

# The Limits of Human Power

*Bertrand Russell*

*This text comprises  
Chapter 4 of Russell's  
New Hopes for a  
Changing World.*

The old humility of the shepherds who felt themselves subject to the influences of Pleiades is no longer appropriate in the scientific world. But there is a danger lest it should be replaced by a species of arrogance towards nature, which can lead to great disasters. Man, however scientific he may be, is not omnipotent. He is hedged in by natural limits. By means of his knowledge and technique he can diminish the narrowness of these limits, but he can never remove them wholly. Some astronomers try to cheer us up in moments of depression by assuring us that one fine day the sun will explode, and in the twinkling of an eye we shall all be turned into gas. I do not know whether this is going to happen, nor when it will happen if it does happen, but I think it is safe to say that if it does it will be a matter outside human control, and that even the best astronomers will be unable to prevent it. This is an extreme example, and one which it is useless to think about, because there is no way in which human behaviour can be adapted to it. It does, however, serve one purpose, which is to remind us that we are not gods. You may exclaim indignantly, 'but I never thought we were!' No doubt, dear reader, you are not one of those who suffer from the more extreme follies of our age, for if you were, you would not be one of my readers. But if you consider the Polit bureau or the American technocrats you will see that there are those who escape atheism by impiously imagining themselves on the throne of the Almighty. Such men have forgotten that while we can coax physical nature into satisfying many of our wishes, we cannot exercise authority over it

or make it change its ways one jot.

The Russian Government appears to think that Soviet decrees can change the laws of genetics; the Vatican apparently believes that ecclesiastical decrees could secure adequate nourishment for us all, even if there were only standing room on the planet. Such opinions, to my mind, represent a form of insane megalomania entirely alien to the scientific spirit.

There are two very different elements in science: scientific knowledge and scientific technique. Those whom I am calling technocrats are interested solely in scientific technique, and the more extreme among them deny that there is such a thing as scientific knowledge, or indeed any kind of knowledge. Scientific theorists, on the other hand, are concerned to discover natural laws, and leave to others the discovery of practical ways in which such laws can be useful. In a word, the technocrat wishes to change nature, while the theorist wishes to understand it. There is practically no one left in the world who will maintain that the point of view of the theorist alone is adequate, but there are many who think that the point of view of the technocrat suffices. Or if at moments they feel it somewhat arid they supplement it, not by any doubt that can be entertained by a scientific inquirer, but by an unscientific form of arrogance, namely the belief that, without the patience and without the submission involved in observing nature, we can arrive by a form of self-assertion at kinds of knowledge which science is incapable of supplying. This again is megalomania. Man is neither impotent nor omnipotent, he has powers and his powers are surprisingly great, but they are not infinite and they are not so great as he might wish.

But let us have done with these generalities. It is not the generalities but their practical application with which I am concerned. How long will it be before the accessible oil in the world is exhausted? Will all the arable land be turned into dust-bowls as it has been in large parts of the United States? Will the population increase to the point where men again, like their remote ancestors, have no leisure to think of anything but the food supply? Such questions are not to be decided by general philosophical reflections. Communists think that there will be plenty of oil if there are no capitalists. Some religious people think that there will be plenty of food if we trust in Providence. Such ideas are superficial, even when they are called scientific, as they are by the Communists.

Modern industry depends upon raw materials which are found at, or near, the earth's surface. These raw materials are the product of past geological ages; for the most part they are not being reproduced by any

natural process. The elements were built up long ago by a process which we are just beginning to understand, and which when understood may enable clever men to put an end to the human race. The process by which the elements were built up required enormous heat, the sort of heat that exists in the interior of the sun. In a great natural laboratory, nature, starting with hydrogen, arrived by various stages at a number of elements. The number used to be ninety-two but is now indefinite. The elements, at temperatures much lower than that at which they were formed, entered into chemical combinations. At a certain stage the earth was at a temperature peculiarly suitable to the formation of complex chemical combinations, and at last combinations were formed which had the properties that are characteristic of living matter. Living matter has a curious property which I have called 'chemical imperialism.' In virtue of this property, when it is put into a suitable environment, it transforms a mass of dead matter into a mass of living matter. It is this property which has made organic evolution possible.

The processes we have been studying are processes of synthesis. They proceed from the simpler to the more complex. The processes of modern industry do exactly the reverse. They use complex raw material and simplify it. So far, this process of simplification is, in the main, not reversible by scientific methods. It may be that it will become so. There is already a hope of turning hydrogen atoms into helium atoms; this is the process which, when perfected, will give us the blessings of the hydrogen bomb. But in all such processes, so far as science is able to control them, there is waste. What is built up in one place is built up by means of dissolution in another place. If by enormous heat we turn a little hydrogen into helium, we shall have turned a very much larger amount of matter into diffused heat which will never again be usable. Many of the processes of nature are irreversible, and these processes are essential in any form of scientific industry that can at present be imagined. In the reign of Edward III, coal lay about on the surface of the ground. People picked it up and used it at home. The smoke was found to be such a nuisance that the burning of coal was made illegal. I do not know whether this law has ever been repealed, or whether, like the law against polytheism, it has been merely forgotten. However that may be, the obtaining of coal is not now the easy process that it was in the fourteenth century, and there is every reason to suppose that more and more human labour will be required to supply a given amount of coal. Many ages ago, the energy supplied by the sun's heat was transformed into luxuriant vegetation. The energy lay locked up in the layers of petrified tropical ferns until ruthless in-

dustrialists seized it and transformed it back again into heat. But the heat that we generate when we burn coal is not localized like the heat in the sun, and is not continually regenerated by atomic processes. It floats off into the atmosphere and becomes for ever useless. There is no process in nature, and there is none imaginable to human ingenuity, by which heat, once diffused, can be reconcentrated, or by which when diffused it can serve any human purpose.

All sources of energy upon which industry depends are wasted when they are employed; and industry is expending them at a continually increasing rate. Already coal has been largely replaced by oil, and oil is being used up so fast that East and West alike conceive it necessary to their own prosperity to destroy the industry of the other. And what is true of oil is equally true of other natural resources. Every day, many square miles of forest are turned into newspaper, but there is no known process by which newspaper can be turned into forest. You will say that this need not worry us, since newspapers will be replaced by radio, but radio requires electricity, electricity requires power, and power depends upon raw materials.

Modern industry, in fact, is a kind of rape. All the long astronomical and geological ages during which the materials which we find useful have been built up, contribute a moment's blaze, a moment's frivolous exuberance. But when his fireworks are finished, what will become of industrial man?

All this, of course, does not appear in practice in the tragic and catastrophic form in which I have been stating it. What we know is that the price of coal goes up, and we do not readily connect this fact with the second law of thermodynamics. If you look up this law in a textbook, you will learn that it states that entropy always increases, and if you are not a physicist you will not be much the wiser. But the law can be stated more simply, and is stated more simply by proverbial wisdom. It states, in fact, that you cannot unscramble eggs. It deals with all the irreversible processes of nature. Some processes are reversible, some are not. If you travel from London to Edinburgh, you can also travel from Edinburgh to London, but if coal is used to make your train go, there is no way by which you can collect the heat which it generates, and turn it back into coal. If you shuffle a pack of cards, you can, if you take enough trouble, unshuffle them again, but if you drop a drop of ink into a glass of water, the ink will gradually spread throughout the water, and there is no way by which you can collect it back again into a drop. All industry depends upon such irreversible processes; it all uses up the earth's capital. Modern industry is, in fact, a spendthrift, and sooner or later must suffer the penalty of spendthrifts.

I know that most people meet such considerations with a kind of facile optimism; they say ‘Oh, the men of science are sure to think of some clever invention, and even if they don’t it will last my time.’ They feel like the proverbial Irishman – ‘Why should I do anything for posterity; it never did anything for me!’ But I am concerned in this book with Man, considered as a single creature with a single biography. I cannot be content with a brief moment of riotous living followed by destitution, and however clever the scientists may be, there are some things that they cannot be expected to achieve. When they have used up all the easily available sources of energy that nature has scattered carelessly over the surface of our planet, they will have to resort to more laborious processes, and these will involve a gradual lowering of the standard of living. Modern industrialists are like men who have come for the first time upon fertile virgin land, and can live for a little while in great comfort with only a modicum of labour. It would be irrational to hope that the present heyday of industrialism will not develop far beyond its present level, but sooner or later, owing to the exhaustion of raw material, its capacity to supply human needs will diminish, not suddenly, but gradually. This could, of course, be prevented if men exercised any restraint or foresight in their present frenzied exploitation. Perhaps before it is too late they will learn to do so. But this is a question of politics, and I do not wish, as yet, to consider the political aspect of our problem.

So far I have been considering the raw materials of industry, but the matter is far more grave as regards soil, which is the raw material of food. Ever since agriculture began it has been carried on wastefully in most parts of the world. Where methods are completely primitive, the cultivator merely moves on after he has exhausted the soil of one piece of land. This requires, of course, a great deal of available territory, and even then, only offers a permanent solution if the damage done to the soil by cultivation is temporary and not permanent. It is no wonder that men worshipped fertility divinities or that they developed a belief in the magical efficacy of human sacrifice. But in former times, while the population of the globe was still sparse, the problem had not the tragic importance that it has in our own day. It has been treated very fully in two books: Fairfield Osborne’s *Our Plundered Planet* and William Vogt’s *Road to Survival*. I could wish to see both these books carefully studied by all who allow themselves a facile optimism, and especially by those who believe that free enterprise and the profit motive will solve all problems. They will learn from these authors many tragic facts about formerly fertile hillsides now turned into barren rock, about irrigated plains now desert, and flourishing civilizations

now buried beneath the sands. They will learn that this process, which devastated Western Asia and North Africa centuries ago, is in full swing at the present day in many parts of the Western hemisphere, including the United States. They will learn that the intense demand for food, which results from increase of population and development of industry, is becoming year by year more difficult to satisfy. We all know that the price of food goes up, but most of us attribute this to the wickedness of the Government. If we live under a progressive Government, it makes us reactionary; if we live under a reactionary Government, it turns us into Socialists. Both these reactions are superficial and frivolous. All Governments, whatever their political complexion, are at present willy-nilly in the grip of natural forces which can only be dealt with by a degree of intelligence of which mankind hitherto has shown little evidence.

I have been speaking hitherto in this chapter of what can be expected on the basis of our present scientific knowledge. It must be admitted, however, that there are favourable possibilities which would bring about, at least for a time, a quite different state of affairs. There are those who tell us that the use of soil for growing plants is quite out of date, and that they can be grown just as well without, by supplying proper chemicals in proper proportions. I have a doubt whether they would taste quite as nice by this process, but I suppose a small quantity of food could still be grown by the old methods for the benefit of captains of industry and the Politbureau. As for the rest of the population, they will have to learn to be scientific in their tastes, and be content with whatever in the way of calories and vitamins the experts consider good for them.

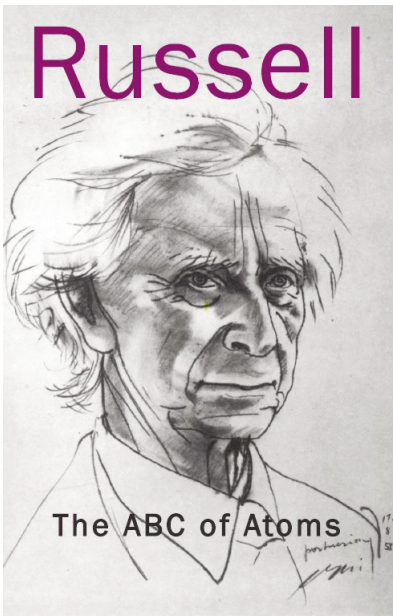
Apart from the question of food, there is the question of energy. It seems clear that, if it were financially worth while, fairly economical methods could be discovered by which more use would be made than at present of energy from the sun. And in theory there is no calculable limit to what can be got out of atomic energy. When people have discovered how to turn hydrogen into helium, sea-water will become their raw material, and it will be a long time before this source of supply is exhausted. Speaking of less specific possibilities, we have to reflect that man has existed for about a million years, and scientific technique for at most two hundred years. Seeing what it has already accomplished, it would be very rash to place any limits upon what it may accomplish in the future. Scientific knowledge is an intoxicating draught, and it may be one which the human race is unable to sustain. It may be that, like the men who built the Tower of Babel in the hope of reaching up to heaven, so the men who pursue the secrets of the atom will be punished for their impiety by providing by accident the

means of exterminating the human species, and perhaps all life on this planet. From some points of view such a consummation might not be wholly regrettable, but these points of view can hardly be ours. Perhaps somewhere else, in some distant nebula, some unimportant star has an unimportant planet on which there are rational beings. Perhaps in another million years their instruments will tell them of our fate, and lead them to agree on an agenda for a conference of foreign ministers. If so, man will not have lived in vain.



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