

# The Utility of Science

Marquis de Condorcet

*Condorcet was a distinguished mathematician as well as political activist and writer. In the ninth stage of his Sketch for a Historical Picture of the Human Mind (1794), he offered a veritable hymn to science and its usefulness in human affairs.*

We may endeavor more especially to trace that practice of genius in the sciences which at one time descends from an abstract and profound theory to learned and delicate applications; at another, simplifying its means, and proportioning them to its wants, concludes by spreading its advantages through the most ordinary practices; it plunges into the most remote speculations, in fear of resources which the ordinary state of our knowledge must have refused.

We may remark that those arguments which are made against the utility of theories, even in the most simple arts, have never shown any thing but the ignorance of the declaimers. We may prove that it is not to the profundity of these theories, but, on the contrary, to their imperfection, that we ought to attribute the inutility or unhappy effects of so many useless applications.

These observations will lead us to one general truth, that in all the arts the results of theory are necessarily modified in practice; that certain sources of inaccuracy exist, which are really inevitable, of which our aim should be to render the effect insensible, without indulging the chimerical hope of removing them; that a great number of data relative to our wants, our means, our time, and our expenses, which are necessarily overlooked in the theory, must enter into the relative problem of immediate and real practice; and that, lastly, by introducing these requisites with that skill which truly constitutes the genius of the practical man, we may at the same time go beyond the narrow limits wherein prejudice against theory threatens to detain the arts, and prevent those errors into which an improper use of theory might lead us.

Those sciences which are remote from each other cannot be extended without bringing them nearer and forming points of contact between them.

An exposition of the progress of each science is sufficient to show that in several the intermediate application of numbers has been useful, as, in almost all, it has been employed to give a greater degree of precision to experiments and observations; and that the sciences are indebted to mechanics, which has supplied them with more perfect and more accurate instruments. How much have the

discovery of microscopes, and of meteorological instruments, contributed to the perfection of natural history? How greatly is this science indebted to chemistry, which, alone, has been sufficient to lead to a more profound knowledge of the objects it considers, by displaying their most intimate nature, and most essential properties—by showing their composition and elements; while natural history offers to chemistry so many operations to execute, such a numerous set of combinations formed by nature, the true elements of which require to be separated, and sometimes discovered, by an imitation of the natural processes; and, lastly, how great is the mutual assistance afforded to each other by chemistry and natural philosophy; and how greatly have anatomy and natural history been already benefited by these sciences.

But we have yet exposed no more than a small portion of the advantages which have been received, or may be expected, from these applications.

Many geometers have given us general methods of deducing, from observations of the empiric laws of phenomena, methods which extend to all the sciences; because they are in all cases capable of affording us the knowledge of the law of the successive values of the same quantity, for a series of instants or positions; or that law according to which they are distributed, or which is followed by the various properties and values of a similar quality among a given number of objects.

Applications have already proved, that the science of combination may be successfully employed to dispose observations, in such a manner, that their relations, results, and sum may with more facility be seen.

The uses of the calculation of probabilities foretell how much they may be applied to advance the progress of other sciences; in one case, to determine the probability of extraordinary facts, and to show whether they ought to be rejected, or whether, on the contrary, they ought to be verified; or in calculating the probability of the return of those facts which often present themselves in the practice of the arts, and are not connected together in an order, yet considered as a general law. Such, for example, in medicine, is the salutary effect of certain remedies, and the success of certain preservatives. These applications likewise show us how great is the probability that a series of phenomena should result from the intention of a thinking being; whether this being depends on other co-existent, or antecedent phenomena; and how much ought to be attributed to the necessary and unknown cause denominated chance, a word the sense of which can only be known with precision by studying this method of computing.

The sciences have likewise taught us to ascertain the several degrees of certainty to which we may hope to attain; the probability according to which we can adopt an opinion, and make it the basis of our reasonings, without injuring the rights of sound argument, and the rules of our conduct—without deficiency in prudence, or offense to justice. They show what are the advantages or disadvantages of various forms of election, and modes of decision dependent on the plurality of voices; the different degrees of probability which may result from such proceedings; the

method which public interest requires to be followed, according to the nature of each question; the means of obtaining it nearly with certainty, when the decision is not absolutely necessary, or when the inconveniences of two conclusions being unequal, neither of them can become legitimate until beneath this probability; or the assurance beforehand of most frequently obtaining this same probability, when, on the contrary, a decision is necessary to be made, and the most feeble preponderance of probability is sufficient to produce a rule of practice.

Among the number of these applications we may likewise state, an examination of the probability of facts for the use of such as have not the power, or means, to support their conclusions upon their own observations; a probability which results either from the authority of witnesses, or the connection of those facts with others immediately observed.

How greatly have inquiries into the duration of human life, and the influence in this respect of sex, temperature, climate, profession, government, and habitudes of life; on the mortality which results from different diseases; the changes which population experiences; the extent of the action of different causes which produce these changes; the manner of its distribution in each country, according to the age, sex, and occupation—how greatly useful have these researches been to the physical knowledge of man, to medicine, and to public economy.

How extensively have computations of this nature been applied for the establishment of annuities, tontines, accumulating funds, benefit societies, and chambers of assurance of every kind.

Is not the application of numbers also necessary to that part of the public economy which includes the theory of public measures, of coin, of banks and financial operations, and lastly, that of taxation, as established by law, and its real distribution, which so frequently differs, in its effects on all the parts of the social system.

What a number of important questions in this same science are there, which could not have been properly resolved without the knowledge acquired in natural history, agriculture, and the philosophy of vegetables, which influence the mechanical or chemical arts.

In a word, such has been the general progress of the sciences, that it may be said there is not one which can be considered as to the whole extent of its principles and detail, without our being obliged to borrow the assistance of all the others.

In presenting this sketch both of the new facts which have enriched the sciences respectively, and the advantages derived in each from the application of theories, or methods, which seem to belong more particularly to another department of knowledge, we may endeavor to ascertain what is the nature and the limits of those truths to which observation, experience, or meditation, may lead us in each science; we may likewise investigate what it is precisely that constitutes that talent of invention which is the first faculty of the human mind, and is known by the name of genius; by what operations the understanding may attain

the discoveries it pursues, or sometimes be led to others not sought, or even possible to have been foretold; we may show how far the methods which lead to discovery may be exhausted, so that science may, in a certain respect, be at a stand, till new methods are invented to afford an additional instrument to genius, or to facilitate the use of those which cannot be employed without too great a consumption of time and fatigue.

If we confine ourselves to exhibit the advantages deduced from the sciences in their immediate use or application to the arts, whether for the welfare of individuals or the prosperity of nations, we shall have shown only a small part of the benefits they afford. The most important perhaps is, that prejudice has been destroyed, and the human understanding in some sort rectified; after having been forced into a wrong direction by absurd objects of belief, transmitted from generation to generation, taught at the misjudging period of infancy, and enforced with the terrors of superstition and the dread of tyranny.

All the errors in politics and in morals are founded upon philosophical mistakes, which, themselves, are connected with physical errors. There does not exist any religious system, or supernatural extravagance, which is not founded on an ignorance of the laws of nature. The inventors and defenders of these absurdities could not foresee the successive progress of the human mind. Being persuaded that the men of their time knew everything they would ever know, and would always believe that in which they then had fixed their faith; they confidently built their reveries upon the general opinions of their own country and their own age.

The progress of natural knowledge is yet more destructive of these errors, because it frequently destroys them without seeming to attack them, by attaching to those who obstinately defend them the degrading ridicule of ignorance.

At the same time, the just habit of reasoning on the object of these sciences, the precise ideas which their methods afford, and the means of ascertaining or proving the truth, must naturally lead us to compare the sentiment which forces us to adhere to opinions founded on these real motives of credibility, and that which attaches us to our habitual prejudices, or forces us to yield to authority. This comparison is sufficient to teach us to mistrust these last opinions, to show that they were not really believed, even when that belief was the most earnestly and the most sincerely professed. When this discovery is once made, their destruction becomes much more speedy and certain.

Lastly, this progress of the physical sciences, which the passions and interest do not interfere to disturb; wherein it is not thought that birth, profession, or appointment have given a right to judge what the individual is not in a situation to understand; this more certain progress cannot be observed, unless enlightened men shall search in the other sciences to bring them continually together. This progress at every step exhibits the model they ought to follow; according to which they may form a judgment of their own efforts, ascertain the false steps they may have taken, preserve themselves from pyrrhonism as well as credulity,

and from a blind mistrust or too extensive submission to the authorities even of men of reputation and knowledge.

The metaphysical analysis would, no doubt, lead to the same results, but it would have afforded only abstract principles. In this method, the same abstract principles being put into action, are enlightened by example and fortified by success.

Until the present epoch, the sciences have been the patrimony only of a few; but they are already become common, and the moment approaches in which their elements, their principles, and their most simple practice will become really popular. Then it will be seen how truly universal their utility will be in their application to the arts, and their influence on the general rectitude of the mind.