I was talking last time of the impacts of man on his environment, coming historically—and prehistorically as well—into the present day. The ecological consequences of technology since the Industrial Revolution are still the burden of what I want to say now, but it is difficult to avoid some reflection on what technology is doing to the nature of man himself. Man, as distinct from woman the family craft-worker, likes steady work rather less and brings his inventive mind to easing craft processes I’m sure man invented the potter’s wheel and the lathe, and then carried on patterns which woman had conceived in the first place. As I’ve said before, the male of the human species has an innate tendency to streamline and mass-produce.

Leonardo’s drawings show us how far man had got by the time of the Renaissance towards transmitting power by way of cog-wheels and directing it at right angles by bevelling the cogs. There was no dearth of ingenious engines but the power was wanting. The 18th century was all ready for an access of power beyond that of wind and falling water when James Watt made steam drive an economical engine which was capable of doing more than pump water out of mines in Cornwall. The Industrial Revolution was on immediately, the biggest factor of change the world has known. But coal was cumbersome stuff and greater efficiency was constantly sought. Hydrocarbon oil could be won more easily than coal, and Benz took the technical step forward of devising an internal combustion engine which made use of the almost academic researches of Faraday and his kind in electricity. Technology and invention run ahead, creating an inexorable momentum. But a momentum in a known, appreciated, desired direction—or a juggernaut spinning this way and that unpredictably? Of one thing we can be almost sure: each inventor in every field would be convinced that his idea, put into practice, was for the human good.

Our Greek derivation in western civilisation gave us the reason which has guided our science, but the Judaic-Christian background gave us a man-centred world. Our technology is a monument to the belief that Jehovah created us in his image, a belief which of course had to be put that way to express the truth that man created Jehovah in his own image. The resources of the planet were for man, without a doubt. They could have no higher end than to serve man at the behest of Jehovah. There could be no doubt of the rightness of technology.

Science, as the natural laws of the universe which we are still discovering, is the basis on which technology advances. Science isn’t easy, because it involves a highly intellectual approach and a capacity to lay aside earlier belief and to think anew. Science is neutral and distinctly impersonal when it is soundly conceived. Technology is not science but the application of scientific principles to physical problems, very much man-centred. There is—nothing impersonal about technology. Moreover, technology is fascinating: it works. What a blessing it is! I’m not being sardonic,
because I live in my era. But I’m one of the least technical of men, except that I do like to know what scientific principles are behind the new gadgetry of living, even if I don’t use it all—quite. Yes, technology is a lot easier than science to understand, and it commands immense respect from the species that has created it. Its capacity for efficiency and for still more efficiency, as new materials are discovered or synthesised and new scientific discoveries applied, increases all the time. Once an advanced technology gets going it creates new demands in machines, things and materials, and so grows geometrically.

Then the whole modern background of technology begins to impinge seriously not only on the natural environment, whose only conscious guardian is man, but on the expanded and immense population of the species that created technology. A harassed minister of government may be perfectly convinced that some new industrial development will spoil something in the natural environment, but he will grimace apologetically and plead that we cannot afford to stand in the way of progress. That 19th-century conception of inevitable and absolute progress is still believed, and it pushes us forward rather than leads on to that which we truly desire. Technology is apt to condition us psychologically so that man becomes its servant, no longer its creator and master. The automobile gets faster, trucks get larger, roads belatedly get wider, but country lanes are no longer for the pedestrian and the advance of mechanical agriculture has meant the loss of footpaths and removal of hedgerow trees. Efficiency demands it. The supersonic aircraft must be produced simply because it can be. If you can’t sleep through it all, wear earcaps or something, but don’t grumble in the path of progress.

Jehovah has been steadily losing out since the Renaissance, though he has fought a good rearguard action. In our century we have seen the mantle of Jehovah passed to Science with a capital ‘s’. But science, as I say, is impersonal and is but truth and understanding as we see them at any one time. The pursuit of science still has humanistic qualities, and many scientists, though not subscribing to any notion of a Jehovah, nevertheless bow to the unknown and unknowable, the Divine Ground that the mystics of all religions and races acknowledge. Technology, on the other hand, is not impersonal: it is not of nature but of man, and now that it is showing the power to direct man as a species, is becoming Technology with a capital ‘t’: the new god, man’s creation of an extension of himself to which he seems inclined to relinquish that power of free will which we have prized so much and accepted as being part of our difference, our apartness, from the animal world. It is not thought impossible any more that a computer could be constructed which by thinking in its own amoral, rapid, electronic fashion could outwit us.

**Committed to Oil**

Leaving philosophy aside for a moment, let me take the example of an industry that illustrates what I have in mind—oil. And what I have to say is said in the realisation that I contribute to whatever the oil industry is doing in shaping our world. Mine is a two-car family and I shall probably continue to go well over 40 miles an hour when driving. This means I’m using leaded petrol. I also fly an average of 50,000 miles a year in airliners, so I’m well and truly committed to oil. Oil is now the great motive fuel and, supplemented by natural gas, is becoming preponderantly our main heating fuel. The oil industry is truly international, either by the fortuitous geography of the
oilfields or because the markets for the oil are often where there are no oil-fields. The United States has a wealth of oilfields in the States bordering the Gulf of Mexico: There are many fields offshore from California. The Middle East is extremely rich. Russia has the Caspian and Volga fields and her own Arctic Ocean find. The oilfields of South-East Asia were one of the hopes of Japan in the 1940s. Now there is the new and vast Arctic Ocean strike in Alaska.

The oil industry is a good example of what I’ve called the technological exponential. To build cars you need steel and aluminium, plastics and rubber. Rubber-growing used up a lot of tropical wilderness, and now petroleum itself is needed as a raw material in the manufacture of synthetic rubber. The oil industry takes over from the older chemical industry and gives us many other things—detergents and plastics. The great assembly lines create aggregations of people, new towns, new roads, services, recreational facilities and so on. Technological growth, as I say, is exponential. People call this the expanding economy and feel pretty smug about it. The gross national product looks better every year, but what of the other side of the coin?

We’re taught that matter is indestructible, and the axiom applies to the products of technology. Junk heaps may offend the eye, and because sight is the foremost of human senses, these may well be dealt with early in the approaching chaos. Worn-out automobiles in huge piles impress us with our capacity for producing waste—time waste, something which we are not prepared to recycle. Plastics seem indestructible, but there are substances left that are less obtrusive visually: the corrosive products of combustion and the soluble pollutants of water. Out of sight, out of mind can, however, be dangerous because pollution has insidious effects on human health and on the persistence of ecosystems that have an unseen function in maintaining life and purifying environments.

Population and Pollution
Population and pollution are the two great problems of our age, and pollution is a function of population increase, though it need not necessarily be so. Most pollution comes from getting rid of wastes at the least possible cost. We are still using our rivers as sewers as were our forefathers tens of thousands of years ago, but there are more of us doing so many more complicated things. Some parts of the chemical industries that emitted noxious and corrosive fumes had to do something about it quite soon, but not before they had devastated many square miles of pleasant country. They installed ‘scrubbers’ on their effluent routes, and some found there was value even in whatever it was they scrubbed out. But whenever wastes could be blown off or run off, the economic factor—a term ill-used in this sense—has been the criterion of whether pollutants of air and water were removed at source or released. We were not prepared to pay the price of our technology, the cost of cleaning up after ourselves. Those 250,000 acres of dereliction in Britain are just the bare bones of our degradation: the more subtle effects of air and water pollution have not been presented in any national balance sheet, but they are dreadful in the real meaning of that word. Their acreage is far greater.

There are examples of some correction through the advance of technology, for do remember that if the will of the people is ultimately that the environment of man shall be clean and decent, it will be technology that will be our handmaiden in achieving it.
In my young days, the Pennine Chain was a region of small farms on sour soil, trying to produce milk for the manufacturing districts. Here was initially calcium-deficient ground on the millstone grit—a bad start—but the farmers could get lime fairly cheaply from the kilns on the adjacent carboniferous limestone. However, Manchester and its satellites and Sheffield and all the rest were belching out a huge tonnage of sulphur dioxide into the air, which, combining with the heavy rainfall, ultimately deposited on the land a quantity of sulphuric acid far greater than could be neutralised by agricultural dressings of lime. Today there are good roads and milk-tankers to move the milk quickly from areas much better fitted for milk production to the centres of population. The distance between cow and consumer can be hundreds of miles, and those Pennine farmers are less harassed men than they were. But no one will dispute that there is still too much sulphuric acid falling in the industrial North.

There are some forms of almost unrestricted pollution that are growing rather than declining and some of them are more dangerous than Sulphuric acid. As the chemical industry expanded in the years after the Second World War, many new products that pleased most of us were introduced. Synthetic detergents were an example of the welcome we gave to a cleanser more effective than soap, especially in hard water. Then those of us who lived in the country found the bacteria in our septic tanks weren’t doing their work any more. They didn’t like detergents. Public sewage works fared no better. Many of us remember the foam that covered the rivers in the Fifties. The chemists hadn’t thought far enough ahead. Detergent pollution of water became so bad that industry had to deal with the problem by urgent ad hoc research. In a short time chemists reached a solution by developing a different molecular structure which could be broken down before the detergent reached the nation’s water and, don’t forget, the fishes’ water. As little as one part per million of the detergents of the Fifties reduced oxygenation of water by almost half, so that natural purification was set back seriously. The moral of this story is that industrial chemistry could have thought ahead much better than it did. The profits were enormous, both in anticipation and realisation, and the research towards producing non-pollutant detergents could have been undertaken before the damage was done.

Water as a scarce commodity was never considered to be much of a problem in Britain, but the expanding demands of industry make us realise how careful we must be with it. Haphazard, unthinking pollution of rivers is something we shall soon be unable to allow. Upland water must be conserved and not used for industrial processes that merely need raw water rather than pure water. Happily, our growing dilemma is calling forth more co-ordination between water authorities and water-using interests. Water conservation will redound not only to the benefit of wild-life conservation but to visual amenity and recreation. Our need will cause us to spend the money, some of which would have gone a lot farther in an earlier day. One more aspect of water use in our technological world is causing us to think hard: namely, water as a cooling agent. The warmed water runs away in rivers and into the sea and is changing the ecosystems of these habitats. Further, have you ever thought of low-temperature heat as a prodigious item of waste? We don’t seem able to recycle it.

**Self-Consuming Serpents**

Advanced technology would have been unlikely to escalate had there not been a large population to absorb it, and the world population would not be what it is had not
technology made it possible. Are we confronted, therefore, with the revolting picture of the two serpents ingesting each other from the tail end? The nearer they come to what is presumed to be desired success, the more congested the picture becomes. What is going to happen? We don’t know. The serpents must either, unwind voluntarily, choke explosively, or wither gradually. I believe we are in this condition of the serpents, with very little time in which to take the first course. Choking seems to me more probable than withering. Choking is not a simple bit of physiology, for several systems of the body are involved. It is possible that the snakes could survive, but for a long time they would be very sick serpents. They might even learn not to do it again but to live in a non-self-consuming harmony.

Pollution is one of the major factors of development that could bring us either to the explosive choking or to the slow withering. The car with its imperfect internal combustion engine is the cause of a large part of present-day pollution. The most visual aspect of this is the smog which lies like a blanket over so many of the cities in which the world population congregates. Los Angeles appears to be the ultimate in idiocy of city development. It lies in a broad hollow and the city is now 50 miles across, laid out on the grid pattern, most of it very much alike. It is an area of frightening monotony. Los Angeles is the paradise of the automobile, and such are the climatic and topographical conditions that the gaseous automobile wastes, the dust in the air and the sunlight combine to form smog. It has been said sardonically that folk in Los Angeles like to see their air, just as smoke over the Black Country 100 years ago meant activity and prosperity of a kind. Carbon monoxide, carbon dioxide and lead spread over our cities and on either side of busy highways. California, having been one of the loveliest places in the world, drew in an immense, non-integrated population of people which sprawled over the state in a devastating way. My colleague, Raymond Dasmann, was moved to write a book which he called *The Destruction of California*.

It is always worth-while to observe examples of the ultimate: it is the ecological slant of mind to find them. California in its state of stress and distress has produced some good forward-thinking minds who have much to tell us about community development, communications and pollution. It is in California that the start will be made with scrubbing the exhaust gases from cars to make them less toxic and less destructive of the environment. London has done much with smoke-abatement laws and zoning, but in the annual inspection of all British cars over three years old, the exhaust system of the engine is entirely ignored. Diesel lorries can apparently eject dense black fumes with impunity, and badly maintained private cars can eject inadequately consumed fuel. Once more, California is thinking ahead to a phasing-out of the internal-combustion engine in cars.

Escalating technology has produced many of the enveloping forms of pollution we deplore, but it could be turned the other way as well, if we are willing to pay for it. When we say, ‘We’ve never had it so good,’ could we not also see that we have never had it so bad? So little of the so-called ‘goods’ would need to be sacrificed to relieve some of the threats of envelopment by pollution. If it is true that pollution costs Britain about £250 million a year—and I’ve no reason to doubt it—it ought to be possible to offset this in considered cost-benefit scenarios.
Two forms of world pollution that have received wide publicity are those of radioactive fall-out and the diffusion and persistence of pesticides. There is a dramatic quality about this kind of pollution which makes a supine inhaler of smog into an ardent crusader for a cleaner world. Much of the literature has had emotional overtones. The scientist regrets incitement to emotion and would prefer that reasoned statement should be sufficient to cause a change of mind. Unfortunately, the possibly less scientifically equipped publicist must usually precede the scientist in arousing attention. Rachel Carson was an exquisite writer and held a degree in biology: her book *Silent Spring* did more to move official attitudes in the United States than more erudite scientific opinion did. I remember being asked in a committee in Britain what I thought of the book. My answer was deplorably equivocal, for I said that although I would not like to have written the book myself, I was very glad it had been written. And I remain glad.

Much fuller and more factual accounts of the pesticide story are to be found in Robert Rudd’s *Pesticides and the Living Environment* and Kenneth Mellanby’s *Pesticides and Pollution*. Britain is showing exemplary action over curtailing use of the organo-chlorine pesticides. Many are now outlawed and have been withdrawn by the manufacturers; public opinion has cut down the use of many others.

Gardeners are of two kinds, I always feel: those whose garden is an oasis and sanctuary—a pleasance, you might say; and the other kind who stalks round his garden, spray-gun in hand, as if it were a besieged fortress. An ecologically balanced garden, one of checks and balances, will keep you busy, but you will get something of all you garden for, including a diversity of bird song. To keep your garden free of dangerous insecticides is a positive act towards wild-life conservation. It is a sobering thought to remember that seals in the Arctic and penguins in the Antarctic have DDT in the fat of their bodies. This stable substance has certainly got around the globe.

Commercial development of the organo-chlorine pesticides, which have caused all the trouble, has been a story of testing ‘candidate’ substances for immediate toxicity in the laboratory, followed by field tests of a few days to a month. The results were no more than short-term toxicity studies: chronic toxicity studies would have taken two years. The ultimate refined assessment was consumer use. In other words, the public was the final guinea-pig. Britain was saved what the United States suffered by her diversified and rotation-conscious agriculture, and by the prompt action of the Nature Conservancy. The future, I think, will see these persistive substances being phased out. Once more, better early research and forward thinking could have saved much trouble.

Radiation is the other pollutant which rouses emotion very quickly. Damage by radiation is cumulative, and when it has occurred it is, so far, irreparable. To all intents and purposes, our fears are concerned with radioactive fall-out, the dust that eventually comes to Earth after nuclear explosions. The so-called atomic powers have realised the danger to a considerable extent and have voluntarily restricted such explosions. They have also shown more foresight than has been usual in disposing of atomic wastes, but such disposal is still a major problem. Old coal mines would be so useful but for the fact that reservoirs of underground water, which we are going to need increasingly, would become contaminated. The abysses of the oceans present the best dumping grounds we know at present; containers for the waste are improving all
the time, and when the casings do eventually disintegrate it is considered that the
degree of radiation will have much decreased and that the remaining radioactivity will
be small. But anxiety remains.

One fall-out component, strontium 90, has serious biological implications. Having
affinities with calcium, it can enter the grass that cows eat and the milk cows give,
and the bones which milk-fed children grow. Barry Commoner of St Louis, who has
become one of the leading world spokesmen on pollution of all kinds, made a
collection of children’s milk teeth, millions of them, and was able to show the general
presence of strontium 90. He demonstrated the consistent underestimation of the soil
content of strontium 90 by the US Atomic Energy Commission. His work so roused
the mothers of the United States that as a result all testing has been much better
controlled of recent years. The State of Alaska was particularly concerned because of
an ecological finding that lichen absorbed particularly large amounts of radioactive
fall-out. Lichen is a major food of caribou and reindeer, and Eskimos and Lapps feed
heavily on these animals. Thus, the bones of people in the Arctic who eat animals
which eat lichen will contain a higher content of strontium 90 than those of people
further south.

Pollution, you see, has entered the wildernesses of the world, and is a function of the
 technological exponential which is in danger of enveloping us. I must say more than I
would wish on pollution because so much of it is invisible, and some deplorable
effects are delayed or apparent only when ecological equilibrium have been upset. If
such upsets are irreversible, impoverishment of our planet has taken place. As a world
problem, pollution and population pressure are partners, spectral and sinister. The
question is whether they are going to shrink our lives to a condition of life in death, or
whether we look outward and proclaim that we live in a beautiful world in which we
believe and which we intend to maintain.