tina, where he found these birds in considerable numbers foisting their eggs upon numerous species of small birds, especially finches. But for choice they seem always to prefer the mud nests of the oven-bird (Furnarius). These seem to have an irresistible and fatal attraction for cow-birds, since all the eggs deposited therein appear invariably to be destroyed by the desertion of the intended dupes, which, whenever they discover the trick that has been played upon them, cover up the eggs with a layer of nesting material, refusing to incubate. In some nests layer after layer of eggs were thus found, but no young were ever met with. The numbers of eggs found in such nests ranged from six to as many as thirty-seven! While this stupidity reduces the numbers of the parasites, it at the same time reduces the number of oven-birds, which, in the areas explored by Mr. Miller, failed to produce offspring. Judging from the coloration of the eggs, Mr. Miller estimated that in some cases as many as thirteen birds may use the same nest. The eggs of a third species (*M. rufoaxillaris*) were also occasionally found in these nests.

That the pin-tailed widow-bird has developed the parasitic habits of the cuckoo seems to be established, judging from the evidence of Mr. Austin Roberts in the Annals of the Transvaal Museum, vol. v., part 4. Mr. Roberts tells us that he has known this bird to deposit its eggs in the nests of no fewer than four different species of waxbill, as well as in those of its relative, the red-collared widow-bird. It frequently deposits more than one egg in the nest of its host, and sometimes it replaces the whole clutch. But in no case does the foundling appear to dislodge the rightful occupants of the nest, which is the invariable custom of the cuckoo. Mr. Roberts believes that two other finches are similarly parasitic. These are Rendall's seed-eater (*Anomalospiza imberbis*) and the red-billed weaver (*Quelea sanguinirostris*). But we venture to think that a mistake has been made, at least in the case of the last-named species, which even in capitivity shows no degeneration in the matter of its parental instincts.

SCIENCE AND ITS FUNCTIONS.[1]

SINCE the earliest times, man, like his poor relation the monkey, has always been of a curious disposition, and has wanted to know the why and wherefore, as well as the mechanism, of all the phenomena that he sees about him. No doubt much early science, especially in the fields of astronomy and alchemy, was practised as a cult, with the view of impressing and mystifying the common people, but at the back of it all there can be little question that the great force that impelled inquiry into Nature, both in ancient times and in the modern world, was curiosity, which in itself is probably of all human emotions the one that has been most conducive both to intellectual and to material progress.

With the appearance in history of that wonderful people the Greeks, we come for the first time in personal contact with the scientific thoughts and the scientific theories of individual philosophers. Prior to that period there must have been scientific thinkers, but we have no distinct record of what their scientific ideas were. All that remains are portions of some of their material constructions, and some accounts of others that time and decay have destroyed. Thales of Miletus, one of the seven wise men of the Grecian golden age, though he lived some 600 years before our area, is no mere name. He was the founder of the physical school of Greek philosophy, who first began to consider the nature of things, and was the first to observe electrical action. To Democritus, a Greek of the fourth century B.C., we owe the earliest ideas about matter, while to Hippocrates, another early Greek, are due the beginnings of medicine and biology. To him is ascribed the immortal and pregnant phrase that while "Life is short, Art is long, Opportunity fleeting, Experiment uncertain, Judgment difficult"—an aphorism in which is summed up for all time the difficulties with which the scientific investigator has to contend. And so we pass on to that most famous of classical philosophers, Aristotle, whose writings have done more than those of any other man to influence the progress of science, and whose authority was so great that it bound the scientific world in iron fetters for centuries. In the great library and museum which was founded in the third century B.C. by Ptolemy at Alexandria, then the intellectual and commercial capital of the Grecian world, we find the apotheosis of Greek scientific activity. Here were preserved all the scientific writings and records that a world-wide search had enabled the founder to collect. Here were taught the philosophy of Aristotle and the geometry of Euclid. Here Claudius Ptolemy experimented in optics, and wrote his great work on the construction of the heavens. Here Eratosthenes measured the earth. Here Ctesibius invented the fire-engine, and Hero the first steam-engine, which, it is interesting to note, was a simple form of steam turbine. Here worked Archimedes, the most famous mathematician and physicist of the ancient world, who laid the foundation of hydrostatics, elucidated the theory of the lever, and invented the burning-glass and the screw-pump which still bears his name. As a man of science the world produced no equal to him for nearly two thousand years. But the days of the great library were numbered, and within those marble halls the drip of the water-clocks of Apollonius were counting drop by drop, and second by second, the approach of the catastrophe. During the siege of Alexandria by Julius Cæsar the library and all its contents were burnt—a fitting funeral pyre to the glory that was Greece.

The Romans made no contributions to pure science at all to be compared with those of the Greeks. They were a practical rather than a speculative people, and were great builders, engineers, and road-makers. Size, solidity, and quantity rather than novelty were the outstanding features of their scientific work. They were not like the Greeks, ever seeking after some new thing.

When Rome fell into decay, and the gloom of the Dark Ages settled down upon Europe, there was for a time an almost complete halt in the progress of science. True, some vestige of learning still struggled to maintain itself in what was left of the Alexandrian library, but this was finally extinguished by the latter's second destruction by order of the Arabian Khalif, Omar. After this it is somewhat surprising that the next revival in scientific investigation, took place amongst the Arabians themselves, now become a highly cultured people. To this revival we owe the invention of algebra, the beginning of systematic chemistry, and much new work in astronomy, medicine, mechanics, and metallurgy. One of the most famous of the Arabian experimental philosophers was Alhazan, who lived shortly before the Norman Conquest of England.

When there began in Europe that great revival of learning known as the Renaissance, it was the printing press that became its principal coadjutor, and caused things to move at a rate much faster and on a scale much larger than ever before. It was with fundamental concepts that the new learning had first of all to contend, particularly with the geocentric theory of the universe, which gave to the earth and

[1] From an address delivered before the Royal Society of Arts on November 21 by A. A. Campbell Swinton, F.R.S., Chairman of the Council.

to human affairs quite an undue importance, and also with the authority of Aristotle, which had become an article of faith and defied all new ideas. By the end of the sixteenth century experimental science, as opposed to the barren speculations of the schoolmen, was again being practised in Europe with noteworthy results, while, a little later, Francis Bacon published his famous "Novum Organon," and thus became the apostle of the revival of this experimental method of attacking scientific problems. On this method, which had been practically abandoned for some hundreds of years, all modern science is based, and as soon as its practice recommenced results of the highest importance began rapidly to accumulate. How a dread of the tentacles of "authority" still lingered in scientific circles is, however, to be seen in the fact that when the Royal Society was founded in 1662 the fellows took for their motto the words, "Nullius in Verba," an excerpt from a line in Horace which reads, "Not pledged to swear by the words of any master." To-day it is difficult to realise what a hold authority had come to have on even scientific ideas, and how, even as late as the seventeenth century, antiquated and frequently unsound scientific principles, as enunciated in the writings of Aristotle, were still regarded as something that had to be faced when dealing with new problems.

And now we have arrived at a period when there commenced those organised efforts in scientific investigation, and those widespread and continuous endeavours to apply the results thus obtained to practical ends, that have produced during the last two centuries such marked effects on civilisation. We have now, in fact, a better opportunity than ever before of seeing what are the functions of science.

To arrive at some measure of the vast changes that have been brought about, let us consider how matters stood about a hundred and sixty years ago, say in 1754, the year in which our Society of Arts was founded. At that date the steam-engine had not yet assumed a practical form, and apart from some small use of water and wind power, when mechanical work had to be done this was accomplished by the aid of the muscular effort of men and animals. The question of power supply was, in fact, in the same condition that had existed for thousands of years, and, in consequence, the employment of machinery of all descriptions that required power to drive it was extremely limited. Nor as regards travel for persons, or transit for goods, were things very different. The steamship was unthought of, and ocean journeying was no faster, and but little more certain, than in the days of Columbus. Railways in the modern sense were non-existent, and even the coaching era had scarcely begun. Travelling of all sorts was no more rapid or more convenient than in the days of the Romans. Indeed, emperors such as Hadrian and Severus, who visited this country in late classical times, probably made the journey to and from Rome quite as expeditiously, and very likely even much more comfortably, than did any traveller of the eighteenth century. Furthermore, at the time of which I speak, the communication of intelligence was limited to the speed at which postmen could travel, for, of course, there were no electric telegraphs, such as have shortened the time of communication with the ends of the earth to a few seconds, and have reduced even ambassadors to the status of clerks at the hourly beck and call of the Home Government. In the eighteenth century, moreover, illuminating gas and electric light had still to be invented, public lighting was practically non-existent, and even in London and other large cities linkmen with torches were required to light the passenger to his home after dark. If printing was in use it was slow and expensive, without any of the modern mechanical, photographic, and other adjuncts that have rendered possible our numerous newspapers and the other derivatives of the press. Nor were there any proper systems either for water supply or for the disposal of sewage. Disease, born of filth and neglect, stalked through the land practically unchecked. Medicine was still almost entirely empiric. Little or nothing was known of the causes and nature of illness, of infection by bacilli, or of treatment by inoculation. Anæsthetics had not yet been applied, and the marvels of modern surgery were undreamt of. It would be easy to multiply instances, but in the aggregate it is not inaccurate to state that at the time this society was founded the general mode of life had not much improved on what obtained in civilised Europe in the days of the Antonines, while, in some respects, it fell much short of this.

To-day we live altogether in a different world, in an age of travel accelerated by steam, petrol, and electricity; of railways on the level, overhead, and in tubes; of trams and motor omnibuses, of bicycles and motor-cars; of steel ships and steel bridges; of mills and factories, with their products of every possible description; of telegraphs by wire and wireless; of telephones; of hourly newspaper editions and tape machines; of electric light indoors and outside; of electric power for every purpose, from carrying us upstairs to brushing our hair and our boots; of gas fires and gas cookers; of electric bells and electroplate; of automatic machines and thermos flasks; of pianos, pianolas, concertinas, and gramophones; of kodaks, snapshots, and kinematographs; of fountain-pens, sewing-machines, typewriters, lawn-mowers, knife-grinders, vacuum cleaners, and barographs; of cigarettes and lucifer matches, which are much newer than many people think; of innumerable new and cheap textile fabrics; of plate-glass, aluminium, indiarubber, celluloid, vulcanite, and all manner of new artificial materials; of laughing-gas for having a tooth out, of chloroform and ether for more serious operations; of X-rays for inspecting our interiors; of dozens of new medicines for every ailment, and ailments with new names discovered every day; of balloons and aeroplanes, in which we may all soon be travelling; besides all the masses of diverse machinery used in manufacture, in agriculture, and in the arts. All these things, as well as many more, are younger than our Royal Society of Arts.

It has been the fashion to divide what we understand by science into two portions, pure science and applied science; but these are only halves of one great whole. Pure science, which is the domain of the research worker and the discoverer, supplies the data, physical, chemical, and mechanical, which it is the function of applied science to turn to account for practical utilitarian purposes. For this latter operation are required the services of the inventor and the engineer, and other experts of a similar character.

Even great scientific discoveries have in some cases been made by chance, but generally only by men of marked intuition and acutely developed powers of observation. More often they have been the result of prolonged thought and of laborious and patient investigation, with delicate experiments. Many have been the issue of elaborate mathematical reasoning. As subjects become more complex, complete knowledge of what has been done before in the same field is more and more necessary. One of the most fruitful sources of new discovery in all branches of science in modern times has been the greater attention paid to quantitative as against merely qualitative research, very accurate measurements of every kind being one of the special features of present-day research methods. A noteworthy point is that the results of research are cumulative, one discovery almost invariably leading to others in course of time.

As a matter of experience all discoveries in pure science, however recondite and however seemingly useless at the moment, find their practical application sooner or later. It may not be for years or even for centuries, but in its own time the application comes. Invention is a faculty of the imagination, the inventive temperament being akin to the artistic temperament, and real inventors, like true artists, being born and not made. In order to be great both must have creative powers in a high degree. Unless gifted at birth with the inventive afflatus, the ordinary man can no more by taking thought make himself an inventor than he can add a cubit to his stature. At the same time, the inventor, to be fully successful, must be suitably educated. By study and the acquisition of knowledge he widens his scope, and can apply his gifts in fields of invention to which, without such knowledge, he could not hope to aspire. This notwithstanding, it is a noticeable and curious fact that many great inventions have been made by men whose ordinary vocations were quite outside the particular field in which their inventions applied. This is no doubt a case of the fresh mind of the outsider looking at things from a new aspect, whereas those who are daily working in any particular line are apt to get into a groove and to be trammelled by usage and convention. Perseverance, and a capacity for continuity in keeping to one subject, are outstanding qualities to be observed in all successful inventors. Many with brilliant ideas fail for lack of these. As has been justly said, great discoveries are never, and great inventions very seldom, the work of a single individual.

At certain periods the general state of progress, both in pure and in applied science, renders particular inventions possible, with the result that a number of persons gifted with the necessary imagination almost simultaneously attack the problem. In such cases, if one individual inventor had not succeeded, it is probable that another would have done so, though perhaps in some slightly different manner.

For these reasons in all these cases it is very difficult, if not impossible, justly to apportion the credit. The public and the Press usually award it all to the individual who makes the first practical and commercial success, being entirely ignorant of all the previous stages that have led up to the final result, and oblivious of the fact that, without the vast amount of previous research by other workers, the final inventor would never have had the data wherewith to achieve what he did.

On the other hand, a contrary and equally mistaken view is not seldom taken by the workers in pure science, who, absorbed in the intricacies of their own achievements, are prone to underrate what the actual inventor accomplishes, usually by slow degrees, and with infinite pains and patience. They, further, do not understand what a long step there is between the mere idea and the worked-out invention, and how much labour, practical ingenuity, and perseverance, and also how much money an invention usually requires to make it successful and to get it taken up industrially. Indeed, this last-mentioned commercial operation is frequently the most difficult of all to bring about, particularly as it is not common for inventors to be good men of business.

The history of particular inventions is frequently instructive, and a good instance is that of wireless telegraphy, which is comparatively recent, so that we know all about it, and can follow accurately each single step in its development.

It, moreover, shows how pure and applied science are indissolubly interwoven, and how the one is dependent upon the other.

According to modern views, enunciated in the first instance about the year 1807 by Thomas Young, light consists of undulations or wave motions in a hypothetical ultra-material substance, known as the æther, which is supposed to fill all space, permeating the solid earth, the planets, the stars, and all material objects, and reaching to the utmost limits of the universe. Just as sound is known to be a wave motion in the air, so light is believed to be a wave motion in this hypothetical æther. About the year 1870 James Clerk Maxwell, professor of physics at the Cavendish Laboratory at Cambridge, chiefly by mathematical reasoning, showed the close connection between electricity, magnetism, and light by demonstrating that all three could be explained on the basis of motions and stresses in the æther. Thus, according to Maxwell, light was an electro-magnetic phenomenon, and consisted of disturbances in the æther of exceedingly short wave-length, whereas longer waves and stresses in the same medium explained the phenomena of electricity and magnetism.

As mentioned, Clerk Maxwell's discovery lay purely in the land of theory, discovered mathematically, and he attempted no experimental proof. Some twenty years later Heinrich Hertz, by a series of most beautiful experiments, proved the truth of Maxwell's theory. By means of suitable apparatus he first of all created electro-magnetic waves, and then with other apparatus he detected them, showing that they could be reflected and refracted, and, in fact, obeyed all the laws with which light is known to comply. Indeed, so completely was this accomplished that, on hearing of it, Lord Kelvin exclaimed that Hertz had annexed the whole science of optics to the domain of electricity.

Up to this stage nothing in these investigations had hinted even in the slightest degree at any useful application. Neither Young, nor Maxwell, nor Hertz was moved by any other ambition than a curiosity to explore the nature of things. On the other hand, had it not been for their labours, what was to follow could not possibly have occurred.

Hertz died young, almost immediately after making the experiments to which allusion has been made, but his work was taken up and largely extended in this country by Sir Oliver Lodge. Hertz's experiments had been on an exceedingly small scale, while Lodge employed, for creating his waves, methods which gave a much greater power; moreover, as a detector of these waves, Lodge used an exceedingly delicate instrument, which he christened the coherer. This was due to a discovery by Branly, of Paris, who also was investigating Nature without any ulterior utilitarian aims.

Lodge, no doubt, was impelled by similar motives, but having a practical mind he threw out the suggestion that the Hertzian waves might possibly be employed for signalling. Indeed, he went so far, at a lecture which he gave at the Royal Institution in 1894, as actually to ring a bell by this means from one end of the building to the other, through the thickness of several partition walls. In the same year, at the British Association meeting at Oxford, he transmitted similar signals over yet greater distances.

These experiments of Lodge led several persons to consider whether the method was not applicable to telegraphy, but nothing practical was done until Mr. Marconi, who was acquainted with the work of both Hertz and of Lodge, and was impressed with the possible commercial value of the idea, came upon the scene, and with great skill very soon showed that it was feasible by Hertzian waves to telegraph across the Channel, and even over much longer distances.

The rest of the history of wireless telegraphy, very interesting though it is, does not concern us here, for what I wish to impress upon you is how, in this instance, as in many others, researches and experiments in pure science, which, so far as their authors could see, showed not the faintest sign of any practical application, led in time to inventions of the greatest possible public utility. Many years elapsed between the researches and theories of Young and Maxwell, the experiments of Hertz, and the advent of practical wireless telegraphy, and when it came all the three original investigators were dead; yet, unless these three great men had evolved their brilliant ideas and worked them out as they did, wireless telegraphy had never been. How difficult it is for the uninitiated to realise the importance and the practical potentialities of some discoveries in physics at the moment of their birth may be made plain by a few words about the remarkable developments that have taken place during the past few years in that department of science known as molecular physics. Up to comparatively recently the theory of the atomic structure of matter, and the idea of the indestructibility of the atom, that smallest material particle that was thought possible to exist, still held its own. First enunciated more than two thousand years ago by the Greek Democritus, developed later by another Greek philosopher, Epicurus, and popularised by the Roman poet Lucretius in his celebrated poem, "De Natura Rerum," this theory of matter was put on a proper scientific basis by the English chemist Dalton rather more than one hundred years ago. Quickly following the discovery of the X-rays by Prof. Röntgen in 1895, and of radio-activity by Prof. Becquerel a few months later, came a most surprising development—indeed, one of the most remarkable in the whole history of science. Mainly owing to the labours of Sir Joseph Thomson and his Cambridge school of experimenters, starting from the previous researches of Sir William Crookes, we now know that the atoms, once called the ultimate atoms, so far from being the indivisible entities as was once thought, are, each individual one of them, something very like a complete solar system, comprising a positively electrified sun or nucleus and a number of negatively electrified electrons or planets. More than this, though the whole atom is so small that it is quite invisible to the most powerful microscope, and that it would take at least three million atoms, perhaps ten or twenty times as many, set close together in a straight line, to cover a single inch, the constituent electrons are so much smaller that, though contained within the compass of the atom, they are as distant from one another, relatively to their size, certainly as are the earth and the moon, and possibly as the sun and the planets. The imagination reels at such an illustration of the microcosm of the infinitely small, just as it reels at the macrocosm of infinitely large astronomical space and its population of innumerable stars; but in Nature, as has been truly said, the adjectives "large" and "small" have no meaning. In Nature there is nothing absolutely great, and there is nothing absolutely little. Whether it be a matter of the dimensions of space or of the lapse of time, all is relative. To us humans space is measured in terms relative to the dimensions of our bodies, time in periods relative to the duration of our lives. To us things appear large or small, periods long or short, but these are appearances only, and have no absolute reality.

Now to those who have not studied the question all this must seem very remote from the practical politics of applied science, such as we make use of in our daily life. But it is not so, for it is to these almost infinitely small negative electrons that we owe the Röntgen rays. When propelled at the incredible velocity of something like fifty thousand miles per second, which they attain under electrical stimulation inside a Crookes vacuum tube, and caused to bombard a piece of metal, they create these rays in much the same way as the bullets from a machine-gun may rattle on a target and thus create sound. The Röntgen rays themselves are a description of light which, until artificially produced by man in the manner described, had never been observed in Nature, and, indeed, had perhaps never previously existed in the whole history of the universe. Their practical utility is, however, now universally realised, and in surgery and medicine they are in everyday demand.

Now, not only have these abstruse and seemingly quite academic discoveries about the electrical structure of the atom, and the properties of its constituent parts, brought about great improvements during the last few years in the design and use of Röntgen-ray tubes, but they have also borne practical fruit in other directions, as, for instance, in what is to-day much the most sensitive and trustworthy apparatus for receiving wireless telegraph signals. Their further utility, moreover, is just now beginning to make itself apparent, and quite recently they have been applied by Sir Joseph Thomson to an entirely novel form of chemical analysis, the possibilities of which it is as yet too early to estimate. Anyway, we see how in a space of only about twenty years discoveries of apparently purely academic interest, in perhaps the most abstruse of all lines of scientific investigation, are already beginning to be usefully applied. We see how the function of science to be utilitarian obtains just as much in the case of highly recondite investigations as in those that are more simple and in which the practical applications are more obvious.

It is impossible to study the history of civilisation without recognising that scientific research and invention, with their innumerable and incalculable actions and reactions, constitute the soul of industrial progress. Consequently, if this progress is to be maintained, every inducement must be provided to encourage those who are capable of carrying on the work. Since the beginning of the world it is not to the masses, but to the few exceptional individuals that all great advances have been due, and it is greatly to be deprecated that politicians, who must, or, at any rate, should, know better, continue to flatter the so-called working-man by telling him that he alone is the creator of wealth. To those who know the facts such a suggestion is, of course, absurd. Still, it is highly necessary that the masses should be educated to learn that unless those who have the requisite capacity are afforded the necessary leisure and facilities to work at research and invention, industries can be neither developed nor even maintained in the face of the world's competition, and that the working-man himself will be the principal sufferer from the resulting stagnation and decay.

It is unfortunate that in this country of late years it has become a fashion to consider the making of large profits as almost a crime, for the working out of many industrial scientific processes and inventions can be accomplished only by great and prolonged expenditure and the risking of vast sums of money, such as only very rich persons or companies can afford. The history of the fine chemical trade in Germany for some years before the war is a good case in point. Here very large sums were in some instances spent on the development of special processes. In many cases the money was lost, but the few speculations of this nature that succeeded recouped all that had been spent on the others, a single product in some instances bringing in an enormous net annual profit. This, again, enabled other similar problems to be attacked. With our system of taxation—income tax and super-tax, and now excess profits tax in addition, and the jealousy and outcry that the making of large profits engenders—it is very difficult to arrive at such results in this country, and this undoubtedly is one of the main reasons for our backwardness in diverse directions. A remedy should be found in exempting from taxation all money spent in new scientific developments. Otherwise, with stinted resources, we cannot expect to maintain our position.

Another point in connection with invention is the injustice and the inexpediency, from a public point of view, of the present system whereby the Patent Office makes a large annual profit out of the fees paid by inventors. There might possibly be some justification for this were the money thus obtained spent on scientific education, on provincial scientific libraries, or on some other object that would further invention and discovery. The money is, however, merged in the ordinary revenues of the country, and thus becomes a veritable tax on brains. It is, moreover, a tax on the cerebral activity of a class of men who are usually by no means overburdened with wealth. Though all inventors are fortunately not driven by poverty to such expedients as Palissy the potter, who actually had to burn his household furniture in order to provide heat for his furnace, still the majority of inventors are undoubtedly poor, and find the cost of protecting their inventions by patent, and still more of maintaining these patents when granted, a considerable strain upon their finances. The truth of this may be seen by the frequency with which patents are dropped merely in order to save the renewal fees, and the patentee in some cases deprived of profits to which he is justly entitled.

We shall, however, never get justice done to science by the Government and its departments until some knowledge of science is made a compulsory part of the curriculum for the training of the Civil Service and an important item in the entrance examinations. Only in this way shall we get the departments filled by men who realise what science means, and how it lies at the root of all material progress. There is an idea afloat in the political world, as also in the bureaucratic mind, that no man can at the same time be a master of science and a good administrator or organiser, either in public or commercial affairs. This idea probably originated from observation of scientific men of the scholastic and professorial types, whose training has been mainly directed to the art of teaching, and who have never had much opportunity of developing their faculties in the administrative sphere. To show, however, how false is the assumption, it is only necessary to mention two such names as those of Benjamin Franklin and Count Rumford, both of whom were consummate men of science and did very valuable original scientific work, but were also both prominent men of business and managed great political undertakings with remarkable success. Or, if we come to more modern times and turn to captains of industry, there are, without going out of this country, and to mention only one or two, such men as Joseph Whitworth, Henry Bessemer, William Armstrong, and Andrew Noble, all of whom had high scientific gifts and knowledge, and also were very successful in the organisation and administration of large industrial enterprises. Indeed, for any business employing technical methods the ideal chief must necessarily be a man of scientific attainments, as it is only such a one who can properly weigh the pros and cons of the propositions put before him by his technical staff, while, what is even more important, it is only such a chief who can command the real respect of his employees, who will never have complete confidence in, or a proper veneration for, a leader whose scientific and technical knowledge and experience are in the aggregate less than their own. These considerations, of course, apply to Government departments which deal with scientific questions equally with industrial undertakings carrying on technical processes or manufacture.

In obtaining Government support for the promotion of applied science, it is most necessary to beware of political interference.

The dangers that arise from this may be seen from the history of one or two typical industrial applications of science during the last century. Take, for instance, the application of mechanical power to road locomotion. In the period covered by the years 1820 to 1836 this made rapid strides, and towards the close of the period many steam-coaches were maintaining regular services between various centres in different parts of the country. In this, England was many years ahead of the rest of the world, and a new and what promised to be a very profitable industry was being developed. Parliament, however, at the instance of rival interests, passed hostile legislation which absolutely shut the whole movement down, and automobilism in this country was completely crushed, not to be heard of again for more than fifty years. When, moreover, a new beginning was made, the fresh start did not take place in England, its original home, where it was prohibited by law, but in France, where legislation was more enlightened. In this way, owing entirely to the politicians, we lost an opportunity of becoming pioneers throughout the world of a completely new and what proved to be a gigantic industry, which might have brought to our manufacturers much wealth and to the working classes much lucrative employment.

Or, to turn to another case, take the history of electric lighting and of the supply of electric power. Here, again, the development of a new scientific industry was greatly impeded by Parliamentary action. In 1882 this country was as far advanced in everything pertaining to the application of electricity as any other country on the globe. Indeed, many of the developments in this branch of science were peculiarly British, having originated in this country. Again Parliament intervened, and with a mistaken idea of protecting the consumer from the dangers of monopoly, so effectually strangled the whole movement that for six years there were practically no consumers at all, as the conditions imposed on undertakers were so onerous that no one would risk the money required to institute a supply. In 1888 the political powers that were, realising their mistake, made some legislative amendments that enabled a start to be made; but it was then too late, for other countries had got ahead, and even then the electrical industry was still hampered by artificial conditions, some of which endure to the present day, with results that have been inimical to proper development. There are other similar instances, such as the telephone, in regard to which the politicians have interfered to the detriment of progress.

To a society such as this, the object of which is the encouragement of the arts, science is mainly interesting from its pre-eminent value for purely materialistic ends, and it is therefore from this point of view that I have endeavoured to give some account of its functions. It must not, however, be supposed that science has not also a very high value from the ethical point of view. As Adam Smith wrote in his "Wealth of Nations" nearly a century and a half ago, "Science is the great antidote to the poison of superstition"; moreover, science is, so far as the limitations of the human intellect will permit, a search for absolute truth. Accuracy is its foundation-stone, acute observation and strict logic are its most powerful agents. These have all an educational value of the highest importance. The study of Nature and the pursuit of knowledge have, in addition, an elevating influence, and produce a breadth and a strength of mind that rise superior to material environment. This is well seen in the blameless lives of the great masters of science, and in the way that many of them sacrificed everything to their work. Some encountered persecution and even martyrdom for their ideas, and met their misfortunes with a fortitude quite equal to that shown by other men for their faith. Among the functions of science we must not therefore forget its moral power.