Proceedings of the Iowa Academy of Science

Volume 47 | Annual Issue Article 7

1940

The Address of the President: Science and Progress

R. B. McClenon
Grinnell College

THE ADDRESS OF THE PRESIDENT

SCIENCE AND PROGRESS

R. B. McCLENON

Science and human welfare have always risen and fallen together. We find this generalization borne out in all recorded history, and even farther back in the dim horizons of prehistory. From the first attempts at counting and measuring, observation of the precision of the periodic recurrence of the seasons, forging of metal tools and weapons, domestication of animals, planting and harvesting of crops, we see that the slow advance of the status of man in his world has been accompanied or even preceded by the advance in science. In the earlier stages, of course, we find art, culture, and the more spiritual phases of life largely rudimentary in their development, and confined at that to a very small fraction of the human race, the élite who were only enabled to maintain their relatively high type of life at the expense of the forced labor of millions. It is a commonplace of history that the abolition of slavery has never been accomplished by purely moral or humanitarian or even religious influences, but in so far as slavery has disappeared, it has been under the impulse of developing industrialism and technology, making free labor more efficient and hence in the long run more economical than slave labor. And even though today we must recognize that far too many human beings are still what may be called "wage slaves" we can none the less see that the hope for betterment of these conditions, the hope for further progress in other words, lies first of all in the continued advance of science, in its more complete understanding and conquest of the fields it already occupies, and in its extension into ever new and broader realms.

Consider as one example the way in which a growing understanding of time and its measurement led to a great upswing in the standard of life and civilization. The recording of the positions of the heavenly bodies enabled men to construct and improve a calendar, and eventually to determine with considerable accuracy the numerical ratio between the length of the day and that of the year, as well as to measure small and ever smaller portions of one day. The story of how instruments were invented for measuring and

recording time-intervals is a most fascinating chapter in the history of science, but it is of course not possible to dwell on details here. The mention of the words hourglass, sundial, waterclock, pendulum clock, watch, chronometer, chronograph, will bring to our minds many of the high spots of this thrilling story. What I wish to emphasize now is that the scientific study of the motions of stars and planets, and later the careful consideration of time as an abstraction (but one which could be dealt with in a perfectly concrete way) necessarily preceded and accompanied the spread of humanity over the wider reaches of our planet, especially over the vast oceans, and the development of trade and commerce. The construction of more and more accurate maps replaced the fairytale notions about the unknown lands of far away which hemmed in the freedom of movement of the ancients through so many generations; and a scientific system of latitude and longitude made possible accurate establishment of positions both on land and on sea. The importance of this to commerce is well shown by the fact that in 1714 the British Government offered a prize of £20,000, an immense sum for those days, for a method by which a ship's longitude could be determined with an error not exceeding 30 miles at the end of a voyage to the West Indies. John Harrison received this award in 1765, and his chronometer cost £450; while a few years later the cooperation of scientists and technicians produced an equally accurate one for less than one-tenth as much.

It is no mere coincidence that the great era of navigation and exploration accompanied a flowering out of scientific investigation and an awakening of that spirit of intellectual adventure which so closely parallels the spirit of physical venturesomeness which was so large an ingredient in the make-up of the great explorers. The invention of trigonometry, or at least its expansion into a science in its own right, went hand in hand with navigation and map-making. It is again no conincidence that Regiomontanus's book De Triangulis which is the first treatise on plane and spherical trigonometry ever written, was published in Nuremberg in 1533, having been written even earlier, just at the height of the period of discoveries and explorations in the New World. The notable thing in all this period of incredibly magnificent strides forward, both materially and intellectually, is that side by side with the bold explorer of the physical surface of our planet, and side by side with the creator of new insight in literature and art, we always find the scientific worker and student — indeed in those days it sometimes happened that scientist and artist were found in the same individual, as supremely in the case of Leonardo Da Vinci.

Another thing that was no coincidence merely, was that all this piling up of new discoveries in the physical world caused men to feel more and more the need and desire for more accurate means of making and recording observations, in order to gain still greater control of the physical environment; and thus the development of precision instruments came in to extend rapidly the possibilities for scientific experimentation and study. Without optics with its practical expression in telescope and microscope nothing even remotely resembling our modern civilization could have been established. And no one, certainly not any devotee of science, will deny that the effects of such fundamental inventions have reached far beyond their spectacular physical manifestations. By demonstrating that the extent of the universe was not limited upward by the visible celestial bodies, nor downward by the power of the unaided human eye, men gained an added feeling of freedom and exhileration as they realized that the human spirit is not limited within the narrow bounds that had previously been accepted as final. And this was of course an entirely sound and helpful change, in spite of its having occasionally led to an arrogance and cocksureness that are thoroughly unscientific. Faith in the trustworthiness of our methods and confidence that the universe is at bottom an order and not a chaos, must be combined with a reasonable amount of caution and humility in the evaluation of specific results, for the most fruitful advances in scientific knowledge. Confidence and caution are two essential ingredients in the spirit of science; but of course the former is much more important, being positive, than the latter which is largely negative.

The connection of science with progress was already well stated by Francis Bacon, who is justly regarded as one of the founders of modern science and especially scientific methods. He wrote: "The true and lawful goal of the sciences is none other than that human life be endowed with new powers and inventions." And of course this applies not only to material or physical "powers and inventions."

I should like to mention briefly a few of such "new powers and inventions" that have grown up and flourished during those three centuries in a way far beyond what Bacon could have imagined in his widest flights of fancy. And first, mathematics may be mentioned as one of the sciences that has been at the bottom of many of these advances. I shall mention explicitly only one, although mathematics is in truth basic in many of the other examples which I shall discuss. One which touches perhaps as wide a range of interests as any is the theory of probabilities and its part in the

gradual building up of a knowledge of correct principles of life insurance, annuities, and statistics. Based on the work of James Bernoulli and Laplace, these principles have established themselves definitely as part of the body of scientific knowledge. Neglect or ignorance of them caused many early attempts at insurance or annuity plans to fail utterly. By now we see a general recognition of these principles in the case of life insurance, and their gradual but sure extension into other fields. Of course the field of old age pensions may have to be excluded for a time, if specious appeals to self-interest should lead to a hasty adoption of one of the unscientific schemes which are just at present being enthusiastically advocated by certain high-pressure groups. There is however no room for doubt that reason will finally win out in this contest, or if not that its defeat will not be for long, for events would move swiftly to turn the tables. A related field in which careful preparation may well lead to a successful outcome, is that of crop insurance, a possibility which naturally interests very directly all residents of the state of Iowa.

As another illustration, take the story of the development of the automobile, which, often as it has been told, is always worth reconsidering, and of course is by no means ended even yet. The attempts made by men of science to improve their current means of transportation reach back to the very beginnings of modern science. All these attempts were however doomed to be futile until a firmer foundation had been laid in the basic sciences of physics and chemistry. The harnessing of the expansive power of steam to the service of land and water transportation gave us the steamboat and the steam locomotive, but something more fundamental was required, and for many years progress was blocked through the apparent impossibility of getting away from the inconvenience and clumsiness due to trying to combine a steam locomotive and a carriage. The invention of the internal combustion engine made possible the generation of vastly greater power in a small space. Having the right road pointed out, scores and hundreds of workers, humble mechanics along with researchers in pure science, cooperated both consciously and unconsciously to introduce the stream of improvements that still amazes us to this day. The simplifying of the starting and operating of the engine, the steering and braking systems, the design and materials of the car, the restoration of electricity to a prominent place in the subsidiary system of ignition, lighting, and heating after it had proved inferior as a motive power, all are an eloquent testimonial to the progress that can be made when a great body of workers are actuated by an intense interest

and zeal in producing definite accomplishments. And of course these rapid developments, marvelous though they are, do not form by any means the whole story. The production of glass, paints, and finishes, of rubber, and of countless new alloys, put new life into many hitherto neglected fields of industry, while the enormously stimulated construction and improvement of roads revolutionized transportation, especially for the rank and file of the people. Thus the standards and manner of life of men everywhere have been changed to an almost incredible extent even since the beginning of the present century. People now carry out journeys of thousands of miles with as little difficulty and inconvenience as formerly were caused by one of a hundred times less extent. That the resulting broader outlook and wider acquaintance has been a great gain is undeniable. However, it would not do to pass over this topic without admitting that many difficult and as yet unsolved problems have been produced by this rapid development, such as those connected with highway safety, and the social problems that have been complicated by extreme mobility of our people. Here is evidently a fruitful opportunity for study on the part of scientists of many fields.

In this connection as in many others, modern psychology has established itself as a full-fledged science. Some of the most promising leads toward solution of pressing problems concerning individual and group behavior, the principles and practices of education, and personnel in business and industry, have been given by psychology, based on biology and mathematics in the first instance. It would seem that there is much ground for hope that even the tremendous problem of unemployment may be at the very least markedly reduced in seriousness by continued use of these methods for a generation.

The study of genetics has made such rapid strides during the present century that many areas of human interest have been transformed to an almost unbelievable extent. The principles which have by courtesy been ascribed to Mendel (although the numerous later workers in this field have developed them far beyond the beginnings due to Mendel himself) these principles of inheritance have joined with the already developed mathematical theory of probability to enable predictions of the greatest value to be made in countless instances. New varieties of grains, fruits, and vegetables have been produced, greatly excelling their predecessors both in quality and in power of resistance to adverse environments. Animal breeding has of course made equally great advances. It is not too much to assert that the inventiveness that has been shown

in these lines, both in theory and in practice, is in no way inferior to that which has produced the so spectacular recent developments in industry. With the continuation of such researches we may with some confidence expect that agriculture, including horticulture and forestry, will make still greater advances in the way of increased control of natural processes. These basic sciences, which may be properly called "applied biology" have already raised the material standard of living of humankind most significantly, have played a very considerable part in the lengthening of the expectation of life, and above all have made life more interesting and worth living to millions through the greater availability and variety of products from the plant and animal world which an ever widening circle of humanity may enjoy.

A few of many departments may be mentioned in which the progress which has as yet been made, although encouraging, is more of a spur to redoubled efforts than a source of satisfaction as if the completion of the task were nearly in sight. Such might be the scientific study of soils and their comparative depletion through various methods of cropping, chemical methods in increasing the productivity of the land, defenses against erosion, effect of intensive tree-planting, especially indirect ones, the conservation of beneficial forms of wild life, devising more effective means of combatting destructive animals, plants, and diseases, and the long-range study of the weather.

Each of the items I have referred to from the history of science must have suggested to you others of similar import. They establish to the full the thesis that the progress of modern civilization both in its material and in its cultural aspects has been based upon and accompanied by developments of science both pure and applied. It is unquestionably one of our proper functions as an Academy of Science to do everything in our power to spread the knowledge and appreciation of this fact among wider circles of people. Especially should we get into educational programs a more adequate emphasis upon such matters; and in this undertaking I hope that our Junior Academy may play an increasingly important part. Also it would seem feasible to work out some plans for obtaining wider and more effective contacts between the Academy and the general public.

To be sure, when we contemplate the tragic fate which is now threatening many of the most highly developed parts of the world, we can not avoid considering the question whether we may not be facing the end of an era of progress, and the beginning of a gradual deterioration of human life even possibly to the recurrence of dark ages where civilization and science may be dragged down together

to a common doom. It seems to me that there is indeed a very real danger, and that it will be only increased by ignoring or denying its existence; but none the less I believe sincerely that it is entirely possible to enlist the cooperation of enough men of intelligence and good will to keep down and eventually to extinguish the fires of ignorance and bigotry until gradually the spirit of science is spread throughout the world, replacing the will to dominate through force by the will to cooperate in raising the standard of life, both material and cultural, to higher and higher levels. We are often reproached with the fact that science has created engines of destruction as well as machinery for advancement; and it has even been suggested that a sort of "holiday" should be declared in scientific inventions, say for ten years, until social standards and ideals can catch up and men learn how better to control what they have learned to create. Although this suggestion is fantastic, yet the reproach is to quite an extent justified; but it is not a charge that can fairly be laid at the door of science. For science has also shown the way toward minimizing the destructive uses of its inventions and bringing to the front the constructive ones. As I have said, faith and imagination are among the elements that it takes to make a scientist. And it is not an unreasonable faith that a solidarity of science workers with other men of good will can be formed, so that the outcome will be to extend into wider circles the means of distinguishing truth from error, so that the years ahead may not bring the end of an epoch, but that science may continue to make vital contributions to real human progress.

DEPARTMENT OF MATHEMATICS,
GRINNELL COLLEGE,
GRINNELL, IOWA.