of course that they exist in the stream and do behave. As we have already pointed out earlier in this chapter, we have therefore to be careful that in discussing the appropriate measure, as a probability, we do not ask, nor endeavour to answer, any illegitimate question. We have no knowledge that enables us to say where exactly a particular photon will be. We do not even know how one photon differs from another. The very conception of a photon is a statistical one, and therefore our measure of probability must be used with great circumspection if it is to be interpreted in individual terms.

Finally in this rather involved sequence of discoveries we come to the last law, the so-called Uncertainty Principle of Heisenberg. This examines the possibility of finding sufficient data to enable a prediction to be made of the motion, and the track, of an individual photon. If the usual deterministic method is to be applied to the photon as a particle it is necessary to state as accurately as possible both the position and the speed (in this case really the momentum) of the photon at a particular moment, and these must be specified independently. Without this we cannot expect on Newtonian principles to trace out its future track. It turns out that this cannot be done, even in theory. For Heisenberg's argument shows that the more closely we try to localise the position of the photon, by reducing the region within which it is to be observed, the more widely divergent are the possible velocities of the photons that may be found to pass through this small space. Roughly we may see it this way.

At a particular point of the wave system the intensity and therefore the probability of the occurrence of a photon is fixed. If we try to limit the region within which it has to be found, it would become less likely that a photon with a narrow limit of velocity will be found. If we therefore have to keep the probability fixed we must allow a greater latitude in the range of velocity that is admissible for our photon. If we decrease the latitude in fixing position we must increase the latitude in fixing velocity.

This is only a rough and ready method of looking at it, but it brings out the point that localisation in space and delimitation of velocity for a particular element of a statistical isolate are mutually inconsistent processes. But quite apart from this it is easily shown that even if we were to attempt to examine the detailed behaviour of such an elementary particle through a microscope it would not be possible. The smallest quantum of light energy that would make an electron, say, visible, would also give it such a blow as to disturb it both in position and in momentum. The very circumstances necessary to receive sufficient light energy to see it would profoundly affect the actual features we proposed to examine. Here then at the very fringes of experimental practice, the physicist is faced with a basic reason why he cannot hope to exclude himself from influencing the course of the experiment no matter how carefully he performs the task.

I have gone into these matters at such length, not because of the intrinsic theoretical importance of this particular field, which is great, but because from the standpoint of causality and determinism the reaction on scientific men to these matters has been of such interest.

Let us first state the position as it would appear from the standpoint adopted in this book.

In the first place there is no intrinsic contradiction involved in the fact that the same large-scale statistical isolate may act as a statistical isolate of a wavelike nature with reference to one of its group qualities, while with reference to other group qualities it behaves as a stream of particles. Even an avalanche of stones can behave like that if it comes down in surges. We can go further if we cared and invert the picture, as in the illustration we have given of the waves breaking on a shore, where each breaking wave can certainly be regarded as an atomic isolate so that the succession of blows act like a stream of individual impacts.

In the second place the specification of a statistical isolate is naturally expressible, as we have seen, in terms of probability, and when interpreted in terms of the atomic elements implies nothing more than the appropriate type of prediction of what is to be found at a particular region of that isolate. There is no intrinsic uncertainty, in that sense, about the actual behaviour. The particle although it cannot be isolated does have a unique behaviour if it is a unique particle.

The fact that it is not physically possible to obtain the data required to carry through the necessary predictions for an *isolated* electron or a photon asserts that mechanical determinism cannot be applied at that level.

For this reason also it requires a different level of causality. The fact that the appropriate measurements are probabilities is itself evidence of this, but unfortunately scientific men have not yet come to see that such measures do indicate the existence of causality. To them causality is always mechanical causality, at the level of Newtonian dynamics. Accordingly when faced with these difficulties they have seen no choice except that between universal mechanical causality and no causality at all. Taking a rigorous mechanical view of the situation they have chosen to assert that causality has disappeared *in toto* from the scheme of science, because in this case mechanical determinism was seen to be inapplicable. With the recognition of levels and their appropriate deterministic measures the path would be cleared for a deeper logical and philosophical development.

The surprise with which scientific men have greeted the discovery that the very experimental conditions required to view a moving electron are themselves conditions incompatible for the electron to be viewed undisturbed, must be taken as an indication of the strength of the tradition that all scientific work can be carried through in such a way as to switch the experimenter out of the picture. Here in this remote but growing point of physical science he has suddenly discovered what would be apparent to him if only he looked through the window of his laboratory at the world outside. The remarkable feature of their work on which scientific men are entitled to pride themselves is their skill in discovering so many aspects of nature that can be handled in this isolated way under controlled conditions, that is, so many situations where the human interaction is reduced to negligible proportions.

Finally, in this connection, let us recollect the two types of isolate of a very general nature to which we originally directed attention. First they were those on a grand or cosmic scale in which the affairs of men did not directly enter except through the mode of description. Relativity has concerned itself with these. Secondly they were those that were explicitly concerned with the interactions of man with his environment, social affairs, problems of human society, of which science and experimental investigation is one detail. It will be seen therefore that in the pursuit of studies in this latter field scientists have, as far as it was possible, carried forward the traditional method learned in the first field. In doing so they have naturally found themselves compelled to confine their attention to a restricted set of social problems, the internal problems of physical science. There have, of course, been other reasons of a social nature that have contributed towards this segregation of their scientific interests. To us, however, the significant point is that in driving this method through to its experimental and logical limit they have finally found themselves faced with a study of the very kind of interaction their methodology has been designed to avoid. It is one more illustration of the law of development to which so much attention has been directed in the last chapter. We are witnessing a transformation of the qualitative relation of scientific method to the material it has to analyse.

PREDICTION TESTS

We can now return, therefore, to the wider problems of causality and determinism in social isolates, and so examine the detailed way in which these show themselves at this new level.

The validity of a law is, in general, subjected to two tests. In the first place it must be consistent with laws related to isolates at higher and lower levels. That is to say, it must fall consistently into the general logical framework of science. If it does not, if it contradicts the assumptions implicit in previous development and if the evidence for it is cogent and inescapable, then the logical framework would have to be rebuilt. This type of transformation has occurred on several occasions, as for example when the whole theory of atomic structure had to be reconsidered as the result of Planck's discovery of the quantum of energy. In the second place it must be capable of furnishing predictions in nature in relation to the forms of isolates with which the law deals. The first type of test is seen to be automatically satisfied from the manner in which we have approached it. Prediction on the other hand, associated, as we have seen, with the problem of determinism and therefore with causality, remains to be examined.

We begin therefore by pointing out that since we are dealing with changes in qualitative phases, predictions may be conceived as occurring in stages, viz. qualitative phase prediction, and measurable prediction. We may point to a regularity in nature by indicating that a specific change of phase will occur, and we may state at which critical value of its measurable qualities it will occur, just as we may assert that a building will fall down, or we may say it will fall down when the stress in a particular support attains a certain value under the load of the roof, or finally we may say it will collapse at a particular time.

It is the last form of prediction with which we appear always to deal in physical science. In fact when it is examined it is the first and second types with which we more usually deal. From the primary cause we predict the occurrence and critical magnitude of the secondary cause.

Predictions concerning changes in phase in a statistical isolate therefore have to be interpreted with reference to the constituent atomic isolates of which it is composed.

We remark in the first place in illustration that numerical predictions within a single phase are perpetually being made for social statistical isolates. All organisations and institutions, business and industrial concerns, local and national government departments whether they have to plan at short or long range do so by disentangling the regularities in behaviour of large or small groups of human beings. These, as statistical isolates, exhibit a deterministic quality expressible in the usual probability measure, and this in spite of, indeed because of, the assertion that the individual members of the group act " of their own free will." The law of change of the group expresses the process quality brought into being by the statistical activity of the individuals.

FREEDOM AND NECESSITY

Now these " free " activities are not conducted in totally unrestricted circumstances. We can see this very simply if we take a case where the conditions that regulate behaviour are very clearly set out. Take for example the laws relating to the payment of taxation. These are legal compulsions, and because of that fact, and the consequences that follow from a refusal to obey, the community as a group pay their taxes. They have no option, one says. It is a necessity of the situation in which they are placed. Thus the general behaviour of the taxpayer can be forecast. The legal law is followed by a law of behaviour. We may describe this by saying that people pay their taxes, in the circumstances, of their own free will, but this must be taken to mean nothing more than that they recognise the necessities of the situation and by their actions conform to them. It is a statement of the fact that they are the causal agents that perform the behaviour in the given circumstances. Freedom and necessity go hand in hand. For a human being who has to survive there is no unrestricted freedom. For a human being in acting under restrictions there is always a form of behaviour that in these circumstances he can feel is his choice. Unless we bear these limiting conditions in mind we shall build up a completely false and idealistic picture of what we mean by freedom.

The *struggle* for freedom, however, is the fight against the restraining constrictions. It is this that gives the fundamental quality to this concept. To submit to the restraining forces and merely to choose " freely " the only outlet that is offered is such a pale reflection of its true meaning as to divest it of any human significance. It is to behave like a piece of inanimate matter. But the struggle against restrictions is itself not carried through in a void. All restrictions are not equally noxious. The struggle for freedom of certain groups in Germany or in Spain at the present moment is an act of free choice on a different plane from that of the individual, who, like a piece of dough, settles down to the shape into which he is being kneaded. The necessities of the situation for the one are not the same as those for the other. Human valuations and desires enter that are expressed in some form of action. It is these desires that, wedded to activity against such restrictions, and supplying the dynamic drive, may ultimately transform the situation so that, in the new phase, the given circumstances in which acquiescence would otherwise have had to take place are themselves transformed. The outcome is to replace the old set of restrictions by a new set more rationally consistent with the necessities of forward development. The struggle for freedom may become the secondary causal agent to which we have directed attention on numerous occasions. We shall have to discuss what criterion, if any, can be found to help us to decide whether any particular struggle is of this nature, or whether it is a fictitious one from this point of view. That will be very fully explored in the next chapter.

THE REVOLT OF THE INCOME-TAX PAYER

In order to trace out the details of how a sociological isolate undergoes a change in quality, consider the case we have just mentioned, a legal compulsion requiring payment of taxation, say income tax. Those liable to this tax in general conform. They pay up. Every Chancellor of the Exchequer knows, however, that at any level of taxation there is always a certain amount of evasion. It is the function of the Inland Revenue authorities to be vigilant on this matter, and to track down those who seek to avoid payment. Thus the return to the Exchequer, in taxation, will depend on the severity of the tax, and in predicting his income and expenditure for the forthcoming year, the Chancellor has to deal with this statistical isolate. When he fixes a figure, there is also a probability index attached to that amount. Let us take as our statistical isolate the actual individuals as a group who are liable to pay. Suppose the tax is steadily increased. This is the external causal agency. As this is intensified, the probability of evasion by any member of the group increases. The quality of evasion, an internal quality, is also intensified. Evasion is countered by greater vigilance. The strain of having to pay, by those who feel they cannot afford to do so, increases. Feelings are aroused, feelings always of injustice. The presence of this sense of injustice, this desire for a change, itself an objective fact in the situation, becomes recognised as such. What type of change? Clearly one that will either abate the cause or transform it. The position as it is becomes unbearable. Small groups express this objective feeling in a new qualitative form. They begin to band together to refuse payment. The revolt spreads, and the situation is ripe for a transformation arising from this internal stress. The objective changes that take place within such an isolate are worth a moment's examination. As the stress is intensified there grows up an appreciation of three points. First that resistance, criticism, and distress are widespread. Secondly that if matters are to be allowed to continue as they are, the position will become unendurable, or more definitely that the people are being driven through a form of behaviour that runs violently counter to their desires and valuations. Thirdly that by an analysis of the situation, of the ultimate necessities that have to be accepted, and those that are capable of modification by human effort, a way out can be found provided the effort to carry it through is a group effort of sufficiently wide basis. We can imagine that on such a basis action could lead to the withdrawal, at least, of the particularly oppressive taxation law or a change of the policy that necessitated it.

This of course corresponds to a relaxation of the causal agent and, therefore, to a retention of the same phase. If the law cannot be relaxed under the necessities of the situation for the government or the governing class, then finally the phase undergoes a change, and that class itself with the machinery for the furtherance of *its* desires and *its* valuations by this taxation is itself overthrown. Such critical phase changes have occurred frequently in history. They occurred in England during the Cromwellian Revolution, in America during the War of Independence, and in France during the French Revolution.

With inanimate matter the nature and approximate point when the phase change occurs can be predicted, in most cases, in terms of the internal state of stress of the medium. The causal qualities of the atomic elements are comparatively simple and can be explored in the laboratory under " repetitive " conditions. With individual human beings the various types of quality manifested in the varying statistical isolates of which they are parts are exceedingly complex, and have hardly been explored. Few of them have been expressed in their appropriate statistical form. The crucial difference in quality between animate and inanimate matter is associated with the phrases " learning by experience," " reacting emotionally," and one of the qualities learned is the power to act as a conscious causal agent, to express an active causal quality. There is no " reproducibility " under such circumstances, but we may anticipate that it is through such qualities that the phase change ultimately occurs in group isolates of human beings. Such a form of analysis will tell us *how* the causal process operates and, in terms of the qualities of subsidiary group-isolates, *when* a change will occur. It does not express the prediction in terms of time. In such an active process, to ask this question of those who analyse is illegitimate. When the situation is ripe for change it must be asked and answered by those who become the causal agents in effecting the change of phase. They can then make their prediction come true.

CHAPTER V

WHAT CAUSES CHANGE IN SOCIETY

BEING A SCIENTIFIC STUDY OF SOCIAL DEVELOPMENT

By a study of social change, successive phases that display group qualities (statistical regularities) are separated out, and analysed in detail with the aid of the general law of change. It is shown that the steadily rising technique of production, and other socio-economic factors, are the primary, although not the sole, agent in social change, both material and ideological. The method is illustrated in detail by an historical-materialist study of probability. The appropriate mode of prediction developed in the last chapter is used for a preliminary discussion of the "inevitability" of the passage to Socialism.

IS THERE NO SCIENCE OF HISTORY?

IN THE LIGHT of the conclusions at which we have already arrived, we propose in this chapter to examine a problem that many from the start will believe is insoluble. It is no less ambitious a task than to see the patterns in history and to see them dynamically related. Many, indeed most, historians will deem this task impossible; there can be no law or order in history; anything—or almost anything—may happen at any moment. There can be no "scientific" way of understanding such a complicated and in a sense arbitrary human process. If this standpoint should be adopted, it follows at once that historians must be individuals who divert themselves watching the unexpected antics of so-called historical characters. It may be an amusing, it cannot be other than a personally interesting study. It cannot point a direction for general human guidance in the future. Historical study could have little of that essential quality of things, social value.

Now let it be granted at once that the conduct of individual actors on the human stage is so complex as almost to defy disentanglement; does it then not follow, reading the most elementary lesson of what has been said here, that the study of history must also be pursued at some other level? Is it the qualities of individuals or of social groups that must be taken in the first instance, to provide us with the units whose historical phases we have to disentangle? If we are to draw the appropriate lessons from our chapters on qualities, the answer is obvious. This is not to discount the part played in the historic movement, and in social change, by the presence of individuals at key positions, or of special ability or of rare genius. It is to recognise first that on the basis of our experiences in other fields, the history of social groups is much more likely to provide us with the kind of pattern that will make the logic of the struggle of man stand out. In the second place it is to assert that the individual, no matter how richly endowed or how powerfully placed, is first and foremost a social animal. Whatever else he does that appears to be highly distinctive in character, he moves with society, eats the food it provides, exchanges its thoughts, speaks its language, receives its protection, wears its clothes, and in one form or another accepts his contribution from it. He is its creature.

Let us then see what weapons we may draw for our purpose from the armoury of science. Any portion of the universe that can be identified throughout a period of time has a history which is traced in the continual process of identification. This applies to a particle of clay, a brick, a house, a town, a country; to an individual, a family, a tribe, or a whole race; an idea, a theory; each and all have their histories. At two successive periods in time we say it is the same in certain respects and yet it is different in other. It is a part of a changing process and in its changes we seek a pattern by means of which we can recognise and follow the stages of its history in a sensible, intelligent and logical way. If we could not detect such a pattern, its history would remain irrational. It is from the fact of this connectedness in the process of change that we anticipate the possibility of recognising a pattern, or what we more usually refer to as a *logic* in the process. When we appreciate this we say it is rational.

Scientists are concerned with one aspect of nature, the atom, the molecule, the particle of clay, the brick, the house. They experiment with it, they tear it to pieces, they put it together again, and they expose its qualities, its modes of behaviour, in their logically connected form. This helps them to see and to understand the underlying pattern in the history of the brick. By experimenting with it, by placing it in a whole variety of controlled environments, they succeed in making those qualities stand out sharply. In this way, they are able to render the history of bricks intelligible and logical. In this way also, the history of a star over a vast stretch of time becomes a sensible, orderly, logical process, once the underlying qualities of the material of which it is composed have been thoroughly explored and their necessary relations exposed.

We will now repeat in a slightly different setting the meaning of the term—*the logic of a process.* We have discussed it also in earlier chapters. The term logic is here borrowed, of course, from the thinking and speaking process we pass through when we examine, describe, and explain some physical change or relation; but in using it in this way we are not arbitrarily imposing a " logic " on the physical process. We are using an appropriate term for the necessary internal qualities and relations that the parts and stages of the process show, and for the way in which these linkages between qualities in nature are put together in speech. The consumption of food, for example, is necessary for living animals. If we wish to maintain an animal alive, therefore, it would be illogical on our part to deprive it of food because we would not be leading it through the necessary physical process for survival. It *stands to reason*, we say, that if an animal is to survive it must have food. The necessary logic of its living becomes logical to us once we see it. The inner stress of hunger driving the objective process onwards—the logic of the animal's process—is reflected by a complementary process in ourselves. We see, follow, anticipate, the cogency of the physical process, and describe it to ourselves as a series of inescapable conclusions. Thus is our logic when *true* indissolubly linked up with the logic of the physical events when accurately described. It is for reasons such as these that we are entitled to use the expression "the logic of a process" *without being guilty of reading our minds into nature.*

SCIENTISTS MAKE HISTORY

In order to discover these underlying relations that constitute the causal quality in any process, scientists in their own way have had to make history. They have taken masses of gas, and by heating, cooling, compressing them, they have forced them to pass through various phases; they have directed their history. By an examination of the details of this history, created in this way under controlled conditions, they are enabled to understand and analyse and explain the history of a stellar system that has pursued its course scarcely affected, and certainly not controlled, by man.

MATERIALIST INTERPRETATION OF SCIENTIFIC HISTORY

It follows from this that all scientific explanation of scientific history is materialistic. A complex process is analysed down to a series of more elementary physical happenings linked together. The explanation of a geological formation is given in terms of previously existing matter. A works chemist does not say that sulphuric acid or nitroglycerine, or artificial silk, is produced in certain circumstances because the *idea* of atoms has operated on the *idea* of the contents of the *idea* of a glass vessel. He states precisely what does happen to the various materials which he is mixing; he states how they are put together, in what circumstances of temperature and pressure; he states how they interact, and he is satisfied that he has given a true logical explanation when he describes and classifies the actual historical behaviour. He links it up in two ways. He shows that each element of the process can be classified with, and is similar to, other processes. Thus he points to the fact that the detailed behaviour of the parts is uniform with certain other processes, with which he is familiar. He knows them, he recognises the elements with which he is dealing. The second form of linkage is when he connects these elements together and so follows the sequence or process which he can almost anticipate. It becomes rational and logical to him physically. Of course the explanation is framed through ideas and words, but they refer to actualities. The logical coherence of his story is knit up with the physical necessities of the process. It is certainly true to say that the *idea* of atoms, like the *idea* of pressure and temperature has been useful in arriving at a decision on how to guide the historic steps in the production of the sulphuric acid, in order to achieve the desired end, but the explanation of the actual process is given in terms of physical changes in that process. There is a necessary unity between the ideas and the things thought of.

Science, then, both in its theory and its practice, is materialistic. The interpretation of science is always materialistic, and, in its application to the history of physical objects in the universe, it uses a materialist conception of history.

History, as it is commonly understood, however, relates to the behaviour of groups of human beings, identified by certain qualities that remain relatively unchanged over an extended period of time. Historians, if they are to apply to this portion of the universe an appropriate method of analysis that will expose its logical structure, that of the particular human group considered, must begin by recognising the material circumstances, the environment, in which such history is made, and the detailed nature of the human stuff that makes this history. Then, and not until then, will it be possible to analyse, to see, the pattern-process it exhibits in its actual history and, if possible, to use the conclusions of that analysis for the deliberate creation of further history. Such activity would imply conscious control directed to satisfy the ends of mankind; just as industrialists use the findings of scientists to make what we call industrial and technological history.

If we have drawn an analogy with the scientist in his active study of the processes of nature, however, let us not suppose that his methods can be automatically transferred unchanged to this new type of problem. A scientist experiments in the laboratory with a portion of matter under conditions he can control, and the information so derived enables him to analyse the history of actual physical processes as they unroll themselves uncontrolled by him. He can thus make certain restricted historical predictions, such as those of eclipses, with great certitude. On the other hand he also changes the course of history, usually unconsciously, by the design and creation of technical processes that profoundly affect social life. Now, while he can predict exactly how much finished produce a machine designed on his principles will discharge, and how efficient it will be in production, he cannot predict what will be the social outcome of the machine he has designed; how it will affect the standard of life of the community or what artistic or intellectual movements it may stimulate. Did the inventors of steam power foresee the devastation that would be wrought in the mining areas of South Wales, or the inventors of moving pictures anticipate the details of a new screen art? That type of social prediction is completely outside his scope as an experimental scientist. Actually, the operation of the machine he has designed, forcing a new consumption of raw material and an altered distribution of finished products, is itself an experiment that changes the lives of men and women, but it is not one that he contemplated or even tries to control. The material operated upon, these human beings in their social setting, has not been the subject of his study. He has no technique for experimenting upon it. And yet, in a restricted sense, he does make history, control its making, and predict its happening. He does this within the four walls of his laboratory.

The history of the past and of the present is not made under conditions that approximate to those in a scientific laboratory. True, both human beings and inanimate matter make their histories in the material environment handed down to them from the past, urged on by their own nature—called variously " human nature " for man, and " properties " for objects. But whereas it is possible to detect the pattern in the history of inanimate matter by first deliberately " making " and " repeating " experimental scientific history in the laboratory in the present, in the case of human history it is in the first place by an analysis of *actual past* uncontrolled events that there can be any hope of unravelling any pattern. On an understanding of this we may be able to achieve something in the present of the nature of deliberate and enlightened history-making.

To do this is not a simple matter. Even geology, and astronomy in its early phase at least, both observational sciences in the sense that neither the heavenly bodies, nor the crust of the earth, nor its interior could be made the subject of controlled experiment, were never faced with such a difficult task. Both have received help directly and indirectly from innumerable small-scale experiments. There is yet another difference. For most purposes, the motion of the heavenly bodies is of a recurrent nature. Planets return periodically to approximately the same relative position so that the complete phase can be scanned and rescanned in detail. The story of man is different; each step he makes in his history alters his environment, each alteration in his environment changes that in which his fellow-men and the oncoming generation live. The background of the child differs from that of the parent; in a changed social atmosphere, men themselves react differently: they acquire new knowledge, new experience, new understanding. They value things anew. Human nature is itself transformed. So the clock of history never strikes twice the same; it is not a mechanical process.

In such a situation of continual flux where, then, are the defining qualities that must serve us for isolating and following the thread of this developing situation? For this purpose let us examine the characteristics of man, and of the material factors in his environment just as is done in other fields of science.

HUMAN BEINGS AS FOOD PRODUCERS

We note that in the first place, in relation to food supply, which is their first essential, animals are gatherers, seeking and hunting their food, and consuming it immediately. As against this human beings are primarily food *producers*, planning their activities in advance towards this end, utilising their accumulated store of knowledge, the experience that has been transmitted from their predecessors, to create tools and devise schemes in order the better to produce their food.

There follows a very significant fact. Where animals are gregarious, living in herds, they are prevented from dispersing mainly because of the need for protection against outside attack. In the sequel they build up internally a complicated species of society. Where food abounds to satisfy their wants the next strongest animal need then becomes the factor that binds the society together. This has been very clearly analysed and explored by Zuckerman in his *Social Life of Monkeys.* There sex mates are conserved and the wives of the strongest monkey or ape become his private property.

MAN VALUES THE FUTURE

The structure of such a society, however, is profoundly different from that of a food *producing* community of human beings. The very fact of production rather than collection and direct consumption argues an active, planned attack on the soil, the changing of the environment in the neighbourhood of the community, and, once the group has surpassed the merely nomadic and pastoral stage, the establishment of settlements leading to farmsteads and villages. Man's struggle with nature is an effort to use and control it. His objectives are different from those of animals. Accordingly the course of his social evolution shows a fundamentally different trend. It would therefore be ridiculous to see any close parallel between the laws of development of animal communities and those of human societies. While the animal seeks only immediate satisfaction or satiety, man schemes for security in the future, for later enjoyment, renouncing the present for the sake of the future. Hence, he begins to esteem *future* as against *present* use. If it is important to safeguard the future, it is valuable and desirable to sacrifice some of the present to that end. He forgoes the " lower " for the sake of the " higher." He evolves a social code of an ethical nature. He strives not simply towards survival but towards development. Thus while animals may wage a struggle for mere existence, human societies wage something on a different level, and the tools and technical methods he devises are an essential feature of this process.

SURVIVAL OF THE FITTEST—AN EXCUSE FOR ECONOMIC OPPRESSION

In the story of the struggle for social betterment this point is continually obscured. To justify the ferocity of economic competition in human society, for example, on the grounds that it is no more than a universal law of nature exemplified in some confused way among the lower animals, is to offer a specious excuse for an anti-social bias. Even the struggle for existence among animals, proposed as the driving force in Darwinian Evolution, is of doubtful validity if one takes account of its source and the period of history when it was proposed. It appears little more than the bald application of certain economic theories concerning the society of man, prevalent at the time of Darwin, to the animal world. That early man was not man until he lived gregariously seems now established. That his ascent from the ape developed among other things with the differentiation of the hand from the foot, so that the former became a tool directing the activity specific to man seems also accepted. Nevertheless, in Darwin's day, Hobbes' theory that saw early society as the struggle between man and man as complete individuals was still prevalent. Coupled with the Malthusian theory that the population of an area tends to increase at a more rapid rate than the food supply, this provided Darwin with the ready-made economic theory to explain the undoubted law of evolution for which he had discovered such ample data. "It is remarkable," writes Engels, " how among beasts and plants Darwin recognises his English society with its division of labour, competition, opening up of new markets, inventions, and Malthusian struggle for existence."

LEARNING BY SOCIAL EXPERIENCE

If, indeed, this tentative suggestion put forward by Darwin to explain evolution owed its origin in this way to the social and economic theories prevalent in these early days of the industrial revolution, it is amusing to see it sent back again as a justification for this anti-social struggle in the guise of a law of nature established in the animal world. For man, the social, scheming, tool-bearing animal, has come to differ most profoundly from his forbears. His powers of thinking, analysing, synthesising, are unique. They enable him to profit or learn from experience, to plan the use of the resources of nature for the production of food and shelter, and above all to secure himself against the uncertainties of his environment. Learning by experience is the discovery of relative certainties. The process of planning is the use of these certainties to safeguard himself against uncertainties, and the understanding of how to transform them into certainties. These constitute thereafter his pattern of nature. Associated with this is his manual dexterity that has come with the differentiation of the hand as distinct from the foot, and its close co-ordination in manipulation with his power of thinking and planning.

These primary characteristics in the make-up of man are learned and exercised not by a unit individual in a human vacuum but by groups in a social environment. This itself embodies a partial summation of the past experience of its predecessors and shows itself in customs, traditions and practices, and in the training and educational institutions that are set up. Each generation in this way begins approximately where the previous left off, and a fund of social experience is steadily stored.

With what materials then and in what way do these active planning creatures strive to fashion an environment that offers them relative security and the satisfaction of their ever expanding needs? These material factors of two sorts immediately suggest themselves:

(i) The *natural resources* of the region in which they live, the contents and products of the sea, the air, and the earth, offering minerals for power and tools, and agricultural produce, birds, fish, and animals, either for consumption or as beasts of burden.

(ii) The *tools, machines and technical implements* that have been forged in the process of striving to gather produce, and utilise these natural resources, in the effort to achieve a higher and higher degree of security, and level of life. From crude implements, through practice and experience, arise more refined tools, always for the purpose of achieving greater economy of effort, and greater efficiency in production. The detailed making of tools and implements in this experimental way especially in its more elaborate and sophisticated form, is itself an illustration of how man is prepared to forgo or delay his immediate advantage for the sake of a greater in the future. Here then we come to the crucial quality, basic to so many others in communal life—the technical level, resources, and skill at the command of the community. For as we shall see, these, and the way in which they are used, provide the basis out of which developments emerge.

UNITY OF RESOURCES AND HANDLING OF RESOURCES

Now while it is always true to say that at any stage the tools and machinery and technical skill of man suffice for the working of the natural resources at his command, it is true only in a static sense. In reality the process is a dynamic one, in which the interaction of the tools with the natural resources results in continual change in one and adaptation in the other. As the tools transform natural resources, they in their turn provide the possibility of more complex machines and more elaborate tools, in ever rising levels, in ever increasing efficiency and in ever new variety. In the wake of the discovery of coal and iron, for instance, follow steam power machines, transport and other modes of communication, all in reality elaborate tools. Extended transport throws open more and more varied minerals from other regions of the earth. In a sense, the boundaries of the area occupied by man are continually extended. Science with its geological theories, metallurgical and chemical investigations, is called into being. Application follows application, the fund of knowledge increases by leaps and bounds, and with it potential control over nature.

TECHNICAL DEVELOPMENT AS A CAUSAL FACTOR

The rise in technical level forces up in its turn the possible level of social life, economises labour, produces goods in abundance, makes it possible and desirable to release the thoughts and the energies of men from the provision of their immediate needs, and to direct them into other more directly æsthetic channels—pure mathematics, art and literature. " The mode of production of material life," says Marx in his *Critique of Political Economy*, " determines the general character of the social, political and spiritual processes of life." The emphasis here is as we shall see on the word "*general.*" There are other qualities that require to be taken into consideration. In the first place it is evident from what has already been said that the natural resources at the disposal of a population in a particular region to which the modes of production are applied, themselves set a direction to the type of economy. A region of rich agriculture but deficient in metals, oils, wood, may remain for an extended period the abode of a simple agricultural or peasant community until its isolation is destroyed by the inroads of transport and communications from without, that bring in these materials in exchange. On the other hand an area rich in coal, iron, and metals that can be worked, may be expected to develop an industrial economy and all that this means for the social life of its inhabitants. In exploiting the natural wealth in each of these regions there will arise an organised form of production that strives to use the technical knowledge and experience of the population and in doing so adds to it. In the early stages factories operated by steam power spring up in the coal-bearing areas and the workers live in the immediate neighbourhood. As experience ripens, technical knowledge expands and transport improves; industrial cities arise on the less expensive sites on the outskirts of towns, and the workers travel long distances to mill and factory. With the coming of electrical power and its easy transference by grid and cables over enormous stretches, factories begin to be transplanted to the heart of the country, and roads extend ribbonwise to carry the manufactured goods to the large cities and to the ports. Accordingly it becomes ever more apparent how important a feature is this steadily developing technology that began as simple elementary tools in the hands of primitive man and has steadily expanded and refined until it has driven through to this age of grandiose mechanisation. It is, as it were, a forcing quality in social life—demanding of the community that it adapt itself to newer and newer levels of life and of production, and yet being itself forced into growth by the human reactions it engenders, the expanding experience and needs of the very members of the community itself. Science and technology are from one side effects of social life. The potential level of social life on the other side is perpetually driven upwards by the very science and technology it produces. Here then is the crucial quality—the casual quality we may term it—to which we must first turn for an understanding of large-scale social and historical movement.

GENERAL PRINCIPLE ILLUSTRATED IN RUSSIAN PLANNING

The significant part played in any community by the power it possesses in technical processes is well illustrated in the contemporary history of Russia. Still a land mainly of serfs and great landowners in 1914, with a relatively minute industrial proletariat, its inability to manufacture and supply its enormous army with rifles, guns, uniforms, transport, roads, railways, preserved foods, munitions, and all the paraphernalia of modern mechanised warfare, meant also an inability to stand up to the destructive powers of industrial Germany. Wooden staves are no match for high-explosive shells. Thus it was driven out of the war. With the outbreak of the Revolution and the deliberate introduction of a period of reconstruction came the industrialisation of large parts of the country, electrification on a grand scale, mechanised farming, elaborate schemes of house and factory building, a mechanised army and a powerful air force. But behind all this and prior to its accomplishment stood millions of peasants and workers, illiterate, totally unskilled in the use of anything but the most primitive agricultural tools, incapable of using machines, of tending and of mending them, unable to read plans and blue prints, untutored and, in the modern sense, uncultured. To lay a technical basis to civilisation meant simultaneously raising the technical and cultural level of the population. It meant teaching them to read, write, and to count. It meant placing books at their disposal in enormous quantities, printing them, making the paper, binding, and distribution. It involved building up the human material to achieve all this. It meant sudden and careful large-scale teaching. It required teachers. It involved overcoming the natural resistance of sections of the population who, nurtured in a feudal state, were unable easily to adapt themselves to the new tempo. It meant instilling people with an enthusiasm for a mighty effort, the outcome of which they could themselves scarcely grasp. It meant a new power and control over nature, a new understanding of the forces with which they had to contend, a new appreciation that in this effort they were making new history. It meant a sudden and widespread interest in science, engineering, the arts, and in philosophy. It implied that a new level had to be and was being struck in the quality of their living. It was a magnificent illustration of the dictum that the technical level of a community sets also the level of its social life. For the technical level cannot be attained without a population educated and skilled in the arts and crafts necessary for the production and maintenance of that technique. It cannot be maintained without creating in the population desires and needs that technical skill if fully applied can satisfy. The low social and cultural level of pre-revolutionary Russia was to its low technical level what the corresponding cultural level in modern Soviet Russia is to its new technical level.

So also in England when one compares the situation in say 1600 with 1850 prior to and subsequent to the Industrial Revolution, or when one compares the England of 1250 with that of 1600. And what applies to the forces of a constructive and civilising nature applies also to the forces of a destructive and barbaric nature; witness the ascending scale and intensity of warfare from one social epoch to another.

It should now be clear how crucial a quality of social life is the stage of technical knowledge and application to which a community has attained. It interpenetrates every phase of communal life; fixing, by paper and book production and by transport, the speed and extent to which information, knowledge and understanding may be disseminated; by its extension of communications destroying distance between peoples, their activities and their thoughts; its unseen control over epidemics, disease, water-supply rendering large communities a social possibility. We need not labour the point. The *drive of technique is ultimately the main causal agency which, as it rises, accentuates and enriches also the quality of communal life.* It corresponds to the causal agent Q of our chapter on the transformation of qualities. It remains for us to examine the relevant internal qualities *q*, the more immediate group of causal factors to which it gives rise.

INTERNAL ASPECT OF TECHNICAL ACTIVITY

In accordance with our analysis of that chapter this must be sought in the internal make-up, in the intimate structure, of the community, and in particular in that aspect of it that is directly related to or affected by Q. Just as a liquid when subjected to heating (Q) takes this up by a mutual adjustment and agitational quality of the molecules, so a community when subjected to growing technical pressure must show this somehow in the actions of its constituent members. They are two manifestations of the same phenomenon. The first relevant activities then are clearly those associated with the immediate application of this technical knowledge. Thus it lies in the region of what is called production and distribution. If we may press the analogy with the liquid we might say that the increase in heat shows itself in a rise in temperature which is effected through the internal properties and relations of the molecules. The increase in technical level generally may be expected to show itself in a rise in tempo in production, and this is effected through the internal mode of organisation for production, i.e. in the productive relations that exist between the various groups co-operating to that end. If the general qualitative law explained in the previous chapter is valid the action and reaction between these groups should become the more immediate causal agency q, from which we are finally to expect a change in social phase. This should show itself when the previous established relation between the groups in production and distribution can no longer be readjusted to accommodate itself to an increase in the technical level. In such circumstances, by a delaying or constraining policy, technical advance must be frustrated—for a time—or new relations between the factors that make for production and distribution must come into being. The longer such a readjustment is delayed, the greater we may expect may become the obstacles in the way of technical advance, and the greater the tension and stress in the community. This is the general direction of change suggested by the analysis in the earlier parts of this book.

Accordingly we turn to a study of these internal qualities in productive organisation to check whether our general qualitative law appears to be true to fact. In doing so we are following the procedure that is adopted in all scientific investigation. The sole difference in this case is that we are concerned at the moment with the qualitative rather than the quantitative aspect of the situation.

REGULARITIES IN MATERIAL DICTATE MODE OF APPROACH

Now in singling out the productive relations for detailed study, we have to recognise at the outset that we are striving to isolate from all the confused welter of social and industrial life something that stands out in a clear and regular way. In all such problems *it is the regularities that present themselves, that settle the level at which the discussion and analysis must proceed.* At first sight therefore it may appear as if we are picking and choosing our isolates in such a way as to over-simplify the issues. This is far from the case. The justification for discussing it at this level must rest in the end on the fact that such a method makes it possible to fit what appears, to begin with, as confused detail into an orderly and rational picture of a process. To that we must return after the bold outline has been sketched in. Accordingly, to understand what these productive relations are, and the way in which they are adapted to take up this technique, let us begin with the problem as it presents itself in modern society. Once that has been made clear it will not be difficult to see the corresponding qualities that have existed in previous epochs.

CREATING SOCIAL VALUES BY SOCIAL EFFORT

The first point to notice is that production is social. By that we mean that a worker does not engage as an individual to construct a locomotive or a reservoir for a town, or build a block of flats. Even when, as is sometimes the case in a country district, he will apparently build a house entirely by himself, it is still very much a social affair, for the screws, nails, nuts, bolts, piping, bricks, paint, planks, cement, plaster, glass, putty, tools, and the various forms of transport that bring these to him are in reality the results of the combined efforts of many men, brought to a focus in each article. It has socially statistical qualities. Thus when an individual worker performs a task as if it were his own entirely, he is merely making one contribution to many that have combined to produce the final result. Any article from the stage where it existed as raw material in the soil, to the final stage at which it is used in social life, embodies, within it, contributions from the labour power of past and present generations of craftsmen. It rests on the technical knowledge and skill that have combined to create all those things that in varying degrees have been needed to bring the object to the stage of social usefulness. This fact in itself forces us at once to recognise that the whole question of productive relations must be dealt with not as an individual or atomic but as a statistical affair.

TWO DISTINCT STATISTICAL GROUP ACTIVITIES

To see the regularities, we shall have to dismiss from our minds the thought of the individual article, the individual worker, the individual employer, individual effort or thought. Socially useful articles emerge out of the application of human labour and thought to raw material, over a long period. They are the outcome of social activity. From this angle therefore we are compelled to recognise two groups of activities that are involved in this productive process, viz. the actual process of working, and that of settling the direction of this work. We are talking statistically. We do not say that any individual member of the class of workers may not sometimes be also a member of the class of employers. That has nothing to do with what we are discussing. Naturally doing work and employing workers are not done in any abstract way but are practices of human beings, and therefore when we separate the two functions, we are also separating two classes of people, but they are statistical classes where an individual may transfer himself from one to the other. In being so transferred, however, the individual changes his functions and we are concerned with the nature of these functions. The separation of function between working and employing to work, is very nearly a separation of personnel also. In dealing with functions however the division is sharp.

LABOUR POWER AND CONTROL POWER

What then is the relation between these group activities? Let us examine the qualities of each that appear relevant. The working class, as workers, possess labour power; they are able to work. That is their characteristic quality, whether they be manual workers, brain workers, administrative officers and so on.

The employing class, acting as employers, own and control the machinery and the raw materials. As things stand, access of labour power in these various forms, therefore, to machinery and raw material is allowed at the discretion of the employing class. We are still discussing functions statistically.

WHAT IS PRODUCED

When this occurs the raw material is transformed into socially useful products of two kinds:

(*a*) Articles that have direct use-value to the members of the community (either for ordinary rapid consumption like food and clothing, or as sources of pleasure that are consumed slowly, like vases, pictures, musical instruments, and so on).

(*b*) Machinery that can then be made to produce articles of the type under (*a*), given the raw material and the labour power.

HOW THE PRODUCT IS DIVIDED

When labour power is allowed access to raw materials and machinery in this way how do each of the two statistical groups fare as regards the outcome of the process?

The working class are given what is called a wage or salary which they then exchange *in toto* for articles of the type (*a*). Such articles of exchange we call *commodities*. The fact that some individuals succeed in saving some of their wage or salary in order to purchase a share in machines and raw materials is again irrelevant to our analysis. These are the individuals who occasionally pass, as regards some of their functions, from one class to the other. The fact that this occurs, as we have already pointed out, has little to do with the kind of statistical regularity to which we are directing attention. The important point is that the working class exchanges its labour power, *in general not what it actually produces, be it noticed, but its power to produce things*, and to give social value to things, for commodities of the type that are slowly or rapidly consumed; in fact, for things that keep it going as a working class. Its labour power, since it is exchanged and consumed, is accordingly also a commodity.

The employing class fare differently in this transaction. As a class they retain the surplus of the commodities under (*a*) and everything under (*b*).

WHAT HAPPENS TO THE UNCONSUMED COMMODITIES

A portion of these excess commodities they consume themselves, but the great mass is retained for the further expansion of production. This is the profit and the savings and the possibility of these provides the underlying motive that inspires the process from the employers' standpoint. More than this, the urge to increase profits forces successive stages of production to higher levels, both in amount and intensity and generally throws the contradictions within the system into greater and greater relief, as we shall see. We note in passing that since we have divided the whole community into the two functional groups, workers and employers, and since we have already supposed that both these have received their share of personally consumable commodities, under such conditions there is certain to arise a difficulty in the disposal by sale of these surplus commodities for profit, if the whole thing be regarded as a static affair. Who is to purchase them, i.e. who is to exchange them for what? We shall have to examine in what way it is a changing, growing process and whether the nature of that process allows of adaptation without limit to meet this suspected difficulty.

EXPAND OR DIE

There are other matters which we must take into account. As we shall see, part of the results of the process of sale of these surplus commodities, when it can occur, is applied to purchase new raw materials to feed the machines and so to replace those already turned into commodities, plus what raw materials are required for the further and greater functioning of the new machines created under (*b*). Thus the very essence of the system we are describing is that it *must* continually expand in production and rid itself of its commodities. If it is to work in this way at all, its output of commodities must steadily increase and it must succeed in disposing of them. But this situation is rendered even more acute by yet another important factor to which we have already referred. This is the extraordinary rise in technical knowledge and efficiency that has been revolutionising the processes of manufacture, multiplying the rate of output of goods by incredible amounts. What is called rationalisation in industry is simply one aspect of this. It makes it possible to flood the market with enormous quantities of manufactured goods awaiting " sale for profit."

FINANCE

Now all this has been discussed without introducing financial factors at all. For the moment they are irrelevant to our purpose, viz. the explanation of the relations between the two primary statistical functions in the community, and the part they play in production. From the standpoint of the worker, money or wages plays with him the rôle of a scheme for allowing him to express his labour power, as one commodity, in terms of a variety of other commodities. For the employing class it plays a corresponding rôle in the realm of exchange, but in that case it performs this function on such an enormous scale, and develops so many specialised characteristics in the process, that to handle it fairly would require detailed treatment. By collecting together the disposable money, however, or small savings in the hands of innumerable small men, it forces an aggregation or unification of capital on a highly centralised basis. The individual loses control. It then plays a part as one of the uncontrolled forces in capitalist production. Here we are concerned with the underlying economic qualities of the productive relationship, however, and not with the special machinery that has been devised to effect its working. For our purpose we can regard the financial side of the problem as part of the increase in technical efficiency. It is a scheme for facilitating and unifying large-scale productive processes.

WHAT SETTLES WAGES

What the worker receives first in exchange for his labour power is wages, and it is through this that he obtains a share in the commodities produced. It is worth while noting the principal factors that settle this matter in general.

1. To maintain an adequate supply of labour power the wages must suffice in food, shelter, and clothing. Once more we are talking statistically. In special groups of workers the wages may not even amount to this, in others it may more than suffice, but in the class as a whole this condition must clearly be satisfied on the average.

2. Over and above this we have to realise that what suffices depends on the standard of life traditionally considered necessary to satisfy these needs in the society or at the social levels in which the workers are reared. Thus at the present moment in India and in China the workers have not become socially awakened to the need for a standard as high as that which British workers or even European workers in general require; hence one of the factors that allow of a much lower wage rate.

3. The extent to which it is possible to remove centres of production from areas or countries in which wage rates traditionally are relatively high to centres in which they are traditionally low. This is undoubtedly one of the factors that has led within the past quarter of a century to the shifting of production from countries like Britain to those inhabited by the black and yellow races.

4. The organised resistance that is exerted by Trade Unions by unifying labour power to maintain and to raise wage levels.

5. The organised resistance of employers through Employers' Federations to resist wage increases by unitedly withholding the access of labour power to machinery and raw material when necessary.

STRESS AT THE INTER-FACE

The tension between the two groups in 4 and 5 is the outward sign in the field of active industry of what is called the class struggle. It shows itself in negotiations, strikes, and lock-outs, a fight between two contending groups over wage rates and conditions of employment. It is the internal stress at the inter-face between the two statistical classes. The one operates to collect commodities for sale profitably over and above that consumed in wages, and to increase capital goods, i.e. machinery, etc.; the other to sell its labour power for as large a proportion of the consumable commodities as it can get. Increased success in its objective by the one group necessarily means increased failure by the other, to that extent. It shows itself in the violent contrast between the average standard of life of the dependants of these two statistical classes, between their social customs and their social status, between their hours of labour and the length and location of their holidays, between the nature of their amusements, and between the magnitude and scale of their personal property. All this stands out sharply even when there is swept into the calculation of the average for the working class that statistical middle group that divides its functions between employer and employee. It is along this front that the battle is waged.

This then is the social reaction internally, the first aspect of the quality q that corresponds to the external quality Q, the technical level to which we have so fully directed attention. It is an inescapable physical consequence of the way in which production and consumption are organised in the present social epoch. It is so closely bound up with the technical level of production because the whole scheme of factory organisation on which these relations have been built, and the scale of production of commodities, depend on the intensity of that technical knowledge. We must not assume, however, that Q necessarily shows itself in production as a *steady* rise. Technical knowledge certainly moves forward almost with uniform pace. What we have to realise, however, is that it is only in periodic spurts that the employing class—as a class—is driven to avail itself of these technical advances.

THE COMING OF ECONOMIC CRISIS. MUST IT BE PERIODIC?

What we have now to consider, therefore, is the precise way in which a rising technical level in production, viz. Q, intensifies this internal stress *q*, and whether this process ever becomes incompatible with the continuance of the present economic relations in society. For the qualitative law we have outlined in the previous chapter would suggest that it is in this direction that we must seek for those factors that will lead to a change in social phase. That this is indeed the case can be seen from certain facts which we shall state. We offer them without at this stage attempting to explain how they emerge. We shall deal with that later, and show that they must arise from the fact to which we have already drawn attention, viz. the need for the employer as a class to dispose of the surplus commodities as its profit, and the only avenue it has to carry this through.

(i) The growth in unemployment in post-war years, contrasted with that of the earlier stages of industrialism. This has meant a diminution in consumption of commodities by the wage-earning class as a whole, relative to the producing capacity of machinery.

(ii) A rapidly advancing efficiency in production, by the application of new labour-saving devices, by the replacement of obsolete by modern machinery, by internal rationalisation within the factories, by more intensive and therefore more highly organised subdivision of labour, and by the use of new synthetic materials that dispense with the presence of large numbers of workers carrying through detailed work of a hand-craft or manual nature.

These two characteristics of the process of production are of course not two separate and distinct features: they are interlocked in a most interesting way. It is not simply that machinery displaces labour, that is, that (ii) is the cause of (i). Such a relation would be much more static than is actually the case in the movement or process of which these are simply two incidents. Let us trace this out very briefly.

(*a*) Production, social needs and social experience generally, corresponding as they do to a rising level of knowledge of technical and scientific matters, force up also the possible technical level of production. All this stimulates the production of commodities, and therefore the sale of the surplus gives rise to an accumulating profit balance awaiting the opportunity to be applied to the further production of capital goods. While it is so waiting, it either lies in the banks or, what amounts to the same thing, is converted into holdings of shares in other producing concerns. This temporary influx of profits into the capital values of existing concerns naturally shows itself as a rise in the price of the shares, the competition for which has been increased. Thus the profit awaiting reinvestment in new capital goods is held in suspension by financiers as a group. Since such purchases of shares do not themselves increase production profits, the rate of return on these investments falls, and the inducement to turn to the production of new capital goods intensifies. While the financier will describe such a situation by saying " money is cheap," and therefore the time is ripe to stimulate new enterprises, we can now perceive the causal factors that are ready to transform these accumulated profits from being a charge on existing industry to becoming the occasion for the construction of new capital goods. While the application of technical processes to production for profit is the cause of this effect, the latter, at a critical stage of profit accumulation, advances technical application a stage further.

(*b*) Competition generally among producers, and the need for production with the smallest amount of wage wastage, is now translated into a need for new machinery. Hence labour power is now turned to the increased production of capital goods. This reinstallation of new machinery, while to some extent it is always occurring, comes in spurts throughout industry. For when competition is keen for one large employer in one industry, it is also keen for every other large and small employer in that industry. The general tendency therefore is *to overhaul or replace machinery simultaneously.* During this period as the result of the extra men employed and the wages they receive there is increased demand for consumable commodities.

(*c*) With the completion of this stage, marked by the end of the spurt in the erection of new plant, *two contradictory factors emerge.*

(i) Workers are no longer required in machine production and therefore become unemployed. Receiving no wages their consuming capacity falls, and therefore as far as they are concerned their labour power can no longer be exchanged for commodities. *There is a fall in consumption once their savings are exhausted.*

(ii) The machinery which they have created, however, is now ready to function *more efficiently than before* as producing plant for new commodities. It can function with fewer hands, and it can produce a greater supply of commodities than heretofore.

Here then we can see how the periodic rise in the technical level or rather its periodic introduction into machine-overhaul and replacement will, other things remaining the same, be accompanied by a periodic accumulation of profits to a critical stage, and so be followed by a periodic crisis of over-production side by side with its necessary partner, under-consumption.

If the main market for these commodities is the home market, it is not difficult to see how this phase of over-production is rapidly transformed into its opposite, viz. under-production. By the time the sum total of the savings of the workers has been used up, after they have been discharged from the making of machinery or capital goods, the market demand falls, production of commodities in the effort to adjust itself to this falling demand also slows down, and what was a profit-accumulating boom slips into a slump, and slowly returns to the stage where only by an overhaul of machinery can the employer hope to pull himself out of the slough into which he has fallen. And so with new capital production and technical advance the cycle starts all over again.

These then are the bare elements of the situation that before the war showed themselves in periodic booms and slumps every ten or eleven years. Superimposed are innumerable other factors also contributing directly and indirectly towards this end. To-day with the greater pace in technical development and the much higher production levels attained, the booms and slumps follow each other at much closer intervals and with much more intensified fluctuations.

Again the reader must be warned to notice the level at which this is being discussed, and not therefore to be drawn away by side-issues of a relatively trivial nature. At the same time it is now clear that we cannot escape examining the nature and whereabouts of these markets on to which commodities have to be discharged for profitable sale. This is a crucial matter, for this reason. We have so far appeared to view the relations between the two sides of the productive relationship as fixed and unchanging, as if in fact all this social activity was taking place and could continue to take place in a society isolated from all other countries in the world. Now such a system as we have described simply would not function, since, having in our statistical way accounted for all the community between the classes, employers and workers, we have left no room for human beings who are to be the market for the profitable sale of the surplus of commodities. The " home market " would very soon be glutted, production come to a standstill, wages cease being paid out and goods cease to be exchanged. Somehow or other the market must expand.

The advantage of approaching it all in this way is that we can now appreciate how important historically to the continued functioning of the capitalist process of production was the finding of such an outlet and how important it is to us to appreciate the nature of the market when found.

There is a preliminary point to which we must direct attention in this connection, viz. that the distribution of the commodities produced between the two statistical classes is not unchanging either in amount or in proportion. Wages rise and fall, price levels rise and fall. Thus the relative share of the commodities which the workers receive itself may fluctuate. Moreover the desire for consumption, if not always the actual consumption of all members of the community, tends to increase, as commodities multiply in variety. This applies to both classes for it follows step by step with the rise in the technical level. These needs—in a sense, luxury needs compared with those of a previous technical level—grow out of an appreciation of what a society efficiently organised for production and distribution should show itself capable of achieving. In spite of all this, however, in spite of the fact that the employing class could, if it cared, utilise a large part of its profit surplus in the form of very high-grade luxury products, and does actually do so, it cannot utilise it all in this way. The inescapable fact remains that the very essence of the productive relation is its profit basis and that this profit shows itself as (1) commodities that have somehow to be exchanged for raw materials on some market and (2) capital goods that must, if the system function at all, be used to produce new commodities. There is no equilibrium position. It is an unstable expanding process.

WHERE IS THIS MARKET?

In one sense, it does not appear to matter where it is. Modern finance has converted itself into a vast international clearing house so that commodities can be exchanged anywhere at any time—*even before they have been produced.* If we rise above this mass of intricate paper detail and look for the group relationship between an industrialised country and its market, our problem becomes that simply of examining the transport of matter by human beings from one part of the earth to another. In any lengthy period we see a net transfer of raw materials, mainly from certain " undeveloped " countries where the standard of life is traditionally low, to industrialised countries where it is traditionally high, and a transfer in return of socially useful commodities in exchange for these. Hence the drive to find a market for surplus commodities is also, on balance, a drive to find sources of raw materials, and this in its turn a drive to find colonies, not for the mere formal pleasure of being their government, but in order to obtain their raw materials and to get their inhabitants to accept manufactured goods in exchange. Seen from the financial aspect these provide a profitable colonial investment. Politically it is the source of the international tensions and the rivalries between states all striving to hold the same fields as markets for their manufacturers. Historically it is the mainspring of the epoch of imperialism, the later phase of the industrial revolution. Here we are considering it from the more fundamental economic standpoint, more fundamental because by viewing it from this angle the other aspects group about it in a reasonable balanced way.

THE EXTERNAL CONTRADICTION

Let us remind ourselves that we set out to make an outline of the productive relations in the community in order to understand their mode of functioning. We have seen that the worker gives his labour power in return for the wherewithal to live so that he may offer his labour power again. We have seen how this labour power is used in association with the technical resources of the community for conferring socially valuable qualities on raw materials. We have seen how this product of labour, machine, and raw material is distributed partly as the wherewithal to the worker as already explained, partly as consumable commodities for the employer, partly as improved machinery and partly as further commodities for profitable exchange by the employer. It is for this profit that the employing class consents to allow the process to be carried through at all: hence the drive for markets and raw materials, and the difficulty of effecting an exchange of the multiplicity of profit-commodities for raw materials with natives of backward countries whose standard of life is traditionally low. Since the motive of the exchange is primarily to make profit on the transaction (and only as a vague aspiration—an afterthought—to do *good* to the native) it follows that what is sought is the greatest quantity of raw material in exchange for the smallest quantity of manufactured goods. If these areas are however to become dumps for the absorption of the profit-commodities, the standard of life of the native must be able to rise *pari passu* with the growth in the powers of technical production, must in fact be forced up with it. One requires only to look at the conditions of life of inhabitants of India, Malay States, East and West Africa, China and so on, in order to appreciate that this is very far from happening. Hence the old dilemma reasserts itself. What then is to happen to the surplus commodities that the capitalist most earnestly desires to exchange for profit? Neither a poverty-line proletariat, the victim of boom and slump, nor a near-slave colonial population can permanently absorb its own technically produced commodities in such circumstances. It must seem clear then that the gathering pressure of saleable commodities, and their necessary exchange for raw materials, demands that expanding markets external to the country of production must be found. One phase of it may be seen in the present situation between Japan and China where, as the former country's industrialisation gathers pace, a drive is made into China as a colony, a market for its goods and a source of raw materials. Another phase can be seen in the position of Germany where a whole nation, mobilised under a rigid fascist dictatorship, is rapidly prepared for war in order, by force of arms if necessary, to tear colonies as markets and sources of raw material from the hold of those capitalist countries that at present control them. The third phase is seen in countries like Britain well supplied with colonies, in which the standard of life of the inhabitants is so low however (India for example) that only a very slight share in the commodities produced that are for sale by profit can be purchased.

RESOLVING THESE DIFFICULTIES BY ABSTRACTIONS

It is sometimes argued that, by various devices, usually some form of financial trick, it will be possible to induce the capitalist to run his business without the profit motive. The idea suggested is that, with this one factor eliminated, the whole of the system would function smoothly. To imagine the continuance of industrial relations of the capitalist type without the profit motive is a phantasy. What does the elimination of the profit motive mean? It would involve giving labour access to machinery and to the raw materials of the soil by those who own and control these things. It would mean no longer treating labour power on the one hand as a mere commodity to be exchanged and as a source of use-value in production on the other. It implies the end of investments for profit. It involves the collapse of all the economic and financial features that shore up the present-day stratification of society. In the end it must involve the classless society, the elimination of class warfare: the reconstruction of the whole state and its legal system in order that the basic conception of private property, in so far as it is related to means of production, be wiped out. History does not relate a single case where property and privilege have not preferred to destroy what it controlled than relinquish its grip. This is happening in Spain at the present moment. It would seem extremely unlikely that the elimination of the profit motive can come by a voluntary financial trick.

If the profit motive then is so fundamental a characteristic of the productive relationship of modern society and if it is unlikely, to say the least, that it will be coaxed out of that relationship by either ethical or theoretical arguments, or by simple book-keeping, it is important to see the direction in which it is driving production. It is like the study of a moving system under an impressed force. The subject matter is the operations of employers as a class driven on by the forces that reside in the productive relations and in particular by that one to which we have attached the term " profit motive."

UNIFORMITY WITH DIVERSITY AMONG EMPLOYERS

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; that is to say, between the atomic elements of the group of employers as a statistical entity. Each seeks a maximum of profit for himself, each strives therefore to undercut the other or to eliminate him from the competing market. Technical resources as we have seen are called in to this end to produce as cheaply and as efficiently as possible, and vast quantities of goods are thrown on the market by each in turn, and simultaneously, in the effort to undermine his competitors. This is the internal form in which the periodic crises show themselves. Not alone in a single country does this occur, but between large groups situated in different countries; for goods are dumped from one country to another under the drive of international competition, sometimes supported by state grants. Hence arises the fantastic situation where a country, in reality the profit-making mechanism, is dealt a severe economic blow by commodities being offered at cheap rates; and so the power of the state is called into being to prevent this " unfairness " by the erection of tariff barriers, and to organise scarcity. Out of this series of surges in production and the periodic flooding of the market with goods in chaotic fashion with ever-increasing amplitude, emerges the increasing amplitudes of industrial crises with which we are only too familiar. The tempo of social life as the strain increases rises to a higher pitch. The quality of uncertainty in the situation deepens. All this has to be seen in relation to the more basic analysis we have already given of the underlying factors that stimulate periodic crises.

THE CHAOS SPREADS

As the frequency 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. This then is the situation to which the application of technical advance to society organised under the present productive conditions moves. In the effort to maintain the relationship intact a series of constraining or delaying devices are naturally resorted to, the possible existence of which have already been hinted at in the previous chapter. They are not always consciously or deliberately applied. Here they begin by taking the direct form of destroying certain of the competitors: hence bankruptcies and failures. Then the surplus commodities for which a market cannot be found are in their turn destroyed. Coffee and grain are burned, crops of cotton are ploughed back into the land, payments are made by the state from taxation to farmers to restrict production, shipyards are closed down, milk is poured out into the drains or deflected from the food market into other channels, fish are emptied back into the sea. All this is done in an uncoordinated way, a second phase of the earlier forms of controlled output as in rubber, oil, etc.

FASCISM—THE NEXT STAGE OF FRUSTRATION

Finally it passes to organised 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 come to be called fascism acts as a delaying factor in order, by force of arms and organised brutality, to prevent the situation from boiling over, and passing into the next socially necessary phase. From being localised in this industry or that, in this country or that, it becomes general. It is like the eddying in the fluid that passes from the phase of localised whirlpools to generalised turbulence. As the international tension deepens, science is rapidly deflected from its humanly desirable end of raising the cultural level of peoples, to the national production of armaments and weapons of destruction. For a while internal tension is relieved as unemployment falls, arms profits rise, and society makes elaborate preparations for mass suicide. The greater the level of scientific and technical knowledge, the more ingenious the devices for wholesale murder. The more highly organised for socially valuable industrial production the countries are, the more capable are they of supplying the multitude of military necessities on a wide front and over extended periods of time. They are marshalled for wholesale destruction and generalised disorder. All this is not only the frustration of science but the direct application of the summation of man's civilising force towards his degradation. It is the final *dénouement* of an outworn and thoroughly decadent system of society.

There is clearly one final solution only, one that must remove the fetters from production and enable the fullest use of the technical achievements of mankind to be applied consciously and intelligently to his service. What it is that constitutes these fetters is now evident. It is the condition imposed by those who legally own and control the forces of production, the machinery and the factories, the land and the raw materials, that there must be no access by labour to these things unless a surplus of commodities is provided to them as the source of profit. That unless production be organised for the primary purpose of securing profits to them rather than for catering for the human needs of men and women without profit or exploitation, it were better that production come to a standstill. Finally if, in order to maintain the régime of profit-making beyond the stage where it can avail itself of the technical knowledge for the advancement of man, that régime should deem it necessary to pervert that knowledge and apply it to destruction, provided it continue to offer the possibility of individual and temporary profit, then again it moves in that direction, without hesitation. At that stage it is the only direction in which it can move, and remain temporarily intact. In doing so it passes on to its own destruction.

INEVITABILITY

To transform this chaos into order involves the elimination of the divisions of society into employer class and working class. It involves an economically classless society, the new quality of the next phase that must emerge if these confusions and contradictions are to be resolved. In the sense that it is indicated by the general qualitative law we have already set out, this transformation is inevitable, given the necessary circumstances; these are the human reactions. How this change comes inevitably into being is a significant point. We are not dealing now with molecules of a gas which when heated up to a certain temperature mechanically become agitated and pass blindly into the new phase. We are dealing with human beings who are partially conscious of what is happening to them: they are conscious that it is being made to happen by the actions of human beings. Human beings by their own actions make the change in phase or retard it. They can do so by the reflection of intelligence in their actions.

Conscious planning in this way can be only of two kinds. It can have as its historic objective the application of restraining forces that will delay the transition as long as possible, no matter how well intentioned the planners may be. In delaying the change the cost in human suffering and distress and the warping of human ideas and valuations is accentuated: witness the present situation in Germany and in Spain. On the other hand conscious planning may be such as recognises the inevitability of the change in phase and works steadily towards spreading an appreciation of that fact. The process of doing this is also the process of bringing the change about in sensible form befitting intelligent people. The exact point at which the transition in quality will occur depends thereafter on a multitude of factors that need not be enumerated here. What our qualitative law apparently predicts is simply the inevitability and nature of the change, and that we human beings will inevitably make the change. We return to this later.

OTHER TIMES, OTHER PHASES

We have chosen to discuss the internal make-up of the present economic epoch in detail, and the nature and origin of the stresses and strains it manifests, principally because, being the period in which we live, it is of immediate interest to us. We are dealing thus with contemporary economic history, and events in which we play a part. Seen from the standpoint of an individual living in that period, that break-up of a social epoch is slow and long-drawn-out although there have been occasions when it has been short and sharp. Established order appears a permanency to him.

The next problem to which we must address ourselves is clear. Have there been other quite different phases of social organisation and have they also manifested a similar type of internal structure? Have they been induced to pass over into a new phase also under the gathering pressure of this internal causal agency?

Here in 1200, say, we have a social group organised together in a very special way, a distinctive series of productive relations existing between the serfs and their feudal lords, legally constituted as are the property rights in the means of production to-day. Again there was a distinct bifurcation of class, manor house or baronial castle *vis-à-vis* the huts of the serfs, the rights of the feudal lord over the fighting powers of the serf, his rights over the product of labour, the inability of the serf to move from the lands of his overlord, one legal system for the one class, another for the other. We need not elaborate the point. Social life at that period possessed a series of distinctive qualities of its own, and, however much the individuals of that epoch may have imagined that the feudal system was destined to remain eternally fixed and unchanging, the fact remains that by 1550 it has all but passed away. True there is a landed gentry, an aristocracy as a special social caste, but the essential economic relationships have been irretrievably broken. We are in a new phase. The towns are busy, thronged with wealthy merchants. Ships arrive laden with merchandise, sold at fairs to which the descendants of the earlier serfs attend without restriction. There are guilds of skilled workmen; merchant companies finance the erection of schools and other educational developments. The cities have their freemen. The power of the feudal church has been broken and in its place a new institution that owes no allegiance to Rome. In the seaport towns, sailors, small traders, craftsmen, journeymen and skilled artisans jostle each other. Flemish weavers have for a century been settled on the East coast and established a flourishing trade. Commerce has expanded, wealth exacted by piracy from the Spanish galleons is pouring into the hands of the owners of frigates and a new and powerful merchant class has arisen. Nor is the change at all characteristic of England alone. Venice, the home of the merchant princes, has its palaces along the banks of the canals, and banking houses are exercising greater and greater directive control over the policies of kings and governments. A virile class has been born from within the womb of the feudal system, a class that in order to acquire and establish its necessary rights and underline its new-won social prestige is prepared to wrest legislative power from the hands of the now weakened feudal aristocracy. It has come with the growth of navigation, with the expansion of handcraft industry and with the resulting power of finance. The very continuation of the feudal system has necessitated the emergence of a new class of worker to cater for the multitude of needs that are of a more general social nature than can be created under the restricted conditions of the now contracted feudal areas. The towns have begun to overshadow the country.

By 1640 it has reached its climax. Whatever the immediate pretext for the revolt, the townsmen and burghers are rallied to Cromwell in his challenge of the Divine Right of Kings. It is not the divinity of the king with which they are concerned, but with the legal rights to carry through the logical development of the new order, unhindered by the traditions and established privileges of a class that had to be ousted. The process was not sudden. Counter-revolution reared its head nearly seventy years later in 1715 when the Old Pretender tried once more to recapture power for his dispossessed class. He was not simply an individual claimant to the throne seeking to re-establish himself upon it *qua* individual. It was a challenge to the new order. By 1745 the last weak effort of the struggle was stilled in the sporadic appearance and disappearance of Bonnie Prince Charlie.

The fact that England as late as the middle of the eighteenth century, when the new industrial phase that was later to be called the Industrial Revolution had already made its appearance, still possessed elements that believed in the return of the " good old days " of feudal and aristocratic power, is a clear indication of a feature of all these successive changes in social structure. Slowly and steadily men, under a gathering experience, were transforming the society they lived in. Here and there an obstacle to change, with its roots deep down in an older epoch, would hold up the inevitable advance for a time. Presently at a critical pressure the obstacle would be forced out of the path, and the route would again be cleared for the next move forward. Revolutions large or small are simply the efforts of men to make up the leeway lost by entrenched reaction. The actual detailed stages in the revolution itself manifest distinctive qualities, different in kind but intimately dependent on those manifested by the steady general advance. The nature of the Cromwell Rebellion hinged on the fact that the townsmen with their new industries, rallying around him, made it possible to fight with muskets and cannon. The new technological order was imposing its power by the use of its new technological weapons.

OTHER COUNTRIES

The sequence of phases through which England has passed from Feudalism to Mercantilism, on to Industrialism and Imperialism, then in its latest stage to Finance Capitalism, were not peculiar to England alone. They are world wide, but particularly in Western Europe have they shown the many successions of form beyond the feudal stage. Even Ancient Greece for all its peculiar social structure, with its slave population, passed in succession from Agriculture to Mercantile and from that through a form of factory system to Imperialist or Colonial stages, before it was swept out of existence by the hordes of " barbarians " that fell on it at the period of colonial decay.

EFFECTS OF UNEVEN DEVELOPMENT

The industrial revolution in England had already firmly grounded itself, before the climax of the previous epoch was reached in France. The Revolution that sought to sweep away entrenched reaction and clear the path for the new bourgeois class is usually dated as 1789, but it is not until after the 1870 Franco-Prussian War that the last remnants of French feudalism have been overthrown, the Republic finally established, and the slow but steady industrialisation of those parts of France began that were not primarily agricultural in their natural resources. The period of incubation in France thus lasted nearly ninety years as contrasted with nearly a hundred years for England. Hardly has the new phase begun before it develops the incipient elements that lead to its final transformation. The more it grows, the nearer it comes to decay. Spain for instance has not yet emancipated itself from the feudal stage in spite of the emergence of industrial elements in various quarters; its church, a feudal church that during the present rebellion has not hesitated to throw in its lot with the combined forces of the feudal aristocracy, the financiers, and the other forces of fascist reaction in Europe.

With the uneven passage from one phase to the next at different parts of a world that is now intimately linked up in innumerable ways, the rapidity with which any one country leaps to the next stage has become intensified enormously. Japan, still a feudal country in one way, has during the past 20 years become highly industrialised and during the past five years has spread across the continent of Asia into China in the orthodox imperialist fashion in the search for raw materials and markets for its manufactured goods. It is well recognised that wherever a Japanese geologist is seen studying the natural resources and raw materials of an area of China there will a military drive manifest itself almost immediately.

INVARIABLE ORDER IN PHASES

When, therefore, we assert that communities in their natural development drive themselves through a succession of phases of the type we have mentioned this does not mean that these phases occur mechanically at regular intervals in any one country or that any one phase lasts roughly the same time in any two countries. What is invariable is the *order* in which they come. We are directing attention to a qualitative feature of the change. The economy of a country does not pass back from the industrial stage to the feudal stage. If an attempt is made to do so, and there have been such sporadic attempts in the contemporary decadent history of Europe, it can only occur artificially by the imposition of artificial constraints such as those employed by fascism. Each epoch necessarily builds on the technological knowledge and experience of the previous. History does not turn back on itself.

TELESCOPING PHASES BY CONSCIOUS GROUP ACTION

But the order in which these transformations occur may on special occasions show peculiar features. The Revolution in Russia that reached its crucial point in 1917 and struggled on through the sanguinary stages of the civil war and interventionist wars by capitalist countries has sought to telescope the stages between feudalism and modern industrialism transformed into socialism, at one stride. If it succeeds, and who can now doubt that ultimately it will, it will provide an excellent illustration of how history can be guided *consciously* at high speed through stages that might have taken many generations of unconscious effort. The cost of this venture must be balanced against the totality of pain and suffering that would have been endured by the population of that country had the process been one of slow undirected struggle. In the same way it seems clear that if the Government of Spain succeeds in throwing off the attack of Germany and Italy, the subsequent movement towards industrialisation or towards the introduction of mechanised methods in agriculture in that peninsula will take place at high speed. In less than a generation Spain will be transformed into a modern socialist state.

This uneven development in various parts of the world at the same time, is a factor of profound significance. Colonial expansion, as we have seen, is a necessity for most industrialised capitalist countries. It has always taken the form of penetration from an economy at a later stage of development into one at an earlier stage. Spain in its early days of mercantilism-cum-feudalism overran South America. With more elaborate methods of offence and with greater mobility of transport, it was more than a match for the less technically equipped South American races. Britain swept up India, Ceylon, North America, New Zealand, Australia, and the greater part of Africa. She organised punitive expeditions against rebellious tribes. China, almost entirely a vast deeply entrenched feudal country, was easily parcelled out into spheres of influence among the Western Powers, and it has been only because of the increasing tempo of European capitalist crisis and decay and the tensions resulting from it, that Japan has been allowed to overrun the rest of China without challenge. The recent savage attack of Italy on Abyssinia is another case in point, while the present position in Spain manifests similar features, where the weight of modern scientific warfare is brought to bear on an undeveloped semi-peasant semi-industrialised population.

UNEVEN DEVELOPMENT MERELY INTERNAL STRAINS AND STRESSES IN SOCIETY AS A WHOLE

These are all illustrative of the uneven development of social groups in various parts of the world. Seen from a wider perspective, that of the whole of human society, they are the internal stresses and strains preparatory to a general and widespread transformation that will even up the differences in development between one section and another. Broadly speaking—that is, discounting these unevennesses—the dominant mode of social organisation throughout the world at the present stage is capitalistic. As it pursues its course in accordance with its internal logic there is aroused, within its human elements, a human reaction against the widespread misery and want, war and slaughter, frustration and destruction of human values it has itself engendered. As its inevitable development becomes itself the subject of analysis, these changes become objective features that are taken into account by the human elements themselves.

The technological advances that have stimulated capitalism, and that capitalist organisation has itself found it essential to develop, become the external causal agency. The internal factors for change become the organisations of humanly understanding men and women who strive to make the inevitable transformation, in accordance with the intelligence and valuations they have acquired during this and preceding epochs. To them the appeal is to human values that are greater than those of the immediate period of decay. They are the growing values of a whole history of human society. These values they inherit, and not simply those of the stage of decadence, for they manifest a reaction against that collapse. From this, coupled with the scientific understanding of what is likely to occur if they do not bestir themselves, emerges the Socialist Movement.

THE NEGATION OF CAPITALISM

It is the first sign of the factor that is finally to negate the capitalist order. Suddenly a crack occurs—in Russia—just at the weakest link in the capitalist chain and a new and vital *point d'appui* for socialists has begun to show itself. In vain do the forces of capitalism seek to submerge it, stifle it, vilify it and undermine world confidence in it. Steadily it becomes stronger and stronger, but not without great travail. The first stage of the transformation begins to show itself. What might imaginatively have been a straight-line development towards a new order is cramped and diverted by the growing dangers from capitalist neighbours and the needs of defence. In the rest of Europe the socialist movement, its vision blurred by the distortions and travesties of the press and by its inability to see in clear-sighted fashion the logical development of the process, hesitates again and again before the necessary unification. The closing of the ranks is inevitable but it is not consciously seen. The constraints are applied in Italy, in Germany, in Poland, in Hungary, in Japan, and in Portugal. It calls itself fascism as if a new name implies a new content. The issues become sharper. Democrats and the democratic countries of Europe, developing at different paces, are faced at last with their first alternative. On which side shall they throw their weight? One side leads to socialism, and the new social order, the other to the retention of capitalism at its decadent stage fascism and through to its next level of debasement. In vain do they hope for a way out. In vain do they call for mutual goodwill in a situation where it cannot live. As they wait the position becomes more intense. Capitalism turns on itself, it can see no way out; one section arms against another through the State it now controls. They manœuvre for position or foment trouble in each other's territory. Democratic countries and democratic parties seek to isolate themselves from the contending groups, but isolation is impossible; the situation has become world-wide. The choice is unavoidable. The question rises insistently. Are they for socialism and the new world order or are they for retention of the present process of decay? The final outcome for those who dare not answer is clear. When the evident travails of the present situation have become more intolerable than the imagined terrors of the new order they will choose the latter. In delaying their answer, in delaying their moral and physical support until that point, they are choosing the path of misery rather than that of intelligent planning to usher in the new epoch.

What is this era into which we are moving?

THE TWO ALTERNATIVE ROUTES

Curiously enough in spite of the inevitability of the final outcome, we have a choice to which we have just referred; in describing it as a choice rather than as alternative routes we are giving the subjective rather than the objective stress to the process. Let us trace in a few words the two routes. The one will be followed by us if, as a social group, we become what I have termed "conscious social isolates." If soon enough, the statistical isolate I have called the workers, and with them all those people who sympathise emotionally and ethically with their struggle for emancipation no matter how confused and unscientific their analysis, can close their ranks; if they acquire governmental power that democratic institutions imply they are entitled to use, and use it consciously for the elimination of the profit motive from production; then *if this can be achieved without the instrument breaking in their hands* the path is clear to the next historical phase. Men will have become conscious planners of their future, in the sense that they will have taken the materialist and historical necessities into account. Freedom, as we have pointed out, cannot be attained by human beings without the recognition of what are the necessities. Man's own necessity as a social being is this final transformation of society. In achieving it he makes himself free. In opposing it he fetters himself. But the strain to which the democratic machine can be submitted must be examined with circumspection. Democracy is an achievement that has been created in the political sense almost entirely during the past hundred years. The acts that broadened the franchise certainly came into being during that period. When we are discussing the use of the democratic machine, therefore, for ushering in a new social and economic era, we have to set out clearly in our minds whether that instrument has been designed for, or is capable of, directing the secondary causal agent that effects this change. Parliament may make laws but can parliament implement them ? The primary forces of action and reaction within the community in modern times are economic, viz. those wielded by employers and by employees, by finance, by the military and the police. When we say that the democratic machine can achieve the desired historical end if it does not break, we are implying that the conditions for success in this way demand that neither economic, financial, military, nor police forces will do other than attempt to implement the desires of parliament and of the people. This is an assumption that, however desirous we might like to be of its truth, cannot lightly be made.

Individuals even with the most elementary political understanding realise how, on various occasions in the past, financial interests have played havoc at election times with the prospects of progressive parties. Within a democracy that believes it is free before it has achieved democratic forms, there are innumerable means to hand of undermining that very freedom. There have been occasions in the not very distant past when a military clique has forced the hand of government, as in the case of the notorious Curragh incident, the prime mover of which ultimately became the leading legal luminary in the country. If one is on the side of reaction, to flaunt the constitution is not in any way to act detrimentally to one's career. It is the other side that demands martyrdom. Working-class leaders have been imprisoned not for what they have done or even said but for what it was presumed they were going to say. Freedom of speech is indeed an essential to all ordered and intelligently directed change; but as the period of transition approaches so do the social and economic tensions sharpen. Freedom to point out, to those who suffer, the direction in which their salvation lies becomes then an essential of intelligent change. But at that stage such matters are regarded as subversive of "established" society. What is a demand for freedom, on the part of those who recognise historical necessity and desire to see it implemented in the easiest, most intelligent, and most human way possible, is seen as licence by those who desire to maintain the situation unchanged. These are two distinct valuations between two contending economic groups and their ideological supporters in society. If therefore in the face of this, restrictions are imposed on freedom of speech, and laws are introduced defining more and more broadly what is to be understood by sedition, giving greater scope to the powers of search of homes of individuals suspected of possessing literature at variance with the existing order, then we can assume not only that these are evidences of the growing state of tension and of uneasiness and insecurity of those who wield economic power in the community, but that these are also signs that the democratic instruments we have forged for social change are beginning to show signs of wear and tear.

It would be false to conclude from this that democracy, as an institution for change, is futile. On the contrary the resistance offered by the Spanish Government at the present moment against the modern arms of Italy and Germany, and the indirect attack of the Non-Intervention Committee, is a living example of what power a democratically elected government, if it can attain to that position in the teeth of Finance, can draw from its supporting democracy. Countries and parties that have refused to recognise this significance of the Spanish struggle and that in this lies the only salvation of democracy, have done the greatest disservice to the belief in ordered government and intelligent change.

These then are some and not by any means the most important of the possible limitations and dangers we have to bear in mind as we pass through democratic processes to Socialism. But that is not the only possible route that human beings may take. Not only have we tacitly assumed that the democratic machine will function efficiently for this purpose, but we have assumed that the very people themselves will in their growing distress and in the confusion of schemes and policies that are insistently presented to them by contending groups be clear-sighted enough to elect a strong democratic and socialistic Government. We will not venture on the probabilities of such an occurrence; but failing it then the other route is clearly that which will be trodden. Governments that deny the inevitability of the next social phase or are not prepared to plan for its introduction can do nothing more at the very best than make the path to decay and misery as smooth as possible; in the process they will, as we have suggested, require to remove from their midst all " dangerous and turbulent " elements, that is to say all those who by speech or action expose the eventual dangers of the path that is being trodden. To maintain itself intact on this downward path it will require to introduce greater and greater measures of fascism. The inevitability of the historic process is not avoided in this way. The route to it is made only more bloody and distressing. Hitler, the self-appointed apostle of anti-communism, is not only the greatest spokesman for his own *bête noire*, but by the path along which he and the financiers and industrialists behind him are forcing a depressed and dragooned population to tread, he is demonstrating to the world at large the dangers of the same path they themselves may presently find themselves treading. Only those who have lost their humanity and their historic sense can face such a situation with equanimity.

THE SUPERSTRUCTURE OF SOCIETY

In the discussion we have just completed there has been a basic assumption that we must examine more closely. The secondary causal agency q, aroused by a causal factor Q mainly of an economic nature, is really an activity on the part of human beings. That secondary activity embraces not only human action in the ordinary sense but also thought analysis and a vast complex of emotion, desire, hunger, wants and æsthetic valuations. It is in the attempt to adjust circumstances to satisfy these desires or to remove the hungers or to satisfy the wants that the intellectual analysis is carried through and that the course of action is finally embarked upon. Such activity readjusts environment, changes the original circumstances, and so reacts in its turn to arouse a new complex set of emotions, desires, hungers, wants and æsthetic valuations. This in skeleton is the simplest illustration of social dialectical change.

Let us examine the levels of importance that human beings attach to these matters. They will be seen to be immediately related directly and indirectly to social and economic security. First come the elements for immediate survival, hunger for food, and the need for clothing and shelter, for himself and for those who are socially and humanly bound to him. Then come those factors associated with security in the future: corresponding to the delay of consumption to a later date, valuing the activity that foresees and plans as against thoughtless immediate consumption. Hence in a social community in which survival as a group is of importance, in which the individual might take action that threatens the future security of the group, ethical and social factors emerge that have a binding significance, a moral cogency to the individual.

With the acquisition of social and individual security come then the search for understanding, at first on matters of immediate social importance, then on those of deferred value, ornaments, art pieces, the growth of institutions of a legal and educational nature, and the emergence of refined æsthetic appreciation. The more highly developed a community is technologically, the more complex and varied the fields of human experiences within which these diverse aspects of human activity may manifest themselves. Superstructure upon superstructure of ideas, theories, ethics, morals, religions, and philosophies are erected. Every individual born into a society inherits its economic structure and its ideological superstructure. As social and economic conditions change, so do the ideologies of the societies and the classes it contains change. Each historic phase to which we have addressed ourselves in this chapter possessed its own distinctive ideology, built up on the tacit unexpressed assumption that the social phase was permanent, unchangeable and in a sense immortal. Within such a society there must likewise grow the critical belief in the transient nature of that dominant ideology, a belief that must be frowned upon by all who maintain the permanence of the immediate phase.

The close linkage between the social background and the nature of the superstructure becomes evident as soon as one approaches a period of economic stress and insecurity.

Increase economic distress, and simple ideological matters become more urgent than the later ones. Æsthetic niceties vanish. When the earlier ones are satisfied, the other become correspondingly more insistent. Moreover we have already seen how scientific and technical development helps to enlarge the scope of them all.

This then is one aspect of what we have meant when we have said that the technological level of a community provides the base-line for the cultural level.

It follows that if this view is correct, it should be possible to follow historically the growth of an idea or a connected sequence of ideas and relate it step by step, although not always directly, to the social and economic background from which it has emerged. This does not mean, be it noted, that we are suggesting a form of economic determinism for ideas. Ideas are produced by human beings and are conditioned by their social context, that is all that is being asserted, but the assertion would be needless were it not that both philosophers and ordinary humans frequently talk as if ideas came entirely out of the void, *free* creations, as they are called, of the human mind. Mathematics, we are told, for example, is *par excellence* the most telling illustration of how the mind in its *free* activity can form ideas that reach the highest pinnacle of human creativeness.

THE SOCIAL HISTORY OF THE THEORY AND PRACTICE OF PROBABILITY

Let us then briefly sketch the development of one branch of mathematics that has frequently been regarded by mathematicians as owing little or nothing to the world of everyday affairs, but one that, since we have developed a statistical view of nature, has recurred frequently in these pages, the Theory of Probability. It will serve as a test of this part of our thesis. Because mathematicians are naturally more directly interested in the logical arrangement and logical coherence of the fields they study they tend almost more than any other class to isolate them from the social background from which they have emerged.

In the case of the theory of probability the treatment has always tended to be of this abstract kind; frequently it is regarded merely as a branch of logic or expressing a subjective sense of expectation. The field of statistics becomes then one of the regions to which, as a sort of miracle, the mathematical theory developed finds application. Outside this, one of the widest and most important fields, it appears to concern itself only with games of chance, card games, dice throwing, and drawing balls from bags. Is there any relation between these totally diverse regions of study other than a purely accidental one. Let us then examine how the *ideas* of probability gradually developed and seek particularly for any relation that might be manifest between these ideas and the social setting in which they expressed themselves.

It would seem to be established that under the Greeks, insurance against loss was a well-accepted procedure. Already in the fifth century B.C. banks were established in Athens, and interest rates on recognised transactions were in use. The first system of insurance mentioned in history is associated with a Greek Antimines about 324 B.C., when he offered to guarantee slave owners against loss by escape of their slaves at a premium of 8 per cent per annum of their market value. The Greek merchant period saw also the rise of marine insurance in the form of sea-loans whereby a merchant received an agreed sum from the banker when a ship set sail. If it reached its destination the capital sum was returned with interest at an arranged rate. If it foundered the capital sum was retained. Again in Roman times the collegium or guild had a regular system of life insurance for its members whereby, on the death of one of them, a definite sum of money was paid to the surviving relatives. Even the word *average* derives from the Latin *averagium*, the proportion of merchandise and goods of an individual merchant that had to be thrown overboard, if necessary, during a storm.

It does not appear to be recorded how these rates were arrived at, but there can be no doubt that from out of the social background, from market talk and general knowledge, a figure like 8 per cent for slave insurance must have been drawn as representative of a sure upper limit to the frequency of slave escapes. It expressed a measure of a statistical social regularity, the isolation of a social quality, an estimate of its quantity, and an application to social practice. Probability had a real objective significance, and was the appropriate form of prediction in the circumstances. It showed itself as an insurance rate.

We need not here trace the subsequent history of insurance, marine and commercial, throughout the Middle Ages. It suffices for us to recognise that quite clearly out of the trade and exchange that developed unceasingly during that period, not only did there emerge a more and more accurate understanding of the laws of material change that are usually subsumed under physical science, but a growth of our understanding of the regularities displayed by human groups in their associations with each other. By the end of the thirteenth century the Florentine merchants already dominated the entire trade of Europe. Behind this experience must have lain an enormous mass of knowledge of such matters, for, by 1350, not only did they have banking establishments in most of the capitals of Europe, but they were in a position to apply their knowledge of statistical regularities to control international exchanges, and to dictate monetary policy. Once more this implies the deliberate use of probability practice. This can be seen for example in the operations of Sir Thomas Gresham in 1552–3 to restore English credit by pegging the exchange, selling foreign currency in Antwerp and restricting trade with Flanders.

What we are trying to suggest is that already there existed a complex social practice expressed as a probability prediction, in spite of the fact that it was not until the last century that the underlying theory of probability had begun to be critically examined.

With the rise of the mercantile class in England and Holland came also a change in the incidence of the problems to which these methods received application. The towns were growing in size and importance, and the burgher class was already in active opposition to the feudal aristocracy—fighting its case as usual on the moral and religious plane—Puritan versus Established Church.

With the achievement of power came also the possibility of application of the methods that had emerged from their commercial experience, to the new social problems of government. In 1662 Captain John Grant devised a method for utilising the weekly returns of deaths in the City of London for determining the growth of the capital; in Holland John De Witt published researches on the mathematics of annuities; and in 1693 Halley, the astronomer, worked out a Life Table and a Table of Annuities for various complex forms of insurance based on the tables of births and deaths for the City of Breslau for the years 1687–91. Such extensive recognition and study of statistical social regularities proceeded apace in an environment in which the results were of immediate practical importance.

Meanwhile in those countries that had not yet thrown off the fetters of the feudal aristocracy, the subject was developing in a characteristic setting. In the sixteenth and seventeenth centuries the leisure of the European aristocracy was assiduously devoted to games of chance and to gambling in general. Cardan wrote a small gambler's manual about 1550 (not published until 1663). Galileo (1564–1642) had his attention directed to problems in dice by an Italian nobleman. In 1655 a long correspondence was initiated between Fermat and Pascal on a series of such problems propounded by the Chevalier de Méré. In 1654 Pascal printed his *Traité du Triangle Arithmétique*, the earliest treatise on the theory of combinations—the results of which he applied to the solution of problems of chance. A long list of contributors to the mathematical theory of probability—it would be more correctly described as the mathematical theory of possible arrangements—can be drawn up, almost all of whom originated from countries in which gambling was not yet frowned upon; that is, countries in which the Catholic feudal aristocracy was not yet displaced by the rising Puritan burghers. It is interesting also to note how, from these theories arising from the needs and occupations of a leisured class, emerged many newer developments in mathematical method. What is important for us, however, is the precise nature of the contribution these investigations made to the unified understanding of statistical isolates. In raising a problem concerning the frequency with which a particular sum will occur when a set of dice is thrown, for example, there is first the tacit assumption that such an event is indeed a statistical regularity. In treating that problem by actually calculating all the possible ways in which the result can be achieved, the statistical isolate is being built up from an atomic level—by the aggregation of all the elementary combinations that can unite to achieve the desired result. It was the first step towards erecting a synthetic theory. The essential " atomic " assumption is the occurrence of a single probability attached, say, to the falling of a six with a single throw. It is an atomic probability.

While these developments in the Catholic countries originated almost independently of the social and commercial statistics of the Puritan countries, it was not long before they began to interpenetrate one with the other. England was already well on the way to the next phase, the industrial revolution. A period of theory and experiment had set in. By 1757 Thomas Simpson in his *Mathematical Tracts* was already examining the implications of taking the average of a set of astronomical observations of what was presumably the same event. The situation was ripe for a study of the " theory of errors ": the reasons for the discordance of a system of measurements of the same quantity. Expressed in terms of the various experimenters or the various conditions under which the same experimenter carried through his work, the system of numbers derived was a measure of a statistical phenomenon. Expressed in terms of the objective process under observation, they were all approximations to the " truth." The basic theory by means of which these " disturbances from the truth " were analysed was that which emerged from the theory of chances as developed in the Catholic countries in their treatment of card and dice regularities. The problem was approached by examining the frequency with which elementary " atomic " errors, positive or negative, could be aggregated together to give a gross error of a given amount. Thus while the practice of these studies was pursued mainly in the laboratories and observatories of England, their theory and their analysis developed in France.

But the unification between the two approaches to probability proceeded very much further. In France the ground was being prepared for a revolution that was to overthrow the power of the aristocracy. The eyes of French thinkers were being increasingly turned to England and what it had achieved. Voltaire, during his exile, had, for example, written accounts of how the English had introduced from Turkey, methods of vaccination against small-pox, with statistics to establish the efficacy of the process. Small-pox was a serious menace to Paris. The application of statistical methods to the elucidation of such social affairs—albeit on a purely rationalist, mechanistic, non-class basis—was already engaging the attention of many of those interested in the French Encyclopædia. The Marquis of Condorcet, under the stimulus of Turgot, directed his mind to such problems as the effects of copper inflation on currency. Immediately subsequent to the Revolution he is already passing to grandiose theories of social planning. He has schemes for the accumulation of data by state institutions in order to discover the precise nature of these detailed social laws of change. Anticipating state-supported industrial development, he suggested a form of social insurance on a contributory basis from wage earners, whereby the state might lucratively engage in enterprise with the accumulated funds, in order thereby to provide widows' and orphans' pensions from the proceeds. The extent to which the new methodology had fired them can be seen from such extravagant suggestions as that the probability of a tribunal arriving at a " true " decision should be analysed and applied in practice—an illustration of his inability to recognise the way in which value-judgments lie at the root of the judicial system of an established state. From our standpoint, however, it illustrates very clearly also the confusion, persisting until to-day, between the subjective and the objective aspects of probability; the latter a measure of a quality of a statistical isolate, the former the sense of expectation it engenders. Nevertheless, even in this connection Condorcet makes a very significant comment when he remarks that for probability to emerge into action, sometimes it needs only a small balance in favour, sometimes a large, sometimes absolute certainty. He recognises the relativity of an interpretation of probability in its relation to the consequences of the next step.

The beginning of the nineteenth century marked a change of profound importance. The Industrial Revolution was firmly grounded in England, and with it there was gradually forced up not only a vast array of social problems involving statistical analysis associated with the rapid growth of large towns and their speedy conversion into slums, but a multitude of others of a different type, namely those relating to standardisation in all aspects of production of manufactured goods, and in engineering proper. Thus from within the realm of industry, to which the mechanistic laws of the Newtonian period had contributed so much, there was thrown up again a demand for an accurate study of the laws of change for statistical isolates, the laws of mass production, the probability of a sample set of engineering products attaining a prescribed standard. We need not labour this point; its use is already a well-established procedure in all large-scale factory units.

On the more purely scientific side, however, complementary changes were being forced into existence that were to revolutionise the whole methodology of Newtonian science. As far back as 1660 Boyle had expounded his gas laws. In 1738 Daniel Bernoulli had shown that these followed atomistically from the assumption that a gas consists of a large number of moving particles. Relative to the impact of a single particle on the wall of the containing vessel, the pressure is then a statistical isolate, and as such could be measured and utilised without reference to its atomic composition. It existed experimentally in its own right. By 1802 Dalton had formulated his law of partial pressures for gas mixtures, an important contribution to the study of a material that was now being used to illuminate the streets of London and for which accurate meters had to be designed. Laplace and Gauss had by now established their law of errors, already alluded to, in dealing with the combination of " random " factors. This development therefore again culminated in a synthesis of the two statistical lines of approach, in the application of the Gauss-Laplace law of randomness to the distribution of gas molecules—in direction and velocity—the achievement of Clerk Maxwell. In this way was laid the foundations for a statistical theory of gases to explain the properties of the mass or group isolate, and those energy states that were characteristic of the gas as a whole. It was a turning-point in scientific development, for it marked the clear exposure of the linkage between two levels of qualities, those of the particle and those of the group level. We need not trace the rapid advances that have taken place since that date. Briefly we may note that with the transition to electrical power and its manifold industrial applications came also the discovery of sub-atomic levels of matter beyond the fringe of direct observability. Two types of statistical problem therefore emerged. On the one hand there is the problem of determining what can be specified and asserted about these sub-atomic particles from an experimental knowledge of their behaviour in streams and showers, the same type of problem as would be encountered if we attempted to assess the characteristics of the individual molecules from the behaviour of the totality composing the gas. To this knowledge of behaviour in the mass is of course to be added what can be inferred from the indirect effects of the individual elements. On the other hand, there is the theoretical problem of attempting to predict the characteristics of the atom from the statistical combination of sub-atomic particles of assumed properties. From the nature of the case, when the detailed behaviour of these sub-atomic particles lies outside the range of individual inspection, the statistical character and the predictions regarding the behaviour of the atom take on the same complexion. This is as it should be, for the atom, as an isolate, is a statistical entity.

These two approaches to the problem are not, therefore, distinct. They fuse and provide us with the modern outlook on the statistical regularities that present themselves both at the atomic and sub-atomic levels.

Uniformity in the presence of diversity is in fact the keynote of this whole chapter of history. The historical examples we have cited show that the need for a theory of probability did not betoken human ignorance, but human resourcefulness in dealing with nature.

More important still : they bring out the manner in which the details of the theory regarded as a mathematically logical set of ideas are completely interwoven with the physical processes man has to handle. Finally they show what has been the principal purpose of this section, that the necessary ideas have been stimulated into existence at successive stages in social history just as human practice demanded. A study of probability, on the other hand, as a logically well-knit set of propositions would appear to present it as a disembodied group of related ideas divorced from time, space, society and the material world.

THE STRUGGLE ON THE IDEOLOGICAL PLANE

That the cultural level of a community is closely related to the technological level we have already seen and illustrated in detail. The point we have just dealt with so fully, viz. the extent to which ideas develop out of the social background of economic needs and human desires, is part of the same general thesis. For us the onward march of technology has been the great causal agent deriving its impulse nevertheless from the very people it affects. Needs and desires, ideas, ethics and morality, science, art, literature, social institutions, social theories are all isolates of various types that are created by man in his progressive development in the material world. If this is indeed so, then we ought to witness the battle of ideas, the battle of books, of art and particularly of those branches of art that are closely related to technological development reach a critical stage just about the same period as social changes themselves approach their critical phases. For the assertion that ideas emerge from their social context implies that as the stresses and strains of social life approach closer and closer to the unbearable stage so will the urge to analyse, explain, and express become more and more insistent. Theorists, artists, writers, moralists begin to take sides. Living science, vital art and realist philosophy will find themselves involved in the struggle for change. They play their part as contributory factors in the process of clarification. At a critical stage in social life therefore it is not difficult to discern those branches of science, art, and philosophy that are necessarily of the decadent past and seek to retain its fetters, and those that reach out already to the future. Most of the great writers that presaged the French Revolution were already dead before the storm burst. The call for Liberty and Equality, the demand for Fraternity were not idealistic notions engendered by deep thought, out of nowhere. They were the expression of concrete demands that were already maturing among the rising bourgeoisie and among the downtrodden peasantry. Writers and artists crystallised out a latent feeling that had itself been created from oppression. They came before the social transformation. Those who followed were of a different stamp. They were nurtured in a different atmosphere.

That situation has its parallel in modern Europe. Religious philosophy unable to grapple with the social forces that work at a level beyond that of the individual is driven inwards, as in the Oxford Group, bows its head and expects mystical control. Here, face to face with it, is a concrete problem of human suffering and social maladjustment, social disorganisation. To solve it, the greatest need of this age, requires all the patience, courage, goodwill, human understanding, and brainwork that man can muster. They are economic, historical and political problems, and man must grapple with them actively at these levels. To seek an escape either consciously or unconsciously is to betray the heritage that has been handed to us. Instead the head bows down in impassive expectancy of guidance from the wise being who has apparently also brought us to this pass. It is the "follow my leader" ideology of a Germany and Italy seeking to blossom out in Nationalist vigour after the period of nationalism is historically gone, seeking thereby to fasten tighter the fetters of decaying capitalism. Thinkers ignore the social confusion, and so calmly tolerate irrationality in their thinking about the world. Scientists point to chaos in the atom as the explanation of matter, by unrealistic philosophy undermining the confidence man has developed in the regularities of nature. Art becomes abstract, more and more a matter of pure symbols, a plaything for an eclectic and isolated group.

At the interregnum between two successive epochs a special responsibility rests on the shoulders of artists and writers. On them falls the duty of sensing the future, clinging to the valuations that man is seeking to rescue from decay, expressing them in their work, applying the best of the past to the creation of the future. The key to this problem rests in the fact that two successive epochs show, at their transition, problems arising fundamentally from the new technological basis.

This can be seen, for example, particularly among designers and architects who have to take account of immediate technical possibilities in the creation of their art pieces. Just as the machine emerged as a new synthesis out of the work of the individual craftsman raising his productive capacity to a new level, so art forms of the new technological period show their characteristic features in so far as they can be seen to have similarly grown out of, and been transformed from, those of the previous epoch. We can see this in the days of the Industrial Revolution.

The coming of the machine altered the stress from the individual worker and his work, to the factory and its output, and so transferred the focus of interest from the process as conducted by the craftsman, to the end product as furnished by the machine. It did not deny the craftsman's contribution a place in the scheme of things. On the contrary it created a new and a higher place for him. It released the energy of man for the creation of new types, and in doing so outstripped the capacity of the machine. Once these types have been conceived and designed, the machine makes their multiplication possible. It does not produce, it reproduces. This statement is subject to severe limitations. The great variety of individual forms are not all reproduced mechanically. The competition of the standardised products of the machine with the individual variety of the artist's creation renders it almost impossible for all the personal designs to survive: and so it appears that the effect of mechanical production of art forms is to force a reduction to a limited number of types, capable of machine reproduction.

While those with valuations that are not easily flexed would see in this a suppression of individuality this need not in itself be regarded as a retrogressive movement when seen in historical perspective. It is significant of progress in all fields that, as time goes on, the unlimited variety of forms is always reduced by classification to a definite number of types. Analysis in all its manifestations follows this line of development. Explanation is of this nature. Scientific prediction is based on an examination of all the possible classes of cases that can arise in nature, not on the individual cases. It is by this means that what appears chaotic and ephemeral is transformed into system, rationality and ordered knowledge. The machine itself is just such an orderly creation, it is a man-made pattern in nature, that produces art forms in certain types to order. More than this; because it makes possible the kind of art that is best adapted to machine production, it has a profound effect on the purpose of the designer. He seeks now not so much for the creation of something that is specifically personal to himself but for general impersonal types. It thus poses a new problem to the designer, it presents him with a new kind of qualitative relation and in doing so opens the door to a new level of art creation. For this he must take the machine and its possibilities into consideration.

It is sometimes contended that this so-called standardisation is a thing to be deplored. This is not necessarily so if the functions of the artist and of the machine are properly co-ordinated and if they reinforce each other. It is true that the scramble for profits may destroy this value in standardisation as it may destroy the artist. But standardisation of art forms based on machine possibilities, when it involves a concentration on art types rather than on art eccentricities, rescues artistic development from the tendency to create something different merely by the addition of useless variations that have neither function nor direct æsthetic appeal. In making possible the creation of new standard types moreover it directs attention away from the mere imitation of older forms of art that belonged to an earlier technological and æsthetic period. In producing such imitations, as in attempting to imitate ancient buildings, designers are in reality frustrating what they have of the knowledge and understanding of the problems of to-day, and contenting themselves with less than the fullest possible solution.

While the social and economic resistance to the advent of the machine was serious and evident enough, it was, as we might have expected, also not without its artistic resistances. The Arts and Crafts movement and the work associated with the name of William Morris, great as its value was as a focusing point for the temporary ideals of the working-class movement, was also in a sense an escape, a mistaken belief that the domination of the machine was to be avoided by avoiding the machine. The great problem of this era is to transform society in such a manner that the machine, far from dominating man or from frustrating his activities, shall be a new and powerful asset in liberating him, in assisting him towards probing greater and greater depths in human expression. But the power to do so is not to be found by a refusal to face the facts of life. If the era of technology is a necessary fact, an inescapable phase in social activity, in the building up of a social structure within which men are to rise to ever greater mental and emotional heights then to shut one's eyes to this, to seek to escape from it, for whatever reason, is to strive to live in a world of make-believe rather than in that of actuality. Only artists who build on all that men have created, who are infused with a sympathy and sensitive appreciation of the new technological order, and all that it may mean for their art, can play their rôle with any certainty that their work will survive historically. In doing so they will also make their contribution to the New Order.

Among scientists generally, however, the problem has rather a different setting. The greater number of them are employees in the narrow sense, workers in industrial research institutions, and, particularly at a period like the present, engaged on work of a direct or indirect military nature. The gathering international clouds cast their shadows over the old spirit of pure research, and men who feel in their hearts that their ingenuity is worthy of a higher human cause, find themselves driven to become the unwilling instruments of inhuman destruction. They must either starve or help to destroy. If their choice is thereby determined for them, they can at least become conscious, and publicly conscious, of the horrible dilemma into which society is steadily forcing them. There are, however, problems of great importance at the present moment to which, with their special equipment, they could address themselves with advantage. The analysis we have outlined in this chapter has been largely of a qualitative nature. To clarify the changes that are imminent, to see in detail what is happening to various sections of society at the present period of decay, becomes then a problem of first importance. What is urgently required is a statistical onslaught on the nature of these changes closely analogous to that conducted in connection with investigations on malnutrition.

We require a comparison of what is happening, with what might happen in a sensibly organised society.

THE SEARCH FOR THE SOCIAL VARIABLES

We return then to the measurement of statistical qualities of a sociological nature. The importance of this field has hardly been recognised or its investigation begun except in certain special fields. Stock exchange journals, and other papers concerned mainly with the profit-making mechanism of the capitalist world, show by their charts and indexes that they are making some effort to analyse its salient features. The immediate purpose of these analyses is to understand as much of the process as will ensure a continuance or an increase in profitable return, and so their charts show fluctuations in the market prices of various commodities, variation in exchange rates, world production of iron, of gold, of tin, etc., etc. Never has there appeared, however, any chart showing the variation in *physical fitness* of the working-class population, or of the unemployed and their dependants: nor has it been worth their while to finance the investigations of medical and biochemical experts to the extent necessary to enable such a complex physiological and sociological isolate to be represented in measurable terms. That is in itself a significant matter for it underlines the extent to which many investigations of fundamental importance to the well-being of the community are neglected or ignored simply because it is not worth while for any individual to prosecute such enquiries. We may rest assured that if there were any specific form of physical weakness to which financiers were prone there would be no lack of funds for its investigation. Be that as it may, it is certain that a measure of physical fitness is ultimately a necessity for a full understanding of the physiological state of the population of any country, of classes of that population, and of individual members of that class. And so it requires no more than a superficial survey to recognise that sociological statistical isolates of human rather than financial and commercial interest have been comparatively neglected in their numerical assessment.

To achieve it requires not only the financial support to make it possible, but the collaboration of a series of experts in all the associated fields to determine what are the salient features that must be grouped together to form this measurable index. It would be false, however, to assert that no action whatsoever had been taken along these lines. For example, psychologists have attempted to find a statistical measure of General Intelligence or General Ability so that it should be possible to pursue a study of its variations in diverse social contexts. Here, as in all such social studies, a serious difficulty faces the investigator. To find the appropriate footrule, indeed to fix on the grouping of qualities that are together to constitute his total measure, he has to build up, and experiment in a " standard environment "; but where is this to be found. He cannot isolate a group of children from birth, rear them in Utopia, and exercise control over all the factors that influence them. He does not know these factors; indeed one of his problems is to find them, and to do so, itself argues the setting up of a standard environment. Since he can deal only with the actual environment in which they develop, school and home life, and since these are notoriously uneven in a stratified society like our own, he must perforce study his material within the various classes themselves, thus achieving some form of statistically uniform environment in a social background presumed changing. If in this way he can derive a measure of a statistical regularity, it must not be forgotten that the results are relative to the class environment as it exists in that stratified society. The effect of deliberate changes of that environment in any wide sense, will hardly be capable of examination. That would involve a type of social activity, re-housing, clothing, feeding, etc., that present-day society does not, in practice, believe it to its interest to provide even for experimental purpose.

Thus an adequate scientific study of such questions necessarily demands large-scale social experimentation.

In one way such experiments are of course continually in operation, but they are not experiments in the sense that they are designed and planned in advance with any anticipation of the results. The development of a new source of power, steam, oil combustion or electricity, and its application to industry, to factory production, and to society, was in a sense an experiment on the community whose effects can be seen in a very general way in the growth of large industrial towns and in the changes that have taken place in factory life. The production of synthetic food-stuffs, the growth of transport, the development of the cinema, are all processes that have had statistical effects on the community as a whole, and on the separate classes within the community. Such experiments are socially chaotic; they have not been directed to a social end. In general they represent undertakings that have been brought into being for the purpose of deriving profit, not for the purpose of investigating their social repercussions. Nevertheless because they are natural processes in that they have occurred in nature, difficult as it might appear, it should be possible to disentangle the cause-effect relations or causal qualities that manifest themselves provided the appropriate level of statistical isolate is recognised and capable of measurable representation. To do this would involve making as searching a study of society and social changes as present circumstances will permit.

Let us examine the direction in which this would lead us. The general problem we are posing amounts to nothing less than a search for the *Social Variables*, the changing measurable quantities that specify the outstanding and dynamic features of society, and in terms of which, if possible, social relations and social change can be expressed. To clear the ground, therefore, we must set out what we regard as the motive force, the large-scale causal agency, and what is the effect produced by this causal agency on social life and on the people. This we have already dealt with in general qualitative terms. We have seen that there is good reason to suppose that, speaking generally, the technical level of the community sets the stage for the cultural development and the physical well-being of its members. We can say that the problems that beset men are those of attaining the social, cultural, intellectual, and physiological level that is consistent with the technical level at which we have arrived. All forms of social frustration, the frustration of science, of art, of humanity arise in the last resort from the fact that the technical resources and technical power that mankind has evolved is not applied in social life in such a way as to enable the cultural and human aspects of mankind to expand and develop in a measure compatible with it. Men's thoughts and energies are deflected to destructive frustration rather than to constructive expression of the human spirit. Values have been evolved in the process of social development that show no prospect of reaching objective fruition. This makes itself evident in the way in which research activity is directed to anti-social purposes, in the extent to which the standard of life of the people in housing, food, and clothing, falls short of the attainable under more effective social organisation: it becomes apparent in the wastage of human effort and human ingenuity; in the nature of the leisure afforded to the members of the community from mere routine machine-like activity, and in the lack of facilities offered to them not only to enjoy the cultural products of others of a different class or of a different period, but to produce their own more direct expression of the realities of their life.

All these are internal qualities of the community related one to the other, and if these are to be studied and examined, if the nature of their relations to the forces that motivate them are to be exposed in detail, then adequate measures must be found to represent them. Only in this way will it be possible to study the laws of movement that their mutual changes exemplify, and thus, as in other branches of science, provide as precise information and understanding as possible to direct change.

Let us turn now to detail some of the actual features of social life that require numerical measures, especially statistical measures. According to our mode of analysis they fall into three main groups:

(1) Those qualities that define the technological level of the community, within which is included also all manner of business and industrial enterprise.

(2) Those defining the physiological level of the population, within which is included all those factors that specify the conditions under which people live.

(3) Those defining the cultural level of the population, within which must be included all those mental and æsthetic qualities that thrive or are frustrated as a result of the conditions exposed in (1) and (2) above.

Translated in terms of these groups our analysis of the problem ultimately seeks to determine whether those features that fall under (1) are so organised as to be working at maximum efficiency measured in terms of output and not of profit, and then to examine how far the human and socially valuable characteristics indicated by (2) and (3) are being intensified or frustrated by the social applications of the features under (1). We shall have to examine what is implied in the phrase "socially valuable."

Let us indicate some of the qualities of a technological nature that await the appropriate mathematical and statistical measures. In doing so it is important to bear in mind that these features are in no sense separate and distinct. There is no advance in technique in any field that does not owe a debt of some magnitude to one or more advances in other fields. In setting out these measures, therefore, as if they were in the first instance distinct and self-contained, we do so expressly so that these variables may be used afterwards to bring out this linkage between various elements in the complex of factors that define the technological level as a whole.

Let us detail *seriatim* some of the indexes that would require constructing.

1. An index of the degree of research activity in the community, and the sub-indexes showing how this is composed of research in fields ranging from highly industrial and engineering to highly abstract, mathematical or logical. The way in which the focus of this activity passes from one part of the scale to the other at different times is a matter of considerable importance, not only to the scientific movement itself but to the development of technology in the community. Why it varies in this way, with what other factors of a statistical nature it is causally correlated, is one of the problems that is immediately suggested for investigation. In this connection a special index requires evaluation to measure the degree to which research is primarily directed towards destructive rather than constructive purposes. We need not consider the detailed composition of such indexes; that is a matter for expert examination, but it is clearly associated among other things with the expenditure on research in each of these regions.

2. An index is required to measure the general technical level of commodity production. By that I mean that some measure of a statistical nature should be forthcoming to tell us how far the commodities that are being produced and sold in the community really reflect the fullest technical knowledge at our disposal. The fact that shoddy articles are produced and consumed, and that it is profitable in this way to maintain an output of commodities below scientific par, that in present circumstances there appears to be a demand for them, is evidence enough of the existence of the quality considered.

3. In this connection, again, we require a measure of the social wastage that occurs in the distributive process particularly, and by reflection, in the productive process, from the fact that all sorts of commodities are forced upon the public by intensive advertisement, irrespective of whether social advantage demands that these things should in fact be consumed. We are simultaneously urged to drink more beer and to consume more milk, but it is obvious not only that these may be incompatible advices but that for

everybody it is an injunction to consume less of something else. What else? And why make this exchange? Whose valuations do we express when we do so? Under this heading also there fall such things as patent medicines. We have therefore to bear in mind not only the wastage in effort involved in the production of the wrong kinds of commodities, or of those of inferior quality, but the loss to the community arising from the fact that thereby they are prevented from consuming the type of commodity that may be most useful to them. This is a complex isolate to disentangle but in present-day society it urgently needs analysis.

4. With the natural resources at our command, including human skill and craftsmanship, it should be possible to set out some standard of maximum social efficiency in shelter and housing provided to the community at any given time. There must exist, therefore, in this connection a relative index of efficiency of housing and accommodation as it is actually provided, and that index would require to be set out for various social classes. That some such index is possible is clear from the fact that we normally grade houses qualitatively by such phrases or adjectives as slum property, jerry-built, up-to-date, modern, not fit for a dog to live in, a regular palace. I need not detail the various elements that must go towards the compilation of this statistical number; but clearly it would contain all those factors and more that are usually collected in connection with studies in overcrowding—floor space, air space, baths, lavatories, lighting, number of people per room, etc.—in addition to the actual type of structure and the extent to which it falls short of the most modern architectural solutions of the social problem of housing. It is a delicate question to decide the relative weights that have to be attached to these constituent elements, but no more delicate and no more difficult than the corresponding problem of finding an appropriate cost of living index. On such points an important issue arises which we shall presently consider.

5. In particular basic industries, such as agriculture, mining, etc., science is continually providing methods of increased efficiency in production and increased safety to the workers. Industry and agriculture drag behind and frequently, as we have seen, are unable to adapt themselves to these new methods. At any particular point in scientific history it should be possible to compare the extent to which any one of these basic industries utilises this scientific knowledge, and to express this as a relative efficiency index. Farmers, for example, are notoriously conservative in their estimate of the value of applying the results of agricultural experiment to practical farming. How conservative are they, measured in terms of their loss in yield ?

6. It is contended that much scientific knowledge and experience that passes into the form of patents becomes ultimately frozen because, for reasons connected with the loss in capital value that would follow from the replacement of plant thereby rendered obsolete, it is not an immediately commercial advantage to utilise these inventions. Here is a problem of fundamental importance to scientists and indeed to the whole community, for a possible rise in the technological level may thereby be defeated. Some index, therefore, that would take this factor and others of a similar nature into consideration would provide a measure of one of the features of the technological level at any given time relative to the theoretical level.

7. Again, by the application of human labour all these industries ultimately transform natural resources to socially useful products. At what rate are the available natural resources being utilised ? At what rate are the limited stores of natural resources being used up ? At what rate are some of them being replaced by synthetic products ? What is the measurable effect of the latter on the shift in consumption of raw materials ?

8. The development of industries, whether of the industrial and factory type or of the agricultural variety, produces its own distinctive effects on the structure of the community and on the geography of the country. At what rate,

for example, is urbanisation developing? Are the larger towns becoming larger, and the smaller ones smaller? At what rate are certain areas becoming depopulated? During the past decade in Britain, for example, there has been a rapid shift in the focus of industrial activity. New factories have been established in the south in close proximity to the new arterial roads. Old factories have been removed from the devastated areas of Lancashire, Scotland and South Wales. Enormous sections of the working-class population whose roots are too deep in these older areas have slipped lower and lower into the social morass, moral and intellectual values laboriously built up have been destroyed. Towns and villages that have spent vast sums during several generations in social development, building roads, halls, parks, have become depopulated and almost forsaken. The work of enormous numbers of public-spirited men in the past is being steadily destroyed. While the shift in industry may be advantageous financially when expressed in terms of the individual firms, the capital loss to the community must be enormous. These are features of social change that must appear somewhere in the communal profit and loss account but no budget finds a place for it. Here then is a fertile field for the construction of social variables to enable us to assess the meaning of these changes.

9. Finally, it has always been argued in the past that the introduction of machinery initiates in the end more occupational tasks and therefore produces more employment than it saves by mechanisation. The very fact that mechanised labour involves economy of effort is in itself evidence that in some degree it must involve technological unemployment as one of the features among the others that go to make up the total unemployment problem. Some index of this quality in the situation requires to be isolated and evaluated.

It is not suggested that these are in any sense exhaustive, nor that they are mutually exclusive. On the contrary, many of them are qualitatively related to each other, and in a changing community altering geographically and in numbers under the impact of technological advance, the relationships must show themselves in correlations or equations connecting these social variables. Between them if they were exhaustive enough, they should provide a fairly complete *résumé* of the whole technological level of the community at any time, and by its variation provide a measure of the rate of technical progress in relation to communal utility. From it we should be able to extract a gauge of the technological level of our society.

We turn now to an examination of the corresponding variables for the social and physiological state of the population itself, in so far as it will be related to the technological level.

1. It will be remembered that, during the war, conscripts were classified into various categories, the only ones of which that have survived in popular language being A1 and C3. These correspond roughly to a qualitative grading of physical fitness; but if the state of health of the community and of the various classes of the community is to be subjected to examination, then clearly what is required is something more detailed and measurable than a mere classification of this general type. What the qualities are that go to make up physical fitness, I am not concerned with. They are primarily matters for medical men, and for biochemists, but the composite figure which has to be taken must provide us with an index of an individual's physical fitness relative to the hundred per cent fitness that the fullest available scientific and medical knowledge can achieve at the moment. Such an index has to be applicable not only to individuals but to social classes. It would be correlated with the standard of feeding, the environment and possibly with age-group, either of the individual or of the class.

2. Hence there is suggested also an environmental index, a figure that would bring together all the factors in the social background of the individual or of the class that would have significance for fitness. In this connection also it would be necessary to reintroduce the housing level

index already referred to as part of that environmental background.

3. Again, the food value level as a composite figure derived from the biochemical value of the food consumed by the individual would be an index of importance in this connection. With this must be associated the Cost of Living Index figure concerning which we shall shortly have some remarks to make.

4. A Resistance Index, as a measure of the extent to which the individual can withstand the onset of various illnesses, diseases or epidemics, among many others is also suggested.

Once again it is clear that these social variables are not independent, but interlocked and qualitatively related. Nor are they intended to be exhaustive. Within this field itself correlations could easily be established, correlations of a causal nature that would link up the way in which, for example, the physical fitness index varied with the food value index, and so on. More than that, it would now be possible also to bring together certain of the social variables in the first series that dealt with technological levels and relate them in a causal sense to those of this particular section.

I do not propose to attempt the impossible task of analysing in detail the features of social life that fall within the scope of "culture." The word itself has an unfortunate flavour because of many of its associations with the early liberal conception of what constituted an educated and cultured gentleman. It suggests the code of manners, morals, and standards of taste of a particular section of society. It suggests the intellectual and æsthetic enjoyments of a leisured class, their appreciation of music, their literature, art that expresses their values and a philosophy that conforms to their outlook on life. These can be attained only by specially endowed, refined, and tenderly sensitive beings, something remote, far above the level of the common man. These things are not necessarily evidences of a socially valuable culture but of that of class distinction and privilege.

Music, literature, drama, painting, sculpture, architecture, philosophy, science and mathematics, history, individual and social sensitiveness and understanding, these indeed, expressions all of social energy, are necessarily parts of the cultural life of man. They are produced in the efforts to cope with the world, produced to share emotional and intellectual meaning among members of society, but created just as an idea, a film, a house, an invention, a machine, a scientific theory is created, from the background of experience of the society from which the creator emerges, for the purpose of clarification of human problems. By form and qualitative grouping a work of art renders concrete a social experience that in the judgment of the artist is important. It is a synthesis of experience, but because it is isolated as of importance, it is also an analysis. In the judgment of his fellow-members of society it will be significant if it renders concrete those things that are significant in *their* social context. In the judgment of history it will survive as a work of art if at the time it is created it expresses and directs the emotional or intellectual energy of men along those channels that lead to an understanding of their powers as a causal and creative agency in the universe.

The arts, and the sciences, the power to raise the material well-being of mankind to ever greater heights, the rising appreciation of the importance of the quality of human relations, individually and in groups, all these constitute a socially valuable human inheritance. Throughout history, the very basis of this slow growth has been threatened periodically. Power and control over the lives and over the minds of vast numbers of human beings pass into the hands of privilege, whether they be those of a feudal church, of merchant princes, of individual dictators, of military cliques, of financial groups or of exploiting industrial combines hungry for dividends. It is not difficult to read the lesson that history teaches in this respect. For the maintenance of their power they will sacrifice when necessary the most sacred valuations that men have laboriously built up. Socialists and Jews will be beaten, murdered and mutilated, and science distorted to justify a degrading process, to make it appear that these things are done in the name of civilisation. Abyssinian women and children are ruthlessly slaughtered or choked in agonising death by poison gas; oppressed and church-ridden Spain seeking to free itself from racking exploitation is reduced to a shambles; finally Europe itself will, if necessary, be devastated, all in the name of colonial expansion masquerading under the title of civilisation. It is the more modern large-scale equivalent of the early cut-throat struggle during the Industrial Revolution when women and children were reduced to virtual slavery in mine and factory, and human values and human relations ruthlessly sacrificed to Mammon. Unfailingly these periodic onslaughts on culture have come at the transition points between social phases. In the last resort it rests on the common man to rescue the cultural store that is his heritage from this wholesale destruction. And so we must distinguish between those manifestations of social activity that are historically permanent contributions to cultural development and those that are mere distortions of an ephemeral ruling or dominant class. The fantastic fripperies, the elaborate and nauseating ornamentation of the Victorians were little more than the effort of the *nouveau riche* with no criterion of social value other than money to express their superficial taste. In the struggle for wealth they had perforce to sacrifice the finer things in men. Like a commodity every man had his price. They achieved power at the expense of culture. To express their empty and superficial vanities, to show that money could buy even the hungry artist, it was essential to erect an imitative and superficial façade.

To-day, therefore, a period of crisis is also one of cleansing on the part of those who have reacted against this defilement of culture. More and more of the younger writers, poets, artists, and architects, in their analysis of this onslaught on human worth have stepped back to see the broad outlines of the problems with which they are faced, the wider generalisations that have become obscured.

Hence the new artistic mood—for example the bold lines of simplicity in architecture—supported as it is, indeed stimulated, by the new materials that that very social organisation of the Victorian period made possible. The " Gold Rush " of the 1800's itself forced up the technical level, compelled a vastly greater potential control over raw materials and manufactured products and so paved the way for the permanent advance in culture that must finally follow from it. It was a necessary historic step. Consciously performed, suffused with desires in accordance with the values of permanent cultural significance, it might also have corresponded to a revolutionary forward step in human welfare. It was not to be. And so in the sphere of literary and artistic effort the struggle now ensues between those who in their values are unconsciously wedded to a decadent Victorian past and those, alive to the æsthetic possibilities that technology offers, who are pressing forward even in this time of stress to add their contribution to the store of cultural energy. The final problem is to release this energy to the service of the common man so that he also can bring his intrinsic contribution to bear, and to share æsthetically in the accumulated treasures of the past. So far for economic reasons he has been denied his inheritance.

How is it possible to assess any form of measurement that could have significance in this confusing series of cross currents and those peculiar qualities of an emotional nature that we have embraced under the title of culture ? Can the varied intensities of æsthetic appreciation be reduced to numbers ? Can the feeling of unrest among an oppressed class be represented in terms of a few bald figures ? That fortunately is not our problem. All human experiences, whether in individuals or in classes, whether these experiences be regarded as subjective or as objective, also show themselves in behaviour. They are qualities in a situation, that are inferred from the way in which the individual or the group acts. We would be far from asserting that measures of this objective behaviour are always measures of the qualities, but what we do assert is that if it is possible to separate out the details of objective behaviour that have relevance for these qualities and concentrate the details of our measuring methods upon them we are likely to arrive, as close as is humanly possible, at the type of estimate necessary for our analysis. In this connection, however, there is one word of warning necessary.

Just because society shows sharp planes of social cleavage we shall make a serious error, however, if we assume that judgments and valuations, emotional experience and æsthetic appreciation lie uniformly across the social field. What is significant and important to one class is far from so appearing to another. We slip easily into the stupidity—it is nothing less—that regards our judgments not as reflecting our values but as objective facts misread by those who value otherwise. This becomes obvious just as soon as we settle down to assess the various qualities that have to be brought together towards the forming of a statistical index in any one of the cases with which we shall deal. Even such a simple number as a Cost of Living Index figure has been the subject of violent controversy not because of any arithmetical difference in the calculation, but because of the relative weights that it is deemed desirable to place on different items in the calculation. There can be no single figure of this nature that somehow or other does not reflect the valuations of the compilers. Bias in that sense is of its essence; while there can be no escape from that we can become conscious of its existence. That is important. Such a statement does not in any sense vitiate the whole mode of analysis. On the contrary it is a feature of its treatment. If men are to become causal agents in the orderly construction and reconstruction of society they must become so in virtue of their desires and their biases. These are intimately bound up with their valuations; these are the factors that give a direction to their activity. When we assert, therefore, that the social variables are intended to provide us not simply with a static picture of the structure of society as it is, not only with an understanding of the direction in which it is moving now, but that they must offer us assistance for future action, we mean that such action will reflect our desires and valuations whether we are conscious of it or not. Hence also a study of the social variables must embrace not simply a colourless description of social change but a colourful picture of what we can do to fulfil our desires. To measure the extent to which this is prevented from occurring, to which we fall short of this at present, implies that these judgments and valuations must find their due place in certain of the social variables. Hence the importance of the task of formulating these variables on the part of those who share those valuations that history will judge were in their day creative.

What then are these forms of group behaviour that might be capable of statistical representation? It is too difficult a problem to set them out even as slightly as we have already done with those of a technological and physiological nature. Each one of them would require a very careful and full discussion that would take us far beyond the scope of the present work. Nevertheless we can see in a general way where these numbers are to be sought. We require, for example, the detailed figures for the educational facilities offered to all classes in the community, the relative numbers that attend the various grades of school, evening classes, technical classes. It is important to decide whether the individuals of good mental quality are receiving the fullest opportunity of developing their latent capabilities and whether those who are not so well endowed intellectually are, for reasons of class privilege, receiving educational instruction when it is being denied to others better able to benefit from it. This would correspond to a wasteful deflection of educational effort. Certain problems of this field have already been the subject of careful statistical analysis by Gray and Moshinsky with startling results. Our worst suspicions have been verified.

We require to know how much of our educational time is spent on matters of permanent cultural value, and how far the conditions under which the instruction is given are likely to leave a lasting impression on the desires and tastes of those taught. How many people, for example, after all their school-training read poetry for pleasure ? And why so few ? In the teaching of history and of civics how far is the predominant outlook of capitalist society accepted unquestioningly in the presentation, particularly in the textbooks that are used in schools and colleges, and how far do these books encourage a critical, a scientific spirit ? In the study of mathematics how far is it regarded entirely as a game, as mental gymnastics or as a purely logical discipline, and how far as a weapon or a tool for the further probing of the objective world ? How far, in fact, is it taught as something entirely divorced from social needs and social practice ? What proportion of the money devoted to educational purposes is spent on technological instruction and what on the humanities ? How far are working-class children encouraged to examine the conditions under which they themselves and their parents live ? How far are they made conscious of the social changes that are taking place in their own environment and of the reasons for them ? What is the relation between the rate of learning and the physical fitness index, or the environmental index ? These and similar problems of an educational nature are clearly not easily reducible to numerical terms, but it does not pass the wit of man to separate out those aspects that are capable of being so assessed.

Again, we require a study of the intellectual and cultural opportunities that are offered and utilised by the various classes. How much holiday time do members of the upper, middle, and working class succeed in obtaining ? How many manage to go abroad; and for how long ? What classes of books and how many of each kind are published annually ? What types are successful as regards sale ? What classes of books are taken from the public lending libraries, what from the private circulating libraries ? Who buys pictures and of what kinds ? What are the attendances at the various types of museum ? What are the classes of films exhibited at the cinemas and which draw the greatest crowds ? Are there any deliberate experiments in public taste in this respect—for what purpose were they conducted and with what results? How many people watch sports of various kinds on Saturday afternoons and how many themselves indulge in it? Who composes the audiences of the public concerts? What proportion of the population is brought annually into contact with, say, Shakespeare, through the theatres? How many societies of a cultural nature are there and what class and what size of membership do they possess? What are the private interests of classes—literary, musical, mechanical or mere light amusement? What sections are unable, after their daily routine, to find time or energy for such interests?

These are only a few of the numerous problems that might be raised. Many of them group together under the same general heading and in that way their measures can be summated to form a single statistical index for each such group.

It has already been explained that it is not the purpose of the present section to work this out in detail. Although many of these questions have received careful consideration already by interested workers seeking statistical regularities in each of the separate sections the purpose behind these suggestions is deeper. It is, as we have explained, to link up the nature of the movements and changes that are taking place in the community by regarding the technological basis as the driving force, by examining how it encourages and how it circumscribes the cultural activities of classes. We are seeking to express the laws of movement of very large-scale sociological isolates in measurable terms, as far as that is possible at all.

Now it is not to be supposed that the nature of these processes is likely to be fully explored by means of our present available mathematical equipment. In the first place we are not dealing with what are scientifically called "reversible processes"—nor are they repetitive. They are truly historical. What is occurring at any stage is influenced not only by past historical events but also by their impact on the conscious understanding of the groups and classes themselves. Their possible future also plays its part. Mere statistical correlations are not enough—valuable as they are. A mathematics and a higher mechanics that presents the dynamic driving forces at this level must sooner or later be elaborated, but it will not be developed until those individuals with the requisite mathematical skill and sociological understanding can be induced to concentrate their attention on it. It is not a task for one man, but for a movement. Social isolates do not aggregate together always like objects in a collection, nor can they be disentangled again without themselves undergoing change. The law of addition is a peculiar one. So also is the law of multiplication. Moreover they are at one and the same time atomic and statistical in their relations. In their interplay either one or the other may become dominant. Their changing qualities have to be seen arising from the dynamic nature of their internal contradictions, as we have termed them. All this argues a new type of symbolism, fundamentally different from the reversible mathematics of "equations." They are in a sense one-way equations and the "given conditions" that in the ordinary mathematics remain unchanged and so effectively render it the mathematics of "isolated process" have themselves to undergo change. These are only a few of the vital differences that here manifest themselves, and many more could be detailed.

In suggesting that mathematicians at the present epoch might well direct their attention to the study of the social variables, I am doing nothing more than attempting to turn the subject back to the source from which historically it has received its greatest inspiration. The history of mathematical science dates in its early stages from the most elementary needs of social life, the counting of seasons or enumeration of flocks, the setting out of distances for cultivation and the measurement of angles and of time. Geometry, algebra, trigonometry and even the first stages of statistical indexes, arise from the needs of pastoral and agricultural life, navigation and commerce. The slave states of Greece released from arduous labour a series of thinkers and philosophers, whose final contribution to mathematics lay in the most abstract domain, that of pure geometry and pure number. Until the middle of the eighteenth century the mathematics of Western Europe was almost always a mixture of what would now be called pure and applied. Not until the early days of the Industrial Revolution, from the late eighteenth century onwards, do mathematicians begin to separate themselves out more sharply into those who are primarily concerned with the "purer" mathematical method, and those whose main interest lies in its meaning for physical changes.

Early in the nineteenth century developed the great liberal movement as the ideological counterpart of the forward industrial surge of that period, and with it the growing tradition that the greatest contribution that the wealthy commercialist or the industrial magnate can make to the cause of "progress" is to establish university schools and professorial chairs for the study of abstract philosophy, pure science and pure mathematics. The universities and technical schools began to expand and the more abstract studies not only thereby received a forward impetus, but also a freedom for "independent" study as a symbol of cultural purity. While the engineer and the industrial scientist, linked up as they were closely with the practical needs of communal life, felt also at times the insecurity that arises from economic instability, the professional groups pursuing their purist studies in secure isolation tended to break further and further adrift from the main stream of technological advance. The extreme form to which this has developed can be seen at the present day in the schools of pure mathematics where a tradition, rarely voiced in public, still persists that problems less abstract than a certain degree, problems that in any sense can be connected up in any way directly or indirectly with objective physical processes, do not fall within the scope of pure mathematics but are in reality physics; as if the ideas of even the purest mathematician are not always either an abstraction or a composite, albeit with new qualities, of ideas drawn from the physical world and our experience of it.

If this point were realised there would appear no mystery in the fact that quite frequently in scientific history, the mathematics of the purist has unexpectedly provided just the mathematical tools that the physical theorist of a later date has required. To form a mental composite of ideas drawn from the world of reality is not necessarily to follow a line of development different from the composites or statistical isolates that physical nature itself produces. What is surely undesirable is, in the face of this, to hold that the two processes are in fact completely independent and that in some way the needs of culture are served by underlining their independence and remaining unconscious of their fundamental unity. To maintain this is to underwrite obscurantism. Conscious appreciation of the inter-relating qualities of human activity with the rest of nature is surely the most elementary step towards a humanistic culture. Nevertheless, it is important also to recognise that from this isolation emerges a mathematical rigour and degree of mathematical abstraction far surpassing anything previously attained in mathematical history. It should be noticed, therefore, that when it is contended that mathematics, in common with other branches of science, emerge out of the social background and are produced for the satisfaction of social needs, that this contention cannot be sustained in that simple form after the middle of last century and that just about the time when science was being harnessed more sharply than ever to technology and to industry the very individuals who were primarily responsible for these enterprises were also responsible for the financing of a movement that was ultimately to drive the pure mathematician further and further away from the main stream of scientific advance. A fundamental change was taking place in the relation between mathematics and other fields of science.

In attempting, therefore, to focus the attention of the mathematician on the study of the social variables, I am striving to make mathematicians cognisant of the fact that they may have been treading a path, however attractive, that has not been in the best interests of progress. Those mathematicians possessed of a social conscience to whom the value of their subject is measured not in the extent to which it can be divorced from the needs and understanding of the common man, but by the measure to which it can be turned towards the furtherance of his, and not only their own cultural advance, might with advantage at this juncture concentrate on the problem of the social variables in the effort to establish the dynamic relations between them. We may then begin to have as detailed an understanding of what human beings are doing to themselves as we have of the habits of ants, of the state of affairs in the interior of a star many millions of miles away, or of the 8-tangent hyperquadrics of Noether's Canonical curve for $p = 5$.

CHAPTER VI

WHAT IT MEANS FOR YOU AND ME
OR
THE UNITY OF THEORY AND PRACTICE

IN THE FIRST CHAPTER of this book we laid down certain conditions that must be fulfilled if a reasonable philosophy is to have a reasonable chance of appealing to reasonable men. We have now, therefore, to bring this discussion to a focus, particularly in relation to our own personal activities. What does it all mean for us?

To answer this let us summarise in brief the general trend of the argument, leaving out the philosophical network and scientific evidence on which it has been erected.

In studying natural change on the grand scale, and in particular in our survey of historical development, we have been driven to recognise the occurrence of successive phases, and we have studied how, from the internal structure of each phase there emerges the causal agency that leads on to the next.

Thus phase changes in social life are brought into being through the active agency of human beings like ourselves. Just as you have probably been induced to read this book because you feel that your best instincts and valuations are in danger of being frustrated and destroyed if matters go as they are going to-day, from bad to worse, so these people have also felt in the past, when they likewise found themselves driven by their best feelings to help forward a change in phase. The French Revolution was not just a call for Freedom and Brotherhood, it was a call from the common people to each other to rescue themselves from the degradation of starvation. They wanted bread, but in wanting bread they demanded it in terms of justice, in terms of the Liberty, Equality, and Fraternity, that was being denied them.

OUR PRESENT DISCONTENTS

Each distinctive form of economic organisation creates a distinct social epoch, and, for the people of each of these, there open up visions of possible human advancement. It is these that reflect themselves in the mental and moral life of the people as schemes for human welfare, as hopes, aspirations, valuations. It is these that, towards the end of a phase, express themselves in criticism and disappointment as failure to harness the forces of production to the well-being of the people becomes more and more pronounced. It is not for lack of desire that it fails: it is, as we have seen, because the technological possibilities have outgrown the form of social organisation that has been erected at an earlier epoch to cope with its problems. This is sometimes confusedly explained nowadays by the foolish statement that our moral values have failed to keep pace with our material advance. The converse is more nearly true.

The failure is inevitable. It arises because every form of society has been organised internally to serve the material and spiritual interests of a dominant class, by using the labour power of a subordinate class. The situation in modern society is of course singular and extraordinary, for under finance capitalism even the slight savings of those workers who sell their labour power are mobilised as added finance towards forcing the social epoch more and more rapidly towards its inevitable change in phase. The proximity of this change shows itself not only in the universal move towards armed state capitalism and international war, but in the ever wider fluctuations of boom and slump in which the anarchy of production is involved. If and when the present rearmament schemes slacken, we shall witness yet deeper depressions. If we wish to appreciate how close we in the West may be to the change in phase we require only to think of the padlocked mouths of Germany, its outcast Socialists, Communists, Trade Unionists and Jews, the sullen and tax-ridden peasantry of Italy, the decimated Abyssinians, the anti-semitism of Hungary, Poland, Roumania with their poverty-stricken populations, the devastated areas of Spain with their thousands of orphan children, the drive of Japan into China, and the rapid conversion of the whole of Europe and large parts of Asia into an armed camp, preparing to destroy itself in the process of changing its economic structure. The only country in Europe that shows a steady and persistent rise in economic stability, at ever increasing pace, is Russia, whose economic organisation stands in striking contrast to that of the others. If the situation in Europe to-day be compared with that of thirty years ago the contrast is even more arresting. At that period Britain was at the zenith of her industrial development. Russian feudal aristocracy was almost at its most debased state. It had taken a minor revolution to achieve the concession of a Duma. The Czar decided to visit England. A threat from British trade unionists to strike if he set foot on English soil was sufficient to scare off an autocratic monarch who had sent countless Socialists to Siberia, and massacred thousands of Jews. That was thirty years ago.

To-day the European situation has turned full circle. Jews exist in Russia on terms of full equality, with Biro Bidyan as a special autonomous Jewish state for those who desire it. In the rest of Europe a rising tide of anti-semitism has swept aside the barriers against the oppression of minorities, that had been slowly erected by civilised men. Even in England, historically the home of the free, with the nation that had threatened to strike if the tyrant Czar had landed, it becomes possible to stage a Blackshirt march through the East End of London, in order to drive terror into the hearts of a simple working-class population. The treatment of minorities is the thermometer that marks the stability of a social system.

That is the pass to which Europe has come, and in the circumstances the lessons are obvious. We need not underline them. We merely note that whatever theories well-intentioned people may have offered for the things they have done, that have led to this situation, their theories are false unless they are precisely the theory of this process of decay and decadence, and not the theory of a fictitious state of affairs that has not come to pass.

That then is the situation into which we have historically worked ourselves. We cannot go back. We have to go forward to the next stage, in a way consistent with the demands of decent and civilised human beings; but to do so means facing the implications of our historical understanding, without illusion, without imagining that we can turn our back on history and hold society petrified on the brink of change. Only deeper and deeper misery can flow from that. It is not that in some mystical way history decrees that we must do so and so, but that an historical analysis shows that we *will* do so and so. We might as well do it deliberately and with enlightenment.

On what grounds do we assert that the next stage will be the classless society?

THE CASE FOR THE CLASSLESS SOCIETY

The case rests on three arguments all inter-connected. In the first place in every preceding historical stage, each of which has led towards collapse, the structure of the society was centred round a dominant class for whose advantage a subordinate class gave their labour power. We have seen how such a situation led inevitably to a new economic and social phase, with a new structure of the class-differentiated type. It was inevitable not because it just happened, but in the sense that the internal logic of the process, when examined, made this inevitability clear to us. It was an illustration of our general theme concerning the transformation of qualities which we have discussed so fully in Chapters II and III. It would follow therefore that a new phase, with a new class alignment, while it might conceivably provide a temporary outlet from immediate social difficulties, cannot release man from the sequence of phases along which he is passing. The same internal struggle between economic classes would arise again.

The second point is a more directly human one. Alongside and in spite of temporary moral set-backs as the period of crisis deepens, there is a persistent and growing repugnance against any system that regards one class as humanly inferior to another, or as a convenient victim for economic exploitation. In the last resort it is this feeling that underlies the emotional drive for a classless society, although the precise meaning of this term may not be clear to those who voice the demand. The *strength* of this feeling has no necessary validity as an argument in itself, but its existence is an essential and significant part of the objective situation that leads to such a change. It would still require to be shown that the classless society was one capable and necessary of achievement from that which preceded it. Otherwise the mere demand for something unattainable, in a scientific and historical analysis of social change, becomes a teleological intrusion. It is this last point then which is crucial and to which we must address ourselves.

The succession of class societies that has culminated in the present capitalist phase must first be regarded as a group, a very large-scale statistical historical isolate, each atomic element of which was itself a phase of the whole succession. The development within the whole group has been of a straight-line statistical nature, successive phases replacing the previous, but still manifesting in each an internal class structure. If we examine this historic process on the widest conceivable scale, we are bound to enquire if this succession of class societies will reach a critical stage and be itself transformed to a new level of development.

It may seem an extravagant extension of the law of development that we have expounded, to attempt to apply it to such an enormous range of human social experience, but the extravagance of the step is more apparent than real. We could easily apply the same law to a range of events in astronomical space-time, within which the range of human affairs would appear as a fleeting second. But quite apart from that, the whole purpose of applying the law is not to make a rigid prediction of the astronomical type, where an eclipse happens whether we like it or not, but to provide us with an indication of what we may find ourselves attempting to do, so that if the prediction does indeed square with our desires, it may illuminate our objective and guide our activity. We are trying to use our analysis to guide our actions.

Now the succession of class societies has certain characteristic features that are significant for their causal passage from one phase to the next. There is in the first place the developing technology that, as we have seen, is the external causal agency to which human society has periodically to adjust itself. This technology by its very nature cannot but intensify. It is driven onwards by the gathering experience of man. In the second place, we have seen that it is through the way in which this technology is used in a class-differentiated society that the successive phases have been brought into being. It is therefore only by a direct or indirect change in this factor of class that this particular succession of phases can be brought to an end. The passage to the next "succession of phases," not simply to the next phase, must mean the elimination of class divisions of an economic nature. That is the first conclusion indicated by our general analysis.

How are we to know when this point of transition has been reached? Perhaps the present class-ridden society is not the last of this series. This we can discover surely by a study of the various classes that have achieved power at each phase change in the past, and the nature of the power they have achieved. Now, as we have seen, each phase change has been accompanied by two characteristic features. A new dominant class has acquired legal power, and has at the same time proceeded to develop a society in which a subordinate class had to give its labour power for the wherewithal to live. That has always been the characteristic internal structure, and the transformations have depended on this type of structure in order to maintain their characteristic quality. Accordingly our analysis indicates that the crucial point of transition to a totally new level of phase changes will be reached when such a quality vanishes of itself. That is surely the stage which we have now reached. The rising class which is slowly achieving legal and political power, or at least is steadily challenging it, is for the first time in history actually the working class itself, that occupying the lowest rung on the economic ladder, the class that has had to exchange its labour power for commodities. If therefore it becomes the dominant class, and this is precisely what is inherent in the present situation, *it becomes dominant over its own labour power*. A completely new era is thus imminent, involving a break with the whole nature of preceding phase changes. Thus the achievement of power by the working class would appear to inaugurate the move towards a classless society, where the problems of production and consumption become of an administrative and not of a class-political nature as at present.

There is no teleology in this analysis. We are not reading our own desires into history, but we have been attempting to see the part that human desires do play in bringing about the history that men make. We are bringing to bear the whole of our understanding of these processes in order to make the kind of qualitative prediction that our past experience of such changes entitles us to make. Having made the prediction we must proceed to verify it, to make it come true, to work out the theory in practice. Only those who do so will ever be in a position to state exactly when the prediction will come true.

UNITY OF THEORY AND PRACTICE

For us the problems of philosophy are resolved into those of guiding ourselves and others towards this classless society. Our philosophical theory has to emerge in political practice. We have to see the actions of individuals and of groups of individuals as agents for or against this desirable tendency in history, and as far as possible we have to make others conscious of the theory which they are unconsciously exhibiting in their actions. Let us consider the various aspects of this linkage between theory and practice. It has a much wider significance even than we have here suggested.

ILLUSTRATED IN THE PROCESS OF DISCOVERY

When a biologist talks of an animal's pattern of behaviour, he means that in certain circumstances it runs through a routine of actions: a bird during the nesting season, a cat with its new born kittens, the rising and dressing of a human being in the morning. Such a behaviour group is isolated for study in order to discover the theory that will *explain* the sequence of actions, that will fit it into a general plan, that will make it logical. This is the process followed whether one deals with stones, planets, human beings, animals or insects. One talks of the behaviour of particles of matter, of a group of electrons, of a system of waves, and in all cases we see the behaviour as illustrating in the special circumstances some underlying theory of action that has meaning in a wider setting. If the process is one over which we cannot exercise control, as in the motion of a planet, we test the accuracy of the theory by predicting the future behaviour of the planet. If the process is one we can control, we deliberately test the theory at specific points by predicting what will happen under controlled conditions in a laboratory. In both cases *Theory is tested in Practice.*

No theory is ever produced out of the void. It is evolved out of an elaborate network of earlier theory and practice. It is always the latest addition to the theory indicated by the latest practice that, suggesting the next experiment, is to act as the test. Every scientific theory bears the stamp of this historic process upon it. That we have discussed very fully in earlier sections. *The process of discovery is one of theory and practice united.*

This is the first stage in an appreciation of the meaning to be attached to the phrase "The Unity of Theory and Practice."

ILLUSTRATED IN PLANNED ACTIVITY

The second stage is approached when this is interpreted from the personal angle. Human beings may be either conscious or unconscious of the theory underlying their actions. A young man runs through a certain pattern of behaviour. We who observe him have a theory that he is in love, while he himself may be so disturbed emotionally that he may be unconscious of the meaning of his actions. A person who maintains that in some absolute sense all men are equal, but behaves as if some were superior and some inferior, is an individual whose theory does not conform to his practice. There is indeed a theory of his practice; it could at least be disentangled, if it were thought worth while, but it is not the theory he professes. A person who advocates as a principle of action "Love thy neighbour as thyself" and is satisfied to leave one single person worse off than himself holds a theory that finds no counterpart in his living.

As soon as an individual becomes conscious of the underlying theory of his activities, sees what he is in fact doing and appreciates the real motives he displays in his conduct, his behaviour begins to be *planned*. He reaches a new level of theory-cum-action. In this sense the systematic movements of the heavenly bodies is unplanned while that of an individual cooking his breakfast is planned. A person who appreciates the changes that have to come over society, and the part that individuals have to play in that change, is ready to become aware of the theory of his own actions. If he desires the change, and takes part in political educational action to that end, he is striving to make his behaviour planned, in the sense we have given to the words. Thus the second interpretation of the unity between theory and practice is the personal one of *becoming aware* *of the actual theory our own actions reflect, and readjusting them to square with the theories we profess.* In ordinary affairs this corresponds simply to intellectual honesty and integrity in action. There is no supernormal sanction required to *make* people do this. Every ordinary human being does it just as soon as he becomes conscious of its true meaning.

ILLUSTRATED IN DESIRES AND VALUATIONS

But to become aware of the theory of one's actions is to be alive to something very different from that involved in the theory of action of an inanimate object. Human beings do not simply have outward behaviour; they have an inner life, subjective appreciations, desires and valuations. They prefer this and that, and it is these preferences that are closely associated with the mainsprings of their actions. An individual who indulges in yachting, shooting-parties, fox-hunting, and expensive dinners is showing in his behaviour a totally different system of values from one who joins a crowd on a Saturday afternoon to attend a football match, who finds the public house more attractive than his home, or who is a dog-racing enthusiast. Each of these corresponds to the valuations of distinct social classes. To appreciate the theory of one's behaviour, therefore, implies also linking up one's valuations with those of a particular class. To become conscious of oneself, in this sense, is to become conscious of the groups of other people who are like oneself. It throws a class affiliation into relief, and so gives a new meaning to one's valuations. Now just as soon as this happens to us we can pass at once to a new stage. We pass from being mere reacters to stimuli, of which we were previously unconcious, to active agents that plan and understand. We begin to readjust our actions, to express new born ideas and new desires in a conscious way. We begin to put a modified outlook into practice, by influencing people, by teaching them what we are learning, by propaganda. We begin to see ourselves as active agents with others in the making of history, trying to direct it in accordance with our desires.

We plan our social activity. Thus we pass from being mere individuals to whom events happen and concerning whom others hold theories, to becoming conscious participators with others of our group in the creation of these events.

SOCIETY UNCONSCIOUS OF THE LINKAGE

Society has certainly not attained this level of understanding of itself. Its members find innumerable events unexpectedly crowd in upon them. From the early nineteenth century to the present day, for example, science, mechanisation, technology, rationalisation, large-scale industry and finance came to them, not because they consciously chose to have these things, not because they foresaw the changes in town life, the rise of the slums, the transformation of the country, the increases in population, the employment and unemployment, the succession of trade crises, the poverty and plenty, the war and slaughter. It just happened to them. As far as they were concerned it was as truly a chance affair as an accidental meeting with a friend. Some individuals required the information, the knowledge, the understanding; some found that it paid them to apply it in industry and manufacture in the way they did. Society—as always, unconscious of itself—found new problems crowding in upon it, but not of its own deliberate choosing. That it would be possible to produce a theory of the social practice at work cannot be denied; we have attempted to do so in this book, but it is equally obvious that society proceeded on its way oblivious of the fact that such a theory was shaping itself in its midst. Without conscious understanding by society itself no planning is possible.

In the same way, the imperialist expansion of the last century developed. That profound forces were at work to extend the area of markets, to bring to bear the full power of the state for safeguarding the interests and property of those who were the unconscious agents of these forces, is now obvious. The history of imperialist expansion in the nineteenth century is the story of the working out in social practice of an underlying theory, albeit unconscious, of capitalist and financial enterprise. Capitalist and financier, worker and investor, alike blindly pursued their activities, engaging when necessary in wars and punitive expeditions on hostile tribes and recalcitrant natives. By August 1914 it became apparent that a critical stage of this phase had been reached. In the fourth decade of the twentieth century, we have suddenly become alive to the fact that a vast experiment has been performed upon the world, of whose theory of action and of whose outcome the experimenters themselves appear to have been ignorant. Through our ignorance, our lack of understanding of theory and practice, we inherit a complex threatening international situation in which world-war looms perpetually overhead. To realise that there does exist a theory that expresses this practice, and a recognition of our relation to, and our valuation of, this practice and this theory, becomes a first essential if we are to become socially conscious beings. It is the third form of the unity between theory and practice.

ILLUSTRATED IN THOUGHT ACTIVITY

The fourth interpretation turns the problem back on ourselves and on our thinking. Here is a changing world, we say. Here are we, parts of it, asserting that in this practice we get to know it, interpret it, and form ideas about it. What is this thinking process, how valid is it, what criterion do we apply to check the validity of the thinking? What is indeed valid thinking? In the last resort, we seem to apply a practical test, but in one sense, not simply a purely practical one. We are testing and acting and theorising all the time. Testing in practice is always interlaced with complicated reasoning, deduction, induction, and inference, all of which are brought to bear to assist in anticipating future processes in practice. This involves the weighing of evidence, the discovery of relevant data, the seeking of experience in a positive active way, the receipt and interpretation of impressions. Interpretation, moreover, is a crucial part of this conscious reception; it is not simply an individual process, but takes place on a foundation of past social values. For example, it is because other people share our experiences and our language that there comes the added assurance that the objects handled and perceived by us at intervals continue to exist even when we are not present. Thus it would have been a travesty of this theory and practice if we had begun the analysis in this book by taking as the starting-point *my* perception and *my* individual sense data, and attempting to erect a view-point on this basis. That is not a starting-point, it is a one-sided and static isolate and it omits the social context of every situation in which perception occurs.

From the fact that this continuous theorising is interpenetrated with inference, deduction, thought-building and social interpretation, and with the perpetual checking of these in practice, we are led to conclude that, in erecting the theory, we follow a mental process that in its own way gears in at all points with the material happenings in nature. Material change and mental change, or in the static sense, object and mental image, are complementary forms of activity intimately bound together by a qualitative relation. We can perhaps follow the process in this way. The objective behaviour of the world stimulates the human being; that is, it causes changes in two apparently separate human qualities, his action and his thinking. The latter, the thinking, sees the former, the action, however, as part of the objective world, infers, deduces, co-ordinates, and the cream of this experience is subsumed into a theory, in what we call a rational form. It is a rational form that is approximately the counterpart of the physical process itself, and it includes his actions. The test of the rationality is finally tried out in further conscious action, which is also the test of theory. Thus, objective process and objective action on the one hand, and thinking-cum-theory on the other, build themselves up in two intertwining spirals, the latter metaphorically the " image " of the former, always similarly related. The fourth stage of the unity between theory and practice therefore implies a very materialist basis to thinking. Suggesting that it is more than merely a " parallel " to a physical change as the old psycho-physical parallelist theory used to maintain, it asserts that a necessary physical process must also be capable of expression in rational form. There can be no question of the universe ever showing itself in fundamentally irrational form. Rational thought forms itself in the process and in so doing becomes an instrument for further discovery. What is actual can be analysed into rational form. Rationality to be valid must have its counterpart as a possible process in physical nature. In this sense are thought and action a unity, two aspects of a process that exhibits, as a single statistical isolate, an active qualitative relation to the physical world.

ILLUSTRATED IN THE IDEOLOGIES OF A SOCIETY

The fifth and final aspect of the unity of theory and practice takes us again to the level of social life. We have already discussed in detail how the ideological superstructure of society is bound up with its material basis. In a statistical sense the former expresses the valuations, ideas and theories of the latter. In particular, however, we can see it in the forms of working-class organisations that have been thrown up during the present epoch, the Trade Union Movement, the Co-operative Movement and the Political Parties of the Left. These are social institutions, a particular form of practice, reflecting a special theory of how best to cope with the problems with which the working class is faced. The steady atomisation of the political parties, side by side with the perpetual call for unity, indicates how different is the actual theory of practice from the theory professed.

ITS MEANING IN STRATEGY

A lack of appreciation of the need for this type of unification has been responsible in the past for numerous mistakes of a serious nature in working-class strategy. In recent history this can be seen, for example, in the sequence of events that led to the coming of the Nazi Dictatorship in Germany. While the various parties of the Left were themselves disunited, all, without exception, adopted the wrong policy with regard to the so-called middle class who flocked into the Nazi ranks and thus made themselves willing instruments for the destruction of democracy. The theory of class society, as we have tried to make clear, is a statistical theory. What is sharp under modern conditions is not the division into employers and employees, but the functions of exchanging labour power, and controlling the access of that power to machinery. Individuals may exercise both type of function. The same person may act sometimes as worker, sometimes as employer, sometimes as financier. An individual may be unemployed and have a small investment income. The middle class, with its possibility of saving small sums that may be invested, plays the part of a wage-earning class and of an investing class. This dual practice is reflected in a special proneness in that class to accept the ideology of the employer or the financier or at least to fling in its lot with them in certain circumstances. The fact that its capacity for investment is small has little to do with this. The theory of social activity, therefore, begins by stressing the functions involved in capitalist society, but ignores the division into personnel. It must then pass on to recognise that the personnel is not divided sharply in accordance with function. It follows that tactics and strategy, where individuals have to be handled, that would ignore this latter point, and that would work in practice on the assumption that divisions in function are also divisions in personnel, will represent a practice that is not in conformity with the actual theory of the situation. All parties on the Left in Germany, prior to the coming of Hitler, appeared to ignore this very vital point. Accordingly as the position became critical the middle class was an easy prey. It was quickly stampeded into action against the Left. The consequences of these false tactics have now become apparent to the whole of Europe, and particularly to the whole working-class movement. It is the most telling modern illustration of the inability to apply practice to theory, and theory to practice.

WHAT IS TRUTH?

We deal finally with one last point.

To describe the process implied in the Unity of Theory and Practice as a mode of arriving at truth would be to falsify it, because it would tend to give the impression that the attainment of truth can be a finished process. In so far as man makes history he makes and creates truth; but since he is in fact carrying on a process, it is a truth-making process. It has a twofold aspect. It has the practical or materially active side to it, the side that we see in behaviour. It has the theoretical or descriptive aspect; what I am trying to do here. Together they constitute the isolate or truth-process, provided the quality relating or binding them is also present. It is in this qualitative relation that the unity with which we have been dealing resides. What we have been considering have been the various types of truth-making process, individual and social, and their corresponding internal qualities.

But the truth-making process is a *process*; it grows or develops in time. Hence if we set it out along the axis of history, it becomes immediately split into two subsidiary isolates, that part of the process that lies in the past and that part that will develop in the future. We stand at the point of separation, the *now*.

We, who are the active agents in change, in that we do things and formulate ideas and theories about our actions, create this future out of this past, tentatively, in circumstances that are partially outside our control. In that sense, we exert the directed qualitative relation between the past and the future. When we are asked therefore, What is Truth?—in that abstract unrelated way, isolated from the changing process—what are we to answer?

If it is to be a statement concerning events in the future, then it cannot be other than a prediction. We turn to our physical and social science for the answer.

If it is to be a statement concerning events in the past, then it is a mere matter of fact, a record of events and their dynamic qualities, but in its time it was a guide to further action, part of the truth-making process.

If it is to be a statement that stands outside time, then it would be isolated from the historic process, it would not be subject to test, it would have no limitations that have meaning in human practice. It would then be a feature of the changing universe concerning which man can learn nothing further by experience. There can be no such statement other than the direct assertion of the existence of a physical world. If we must answer the question, What is Truth? we would say, truth is the summation of man's experience at any given moment, truth is a lantern that illuminates his next few steps, past truth becomes incomplete as a greater truth replaces it, truth is an instrument for the creation and working out of a human purpose, becoming sharper and more effective as that purpose becomes itself clearer, and as man's reading of natural process becomes more and more accurate.

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