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Lesson1 Finding fossil man

We can read of things that happened 5,000 years ago in the Near East, where people first learned to write. But there are some parts of the world where even now people cannot write. The only way that they can preserve their history is to recount it as sagas--legends handed down from one generation of story-tellers to another. These legends are useful because they can tell us something about migrations of people who lived long ago, but none could write down what they did. Anthropologists wondered where the remote ancestors of the Polynesian peoples now living in the Pacific Islands came from. The sagas of these people explain that some of them came from Indonesia about 2,000 years ago.

But the first people who were like ourselves lived so long ago that even their sagas, if they had any, are forgotten. So archaeologists have neither history nor legends to help them to find out where the first 'modern men' came from.

Fortunately, however, ancient men made tools of stone, especially flint, because this is easier to shape than other kinds. They may also have used wood and skins, but these have rotted away. Stone does not decay, and so the tools of long ago have remained when even the bones of the men who made them have disappeared without trace.

Lesson2 Spare that spider

Why, you may wonder, should spiders be our friends? Because they destroy so many insects, and insects include some of the greatest enemies of the human race. Insects would make it impossible for us to live in the world; they would devour all our crops and kill our flocks and herds, if it were not for the protection we get from insect-eating animals. We owe a lot to the birds and beasts who eat insects but all of them put together kill only a fraction of the number destroyed by spiders. Moreover, unlike some of the other insect eaters, spiders never do the least harm to us or our belongings.

Spiders are not insects, as many people think, nor even nearly related to them. One can tell the difference almost at a glance for a spider always has eight legs and an insect never more than six.

How many spiders are engaged in this work on our behalf? One authority on spiders made a census of the spiders in a grass field in the south of England, and he estimated that there were more than 2,250,000 in one acre; that is something like 6,000,000 spiders of different kinds on a football pitch. Spiders are busy for at least half the year in killing insects. It is impossible to make more than the wildest guess at how many they kill, but they are hungry creatures, not content with only three meals a day. It has been estimated that the weight of all the insects destroyed by spiders in Britain in one year would be greater than the total weight of all the human beings in the country.

Lesson3 Matterhorn man

Modern alpinists try to climb mountains by a route which will give them good sport, and the more difficult it is, the more highly it is regarded. In the pioneering days, however, this was not the case at all. The early climbers were looking for the easiest way to the top because the summit was the prize they sought, especially if it had never been attained before. It is true that during their explorations they often faced difficulties and dangers of the most perilous nature, equipped in a manner which would make a modern climber shudder at the thought, but they did not go out of their way to court such excitement. They had a single aim, a solitary goal--the top!

It is hard for us to realize nowadays how difficult it was for the

pioneers. Except for one or two places such as Zermatt and Chamonix, which had rapidly become popular, Alpine villages tended to be impoverished settlements cut off from civilization by the high mountains. Such inns as there were were generally dirty and flea-ridden; the food simply local cheese accompanied by bread often twelve months old, all washed down with coarse wine. Often a valley boasted no inn at all, and climbers found shelter wherever they could--sometimes with the local priest (who was usually as poor as his parishioners), sometimes with shepherds or cheese-makers. Invariably the background was the same: dirt and poverty, and very uncomfortable. For men accustomed to eating seven-course dinners and sleeping between fine linen sheets at home, the change to the Alps must have been very hard indeed.

Lesson4 Seeing hands

In the Soviet Union several cases have been reported recently of people who can read and detect colours with their fingers, and even see through solid doors and walls. One case concerns an eleven-year-old schoolgirl, Vera Petrova, who has normal vision but who can also perceive things with different parts of her skin, and through solid walls. This ability was first noticed by her father. One day she came into his office and happened to put her hands on the door of a locked safe. Suddenly she asked her father why he kept so many old newspapers locked away there, and even described the way they were done up in bundles.

Vera's curious talent was brought to the notice of a scientific research institute in the town of UIyanovsk, near where she lives, and in April she was given a series of tests by a special commission of the Ministry of Health of the Russian Federal Republic. During these tests she was able to read a newspaper through an opaque screen and, stranger still, by moving her elbow over a child's game of Lotto she was able to describe the figures and colours printed on it; and, in another instance, wearing stockings and slippers, to make out with her foot the outlines and colours of a picture hidden under a carpet. Other experiments showed that her knees and shoulders had a similar sensitivity. During all these tests Vera was blindfold; and, indeed, except when blindfold she lacked the ability to perceive things with her skin. It was also found that although she could perceive things with her fingers this ability ceased the moment her hands were wet.

Lesson5 No room in the Ark

The gorilla is something of a paradox in the African scene. One thinks one knows him very well. For a hundred years or more he has been killed, captured, and imprisoned in zoos. His bones have been mounted in natural history museums everywhere, and he has always exerted a strong fascination upon scientists and romantics alike. He is the stereotyped monster of the horror films and the adventure books, and an obvious (though not perhaps strictly scientific) link with our ancestral past.

Yet the fact is we know very little about gorillas. No really satisfactory photograph has ever been taken of one in a wild state, no zoologist, however intrepid, has been able to keep the animal under close and constant observation in the dark jungles in which he lives. Carl Akeley, the American naturalist, led two expeditions in the nineteen-twenties, and now lies buried among the animals he loved so well. But even he was unable to discover how long the gorilla lives, or how or why it dies, nor was he able to define the exact social pattern of the family groups, or indicate the final extent of their intelligence. All this and many other things remain almost as much a mystery as they were when the French explorer Du Chailly first described the animal to the civilized world a century ago.

The Abominable Snowman who haunts the imagination of climbers in the Himalayas is hardly more elusive.

Lesson6 Youth

People are always talking about 'the problem of youth'. If there is one--which I take leave to doubt--then it is older people who create it, not the young themselves. Let us get down to fundamentals and agree that the young are after all human beings--people just like their elders. There is only one difference between an old man and a young one: the young man has a glorious future before him and the old one has a splendid future behind him: and maybe that is where the rub is.

When I was a teenager, I felt that I was just young and uncertain--that I was a new boy in a huge school, and I would have been very pleased to be regarded as something so interesting as a problem. For one thing, being a problem gives you a certain identity, and that is one of the things the young are busily engaged in seeking.

I find young people exciting. They have an air of freedom, and they have not a dreary commitment to mean ambitions or love of comfort. They are not anxious social climbers, and they have no devotion to material things. All this seems to me to link them with life, and the origins of things. It's as if they were in some sense cosmic beings in violent and lovely contrast with us suburban creatures. All that is in my mind when I meet a young person. He may be conceited, ill-mannered, presumptuous or fatuous, but I do not turn for protection to dreary clichés about respect for elders--as if mere age were a reason for respect. I accept that we are equals, and I will argue with him, as an equal, if I think he is wrong.

Lesson7 The sporting spirit

I am always amazed when I hear people saying that sport creates goodwill between the nations, and that if only the common peoples of the world could meet one another at football or cricket, they would have no inclination to meet on the battlefield. Even if one didn't know from concrete examples (the 1936 Olympic Games, for instance) that international sporting contests lead to orgies of hatred, one could deduce it from general principles.

Nearly all the sports practised nowadays are competitive. You play to win, and the game has little meaning unless you do your utmost to win. On the village green, where you pick up sides and no feeling of local patriotism is involved, it is possible to play simply for the fun and exercise: but as soon as the question of prestige arises, as soon as you feel that you and some larger unit will be disgraced if you lose, the most savage combative instincts are aroused. Anyone who has played even in a school football match knows this. At the international level sport is frankly mimic warfare. But the significant thing is not the behaviour of the players but the attitude of the spectators: and, behind the spectators, of the nations who work themselves into furies over these absurd contests, and seriously believe--at any rate for short periods--that running, jumping and kicking a ball are tests of national virtue.

Lesson8 Education

Parents have to do much less for their children today than they used to do, and home has become much less of a workshop. Clothes can be bought ready made, washing can go to the laundry, food can be bought cooked, canned or preserved, bread is baked and delivered by the baker, milk arrives on the doorstep, meals can be had at the restaurant, the works' canteen, and the school dining-room.

It is unusual now for father to pursue his trade or other employment at

home, and his children rarely, if ever, see him at his place of work. Boys are therefore seldom trained to follow their father's occupation, and in many towns they have a fairly wide choice of employment and so do girls. The young wage-earner often earns good money, and soon acquires a feeling of economic independence. In textile areas it has long been customary for mothers to go out to work, but this practice has become so widespread that the working mother is now a not unusual factor in a child's home life, the number of married women in employment having more than doubled in the last twenty-five years. With mother earning and his older children drawing substantial wages father is seldom the dominant figure that he still was at the beginning of the century. When mother works economic advantages accrue, but children lose something of great value if mother's employment prevents her from being home to greet them when they return from school.

Lesson9 Curiosities of animal life

Not all sounds made by animals serve as language, and we have only to turn to that extraordinary discovery of echo-location in bats to see a case in which the voice plays a strictly utilitarian role.

To get a full appreciation of what this means we must turn first to some recent human inventions. Everyone knows that if he shouts in the vicinity of a wall or a mountainside, an echo will come back. The further off this solid obstruction, the longer time will elapse for the return of the echo. A sound made by tapping on the hull of a ship will be reflected from the sea bottom, and by measuring the time interval between the taps and the receipt of the echoes the depth of the sea at that point can be calculated. So was born the echo-sounding apparatus, now in general use in ships. Every solid object will reflect a sound, varying according to the size and nature of the object. A shoal of fish will do this. So it is a comparatively simple step from locating the sea bottom to locating a shoal of fish. With experience, and with improved apparatus, it is now possible not only to locate a shoal but to tell if it is herring, cod, or other well-known fish, by the pattern of its echo.

A few years ago it was found that certain bats emit squeaks and by receiving the echoes they could locate and steer clear of obstacles--or locate flying insects on which they feed. This echo-location in bats is often compared with radar, the principle of which is similar.

Lesson10 Thoughts in the wilderness

In our new society there is a growing dislike of original, creative men. The manipulated do not understand them; the manipulators fear them. The tidy committee men regard them with horror, knowing that no pigeonholes can be found for them. We could do with a few original, creative men in our political life--if only to create some enthusiasm, release some energy--but where are they? We are asked to choose between various shades of the negative. The engine is falling to pieces while the joint owners of the car argue whether the footbrake or the handbrake should be applied. Notice how the cold, colourless men, without ideas and with no other passion but a craving for success, get on in this society, capturing one plum after another and taking the juice and taste out of them. Sometimes you might think the machines we worship make all the chief appointments, promoting the human beings who seem closest to them. Between midnight and dawn, when sleep will not come and all the old wounds begin to ache, I often have an nightmare vision of a future world in which there are billions of people, all numbered and registered, with not a gleam of genius anywhere, not an original mind, a rich personality, on the whole packed globe. The twin ideals of our time, organization and quantity, will have won for ever.

Lesson11 Spies in Britain

Alfred the Great acted as his own spy, visiting Danish camps disguised as a minstrel. In those days wandering minstrels were welcome everywhere. They were not fighting men, and their harp was their passport. Alfred had learned many of their ballads in his youth, and could vary his programme with acrobatic tricks and simple conjuring.

While Alfred's little army slowly began to gather at Athelney, the king himself set out to penetrate the camp of Guthrum, the commander of the Danish invaders. These had settled down for the winter at Chippenham: thither Alfred went. He noticed at once that discipline was slack: the Danes had the self-confidence of conquerors, and their security precautions were casual. They lived well, on the proceeds of raids on neighbouring regions. There they collected women as well as food and drink, and a life of ease had made them soft.

Alfred stayed in the camp a week before he returned to Athelney. The force there assembled was trivial compared with the Danish horde. But Alfred had deduced that the Danes were no longer fit for prolonged battle: and that their commissariat had no organization, but depended on irregular raids. So, faced with the Danish advance, Alfred did not risk open battle but harried the enemy. He was constantly on the move, drawing the Danes after him. His patrols halted the raiding parties: hunger assailed the Danish army. Now Alfred began a long series of skirmishes--and within a month the Danes had surrendered. The episode could reasonably serve as a unique epic of royal espionage!

Lesson12 The language of Hollywood

What characterizes almost all Hollywood pictures is their inner emptiness. This is compensated for by an outer impressiveness. Such impressiveness usually takes the form of a truly grandiose realism. Nothing is spared to make the setting, the costumes, all of the surface details correct. These efforts help to mask the essential emptiness of the characterization, and the absurdities and trivialities of the plots. The houses look like houses, the streets look like streets; the people look and talk like people; but they are empty of humanity, credibility, and motivation. Needless to say, the disgraceful censorship code is an important factor in predetermining the content of these pictures. But the code does not disturb the profits, nor the entertainment value of the films; it merely helps to prevent them from being credible. It isn't too heavy a burden for the industry to bear. In addition to the impressiveness of the settings, there is a use of the camera which at times seems magical. But of what human import is all this skill, all this effort, all this energy in the production of effects, when the story, the representation of life is hollow, stupid, banal, childish?

Lesson13 Thames waters

Oxford has been ruined by the motor industry. The peace which Oxford once knew, and which a great university city should always have, has been swept ruthlessly away; and no benefactions and research endowments can make up for the change in character which the city has suffered. At six in the morning the old courts shake to the roar of buses taking the next shift to Cowley and Pressed Steel, great lorries with a double deck cargo of cars for export lumber past Magdalen and the University Church. Loads of motor-engines are hurried hither and thither and the streets are thronged with a population which has no interest in learning and knows no studies beyond servo-systems and distributors, compression ratios and camshafts. Theoretically the marriage of an old seat of learning and tradition with a new and wealthy industry might be expected to produce some interesting

children. It might have been thought that the culture of the university would radiate out and transform the lives of the workers. That this has not happened may be the fault of the university, for at both Oxford and Cambridge the colleges tend to live in an era which is certainly not of the twentieth century, and upon a planet which bears little resemblance to the war-torn Earth. Wherever the fault may lie the fact remains that it is the theatre at Oxford and not at Cambridge which is on the verge of extinction, and the only fruit of the combination of industry and the rarefied atmosphere of learning is the dust in the streets, and a pathetic sense of being lost which hangs over some of the colleges.

Lesson14 How to grow old

Some old people are oppressed by the fear of death. In the young there is a justification for this feeling. Young men who have reason to fear that they will be killed in battle may justifiably feel bitter in the thought that they have been cheated of the best things that life has to offer. But in an old man who has known human joys and sorrows, and has achieved whatever work it was in him to do, the fear of death is somewhat abject and ignoble. The best way to overcome it--so at least it seems to me--is to make your interests gradually wider and more impersonal, until bit by bit the walls of the ego recede, and your life becomes increasingly merged in the universal life. An individual human existence should be like a river--small at first, narrowly contained within its banks, and rushing passionately past boulders and over waterfalls. Gradually the river grows wider, the banks recede, the waters flow more quietly, and in the end, without any visible break, they become merged in the sea, and painlessly lose their individual being. The man who, in old age, can see his life in this way, will not suffer from the fear of death, since the things he cares for will continue. And if, with the decay of vitality, weariness increases, the thought of rest will be not unwelcome. I should wish to die while still at work, knowing that others will carry on what I can no longer do, and content in the thought that what was possible has been done.

Lesson15 The consumer society and the law

When anyone opens a current account at a bank, he is lending the bank money, repayment of which he may demand at any time, either in cash or by drawing a cheque in favour of another person. Primarily, the banker-customer relationship is that of debtor and creditor--who is which depending on whether the customer's account is in credit or is overdrawn. But, in addition to that basically simple concept, the bank and its customer owe a large number of obligations to one another. Many of these obligations can give rise to problems and complications but a bank customer, unlike, say, a buyer of goods, cannot complain that the law is loaded against him.

The bank must obey its customer's instructions, and not those of anyone else. When, for example, a customer first opens an account, he instructs the bank to debit his account only in respect of cheques drawn by himself. He gives the bank specimens of his signature, and there is a very firm rule that the bank has no right or authority to pay out a customer's money on a cheque on which its customer's signature has been forged. It makes no difference that the forgery may have been a very skilful one: the bank must recognize its customer's signature. For this reason there is no risk to the customer in the modern practice, adopted by some banks, of printing the customer's name on his cheques. If this facilitates forgery it is the bank which will lose, not the customer.

Lesson16 The search for the Earth's minerals

The deepest holes of all are made for oil, and they go down to as much as 25,000 feet. But we do not need to send men down to get the oil out, as we must with other mineral deposits. The holes are only borings, less than a foot in diameter. My particular experience is largely in oil, and the search for oil has done more to improve deep drilling than any other mining activity. When it has been decided where we are going to drill, we put up at the surface an oil derrick. It has to be tall because it is like a giant block and tackle, and we have to lower into the ground and haul out of the ground great lengths of drill pipe which are rotated by an engine at the top and are fitted with a cutting bit at the bottom. The geologist needs to know what rocks the drill has reached, so every so often a sample is obtained with a coring bit. It cuts a clean cylinder of rock, from which can be seen the strata the drill has been cutting through. Once we get down to the oil, it usually flows to the surface because great pressure, either from gas or water, is pushing it. This pressure must be under control, and we control it by means of the mud which we circulate down the drill pipe. We endeavour to avoid the old, romantic idea of a gusher, which wastes oil and gas. We want it to stay down the hole until we can lead it off in a controlled manner.

Lesson17 Learning to live

The fact that we are not sure what 'intelligence' is, nor what is passed on, does not prevent us from finding it a very useful working concept, and placing a certain amount of reliance on tests which 'measure' it. In an intelligence test we take a sample of an individual's ability to solve puzzles and problems of various kinds, and if we have taken a representative sample it will allow us to predict successfully the level of performance he will reach in a wide variety of occupations. This became of particular importance when, as a result of the 1944 Education Act, secondary schooling for all became law, and grammar schools, with the exception of a small number of independent foundation schools, became available to the whole population. Since the number of grammar schools in the country could accommodate at most approximately 25 per cent of the total child population of eleven-plus, some kind of selection had to be made. Narrowly academic examinations and tests were felt, quite rightly, to be heavily weighted in favour of children who had had the advantage of highly-academic primary schools and academically biased homes. Intelligence tests were devised to counteract this narrow specialization, by introducing problems which were not based on specifically scholastically-acquired knowledge. The intelligence test is an attempt to assess the general ability of any child to think, reason, judge, analyse and synthesize by presenting him with situations, both verbal and practical, which are within his range of competence and understanding.

Lesson18 The social function of science

Two factors weigh heavily against the effectiveness of scientific research in industry. One is the general atmosphere of secrecy in which it is carried out, the other the lack of freedom of the individual research worker. In so far as any inquiry is a secret one, it naturally limits all those engaged in carrying it out from effective contact with their fellow scientists either in other countries or in universities, or even, often enough, in other departments of the same firm. The degree of secrecy naturally varies considerably. Some of the bigger firms are engaged in researches which are of such general and fundamental nature that it is a positive advantage to them not to keep them secret. Yet a great many

processes depending on such research are sought for with complete secrecy until the stage at which patents can be taken out. Even more processes are never patented at all but kept as secret processes. This applies particularly to chemical industries, where chance discoveries play a much larger part than they do in physical and mechanical industries. Sometimes the secrecy goes to such an extent that the whole nature of the research cannot be mentioned. Many firms, for instance, have great difficulty in obtaining technical or scientific books from libraries because they are unwilling to have their names entered as having taken out such and such a book for fear the agents of other firms should be able to trace the kind of research they are likely to be undertaking.

Lesson19 English social differences

A gentleman is, rather than does. He is interested in nothing in a professional way. He is allowed to cultivate hobbies, even eccentricities, but must not practise a vocation. He must know how to ride and shoot and cast a fly. He should have relatives in the army and navy and at least one connection in the diplomatic service. But there are weaknesses in the English gentleman's ability to rule us today. He usually knows nothing of political economy and less about how foreign countries are governed. He does not respect learning and prefers 'sport'. The problem set for society is not the virtues of the type so much as its adequacy for its function, and here grave difficulties arise. He refuses to consider sufficiently the wants of the customer, who must buy, not the thing he desires but the thing the English gentleman wants to sell. He attends inadequately to technological development. Disbelieving in the necessity of large-scale production in the modern world, he is passionately devoted to excessive secrecy, both in finance and method of production. He has an incurable and widespread nepotism in appointment, discounting ability and relying upon a mystic entity called 'character,' which means, in a gentleman's mouth, the qualities he traditionally possesses himself. His lack of imagination and the narrowness of his social loyalties have ranged against him one of the fundamental estates of the realm. He is incapable of that imaginative realism which admits that this is a new world to which he must adjust himself and his institutions, that every privilege he formerly took as of right he can now attain only by offering proof that it is directly relevant to social welfare.

Lesson20 Man, the unknown

In the organization of industrial life the influence of the factory upon the physiological and mental state of the workers has been completely neglected. Modern industry is based on the conception of the maximum production at lowest cost, in order that an individual or a group of individuals may earn as much money as possible. It has expanded without any idea of the true nature of the human beings who run the machines, and without giving any consideration to the effects produced on the individuals and on their descendants by the artificial mode of existence imposed by the factory. The great cities have been built with no regard for us. The shape and dimensions of the skyscrapers depend entirely on the necessity of obtaining the maximum income per square foot of ground, and of offering to the tenants offices and apartments that please them. This caused the construction of gigantic buildings where too large masses of human beings are crowded together. Civilized men like such a way of living. While they enjoy the comfort and banal luxury of their dwelling, they do not realize that they are deprived of the necessities of life. The modern city consists of monstrous edifices and of dark, narrow streets full of petrol fumes, coal dust, and toxic gases, torn by the noise of the

taxi-cabs, lorries and buses, and thronged ceaselessly by great crowds. Obviously, it has not been planned for the good of its inhabitants.

Lesson 21 Science makes sense

In the early days of the settlement of Australia, enterprising settlers unwisely introduced the European rabbit. This rabbit had no natural enemies in the Antipodes, so that it multiplied with that promiscuous abandon characteristic of rabbits. It overran a whole continent. It caused devastation by burrowing and by devouring the herbage which might have maintained millions of sheep and cattle. Scientists discovered that this particular variety of rabbit (and apparently no other animal) was susceptible to a fatal virus disease, myxomatosis. By infecting animals and letting them loose in the burrows, local epidemics of this disease could be created. Later it was found that there was a type of mosquito which acted as the carrier of this disease and passed it on to the rabbits. So while the rest of the world was trying to get rid of mosquitoes, Australia was encouraging this one. It effectively spread the disease all over the continent and drastically reduced the rabbit population. It later became apparent that rabbits were developing a degree of resistance to this disease, so that the rabbit population was unlikely to be completely exterminated. There were hopes, however, that the problem of the rabbit would become manageable.

Ironically, Europe, which had bequeathed the rabbit as a pest to Australia, acquired this man-made disease as a pestilence. A French physician decided to get rid of the wild rabbits on his own estate and introduced myxomatosis. It did not, however, remain within the confines of his estate. It spread through France, where wild rabbits are not generally regarded as a pest but as a sport and a useful food supply, and it spread to Britain where wild rabbits are regarded as a pest but where domesticated rabbits, equally susceptible to the disease, are the basis of a profitable fur industry. The question became one of whether Man could control the disease he had invented.

Lesson 22 Window in the sea

There has long been a superstition among mariners that porpoises will save drowning men by pushing them to the surface, or protect them from sharks by surrounding them in defensive formation. Marine biologists have pointed out that, however intelligent they may be, it is probably a mistake to credit dolphins with any motive of life-saving. On the occasions when they have pushed to shore an unconscious human being they have much more likely done it out of curiosity or for sport, as in riding the bow waves of a ship. In 1928 some porpoises were photographed working like beavers to push ashore a waterlogged mattress. If, as has been reported, they have protected humans from sharks, it may have been because curiosity attracted them and because the scent of a possible meal attracted the sharks. Porpoises and sharks are natural enemies. It is possible that upon such an occasion a battle ensued, with the sharks being driven away or killed.

Whether it be bird, fish or beast, the porpoise is intrigued with anything that is alive. They are constantly after the turtles, the Ferdinands of marine life, who peacefully submit to all sorts of indignities. One young calf especially enjoyed raising a turtle to the surface with his snout and then shoving him across the tank like an aquaplane. Almost any day a young porpoise may be seen trying to turn a 300-pound sea turtle over by sticking his snout under the edge of his shell and pushing up for dear life. This is not easy, and may require two porpoises working together. In another game, as the turtle swims across the oceanarium, the first

porpoise swoops down from above and butts his shell with his belly. This knocks the turtle down several feet. He no sooner recovers his equilibrium than the next porpoise comes along and hits him another crack. Eventually the turtle has been butted all the way down to the floor of the tank. He is now satisfied merely to try to stand up, but as soon as he does so a porpoise knocks him flat. The turtle at last gives up by pulling his feet under his shell and the game is over.

Lesson23 The stuff of dreams

It is fairly clear that the sleeping period must have some function, and because there is so much of it the function would seem to be important. Speculations about its nature have been going on for literally thousands of years, and one odd finding that makes the problem puzzling is that it looks very much as if sleeping is not simply a matter of giving the body a rest. 'Rest', in terms of muscle relaxation and so on, can be achieved by a brief period lying, or even sitting down. The body's tissues are self-repairing and self-restoring to a degree, and function best when more or less continuously active. In fact a basic amount of movement occurs during sleep which is specifically concerned with preventing muscle inactivity. If it is not a question of resting the body, then perhaps it is the brain that needs resting? This might be a plausible hypothesis were it not for two factors. First the electroencephalograph (which is simply a device for recording the electrical activity of the brain by attaching electrodes to the scalp) shows that while there is a change in the pattern of activity during sleep, there is no evidence that the total amount of activity is any less. The second factor is more interesting and more fundamental. In 1960 an American psychiatrist named William Dement published experiments dealing with the recording of eye-movements during sleep. He showed that the average individual's sleep cycle is punctuated with peculiar bursts of eye-movements, some drifting and slow, others jerky and rapid. People woken during these periods of eye-movements generally reported that they had been dreaming. When woken at other times they reported no dreams. If one group of people were disturbed from their eye-movement sleep for several nights on end, and another group were disturbed for an equal period of time but when they were not exhibiting eye-movements, the first group began to show some personality disorders while the others seemed more or less unaffected. The implications of all this were that it was not the disturbance of sleep that mattered, but the disturbance of dreaming.

Lesson24 Going out for a walk

Walking for walking's sake may be as highly laudable and exemplary a thing as it is held to be by those who practise it. My objection to it is that it stops the brain. Many a man has professed to me that his brain never works so well as when he is swinging along the high road or over hill and dale. This boast is not confirmed by my memory of anybody who on a Sunday morning has forced me to partake of his adventure. Experience teaches me that whatever a fellow-guest may have of power to instruct or to amuse when he is sitting in a chair, or standing on a hearth-rug, quickly leaves him when he takes one out for a walk. The ideas that come so thick and fast to him in any room, where are they now? where that encyclopaedic knowledge which he bore so lightly? where the kindling fancy that played like summer lightning over any topic that was started? The man's face that was so mobile is set now; gone is the light from his fine eyes. He says that A (our host) is a thoroughly good fellow. Fifty yards further on, he adds that A is one of the best fellows he has ever met. We tramp another furlong or so, and he says that Mrs A is a charming woman. Presently he adds that she is one of the most charming women he has ever known. We pass

an inn. He reads vapidly aloud to me: 'The King's Arms. Licensed to sell Ales and Spirits.' I foresee that during the rest of the walk he will read aloud any inscription that occurs. We pass a milestone. He points at it with his stick, and says 'Uxminster. II Miles.' We turn a sharp corner at the foot of the hill. He points at the wall, and says 'Drive Slowly.' I see far ahead, on the other side of the hedge bordering the high road, a small notice-board. He sees it too. He keeps his eye on it. And in due course 'Trespassers,' he says, 'will be Prosecuted.' Poor man!!*mentally a wreck.

Lesson25 The snake

How it came about that snakes manufactured poison is a mystery. Over the periods their saliva, a mild, digestive juice like our own, was converted into a poison that defies analysis even today. It was not forced upon them by the survival competition; they could have caught and lived on prey without using poison just as the thousands of non-poisonous snakes still do. Poison to a snake is merely a luxury; it enables it to get its food with very little effort, no more effort than one bite. And why only snakes? Cats, for instance, would be greatly helped; no running fights with large, fierce rats or tussles with grown rabbits--just a bite and no more effort needed. In fact, it would be an assistance to all the carnivora--though it would be a two-edged weapon when they fought each other. But, of the vertebrates, unpredictable Nature selected only snakes (and one lizard). One wonders also why Nature, with some snakes concocted poison of such extreme potency.

In the conversion of saliva into poison one might suppose that a fixed process took place. It did not; some snakes manufactured a poison different in every respect from that of others, as different as arsenic is from strychnine, and having different effects. One poison acts on the nerves, the other on the blood.

The makers of the nerve poison include the mambas and the cobras and their venom is called neurotoxic. Vipers (adders) and rattlesnakes manufacture the blood poison, which is known as haemolytic. Both poisons are unpleasant, but by far the more unpleasant is the blood poison. It is said that the nerve poison is the more primitive of the two, that the blood poison is, so to speak, a newer product from an improved formula. Be that as it may, the nerve poison does its business with man far more quickly than the blood poison. This, however, means nothing. Snakes did not acquire their poison for use against man but for use against prey such as rats and mice, and the effects on these of viperine poison is almost immediate.

Lesson26 Virtue and a fast gun

William S. Hart was, perhaps, the greatest of all Western stars, for unlike Gary Cooper and John Wayne he appeared in nothing but Westerns. From 1914 to 1924 he was supreme and unchallenged. It was Hart who created the basic formula of the Western film, and devised the protagonist he played in every film he made, the good-bad man, the accidental, noble outlaw, or the honest but framed cowboy, or the sheriff made suspect by vicious gossip; in short, the individual in conflict with himself and his frontier environment.

Unlike most of his contemporaries in Hollywood, Hart actually knew something of the old West. He had lived in it as a child when it was already disappearing, and his hero was firmly rooted in his memories and experiences, and in both the history and the mythology of the vanished frontier. And although no period or place in American history has been more absurdly romanticized, myth and reality did join hands in at least

one arena, the conflict between the individual and encroaching civilization.

Men accustomed to struggling for survival against the elements and Indian were bewildered by politicians, bankers and business-men, and unhorsed by fences, laws and alien taboos. Hart's good-bad man was always an outsider, always one of the disinherited, and if he found it necessary to shoot a sheriff or rob a bank along the way, his early audiences found it easy to understand and forgive, especially when it was Hart who, in the end, overcame the attacking Indians.

Audiences in the second decade of the twentieth century found it pleasant to escape to a time when life, though hard, was relatively simple. We still do; living in a world in which undeclared aggression, war, hypocrisy, chicanery, anarchy and impending immolation are part of our daily lives, we all want a code to live by.

Lesson27 The personality of man

Why does the idea of progress loom so large in the modern world? Surely because progress of a particular kind is actually taking place around us and is becoming more and more manifest. Although mankind has undergone no general improvement in intelligence or morality, it has made extraordinary progress in the accumulation of knowledge. Knowledge began to increase as soon as the thoughts of one individual could be communicated to another by means of speech. With the invention of writing, a great advance was made, for knowledge could then be not only communicated but also stored.

Libraries made education possible, and education in its turn added to libraries: the growth of knowledge followed a kind of compound-interest law, which was greatly enhanced by the invention of printing. All this was comparatively slow until, with the coming of science, the tempo was suddenly raised. Then knowledge began to be accumulated according to a systematic plan. The trickle became a stream; the stream has now become a torrent. Moreover, as soon as new knowledge is acquired, it is now turned to practical account. What is called 'modern civilization' is not the result of a balanced development of all man's nature, but of accumulated knowledge applied to practical life. The problem now facing humanity is: What is going to be done with all this knowledge? As is so often pointed out, knowledge is a two-edged weapon which can be used equally for good or evil. It is now being used indifferently for both. Could any spectacle, for instance, be more grimly whimsical than that of gunners using science to shatter men's bodies while, close at hand, surgeons use it to restore them? We have to ask ourselves very seriously what will happen if this twofold use of knowledge, with its ever-increasing power, continues.

Lesson28 A countryman's creed

No two sorts of birds practise quite the same sort of flight; the varieties are infinite, but two classes may be roughly seen. Any ship that crosses the Pacific is accompanied for many days by the smaller albatross, which may keep company with the vessel for an hour without visible or more than occasional movement of wing. The currents of air that the walls of the ship direct upwards, as well as in the line of its course are enough to give the great bird with its immense wings sufficient sustenance and progress. The albatross is the king of the gliders, the class of fliers which harness the air to their purpose, but must yield to its opposition. In the contrary school the duck is supreme. It comes nearer to the engines with which man has 'conquered' the air, as he boasts. Duck, and like them the pigeons, are endowed with steel-like muscles, that are a good part of the weight of the bird, and these will ply the short wings with irresistible power that they can bore for long distances through an

opposite gale before exhaustion follows. Their humbler followers, such as partridges, have a like power of strong propulsion, but soon tire. You may pick them up in utter exhaustion, if wind over the sea has driven them to a long journey. The swallow shares the virtues of both schools in highest measure. It tires not nor does it boast of its power; but belongs to the air, travelling it may be six thousand miles to and from its northern nesting home feeding its flown young as it flies and slipping through a medium that seems to help its passage even when the wind is adverse. Such birds do us good, though we no longer take omens from their flight on this side and that; and even the most superstitious villagers no longer take off their hats to the magpie and wish it good-morning.

Lesson29 Pieces of mind

A young man sees a sunset and, unable to understand or to express the emotion that it rouses in him, concludes that it must be the gateway to a world that lies beyond. It is difficult for any of us in moments of intense aesthetic experience to resist the suggestion that we are catching a glimpse of a light that shines down to us from a different realm of existence, different and, because the experience is intensely moving, in some way higher. And, though the gleams blind and dazzle, yet do they convey a hint of beauty and serenity greater than we have known or imagined. Greater too than we can describe; for language, which was invented to convey the meanings of this world, cannot readily be fitted to the uses of another.

That all great art has this power of suggesting a world beyond is undeniable. In some moods Nature shares it. There is no sky in June so blue that it does not point forward to a bluer, no sunset so beautiful that it does not waken the vision of a greater beauty, a vision which passes before it is fully glimpsed, and in passing leaves an indefinable longing and regret. But, if this world is not merely a bad joke, life a vulgar flare amid the cool radiance of the stars, and existence an empty laugh braying across the mysteries; if these intimations of a something behind and beyond are not evil humour born of indigestion, or whimsies sent by the devil to mock and madden us, if, in a word, beauty means something, yet we must not seek to interpret the meaning. If we glimpse the unutterable, it is unwise to try to utter it, nor should we seek to invest with significance that which we cannot grasp. Beauty in terms of our human meanings is meaningless.

Lesson30 Adventures of ideas

Each civilization is born, it culminates, and it decays. There is a widespread testimony that this ominous fact is due to inherent biological defects in the crowded life of cities. Now, slowly and at first faintly, an opposite tendency is showing itself. Better roads and better vehicles at first induced the wealthier classes to live on the outskirts of the cities. The urgent need for defence had also vanished. This tendency is now spreading rapidly downwards. But a new set of conditions is just showing itself. Up to the present time, throughout the eighteenth and nineteenth centuries, this new tendency placed the home in the immediate suburbs, but concentrated manufacturing activity, business relations, government, and pleasure in the centres of the cities. Apart from the care of children and periods of sheer rest, the active lives were spent in the cities. In some ways the concentration of such activities was even more emphasized, and the homes were pushed outwards even at the cost of the discomfort of commuting. But, if we examine the trend of technology during the past generation, the reasons for this concentration are largely disappearing. Still more, the reasons for the choice of sites for cities

are also altering. Mechanical power can be transmitted for hundreds of miles, men can communicate almost instantaneously by telephone, the chiefs of great organizations can be transported by airplanes, the cinemas can produce plays in every village, music, speeches, and sermons can be broadcast. Almost every reason for the growth of cities, concurrently with the growth of civilization has been profoundly modified.

Lesson31 Non-auditory effects of noise

Many people in industry and the Services, who have practical experience of noise, regard any investigation of this question as a waste of time; they are not prepared even to admit the possibility that noise affects people. On the other hand, those who dislike noise will sometimes use most inadequate evidence to support their pleas for a quieter society. This is a pity, because noise abatement really is a good cause, and it is likely to be discredited if it gets to be associated with bad science.

One allegation often made is that noise produces mental illness. A recent article in a weekly newspaper, for instance, was headed with a striking illustration of a lady in a state of considerable distress, with the caption 'She was yet another victim, reduced to a screaming wreck'. On turning eagerly to the text, one learns that the lady was a typist who found the sound of office typewriters worried her more and more until eventually she had to go into a mental hospital. Now the snag in this sort of anecdote is of course that one cannot distinguish cause and effect. Was the noise a cause of the illness, or were the complaints about noise merely a symptom? Another patient might equally well complain that her neighbours were combining to slander her and persecute her, and yet one might be cautious about believing this statement.

What is needed in the case of noise is a study of large numbers of people living under noisy conditions, to discover whether they are mentally ill more often than other people are. The United States Navy, for instance, recently examined a very large number of men working on aircraft carriers: the study was known as Project Anehin. It can be unpleasant to live even several miles from an aerodrome; if you think what it must be like to share the deck of a ship with several squadrons of jet aircraft, you will realize that a modern navy is a good place to study noise. But neither psychiatric interviews nor objective tests were able to show any effects upon these American sailors. This result merely confirms earlier American and British studies: if there is any effect of noise upon mental health it must be so small that present methods of psychiatric diagnosis cannot find it. That does not prove that it does not exist; but it does mean that noise is less dangerous than, say, being brought up in an orphanage-- which really is a mental health hazard.

Lesson32 The past life of the Earth

It is animals and plants which lived in or near water whose remains are most likely to be preserved, for one of the necessary conditions of preservation is quick burial, and it is only in the seas and rivers, and sometimes lakes, where mud and silt have been continuously deposited, that bodies and the like can be rapidly covered over and preserved.

But even in the most favourable circumstances only a small fraction of the creatures that die are preserved in this way before decay sets in or, even more likely, before scavengers eat them. After all, all living creatures live by feeding on something else, whether it be plant or animal, dead or alive, and it is only by chance that such a fate is avoided. The remains of plants and animals that lived on land are much more rarely preserved, for there is seldom anything to cover them over. When you think of the innumerable birds that one sees flying about, not to mention the equally numerous small animals like field mice and voles which you do not see, it

is very rarely that one comes across a dead body, except, of course, on the roads. They decompose and are quickly destroyed by the weather or eaten by some other creature.

It is almost always due to some very special circumstances that traces of land animals survive, as by falling into inaccessible caves, or into an ice crevasse, like the Siberian mammoths, when the whole animal is sometimes preserved, as in a refrigerator. This is what happened to the famous Beresovka mammoth which was found preserved and in good condition. In his mouth were the remains of fir trees--the last meal that he had before he fell into the crevasse and broke his back. The mammoth has now been restored in the Palaeontological Museum in Leningrad. Other animals were trapped in tar pits, like the elephants, sabre-toothed cats, and numerous other creatures that are found at Rancho la Brea, which is now just a suburb of Los Angeles. Apparently what happened was that water collected on these tar pits, and the bigger animals like the elephants ventured out on to the apparently firm surface to drink, and were promptly bogged in the tar. And then, when they were dead, the carnivores, like the sabre-toothed cats and the giant wolves, came out to feed and suffered exactly the same fate. There are also endless numbers of birds in the tar as well.

Lesson33 The raising of the 'Vasa'

From the seventeenth-century empire of Sweden, the story of a galleon that sank at the start of her maiden voyage in 1628 must be one of the strangest tales of the sea. For nearly three and a half centuries she lay at the bottom of Stockholm harbour until her discovery in 1956. This was the Vasa, royal flagship of the great imperial fleet.

King Gustavus Adolphus, 'The Northern Hurricane', then at the height of his military success in the Thirty Years' War, had dictated her measurements and armament. Triple gun-decks mounted sixty-four bronze cannon. She was intended to play a leading role in the growing might of Sweden.

As she was prepared for her maiden voyage on August 10, 1628, Stockholm was in a ferment. From the Skeppsbron and surrounding islands the people watched this thing of beauty begin to spread her sails and catch the wind. They had laboured for three years to produce this floating work of art; she was more richly carved and ornamented than any previous ship. The high stern castle was a riot of carved gods, demons, knights, kings, warriors, mermaids, cherubs; and zoomorphic animal shapes ablaze with red and gold and blue, symbols of courage, power, and cruelty, were portrayed to stir the imaginations of the superstitious sailors of the day.

Then the cannons of the anchored warships thundered a salute to which the Vasa fired in reply. As she emerged from her drifting cloud of gun smoke with the water churned to foam beneath her bow, her flags flying, pennants waving, sails filling in the breeze, and the red and gold of her superstructure ablaze with colour, she presented a more majestic spectacle than Stockholmers had ever seen before. All gun-ports were open and the muzzles peeped wickedly from them.

As the wind freshened there came a sudden squall and the ship made a strange movement, listing to port. The Ordnance Officer ordered all the port cannon to be heaved to starboard to counteract the list, but the steepening angle of the decks increased. Then the sound of rumbling thunder reached the watchers on the shore, as cargo, ballast, ammunition and 400 people went sliding and crashing down to the port side of the steeply listing ship. The lower gun-ports were now below water and the inrush sealed the ship's fate. In that first glorious hour, the mighty Vasa, which was intended to rule the Baltic, sank with all flags flying!

*in the harbour of her birth.

Lesson34 The patients and doctors

This is a sceptical age, but although our faith in many of the things in which our forefathers fervently believed has weakened, our confidence in the curative properties of the bottle of medicine remains the same as theirs. This modern faith in medicines is roved by the fact that the annual drug bill of the Health Services is mounting to astronomical figures and shows no signs at present of ceasing to rise. The majority of the patients attending the medical out-patients departments of our hospitals feel that they have not received adequate treatment unless they are able to carry home with them some tangible remedy in the shape of a bottle of medicine, a box of pills, or a small jar of ointment, and the doctor in charge of the department is only too ready to provide them with these requirements. There is no quicker method of disposing of patients than by giving them what they are asking for, and since most medical men in the Health Services are overworked and have little time for offering time-consuming and little-appreciated advice on such subjects as diet, right living, and the need for abandoning bad habits, etc., the bottle, the box, and the jar are almost always granted them.

Nor is it only the ignorant and ill-educated person who has such faith in the bottle of medicine, especially if it be wrapped in white paper and sealed with a dab of red sealing-wax by a clever chemist. It is recounted of Thomas Carlyle that when he heard of the illness of his friend, Henry Taylor, he went off immediately to visit him, carrying with him in his pocket what remained of a bottle of medicine formerly prescribed for an indisposition of Mrs Carlyle's. Carlyle was entirely ignorant of what the bottle in his pocket contained, of the nature of the illness from which his friend was suffering, and of what had previously been wrong with his wife, but a medicine that had worked so well in one form of illness would surely be of equal benefit in another, and comforted by the thought of the help he was bringing to his friend, he hastened to Henry Taylor's house. History does not relate whether his friend accepted his medical help, but in all probability he did. The great advantage of taking medicine is that it makes no demands on the taker beyond that of putting up for a moment with a disgusting taste, and that is what all patients demand of their doctors--to be cured at no inconvenience to themselves.

Lesson35 The pegasus book of inventors

Many strange new means of transport have been developed in our century, the strangest of them being perhaps the hovercraft. In 1953, a former electronics engineer in his fifties, Christopher Cockerell, who had turned to boat-building on the Norfolk Broads, suggested an idea on which he had been working for many years to the British Government and industrial circles. It was the idea of supporting a craft on a 'pad', or cushion, of low-pressure air, ringed with a curtain of higher pressure air. Ever since, people have had difficulty in deciding whether the craft should be ranged among ships, planes, or land vehicles--for it is something in between a boat and an aircraft. As a shipbuilder, Cockerell was trying to find a solution to the problem of the wave resistance which wastes a good deal of a surface ship's power and limits its speed. His answer was to lift the vessel out of the water by making it ride on a cushion of air, no more than one or two feet thick. This is done by a great number of ring-shaped air jets on the bottom of the craft. It 'flies', therefore, but it cannot fly higher--its action depends on the surface, water or ground, over which it rides.

The first tests on the Solent in 1959 caused a sensation. The hovercraft

travelled first over the water, then mounted the beach, climbed up the dunes, and sat down on a road. Later it crossed the Channel, riding smoothly over the waves, which presented no problem.

Since that time, various types of hovercraft have appeared and taken up regular service--cruises on the Thames in London, for instance, have become an annual attraction. But we are only at the beginning of a development that may transform sea and land transport. Christopher Cockerell's craft can establish transport networks in large areas with poor communications such as Africa or Australia; it can become a 'flying fruit-bowl', carrying bananas from the plantations to the ports; giant hovercraft liners could span the Atlantic; and the railway of the future may well be the 'hovertrain', riding on its air cushion over a single rail, which it never touches, at speeds up to 300 m.p.h.--the possibilities appear unlimited.

Lesson36 Exploring the sea-floor

Our knowledge of the oceans a hundred years ago was confined to the two-dimensional shape of the sea-surface and the hazards of navigation presented by the irregularities in depth of the shallow water close to the land. The open sea was deep and mysterious, and anyone who gave more than a passing thought to the bottom confines of the oceans probably assumed that the sea-bed was flat. Sir James Clark Ross had obtained a sounding of over 2,400 fathoms in 1839, but it was not until 1869, when H.M.S. Porcupine was put at the disposal of the Royal Society for several cruises, that a series of deep soundings was obtained in the Atlantic and the first samples were collected by dredging the bottom. Shortly after this the famous H.M.S. Challenger expedition established the study of the sea-floor as a subject worthy of the most qualified physicists and geologists. A burst of activity associated with the laying of submarine cables soon confirmed the Challenger's observation that many parts of the ocean were two to three miles deep, and the existence of underwater features of considerable magnitude.

Today enough soundings are available to enable a relief map of the Atlantic to be drawn and we know something of the great variety of the sea-bed's topography. Since the sea covers the greater part of the earth's surface it is quite reasonable to regard the sea-floor as the basic form of the crust of the earth, with superimposed upon it the continents, together with the islands and other features of the oceans. The continents form rugged tablelands which stand nearly three miles above the floor of the open ocean. From the shore-line out to a distance which may be anywhere from a few miles to a few hundred miles runs the gentle slope of the continental shelf, geologically part of the continents. The real dividing-line between continents and oceans occurs at the foot of a steeper slope.

This continental slope usually starts at a place somewhere near the 100-fathom mark and in the course of a few hundred miles reaches the true ocean-floor at 2,500-3,000 fathoms. The slope averages about 1 in 30, but contains steep, probably vertical, cliffs, and gentle sediment-covered terraces, and near its lower reaches there is a long tailing-off which is almost certainly the result of material transported out to deep water after being eroded from the continental masses.

Lesson37 On telling the truth

The Victorians, realizing that the greatest happiness accorded to man is that provided by a happy marriage, endeavoured to pretend that all their marriages were happy. We, for our part, admitting the fact that no feat of intelligence and character is so exacting as that required of two people

who desire to live permanently together on a basis of amity, are obsessed by the problem of how to render the basic facts of cohabitation simpler and more reasonable, in order that unhappy marriages may less frequently result. The Victorians would have considered it 'painful' or 'unpleasant' were one to point out that only four marriages out of every ten are anything but forced servitudes. We ourselves start from this very assumption and try to build from it a theory of more sensible relations between the sexes. Of all forms of arrant untruthfulness Victorian optimism appears to me to have been the most cowardly and the most damaging.

Truth, therefore, is an attitude of the mind. It is important, if one does not wish to inconvenience and to bore one's friends, not to tell lies. But it is more important not to think lies, or to slide into those mechanical and untruthful habits of thought which are so pleasant and so easy as descents to mental ineptitude. The Victorian habit of mind (which I consider to have been a bad habit of mind) was unduly preoccupied by what was socially and morally convenient. Convenience is, however, in all affairs of life, an execrable test of value. One should have the courage to think uncomfortably, since it is only by rejecting the convenient that one can come to think the truth.

Not, after all, that there is any such thing as truth. At best we can approach to some relative approximation. On the other hand, there is surely such a thing as untruth. One is generally aware when one has said something, or acted in some way which has left on other people an impression not strictly in accordance with the facts. One is generally aware, also, when one has thrust aside an inconvenient thought and slid into its place another thought which is convenient. One's awareness in the former case is in general more acute than in the latter, since we are more on the look-out for the lies we utter than for those we merely think. In fact, however, it is the untruthful thought which is the more vicious of the two. Spoken lies are invariably tiresome and may actually be dishonest. But continuous lying in the mind, a disease to which the Anglo-Saxon is peculiarly exposed, spells the destruction of human thought and character.

Lesson 38 The sculptor speaks

Appreciation of sculpture depends upon the ability to respond to form in three dimensions. That is perhaps why sculpture has been described as the most difficult of all arts; certainly it is more difficult than the arts which involve appreciation of flat forms, shape in only two dimensions. Many more people are 'form-blind' than colour-blind. The child learning to see, first distinguishes only two-dimensional shape; it cannot judge distances, depths. Later, for its personal safety and practical needs, it has to develop (partly by means of touch) the ability to judge roughly three-dimensional distances. But having satisfied the requirements of practical necessity, most people go no further. Though they may attain considerable accuracy in the perception of flat form, they do not make the further intellectual and emotional effort needed to comprehend form in its full spatial existence.

This is what the sculptor must do. He must strive continually to think of, and use, form in its full spatial completeness. He gets the solid shape, as it were, inside his head--he thinks of it, whatever its size, as if he were holding it completely enclosed in the hollow of his hand. He mentally visualizes a complex form from all round itself; he knows while he looks at one side what the other side is like; he identifies himself with its centre of gravity, its mass, its weight; he realizes its volume, as the space that the shape displaces in the air.

And the sensitive observer of sculpture must also learn to feel shape simply as shape, not as description or reminiscence. He must, for example, perceive an egg as a simple single solid shape, quite apart from its significance as food, or from the literary idea that it will become a bird. And so with solids such as a shell, a nut, a plum, a pear, a tadpole, a mushroom, a mountain peak, a kidney, a carrot, a tree-trunk, a bird, a bud, a lark, a ladybird, a bulrush, a bone. From these he can go on to appreciate more complex forms or combinations of several forms.

Lesson39 Galileo reborn

In his own lifetime Galileo was the centre of violent controversy; but the scientific dust has long since settled, and today we can see even his famous clash with the Inquisition in something like its proper perspective. But, in contrast, it is only in modern times that Galileo has become a problem child for historians of science.

The old view of Galileo was delightfully uncomplicated. He was, above all, a man who experimented: who despised the prejudices and book learning of the Aristotelians, who put his questions to nature instead of to the ancients, and who drew his conclusions fearlessly. He had been the first to turn a telescope to the sky, and he had seen there evidence enough to overthrow Aristotle and Ptolemy together. He was the man who climbed the Leaning Tower of Pisa and dropped various weights from the top, who rolled balls down inclined planes, and then generalized the results of his many experiments into the famous law of free fall.

But a closer study of the evidence, supported by a deeper sense of the period, and particularly by a new consciousness of the philosophical undercurrents in the scientific revolution, has profoundly modified this view of Galileo. Today, although the old Galileo lives on in many popular writings, among historians of science a new and more sophisticated picture has emerged. At the same time our sympathy for Galileo's opponents has grown somewhat. His telescopic observations are justly immortal; they aroused great interest at the time, they had important theoretical consequences, and they provided a striking demonstration of the potentialities hidden in instruments and apparatus. But can we blame those who looked and failed to see what Galileo saw, if we remember that to use a telescope at the limit of its powers calls for long experience and intimate familiarity with one's instrument? Was the philosopher who refused to look through Galileo's telescope more culpable than those who alleged that the spiral nebulae observed with Lord Rosse's great telescope in the eighteen-forties were scratches left by the grinder? We can perhaps forgive those who said the moons of Jupiter were produced by Galileo's spy-glass if we recall that in his day, as for centuries before, curved glass was the popular contrivance for producing not truth but illusion, untruth; and if a single curved glass would distort nature, how much more would a pair of them?

Lesson40 Themes and variations

Populations increase and decrease relatively not only to one another, but also to natural resources. In most parts of the world, the relation between population and resources is already unfavourable and will probably become even more unfavourable in the future. This growing poverty in the midst of growing poverty constitutes a permanent menace to peace. And not only to peace, but also to democratic institutions and personal liberty. For overpopulation is not compatible with freedom. An unfavourable relationship between numbers and resources tends to make the earning of a living almost intolerably difficult. Labour is more abundant than goods, and the individual is compelled to work long hours for little pay. No

surplus of accumulated purchasing power stands between him and the tyrannies of unfriendly nature or of the equally unfriendly wielders of political and economic power. Democracy is, among other things, the ability to say 'no' to the boss. But a man cannot say 'no' to the boss, unless he is sure of being able to eat when the boss's favour has been withdrawn. And he cannot be certain of his next meal unless he owns the means of producing enough wealth for his family to live on, or has been able to accumulate a surplus out of past wages, or has a chance of moving to virgin territories, where he can make a fresh start. In an overcrowded country, very few people own enough to make them financially independent; very few are in a position to accumulate purchasing power; and there is no free land. Moreover, in any country where population presses hard upon natural resources, the general economic situation is apt to be so precarious that government control of capital and labour, production and consumption, becomes inevitable. It is no accident that the twentieth century should be the century of highly centralized governments and totalitarian dictatorships; it had to be so for the simple reason that the twentieth century is the century of planetary overcrowding.

Lesson41 The origin of things

Education is one of the key words of our time. A man without an education, many of us believe, is an unfortunate victim of adverse circumstances deprived of one of the greatest twentieth-century opportunities. Convinced of the importance of education, modern states 'invest' in institutions of learning to get back 'interest' in the form of a large group of enlightened young men and women who are potential leaders. Education, with its cycles of instruction so carefully worked out, punctuated by text-books--those purchasable wells of wisdom--what would civilization be like without its benefits?

So much is certain: that we would have doctors and preachers, lawyers and defendants, marriages and births--but our spiritual outlook would be different. We would lay less stress on 'facts and figures' and more on a good memory, on applied psychology, and on the capacity of a man to get along with his fellow-citizens. If our educational system were fashioned after its bookless past we would have the most democratic form of 'college' imaginable. Among the people whom we like to call savages all knowledge inherited by tradition is shared by all; it is taught to every member of the tribe so that in this respect everybody is equally equipped for life.

It is the ideal condition of the 'equal start' which only our most progressive forms of modern education try to regain. In primitive cultures the obligation to seek and to receive the traditional instruction is binding to all. There are no 'illiterates'--if the term can be applied to peoples without a script--while our own compulsory school attendance became law in Germany in 1642, in France in 1806, and in England in 1876, and is still non-existent in a number of 'civilized' nations. This shows how long it was before we deemed it necessary to make sure that all our children could share in the knowledge accumulated by the 'happy few' during the past centuries.

Education in the wilderness is not a matter of monetary means. All are entitled to an equal start. There is none of the hurry which, in our society, often hampers the full development of a growing personality. There, a child grows up under the ever-present attention of his parents; therefore the jungles and the savannahs know of no 'juvenile delinquency.' No necessity of making a living away from home results in neglect of children, and no father is confronted with his inability to 'buy' an education for his child.

Lesson42 Journey through adolescence

Parents are often upset when their children praise the homes of their friends and regard it as a slur on their own cooking, or cleaning, or furniture, and often are foolish enough to let the adolescents see that they are annoyed. They may even accuse them of disloyalty, or make some spiteful remark about the friends' parents. Such a loss of dignity and descent into childish behaviour on the part of the adults deeply shocks the adolescents, and makes them resolve that in future they will not talk to their parents about the places or people they visit. Before very long the parents will be complaining that the child is so secretive and never tells them anything, but they seldom realize that they have brought this on themselves.

Disillusionment with the parents, however good and adequate they may be both as parents and as individuals, is to some degree inevitable. Most children have such a high ideal of their parents, unless the parents themselves have been unsatisfactory, that it can hardly hope to stand up to a realistic evaluation. Parents would be greatly surprised and deeply touched if they realized how much belief their children usually have in their character and infallibility, and how much this faith means to a child. If parents were prepared for this adolescent reaction, and realized that it was a sign that the child was growing up and developing valuable powers of observation and independent judgment, they would not be so hurt, and therefore would not drive the child into opposition by resenting and resisting it.

The adolescent, with his passion for sincerity, always respects a parent who admits that he is wrong, or ignorant, or even that he has been unfair or unjust. What the child cannot forgive is the parents' refusal to admit these charges if the child knows them to be true.

Victorian parents believed that they kept their dignity by retreating behind an unreasoning authoritarian attitude; in fact they did nothing of the kind, but children were then too cowed to let them know how they really felt. Today we tend to go to the other extreme, but on the whole this is a healthier attitude both for the child and the parent. It is always wiser and safer to face up to reality, however painful it may be at the moment.

Lesson43 Our developing world

Faith in controlled nuclear fission is now being shown by the construction of atomic power stations. In Britain, Calder Hall on the coast of Cumberland first made its contribution to the National Electricity grid in 1957. Subsequently a chain of nuclear power stations was planned. Of necessity they are sited near the coasts or tidal water because of the need of much water for cooling and a certain discharge of possible radioactive effluent. Atomic power is associated in the public mind with the destructive force of atom bombs and partly for this reason, though it is claimed that there is no danger to be associated with atomic power stations, they are being sited away from populous centres.

The present position is that the three main sources of power are coal, oil and water power. We sometimes refer to electricity, gas or petrol as if they were the actual sources of power, forgetting that electricity must be generated by the consumption of coal or oil or by the utilization of water power, whilst coke, gas and petrol are examples of secondary fuels by which coal and oil may be more effectively used.

Where alternative sources of power are available there are some marked contrasts in handling. The bulk and weight of coal required in the majority of manufacturing industries is large in comparison with the bulk and weight of other raw materials. This is not always true--as with the

manufacture of pig iron and steel from low-grade iron ores--but it did lead to the concentration of industrial developments on the coal-fields, a phenomenon well seen in such countries as Britain where the Industrial Revolution came before the days of oil or electricity. Coal being a solid must be distributed mainly by rail or water.

By way of contrast oil can be transported large distances by pipeline but overseas movement has involved building of large numbers of tankers, including now some of the largest vessels afloat. Unless suitable on other grounds oilfields have not become industrial regions; on the contrary the oil industry is marked by a certain amount of smell and an element of danger, hence the siting of refineries at a distance from population centres. It is not always realized that the owners of pipelines can handle the oil of different customers, sending it through at different periods. Natural gas can also be transported large distances by pipe. Early in 1959 Britain received the first ship cargo of natural gas--liquefied for the purpose of transport.

Lesson44 The backward society

If a nation is essentially disunited, it is left to the government to hold it together. This increases the expense of government, and reduces correspondingly the amount of economic resources that could be used for developing the country. And it should not be forgotten how small those resources are in a poor and backward country. Where the cost of government is high, resources for development are correspondingly low.

This may be illustrated by comparing the position of a nation with that of a private business enterprise. An enterprise has to incur certain costs and expenses in order to stay in business. For our purposes, we are concerned only with one kind of cost--the cost of managing and administering the business. Such administrative overhead in a business is analogous to the cost of government in a nation. The administrative overhead of a business is low to the extent that everyone working in the business can be trusted to behave in a way that best promotes the interests of the firm. If they can each be trusted to take such responsibilities, and to exercise such initiative as falls within their sphere, then administrative overhead will be low. It will be low because it will be necessary to have only one man looking after each job, without having another man to check upon what he is doing, keep him in line, and report on him to someone else. But if no one can be trusted to act in a loyal and responsible manner toward his job, then the business will require armies of administrators, checkers, and foremen, and administrative overhead will rise correspondingly. As administrative overhead rises, so the earnings of the business, after meeting the expense of administration, will fall; and the business will have less money to distribute as dividends or invest directly in its future progress and development.

It is precisely the same with a nation. To the extent that the people can be relied upon to behave in a loyal and responsible manner, the government does not require armies of police and civil servants to keep them in order. But if a nation is disunited, the government cannot be sure that the actions of the people will be in the interests of the nation; and it will have to watch, check, and control the people accordingly. A disunited nation therefore has to incur unduly high costs of government.

Lesson45 The process of ageing

At the age of twelve years, the human body is at its most vigorous. It has yet to reach its full size and strength, and its owner his or her full intelligence; but at this age the likelihood of death is least. Earlier we

were infants and young children, and consequently more vulnerable; later, we shall undergo a progressive loss of our vigour and resistance which, though imperceptible at first, will finally become so steep that we can live no longer, however well we look after ourselves, and however well society, and our doctors, look after us. This decline in vigour with the passing of time is called ageing. It is one of the most unpleasant discoveries which we all make that we must decline in this way, that if we escape wars, accidents and diseases we shall eventually 'die of old age', and that this happens at a rate which differs little from person to person, so that there are heavy odds in favour of our dying between the ages of sixty-five and eighty. Some of us will die sooner, a few will live longer--on into a ninth or tenth decade. But the chances are against it, and there is a virtual limit on how long we can hope to remain alive, however lucky and robust we are.

Normal people tend to forget this process unless and until they are reminded of it. We are so familiar with the fact that man ages, that people have for years assumed that the process of losing vigour with time, of becoming more likely to die the older we get, was something self-evident, like the cooling of a hot kettle or the wearing-out of a pair of shoes. They have also assumed that all animals, and probably other organisms such as trees, or even the universe itself, must in the nature of things 'wear out'. Most animals we commonly observe do in fact age as we do if given the chance to live long enough; and mechanical systems like a wound watch, or the sun, do in fact run out of energy in accordance with the second law of thermodynamics (whether the whole universe does so is a moot point at present). But these are not analogous to what happens when man ages. A run-down watch is still a watch and can be rewound. An old watch, by contrast, becomes so worn and unreliable that it eventually is not worth mending. But a watch could never repair itself--it does not consist of living parts, only of metal, which wears away by friction. We could, at one time, repair ourselves--well enough, at least, to overcome all but the most instantly fatal illnesses and accidents. Between twelve and eighty years we gradually lose this power; an illness which at twelve would knock us over, at eighty can knock us out, and into our grave. If we could stay as vigorous as we are at twelve, it would take about 700 years for half of us to die, and another 700 for the survivors to be reduced by half again.

Lesson46 The menace of urban explosion

After millennia of growth so slow that each generation hardly noticed it, the cities are suddenly racing off in every direction. The world population goes up by two per cent a year, city population goes up by four per cent a year, but in big cities the rate may be as much as five and six per cent a year. To give only one example of almost visible acceleration, Athens today grows by three dwellings and 100 square metres of road every hour. There is no reason to believe that this pace will slacken. As technology gradually swallows up all forms of work, industrial and agricultural, the rural areas are going to shrink, just as they have shrunk in Britain, and the vast majority of their people will move into the city. In fact, in Britain now only about four or five per cent of people live in rural areas and depend upon them; all through the developing world the vanguard of the rural exodus has reached the urban fringes already, and there they huddle, migrants in the favellas and barrios of Latin America, in shanty towns in Africa, in those horrifying encampments one sees on the outskirts of Calcutta and Bombay. We are heading towards an urban world.

This enormous increase will go ahead whatever we do, and we have to

remember that the new cities devour space. People now acquire far more goods and things. There is a greater density of household goods; they demand more services such as sewage and drainage. Above all the car changes everything: rising incomes and rising populations can make urban car density increase by something like four and five per cent in a decade; traffic flows rise to fill whatever scale of highways are provided for them. The car also has a curious ambivalence: it creates and then it destroys mobility. The car tempts people further out and then gives them the appalling problem of getting back. It makes them believe they can spend Sunday in Brighton, but makes it impossible for them to return before, say, two in the morning. People go further and further away to reach open air and countryside which continuously recedes from them, and just as their working weeks decline and they begin to have more time for leisure, they find they cannot get to the open spaces or the recreation or the beaches which they now have the time to enjoy.

Recently some studies were made in the behaviour of mice when exposed to more than a certain degree of density, frustration, and noise, and the mice just became deranged. I think some sociologists wonder whether it might not be the same for men. This combination of very high density of population, goods and services, and machines, all increasing with almost brutal speed, does account for some really antisocial tendencies in modern urban growth.

Lesson47 Plato today

The modern Plato, like his ancient counterpart, has an unbounded contempt for politicians and statesmen and party leaders who are not university men. He finds politics a dirty game, and only enters them reluctantly because he knows that at the very least he and his friends are better than the present gang. Brought up in the traditions of the ruling classes, he has a natural pity for the common people whom he has learnt to know as servants, and observed from a distance at their work in the factory, at their play in the parks and holiday resorts. He has never mixed with them or spoken to them on equal terms, but has demanded and generally received a respect due to his position and superior intelligence. He knows that if they trust him, he can give them the happiness which they crave. A man of culture, he genuinely despises the self-made industrialist and news-paperking: with a modest professional salary and a little private income of his own, he regards money-making as vulgar and avoids all ostentation. Industry and finance seem to him to be activities unworthy of gentlemen, although, alas, many are forced by exigencies of circumstance to take some part in them. An intellectual, he gently laughs at the superstitions of most Christians, but attends church regularly because he sees the importance of organized religion for the maintenance of sound morality among the lower orders, and because he dislikes the scepticism and materialism of radical teachers. His genuine passions are for literature and the philosophy of science and he would gladly spend all his time in studying them. But the plight of the world compels his unwilling attention, and when he sees that human stupidity and greed are about to plunge Europe into chaos and destroy the most glorious civilization which the world has known, he feels that it is high time for men of good sense and good will to intervene and to take politics out of the hands of the plutocrats of the Right and the woolly-minded idealists of the Left. Since he and his kind are the only representatives of decency combined with intelligence, they must step down into the arena and save the masses for themselves.

Lesson48 What every writer wants

I have known very few writers, but those I have known, and whom I respected, confess at once that they have little idea where they are going when they first set pen to paper. They have a character, perhaps two; they are in that condition of eager discomfort which passes for inspiration; all admit radical changes of destination once the journey has begun; one, to my certain knowledge, spent nine months on a novel about Kashmir, then reset the whole thing in the Scottish Highlands. I never heard of anyone making a 'skeleton', as we were taught at school. In the breaking and remaking, in the timing, interweaving, beginning afresh, the writer comes to discern things in his material which were not consciously in his mind when he began. This organic process, often leading to moments of extraordinary self-discovery, is of an indescribable fascination. A blurred image appears; he adds a brushstroke and another, and it is gone; but something was there, and he will not rest till he has captured it. Sometimes the yeast within a writer outlives a book he has written. I have heard of writers who read nothing but their own books; like adolescents they stand before the mirror, and still cannot fathom the exact outline of the vision before them. For the same reason, writers talk interminably about their own books, winking out hidden meanings, super-imposing new ones, begging response from those around them. Of course a writer doing this is misunderstood: he might as well try to explain a crime or a love affair. He is also, incidentally, an unforgivable bore. This temptation to cover the distance between himself and the reader, to study his image in the sight of those who do not know him, can be his undoing: he has begun to write to please. A young English writer made the pertinent observation a year or two back that the talent goes into the first draft, and the art into the drafts that follow. For this reason also the writer, like any other artist, has no resting place, no crowd or movement in which he may take comfort, no judgment from outside which can replace the judgment from within. A writer makes order out of the anarchy of his heart; he submits himself to a more ruthless discipline than any critic dreamed of, and when he flirts with fame, he is taking time off from living with himself, from the search for what *his* world contains at its inmost point.

Lesson 49 Balloon Astronomy

Rockets and artificial satellites can go far above the ionosphere, and even escape from the Earth. Yet they are complex and expensive, and in their present stage of development they cannot lift massive telescopes, keep them steady while the observations are being carried out, and then return them safely. Balloons are much easier to handle, and are also vastly cheaper. Their main limitation is that they are incapable of rising to the ionosphere. A height of between 80,000 and 90,000 feet is as much as can reasonably be expected, and so balloon-borne instruments can contribute little to either ultra-violet astronomy or X-ray astronomy. All the same, the balloon has much to be said in its favour, since it can at least carry heavy equipment above most of the atmospheric mass--thus eliminating blurring and unsteadiness of the images. Moreover, water-vapour and carbon dioxide in the lower air absorb most of the infra-red radiations sent to us from the planets. Balloon ascents overcome this hazard with ease.

Hot-air balloons date back to the year 1783, and within a few months of the first flight a French scientist, Charles, went up two miles in a free balloon. Yet there is little resemblance between these crude vehicles and a modern scientific balloon, which has by now become an important research tool.

The main development has been carried out by M. Schwarzschild and his team

at Princeton University in the United States, in collaboration with the United States Navy, the National Science Foundation, and the National Aeronautics and Space Administration. The 'Stratoscope' flights of 1959, concerned mainly with studies of the Sun, were remarkably successful, and the project has now been extended. With Stratoscope II, the overall height from the telescope to the top of the launch balloon is 660 feet; the balloons together weigh over two tons, and another two tons of ballast are carried for later release if height has to be maintained during the night. The telescope, plus its controls, weighs three-and-a-half tons. Two large parachutes are also carried; in case of emergency, the instruments and their records can be separated from the main balloon system, and brought down gently. Many of the radio and electronic devices used are similar to those of artificial satellites.

Lesson50 British canals

In mediaeval times rivers were the veins of the body politic as well as economic. Boundaries between states or shires, they were crossed by fords which became the sites of towns, or by bridges which were often points of battle. Upon rivers the people of that time depended for food, power and transport.

In our day fish are caught in the sea and brought to us by rail and lorry; only the angler still thinks fresh-water fish important, and pollution of rivers drives him into smaller and smaller reaches in which to practise his sport. But in earlier times, when sea fish were eaten only by those who lived on the sea coast, when meat was obtainable only for part of the year, and when fasts were frequent and universally practised, river fish played an important part in the national life. Every abbey and great man's house had its fish pond, and across the rivers great and small stretched the fish weirs, usually made of stakes and nets or basket-work. Between the owners of the fisheries and the bargemaster who needed an unimpeded passage continuous war was fought, till the importance of fresh-water fish lessened as the practice of fasting ceased to be universal, as meat became available all the year round, and as the transport of sea fish inland became practicable.

Rivers were also the most important source of power. Every stream had its mills, not only for grinding corn, but for all the other industrial processes of the time, such as fulling cloth or driving the hammers of ironworks. Placed down the bank wherever a head of water could be got, these mills were to be found on the tiny stream that ran through a village, or on the bigger river that was also used for navigation. An artificial cut was made from the river to bring the water at proper height to the water-wheel, and, in order to make sure of a supply of water at all seasons, the mill-owner usually built a weir across the river to hold back the water and so form an artificial reservoir. If the river were navigable, the centre of such a weir was made of planks held vertically by cross beams so that they could be removed when it was necessary to pass a barge, or was fitted with a single pair of gates. Such weirs were called staunches or flash-locks; they did not disappear from the bigger rivers till present times, and may still be seen in the Fens.

Lesson51 Elephants

Two main techniques have been used for training elephants, which we may call respectively the tough and the gentle. The former method simply consists of setting an elephant to work and beating him until he does what is expected of him. Apart from any moral considerations this is a stupid method of training, for it produces a resentful animal who at a later stage may well turn man-killer. The gentle method requires more patience

in the early stages, but produces a cheerful, good-tempered elephant who will give many years of loyal service.

The first essential in elephant training is to assign to the animal a single mahout who will be entirely responsible for the job. Elephants like to have one master just as dogs do, and are capable of a considerable degree of personal affection. There are even stories of half-trained elephant calves who have refused to feed and pined to death when by some unavoidable circumstance they have been deprived of their own trainer. Such extreme cases must probably be taken with a grain of salt, but they do underline the general principle that the relationship between elephant and mahout is the key to successful training.

The most economical age to capture an elephant for training is between fifteen and twenty years, for it is then almost ready to undertake heavy work and can begin to earn its keep straight away. But animals of this age do not easily become subservient to man, and a very firm hand must be employed in the early stages. The captive elephant, still roped to a tree, plunges and screams every time a man approaches, and for several days will probably refuse all food through anger and fear. Sometimes a tame elephant is tethered nearby to give the wild one confidence, and in most cases the captive gradually quiets down and begins to accept its food. The next stage is to get the elephant to the training establishment, a ticklish business which is achieved with the aid of two tame elephants roped to the captive on either side.

When several elephants are being trained at one time it is customary for the new arrival to be placed between the stalls of two captives whose training is already well advanced. It is then left completely undisturbed with plenty of food and water so that it can absorb the atmosphere of its new home and see that nothing particularly alarming is happening to its companions. When it is eating normally its own training begins. The trainer stands in front of the elephant holding a long stick with a sharp metal point. Two assistants, mounted on tame elephants, control the captive from either side, while others rub their hands over his skin to the accompaniment of a monotonous and soothing chant. This is supposed to induce pleasurable sensations in the elephant, and its effects are reinforced by the use of endearing epithets, such as 'ho! my son', or 'ho! my father', or 'my mother', according to the age and sex of the captive. The elephant is not immediately susceptible to such blandishments, however, and usually lashes fiercely with its trunk in all directions. These movements are controlled by the trainer with the metal-pointed stick, and the trunk eventually becomes so sore that the elephant curls it up and seldom afterwards uses it for offensive purposes.

Lesson 52 The earth beneath us

An earthquake comes like a thief in the night, without warning. It was necessary, therefore, to invent instruments that neither slumbered nor slept. Some devices were quite simple. One, for instance, consisted of rods of various lengths and thicknesses which would stand up on end like ninepins. When a shock came it shook the rigid table upon which these stood. If it were gentle, only the more unstable rods fell. If it were severe, they all fell. Thus the rods by falling, and by the direction in which they fell, recorded for the slumbering scientist the strength of a shock that was too weak to waken him and the direction from which it came. But instruments far more delicate than that were needed if any really serious advance was to be made. The ideal to be aimed at was to devise an instrument that could record with a pen on paper the movements, of the ground or of the table, as the quake passed by. While I write my pen moves, but the paper keeps still. With practice, no doubt, I could in time

learn to write by holding the pen still while the paper moved. That sounds a silly suggestion, but that was precisely the idea adopted in some of the early instruments (seismometers) for recording earthquake waves. But when table, penholder and paper are all moving how is it possible to write legibly? The key to a solution of that problem lay in an everyday observation. Why does a person standing in a bus or train tend to fall when a sudden start is made? It is because his feet move on, but his head stays still. A simple experiment will help us a little further. Tie a heavy weight at the end of a long piece of string. With the hand held high in the air hold the strings so that the weight nearly touches the ground. Now move the hand to and fro and around but not up and down. It will be found that the weight moves but slightly or not at all. Imagine a pen attached to the weight in such a way that its point rests upon a piece of paper on the floor. Imagine an earthquake shock shaking the floor, the paper, you and your hand. In the midst of all this movement the weight and the pen would be still. But as the paper moved from side to side under the pen point its movement would be recorded in ink upon its surface. It was upon this principle that the first instruments were made, but the paper was wrapped round a drum which rotated slowly. As long as all was still the pen drew a straight line, but while the drum was being shaken the line that the pen was drawing wriggled from side to side. The apparatus thus described, however, records only the horizontal component of the wave movement, which is, in fact, much more complicated. If we could actually see the path described by a particle, such as a sand grain in the rock, it would be more like that of a bluebottle buzzing round the room; it would be up and down, to and fro and from side to side. Instruments have been devised and can be so placed that all three elements can be recorded in different graphs.

When the instrument is situated at more than 700 miles from the earthquake centre, the graphic record shows three waves arriving one after the other at short intervals. The first records the arrival of longitudinal vibrations. The second marks the arrival of transverse vibrations which travel more slowly and arrive several minutes after the first. These two have travelled through the earth. It was from the study of these that so much was learnt about the interior of the earth. The third, or main wave, is the slowest and has travelled round the earth through the surface rocks.

Lesson 53 The story of the French Foreign Legion

The French Foreign Legion was founded by a Royal Ordinance, written on a small piece of official French War Office notepaper dated March 9th, 1831, and signed by the then reigning monarch of France, Louis-Philippe. He had been on the throne for barely eight months when he authorized this measure, which was as much a product of necessity as of careful planning, although there may be divided views on this.

The reasons for forming the French Foreign Legion were probably twofold. In the first place the men of the disbanded royal bodyguard and the Regiment of Hohenlohe, suddenly turned loose on to the street of a capital seething with unrest, unemployed and perhaps disgruntled at their abrupt dismissal, were a potentially dangerous element. They were trained to the use of arms, and should they become tools of the politically ambitious or discontented they would present a distinct menace to the new regime, not yet too firmly established and sure of itself.

For some time Paris had been swarming with countless other discharged foreign soldiers who had served in the French army at various times under the Empire and the Republic, many of whom were in needy circumstances and open to suggestion, whilst others were openly looking for trouble and

always ready to take part in any disturbance. It was clearly both expedient and desirable to remove these dangers as far away from the capital as possible.

Next, the Algerian adventure had begun, and it appeared that this might prove expensive in lives. The more Frenchmen killed in North Africa, the less popular the government at home would be, so if foreign cannon fodder was available so much the better. The Algerian landing had been viewed with mixed feelings in a politically divided France, but there does not seem to have been any marked indication on the part of the politicians that they were unanimous that the occupation should be abruptly terminated; most were wary and many apprehensive as to how the Algerian business would turn out.

The formation of a foreign legion seemed therefore to be an ideal method of killing these two birds with one stone. Once the conditions were made clear there does not seem to have been any serious opposition.

Marshal Soult was reputed to be the man behind the scheme both for removing and using the unemployed foreign ex-soldiers. He could not have failed to recognize, once they were formed into disciplined units, how useful they would be, both for garrison duty and for active operations in Algeria, nor the fact that if their casualties were heavy or their conditions not of the best, there would be no embarrassing reaction for agitation in France on their behalf.

The Royal Ordinance decreed that there should be a legion formed of foreigners for service outside France, which was to be called the 'Foreign Legion' and it was to be part of the French army and under the control of the War Minister. It laid down that as far as possible companies should be composed of men of the same nationality or who spoke a common language. Algeria was not specifically mentioned but as it was the only scrap of foreign territory of any size possessed by France at that moment, there was no doubt as to the meaning of the phrase 'outside France'.

In the anxiety to get dubious, restless characters out of the country no questions were asked as to nationality, previous record or history, and no proof of identity was required. The name and particulars given by the recruit were accepted at face value and many gave *noms de guerre*, for understandable reasons. Thus the practice began, and the tradition started of 'asking no questions'. This tradition of guaranteeing anonymity began to develop quickly, although it was not until later that it was carried to the extreme of denying all knowledge of any individuals who were in its ranks and of refusing point blank to answer questions or to allow any outside contact with the legionnaires.

Lesson54 Are there strangers in space

We must conclude from the work of those who have studied the origin of life, that given a planet only approximately like our own, life is almost certain to start. Of all the planets in our own solar system we are now pretty certain the Earth is the only one on which life can survive. Mars is too dry and poor in oxygen, Venus far too hot, and so is Mercury, and the outer planets have temperatures near absolute zero and hydrogen-dominated atmospheres. But other suns, stars as the astronomers call them, are bound to have planets like our own, and as the number of stars in the universe is so vast, this possibility becomes virtual certainty. There are one hundred thousand million stars in our own Milky Way alone, and then there are three thousand million other Milky Ways, or Galaxies, in the universe. So the number of stars that we know exist is now estimated at about 300 million million.

Although perhaps only 1 per cent of the life that has started somewhere will develop into highly complex and intelligent patterns, so vast is the

number of planets that intelligent life is bound to be a natural part of the universe.

If then we are so certain that other intelligent life exists in the universe, why have we had no visitors from outer space yet? First of all, they may have come to this planet of ours thousands or millions of years ago, and found our then prevailing primitive state completely uninteresting to their own advanced knowledge. Professor Ronald Bracewell, a leading American radio-astronomer, argued in *Nature* that such a superior civilization, on a visit to our own solar system, may have left an automatic messenger behind to await the possible awakening of an advanced civilization. Such a messenger, receiving our radio and television signals, might well re-transmit them back to its home-planet, although what impression any other civilization would thus get from us is best left unsaid.

But here we come up against the most difficult of all obstacles to contact with people on other planets--the astronomical distances which separate us. As a reasonable guess, they might, on an average, be 100 light years away. (A light year is the distance which light travels at 186,000 miles per second in one year, namely 6 million million miles.) Radio waves also travel at the speed of light, and assuming such an automatic messenger picked up our first broadcasts of the 1920's, the message to its home planet is barely half-way there. Similarly, our own present primitive chemical rockets, though good enough to orbit men, have no chance of transporting us to the nearest other star, four light years away, let alone distances of tens or hundreds of light years.

Fortunately, there is a 'uniquely rational way' for us to communicate with other intelligent beings, as Walter Sullivan has put it in his excellent recent book, *We are not alone*. This depends on the precise radio-frequency of the 21-cm wavelength, or 1420 megacycles per second. It is the natural frequency of emission of the hydrogen atoms in space and was discovered by us in 1951; it must be known to any kind of radio-astronomer in the universe.

Once the existence of this wave-length had been discovered, it was not long before its use as the uniquely recognizable broadcasting frequency for interstellar communication was suggested. Without something of this kind, searching for intelligences on other planets would be like trying to meet a friend in London without a pre-arranged rendezvous and absurdly wandering the streets in the hope of a chance encounter.

Lesson55 Patterns of culture

Custom has not been commonly regarded as a subject of any great moment. The inner workings of our own brains we feel to be uniquely worthy of investigation, but custom, we have a way of thinking, is behaviour at its most commonplace. As a matter of fact, it is the other way around. Traditional custom, taken the world over, is a mass of detailed behaviour more astonishing than what any one person can ever evolve in individual actions, no matter how aberrant. Yet that is a rather trivial aspect of the matter. The fact of first-rate importance is the predominant role that custom plays in experience and in belief, and the very great varieties it may manifest.

No man ever looks at the world with pristine eyes. He sees it edited by a definite set of customs and institutions and ways of thinking. Even in his philosophical probings he cannot go behind these stereotypes; his very concepts of the true and the false will still have reference to his particular traditional customs. John Dewey has said in all seriousness that the part played by custom in shaping the behaviour of the individual as over against any way in which he can affect traditional custom, is as

the proportion of the total vocabulary of his mother tongue over against those words of his own baby talk that are taken up into the vernacular of his family. When one seriously studies the social orders that have had the opportunity to develop autonomously, the figure becomes no more than an exact and matter-of-fact observation. The life history of the individual is first and foremost an accommodation to the patterns and standards traditionally handed down in his community. From the moment of his birth the customs into which he is born shape his experience and behaviour. By the time he can talk, he is the little creature of his culture, and by the time he is grown and able to take part in its activities, its habits are his habits, its beliefs his beliefs, its impossibilities his impossibilities. Every child that is born into his group will share them with him, and no child born into one on the opposite side of the globe can ever achieve the thousandth part. There is no social problem it is more incumbent upon us to understand than this of the role of custom. Until we are intelligent as to its laws and varieties, the main complicating facts of human life must remain unintelligible.

The study of custom can be profitable only after certain preliminary propositions have been accepted, and some of these propositions have been violently opposed. In the first place any scientific study requires that there be no preferential weighting of one or another of the items in the series it selects for its consideration. In all the less controversial fields like the study of cacti or termites or the nature of nebulae, the necessary method of study is to group the relevant material and to take note of all possible variant forms and conditions. In this way we have learned all that we know of the laws of astronomy, or of the habits of the social insects, let us say. It is only in the study of man himself that the major social sciences have substituted the study of one local variation, that of Western civilization.

Anthropology was by definition impossible as long as these distinctions between ourselves and the primitive, ourselves and the barbarian, ourselves and the pagan, held sway over people's minds. It was necessary first to arrive at that degree of sophistication where we no longer set our own belief over against our neighbour's superstition. It was necessary to recognize that these institutions which are based on the same premises, let us say the supernatural, must be considered together, our own among the rest.

Lesson 56 The age of automation

Science and technology have come to pervade every aspect of our lives and, as a result, society is changing at a speed which is quite unprecedented. There is a great technological explosion around us, generated by science. This explosion is already freeing vast numbers of people from their traditional bondage to nature, and now at last we have it in our power to free mankind once and for all from the fear which is based on want. Now, for the first time, man can reasonably begin to think that life can be something more than a grim struggle for survival. But even today, in spite of the high standard of living which has become general in the more fortunate West, the majority of people in the world still spend nearly all their time and energy in a never-ending struggle with nature to secure the food and shelter they need. Even in this elementary effort millions of human beings each year die unnecessarily and wastefully from hunger, disease, or flood.

Yet, in the West, science and technology have made it possible for us to have a plentiful supply of food, produced by only a fraction of the labour that was necessary even a few decades ago. In the United States, for instance, one man on the land produces more than enough food to feed

fifteen men in the cities, and, in fact, there is a surplus of food grown even by this small proportion of the American labour force. We have considerably extended our expectation of life. We have enriched our lives by creating physical mobility through the motor-car, the jet aeroplane, and other means of mechanical transport; and we have added to our intellectual mobility by the telephone, radio, and television. Not content with these advances, we are now thrusting forward to the stars, and the conquest of space no longer strikes us as Wellsian or Jules Vernian. And with the advent of the new phase of technology we call automation, we have the promise both of greater leisure and of even greater material and intellectual riches.

But this is not inevitable. It depends on automation being adequately exploited. We shall need to apply our scientific and technological resources to literally every aspect of our society, to our commerce, our industry, our medicine, our agriculture, our transportation.

It is fascinating and encouraging to observe the development of this immense process, a process in which man appears all the time to be engaged in the act of creating an extension of himself. In his new technological successes this appears particularly true. He is extending his eyes with radar; his tongue and his ear through telecommunications; his muscle and body structure through mechanization. He extends his own energies by the generation and transmission of power and his nervous system and his thinking and decision-making faculties through automation. If this observation is accurate, as I believe it is, the implications are far-reaching. It might be reasonable to conclude that the direction of modern science and technology is towards the creation of a series of machine-systems based on man as a model.

Lesson 57 Of men and galaxies

In man's early days, competition with other creatures must have been critical. But this phase of our development is now finished. Indeed, we lack practice and experience nowadays in dealing with primitive conditions. I am sure that, without modern weapons, I would make a very poor show of disputing the ownership of a cave with a bear, and in this I do not think that I stand alone. The last creature to compete with man was the mosquito. But even the mosquito has been subdued by attention to drainage and by chemical sprays.

Competition between ourselves, person against person, community against community, still persists, however; and it is as fierce as it ever was. But the competition of man against man is not the simple process envisioned in biology. It is not a simple competition for a fixed amount of food determined by the physical environment, because the environment that determines our evolution is no longer essentially physical. Our environment is chiefly conditioned by the things we believe. Morocco and California are bits of the Earth in very similar latitudes, both on the west coasts of continents with similar climates, and probably with rather similar natural resources. Yet their present development is wholly different, not so much because of different people even, but because of the different thoughts that exist in the minds of their inhabitants. This is the point I wish to emphasize. The most important factor in our environment is the state of our own minds.

It is well known that where the white man has invaded a primitive culture the most destructive effects have come not from physical weapons but from ideas. Ideas are dangerous. The Holy Office knew this full well when it caused heretics to be burned in days gone by. Indeed, the concept of free speech only exists in our modern society because when you are inside a community you are conditioned by the conventions of the community to such

a degree that it is very difficult to conceive of anything really destructive. It is only someone looking on from outside that can inject the dangerous thoughts. I do not doubt that it would be possible to inject ideas into the modern world that would utterly destroy us. I would like to give you an example, but fortunately I cannot do so. Perhaps it will suffice to mention the nuclear bomb. Imagine the effect on a reasonably advanced technological society, one that still does not possess the bomb, of making it aware of the possibility, of supplying sufficient details to enable the thing to be constructed. Twenty or thirty pages of information handed to any of the major world powers around the year 1925 would have been sufficient to change the course of world history. It is a strange thought, but I believe a correct one, that twenty or thirty pages of ideas and information would be capable of turning the present-day world upside down, or even destroying it. I have often tried to conceive of what those pages might contain, but of course I cannot do so because I am a prisoner of the present-day world, just as all of you are. We cannot think outside the particular patterns that our brains are conditioned to, or, to be more accurate, we can think only a very little way outside, and then only if we are very original.

Lesson58 Painting as a pastime

A gifted American psychologist has said, 'Worry is a spasm of the emotion; the mind catches hold of something and will not let it go.' It is useless to argue with the mind in this condition. The stronger the will, the more futile the task. One can only gently insinuate something else into its convulsive grasp. And if this something else is rightly chosen, if it is really attended by the illumination of another field of interest, gradually, and often quite swiftly, the old undue grip relaxes and the process of recuperation and repair begins.

The cultivation of a hobby and new forms of interest is therefore a policy of first importance to a public man. But this is not a business that can be undertaken in a day or swiftly improvised by a mere command of the will. The growth of alternative mental interests is a long process. The seeds must be carefully chosen; they must fall on good ground; they must be sedulously tended, if the vivifying fruits are to be at hand when needed.

To be really happy and really safe, one ought to have at least two or three hobbies, and they must all be real. It is no use starting late in life to say: 'I will take an interest in this or that.' Such an attempt only aggravates the strain of mental effort. A man may acquire great knowledge of topics unconnected with his daily work, and yet hardly get any benefit or relief. It is no use doing what you like; you have got to like what you do. Broadly speaking, human beings may be divided into three classes: those who are toiled to death, those who are worried to death, and those who are bored to death. It is no use offering the manual labourer, tired out with a hard week's sweat and effort, the chance of playing a game of football or baseball on Saturday afternoon. It is no use inviting the politician or the professional or business man, who has been working or worrying about serious things for six days, to work or worry about trifling things at the week-end.

As for the unfortunate people who can command everything they want, who can gratify every caprice and lay their hands on almost every object of desire--for them a new pleasure, a new excitement is only an additional satiation. In vain they rush frantically round from place to place, trying to escape from avenging boredom by mere clatter and motion. For them discipline in one form or another is the most hopeful path.

It may also be said that rational, industrious, useful human beings are

divided into two classes: first, those whose work is work and whose pleasure is pleasure; and secondly, those whose work and pleasure are one. Of these the former are the majority. They have their compensations. The long hours in the office or the factory bring with them as their reward, not only the means of sustenance, but a keen appetite for pleasure even in its simplest and most modest forms. But Fortune's favoured children belong to the second class. Their life is a natural harmony. For them the working hours are never long enough. Each day is a holiday, and ordinary holidays when they come are grudged as enforced interruptions in an absorbing vocation. Yet to both classes the need of an alternative outlook, of a change of atmosphere, of a diversion of effort, is essential. Indeed, it may well be that those whose work is their pleasure are those who most need the means of banishing it at intervals from their minds.

Lesson 59 The great escape

Economy is one powerful motive for camping, since after the initial outlay upon equipment, or through hiring it, the total expense can be far less than the cost of hotels. But, contrary to a popular assumption, it is far from being the only one, or even the greatest. The man who manoeuvres carelessly into his five shillings' worth of space at one of Europe's myriad permanent sites may find himself bumping a Bentley. More likely, Ford Consul will be hub to hub with Renault or Mercedes, but rarely with bicycles made for two.

That the equipment of modern camping becomes yearly more sophisticated is an entertaining paradox for the cynic, a brighter promise for the hopeful traveler who has sworn to get away from it all. It also provides--and some student sociologist might care to base his thesis upon the phenomenon--an escape of another kind. The modern traveller is often a man who dislikes the Splendide and the Bellavista, not because he cannot afford, or shuns, their material comforts, but because he is afraid of them. Affluent he may be, but he is by no means sure what to tip the doorman or the chambermaid. Master in his own house, he has little idea of when to say boo to a *maitre d'hotel*.

From all such fears camping releases him. Granted, a snobbery of camping itself, based upon equipment and techniques, already exists; but it is of a kind that, if he meets it, he can readily understand and deal with. There is no superior 'they' in the shape of managements and hotel hierarchies to darken his holiday days.

To such motives, yet another must be added. The contemporary phenomenon of motor-car worship is to be explained not least by the sense of independence and freedom that ownership entails. To this pleasure camping gives an exquisite refinement.

From one's own front door to home or foreign hills or sands and back again, everything is to hand. Not only are the means of arriving at the holiday paradise entirely within one's own command and keeping, but the means of escape from holiday hell (if the beach proves too crowded, the local weather too inclement) are there, outside--or, as likely, part of--the tent.

Idealists have objected to the practice of camping, as to the packaged tour, that the traveller abroad thereby denies himself the opportunity of getting to know the people of the country visited. Insularity and self-containment, it is argued, go hand in hand. The opinion does not survive experience of a popular Continental camping place. Holiday hotels tend to cater for one nationality of visitors especially, sometimes exclusively. Camping sites, by contrast, are highly cosmopolitan. Granted, a preponderance of Germans is a characteristic that seems common to most Mediterranean sites; but as yet there is no overwhelmingly specialized

patronage. Notices forbidding the open-air drying of clothes, or the use of water points for car washing, or those inviting 'our camping friends' to a dance or a boat trip are printed not only in French or Italian or Spanish, but also in English, German and Dutch. At meal times the odour of sauerkraut vies with that of garlic. The Frenchman's breakfast coffee competes with the Englishman's bacon and eggs.

Whether the remarkable growth of organized camping means the eventual death of the more independent kind is hard to say. Municipalities naturally want to secure the campers' site fees and other custom. Police are wary of itinerants who cannot be traced to a recognized camp boundary or to four walls. But most probably it will all depend upon campers themselves: how many heath fires they cause; how much litter they leave; in short, whether or not they wholly alienate landowners and those who live in the countryside. Only good scouting is likely to preserve the freedoms so dear to the heart of the eternal Boy Scout.

Lesson60 On moral courage

Although truth and justice may be the most powerful impulses to show moral courage, there are others. Compassion is one of these. Tentatively it can be suggested that this is the main influence upon those who urge the abolition of capital punishment. It is recognition of compassion's part that leads the upholders of capital punishment to accuse the abolitionists of sentimentality in being more sorry for the murderer than for his victim. This is nonsense but with it some organs of the popular Press played upon the emotions of their readers so successfully that many candidates for Parliament were afraid to support abolition for fear of losing votes and the result was the muddle-headed Homicide Act of 1957 which made murder with robbery a capital crime and allowed the poisoner to escape the gallows. That illogical qualification shows how flimsy is the argument that capital punishment is a deterrent to murder. The poisoner always works on a calculated plan of action and therefore is able to consider whether or not his taking another's life is worth the risk of his own; the violent thief is usually at the mercy of an instant emotion. The only arguable plea for capital punishment is the right of society to retribution in this world with the prospect of life in another, but since what used to seem to the great majority of civilized humanity the assurance of another life beyond the grave has come to seem to more and more people less certain, a feeling for the value of human life has become deeper and more widespread. This may seem a paradoxical claim to make at a time when mankind is so much preoccupied with weapons of destruction. Nevertheless, it is a claim that can be sustained and if compassion animates those who urge the abolition of the death penalty it is not a sentimental compassion for the mental agony inflicted upon a condemned man but a dread of destroying the miracle of life.

When in the eighteenth century offences against the law that today would no earn a month in prison were punished with the death penalty, the severity of the penal code had no serious effect on the prevalence of crime. When it made no difference to the fate of a highwayman whether he had killed his victim or merely robbed him of a few pieces of silver, there were no more murders then than there were when men like Sir Francis Burdett succeeded in lightening the excessive severity of the penal laws. In those days the sacredness of life on earth was not greatly regarded because a life in the world to come was taken for granted except by a comparatively small minority of philosophers.

Nor was the long-drawn ordeal of the condemned cell inflicted either upon the condemned man or his gaolers once upon a time. Those who believe in capital punishment may have arguments for its retention, but surely no

reasonable argument can be found for retention of the sickening mumbo-jumbo that accompanies it from the moment that the judge dons the black cap with what looks like a pen-wiper balanced on the top of his wig, to the reading of the burial service over the condemned man before he is dead. Moreover, it was more merciful to launch the condemned man into eternity twenty-four hours after he was sentenced than to keep him shivering on the brink of that dread gulf for nearly three weeks. Hanging is an atrociously archaic way of killing a human being and the self-satisfied modernity of the electric chair is just as atrocious. The administration of a strong sleeping draught to the condemned man every night from which one night he does not awake, seems a more civilized alternative to our present barbarous procedure, if capital punishment through the influence of backward minds be retained.