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SCIENCE IN OUR LIVES

WHATEVER else we may say about science, we must admit two things: it has played its part in bringing about the comfortable living conditions of today compared with a century or two ago, and it has at the same time added to the complexities of living.

So much progress has been made in the application of science that we are only surprised these days if we are not amazed by something new at close intervals. Things which would have seemed nothing short of miraculous to our grandfathers are accepted as a matter of course. We are being weaned, very slowly, from the idea that an inventor, a scientist, or a professor, is a long-haired gentleman, a little wild in the head, who has crazy ideas which sometimes work out.

Advancement has been accomplished by fits and starts. Some unknown genius of the long-ago past mixed nine parts of copper with one part of tin and made bronze, thereby lifting all mankind from the stone to the metal age.

Archimedes discovered the screw about 250 B.C., but it was not developed past its primitive form until Leonardo da Vinci went to work on it in the 15th Century. And only the other day, Great Britain, Canada and the United States got together for the first time to standardize threads, so as to make screws interchangeable.

It was not until the 18th Century that a Swedish savant, Linnaeus, undertook the task which, according to the Book of Genesis, had been Adam's: to name all the animals and plants. Linnaeus did a scientific job.

What is Science?

An interesting pyramid descriptive of the sciences is set up by Professor R.C. Tolman, of the California Institute of Technology.

At the base he places mathematics, which selects for study from the real world only the simplest and most general ideas such as those of order, number and size.

By adding further ideas, like those of matter, energy and electricity, we come to the science of physics.

By including the ideas of different kinds of substance and of chemical change from one kind to another, we arrive at chemistry.

By adding the ideas of a special kind of matter called living, and of a special kind of behaviour called mental, we come to biology and psychology. And, says Professor Tolman, "by including in our study more and more of the complexities of the actual world around us, we could pass on to social psychology, economics, and the social sciences in general."

This view brings out the important maxim that we should not be so impressed by the apparent diversity of science as by its real unity.

Discoveries in science almost always have their starting point in an hypothesis supplied by imagination and intellectual adventure. In early days the scientist roamed no farther than his city walls, and everything beyond a very small radius was unknown: today we have built a huge telescope to pierce the Milky Way.

After imagination comes trying things out. The mischievous monkey pulls things apart; the same urge in man leads him to put things together in ever differing forms. Much of his struggle seems to the outsider to be quite pointless, but he has his eye on some goal which may have to be reached by a roundabout road. More discoveries have been made as a result of persistence than because of mental brilliance.

The Scientific Method

Scientists must be doubters and sceptics, because those who are satisfied with things as they are, and with today's explanations of things, will never discover anything new, nor will they add to the advancement of culture or the living standard of mankind.

Science is primarily a matter of getting at facts and trying to explain them. The scientist must be unbiased in collecting his facts and weighing the evidence. When he comes upon unexpected phenomena his first response is doubt. Darwin's writings are a model of refusal to go beyond the direct evidence, and he gives its full weight to every possible hypothesis.

Gravitation was just an hypothesis until it had been tested, then it became a theory. Applying this theory, and observing the behaviour of other planets, Leverrier and Adams discovered a planet (Neptune) they could not see.

One must be grateful to Carl L. Becker, author of *The Heavenly City of the Eighteenth-Century Philosophers,* for the happy way in which he describes this scientific penetration of the Unknown: "Newton did not doubt that the heavens declare the glory of God; but he was concerned to find out, by looking through a telescope and doing a sum in mathematics, precisely how they managed it."

The experiment is another method of science. Galileo did not rest content with what Aristotle had said about falling bodies, nor did he accept the reasonable supposition that a ten-pound weight would fall to the ground more quickly than a one-pound weight: he let them fall from the leaning tower of Pisa and showed that things naturally fall with the same speed, not proportioned to their weight.

These virtues of the method of science: scepticism until the proof is shown; collection of all the facts; classification; forming an hypothesis and testing it, not only within itself but against other hypotheses: these virtues might well be carried over into social and political life with benefit to individuals and to the country.

Kinds of Research

There are, roughly, three divisions in scientific research: pure research, where the possibilities of practical application are remote; fundamental applied research, in which a general use is in mind, but no definite application; and immediate research, wherein the work is undertaken to solve a definite problem.

Thomas H. Huxley stood staunchly on the ground that the great steps in the world's progress have been made and will be made by men who seek knowledge simply because they crave for it. Newton crowned the long labours of the astronomers and the physicists by drawing their discoveries together and adding the catalyst which dissolved them into one vast system, but his principles helped no man to either wealth or comfort. And Plato remarked in his *Republic*: "Science is pursued for the sake of knowledge of what eternally exists, and not what comes for a moment into existence and then perishes."

Fundamental research asks "What is this, how does it work, and why does it work that way?" Applied research asks "How should we do this?" The first is attempting to understand nature, the second is attempting to control nature.

Technologists and engineers take the products of scientific thinking and turn them into the wages of workmen and the stores-full-of-goods for customers. It likely required a greater mental effort and more determination by the technologist Edison to produce the first electric lamp than it did for the scientist Faraday to write his *Experimental Researches in Electricity.*

Sir Robert Watson-Watt, the physicist whose name is linked with the development of radar, summed up the distinction neatly: "The difference between the physicist and the engineer is that the physicist is interested in the forces of nature but the engineer is primarily interested in the needs of man."

Science and Society

There is nothing new in the basic social problem posed by scientific discoveries. The very first flint axe could be used for the purpose of killing men, as well as for procuring food.

When a discovery is made, such as that of the stone axe or of the electron, the discoverer cannot possibly foresee the uses to which it may be put by succeeding generations. In short, science cannot be held accountable for social judgments. It can show us the better ways of producing things, but it can't see that we don't use these things to blow ourselves up or otherwise destroy civilization.

The only efficient protection, says Dr. du Noüy in *Human Destiny,* lies in a greater and higher moral development.

For the first time in history man is afraid of what he has done with his intelligence. He is asking these questions: Where does this tremendous progress tend? What is its goal? What is its probable effect upon the future of the human race?

These are questions asked regarding science by Sir Alfred Ewing more than ten years before the atomic bomb burst over Hiroshima. How much more do they need to be answered today!

Science and Industry

Science is the foundation of our wealth, but the rise of new businesses on that foundation creates new problems. On the one hand there is increasing need for an understanding of industry by the community, and on the other hand the need on industry's part to develop its understanding of the community and of employees.

The revolutionary advances of science and technology in the past few years have resulted in increasing production with less labour. The fact that an industrial worker in Canada is paid several times as much in real wages as his predecessor received for much longer hours of work a generation or two ago is a condition which rests upon scientific discoveries.

The increase in output per man-hour has been going on at about the rate of 1.7 per cent a year for industry as a whole, it was reported by Professor Sumner H. Slichter, of Harvard University, in the *Annals* of the American Academy of Political and Social Science, an issue entitled *Social Implications of Modern Science*. This, he said, means doubling output per man-hour about every forty years.

The whole economy has been affected by science. Consider as instances the increased number of materials and processes; the increased geographical mobility of labour and capital; the increased rate of change, leading to quicker depreciation and obsolescence of capital goods; the increase in the supply of investment opportunities, offset to some extent by the reduction in the inclination to save.

These are not surface changes. They go to the very foundation of human nature. Science has transplanted civilization to wildernesses, as in northern Quebec and Ontario, with resulting changes in people's ways of living. Science has enabled some nations to shift their productive pattern, throwing them into competition with old-established economies in other nations. It has brought necessities and luxuries within the reach of more people, changing the aspirations and outlook of whole countries.

In agriculture, science has been equally revolutionary. Refrigeration, for example, has transformed the waste land of Caribbean countries into banana plantations. Irrigation and scientific culture have converted deserts into truck gardens. Mechanization and scientific farm practices have enlarged the economic land unit for crops, and at the same time encouraged the migration of people from farm to city.

So closely does technology tread upon the heels of science that the implement or machine purchased today may have to be scrapped four or five years hence, an expense which must be taken into account when making production plans and deciding profit levels, shareholders' dividends, and the length to which to carry expansion of factories.

Science and Employment

Contrary to the teachings of some labour sects, science has not caused a large amount of technological unemployment, and the problems created by displacement have been few.

Lord Stamp summed it up in this way: "At any given moment the impact of science is always causing some unemployment, but at that same time the constructive additional employment following upon past expired impacts is being enjoyed." He went on to point out that there are other features which have a greater effect on employment: changes of fashion, exhaustion of resources, changing tariffs, psychological booms and depressions. These, and political factors such as threats of war, expand and contract employment in particular places and lines of activity.

Scientific discoveries have stimulated economic expansion, created new trades and professions, and enabled men and women to find occupations which suit their capacities and provide them with interesting means of self-expression.

Social Science

Up to a little while ago mankind had been principally occupied with learning to control his surroundings; now he needs to learn to manage himself.

The development of physical science leaves the human part of the world of man untouched — a part which was already old before Darwin or Faraday or Rutherford existed. This human part of creation cannot be reduced to a slide-rule study of reactions. Every human being carries within him the results of the social influences that have been working on him since birth, and on the whole human race since its beginning.

This fact makes social science most difficult. Consider the personal prejudices, the class and national interests, the varying religious training, and the different educational and ethical achievements of men and women. Personal interests are hard to reconcile with the larger interests of the community and of the world.

But the difficulty does not excuse us from trying, and unless we do try with some success the future of the human race may be black indeed.

Education in Science

Nothing can do more to remove prejudice, create common interests, and inform mankind against the dangers of social anarchy, than can education. There is enough exhortation going on in the world, but not enough explanation and expounding to make a real understanding of science one of the common possessions of mankind.

Science and its works can be given in popular form without losing any necessary accuracy. In fact, by shedding some of its technicalities and abstractions it can gain by becoming more closely related to ordinary life.

J. D. Bernal, who wrote *The Social Function of Science*, sees a double benefit through education of ordinary people like ourselves: to them and to science. Science can only develop adequately, he says, if it is supported by informed public opinion, and we will find in such information our only safeguard against mystical enthusiasms and anti-rational tendencies which make their appearance every once in a while through tyrants, demagogues and revolutionaries.

The education which will make people understand the needs and nature of science must start in school. It is not preparation for a professional life, but an element in the training of the ordinary citizen. It should teach the child something about the universe in which he lives, make him acquainted with the results of scientific discovery in things around him, and, most important, teach him to think logically and to weigh evidence.

Knowledge should be imparted in every manufacturing plant, so as to make workers acquainted with the principles behind the tasks they perform and thereby enhance their interest in their jobs.

It was easy to coast along in the world of a century ago in which everything touching the common man was so usual, so cut-and-dried, without hint of the mysterious universe which is now exploded into a million question marks by physics, chemistry and biology. Life in those times was on a slow velocity basis, when it was thought dangerous to have trains travel faster than horses because the speed would have a bad effect on the human body. Today, everything is high velocity, and we may be tempted to go so fast that we have no time to tell people at benches the social benefits of the jobs they are doing.

Canada and Science

Canada's rise from scientific youth to maturity is one of the significant features about her development. Dr. C. J. Mackenzie, president of the National Research Council and head of the Atomic Energy Control Board, said last year that Canada "is in the front line of the scientific world for the first time in any sizeable way."

Expenditures of the Council in the fiscal year 1947-48 were $7 million, ten times greater than just before the war, and this sum does not include $6 million for the Chalk River plant where scientists are helping shape tomorrow's advances. Tests are being made there, in the heavy water radioactive pile, which cannot be duplicated anywhere in the world.

Among the "practical" things developed out of the work of the National Research Council are: a dependable method of de-icing airplane propellors by electric heating; a radar instrument which shows the airman his distance continuously from the ground; a quick method of producing anti-typhus serum; a method of producing magnesium from dolomite (introducing a new industry to Canada); construction of a "flying wing" type of aircraft in moulded plywood, proven satisfactory in tests; an emergency arrangement for refrigerating the holds of cargo ships; development of rot-proofing, flame-proofing, and water-repellancy treatments for fabrics; and, of course, contributions in radar, RDX explosives, atomic energy and other scientific projects connected with war.

Just last fall it was announced that a missing element in the periodic table had been explained through the work of the Division of Atomic Energy of the National Research Council of Canada and two University of California nuclear chemists.

Science Internationally

Science has never been accustomed to confining itself within national boundaries. As emphasized at a recent meeting of the American Association for the Advancement of Science, it is built up by the combined efforts of conscientiously and objectively working investigators the world over.

It is not surprising, therefore, to find that science has a leading place in the programme of UNESCO. This plan calls for rehabilitation of science education in devastated countries, international exchange and conferences of scientists and technologists, and promotion of research programmes of international concern. As a beginning, UNESCO will co-ordinate the research by specialists from many nations on the resources and conditions of life.

The development of economic nationalism has obstructed the application of science to human welfare. Science has shown us how to produce two blades of grass where only one grew before, but nationalism, flying in the face of man's increasing interdependence, prevents the best use being made of the extra blade.

If statesmanship can bring to the common man all the benefits offered by science, it can give him new and now unknown powers of personal satisfaction, political efficiency and social service. An exaggerated Darwinism introduces struggle for survival into every phase of national and international life, whereas science, when closely linked with democracy, will show the far greater benefits to be attained through co-operation.

There are large tasks left for attention, despite all our progress. Besides the conquest of space, much talked about today, and of disease, there is the crucial matter of living together.

How far we have advanced in some ways is shown by the action of a delegate to the United Nations meeting at Lake Success last year who cabled to his government for permission to bring up the question of ownership of the moon. And yet the people of the earth cannot settle their own national boundaries, and the ambition of a single tyrannous government keeps three continents in turmoil.

This brings us back to the social sciences. While scientists continue their search for knowledge in the natural sciences, we ordinary people must stop viewing their achievements merely in primitive wonder. What they do brings us the possibility of a new kind of life, if we have the sense to develop the ethical, spiritual, political and social environment in which that new life can develop.

Science has placed us on an eminence from which we can see very far, though we do not know what lies below the horizon. But the most challenging problem of all is right at our feet: how to behave ourselves socially so that science *may* do what science *can* do to make life happier, easier, and more satisfying.

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