# Goals in Understanding Science

## Our lives are better for understanding science and the knowledge that the earth is but a tiny speck in a vast universe

*Excerpts of remarks by Dr. Glenn T. Seaborg, Chairman, U.S. Atomic Energy Commission at the Arches of Science Award Banquet, Pacific Science Center, Seattle, Oct. 19. (See SN, 90:292, 1966.)*

Why should it be so important that our people understand something about science? Why should people know what a scientist does, what motivates him, and the implications of scientific results? What are our goals?

In my opinion, there are two major, interrelated goals. The first is philosophical, involving the quality and the dignity of human life and the fullest use by man of his capacities; in sum, the increase in man's significance. The evolution of cultures from the primitive to the sophisticated, from intellectual poverty to intellectual riches, from needless fears and superstitions to the relative security of relative understanding; these forward movements have been paced by the painstaking ascent of the mountain of knowledge.

Our lives are better for knowing the sources of lightning and earthquakes, and for understanding that the earth, far from being the center of the universe, is but a tiny speck in a pageant of immense grandeur.

### Knowledge Enriches

We are enriched by knowing why a tree is green and how it captures and stores the energy of the sun, and thereby grows.

To know that we inherit our individual characteristics from a lovely, orderly strand of molecules and to comprehend the arrangement of those molecules seems to me to be a triumph for the human spirit, entirely apart from the future practical nature of this knowledge.

All of this knowledge, it seems to me, increases and in no way diminishes man. For me, the beauty of a starry night or a forest or a rainbow is enhanced by an understanding of them. Nor does scientific knowledge, in my opinion, reduce appreciation of a poet's sonnet, a musician's theme or a painter's canvas.

A second major goal, not unrelated to the first, is concerned with the continuation of freedom and of the most effective functioning of democratic government in a period of revolutionary social change. This revolution is well-named "The Scientific Revolution," since the engines that drive it are science and technology. In the last three decades, science, once a peripheral preoccupation of a few intellectuals, has emerged as a central force in domestic and world affairs. . . .

Today, flourishing industries, employing thousands of people, are based on knowledge that did not exist a decade ago. We use science and technology as instruments for improving the material quality of human life, both in our own country and abroad.

Moreover, we are dependent upon science and an aggressively exploitative technology for the continuation of the kind of society in which we now live. And we must redouble these efforts if we are to realize present, and perhaps better, living conditions for immensely larger populations in the world of the future.

All of this means, of course, that some of the most important decisions affecting our lives and those of millions of people around the world revolve around science and technology. Our form of government is flexible enough so that we have, I believe, an excellent cross section of representation in making these decisions in the executive and legislative branches of the government. This representation is similar in kind to that employed in technical decisions in finance, foreign affairs, agriculture, and other fields.

Yet, the heart of freedom and its agency, democracy, is widespread, in-

North American Aviation, Inc.

NEW SPACECRAFT TESTER—This clamp-shaped device is used to test Apollo command module's strength and resistance to heat and cold. Produced by North American's Space and Information Systems Division, Downey, Calif., the tester provides radiant heat of more than 600 degrees F. to half of command module while drenching other side of craft with liquid-nitrogen at 320 degrees below zero F.

formed participation in the processes of government. I fear that the central forces of change in today's world—science and technology—are but dimly understood, or not understood at all, by the majority of the electorate.

We cannot hope that now, or perhaps ever, the majority of people will be able to explain the quantum theory or the third law of thermodynamics. Nor is this necessary. But I believe there are minimum levels of understanding that can be conveyed to all citizens and there is more sophisticated knowledge that can be conveyed to a large percentage of our people.

Such understanding can, I believe, help our society to react more intelligently and quickly, and in a democratic way, to challenge and opportunity as we travel farther along the road of the Scientific Revolution.

We may learn, for example, to better adapt to swift social changes like those forced by automation, more readily accept necessary technologies such as automation and nuclear power, and perhaps even support science for the right reasons. . . .

There are certain fundamental ideas that, I believe, virtually every citizen can grasp and that represent minimum attainable levels in public understanding. The minimum level that can be achieved almost universally, I believe, is an understanding of what science is, what technology is, and the difference between the two.

## Search for Knowledge

As we all know, science is a search for an understanding of new knowledge about nature. Generally, it does not have an immediately practical goal, although sometimes applications may be easy to foresee. The essence of basic research is freedom of the scientist to pursue his curiosity where it leads him.

New knowledge is hard to acquire; nevertheless, it is necessary in order to synthesize the bits and pieces into general laws representing major progress.

On the other hand, technology, or more correctly engineering development, involves the transformation of the knowledge we gain from basic science into useful things. Our radios, television sets, automobiles, synthetic fibers and plastics, nuclear reactors and moon rockets are all engineering developments rising from towering edifices of basic knowledge erected by chemists and physicists. . . .

Confusion over what science is and is not can do considerable mischief. Not uncommonly, men are hostile to what they do not understand. Many people, among them some otherwise well informed individuals, are critical of government support of science.

Not infrequently this criticism is based on two mistaken notions: first, that the $15 billion annual Federal budget for research and development is all for "science", and second, that "science" may not be "producing" enough "gadgets" to justify the outlay. Actually, only about $1.5 billion, or about 10 per cent of this sum, is allocated for basic science, with the remainder being allocated for applications of knowledge.

Lack of understanding causes still other mischief. Science receives much credit for its accomplishments, of course, but it also is the whipping boy for those who would like to find a simple explanation for man's destructive weapons.

It is true, for example, that nuclear weapons were an outgrowth of new scientific knowledge. But so is the nuclear reactor, which promises to perpetuate a technological civilization that is dependent upon the production of huge quantities of energy.

ITT

PASTORAL SETTING—The tower of Ostersund, Sweden, is part of a 39-station network bringing telephones and television to Sweden's Arctic North. The system is the work of International Telephone and Telegraph Corporation's major British affiliate.

In other words, knowledge is born without moral properties. It is man who applies knowledge, and he applies it according to his acquired patterns of behavior. The point is that misunderstanding on this can mislead us about causality. Man, not knowledge, is the cause of violence. . . .

A great deal of dedicated work toward public understanding of science has been done for many years, and is being expanded. A commendable contribution is being made by newspapers, magazines, television, radio and through educational films to give the public a sense of the significance and scope of scientific discovery.

Considerable credit belongs to the National Association of Science Writers and the Council for the Advancement of Science Writing for improving and increasing the nation's corps of professional writers on science for the mass media.

Private foundations and the Government have supported these and other efforts at popularization. SCIENCE SERVICE, of which I have the honor to be president, has done yeoman's service for over 40 years in popularizing science through its news services and Science News Letter, now Science News.

The scientific societies have also established helpful programs, among them the American Association for the Advancement of Science, the American Institute of Physics and the American Chemical Society. Government agencies, including the National Science Foundation and the Atomic Energy Commission, have made significant efforts to explain science to the public.

Occupying the middle ground is the unique Scientific American, serving highly motivated, intelligent laymen as well as scientists, engineers and other technical people. I had the privilege of being among the company of those who encouraged Gerard Piel and Dennis Flanagan in launching this valuable publication in 1948.

## Some Gaps

I wonder if there are not some gaps in the popularization of science in the mass media for communication that might be filled to the profit of media management and the public. For example, some surveys indicate that the public is interested in reading more science than they are getting in the newspapers.

Is there a place, for example, for more regular column or feature material that would make good reading and that, being free of the restriction of the news lead, would provide a larger opportunity for revealing more about the rather interesting processes and personalities of science? Is there a place for a national science newspaper?

Might it not be profitable to publish a high quality popular science magazine that would interest a mass audience? In connection with these

thoughts, I believe it is germane to remember that the technically oriented community is growing larger every day, and will inevitably grow larger in the future.

While the mass media are the primary instruments for informing the present generation on science, I have always believed that there should be intensive concentration on developing a future electorate well versed in the principles and processes of science.

I believe we can all take heart in the significant programs that have been developing in recent years to make science a real part of the education of the young. These include experimental programs to develop materials and techniques for teaching science to elementary school children.

The curricula of high school science have been immensely improved by the work in physics of the Physical Sciences Study Committee and Educational Services, Inc.; by the work in chemistry of the Chemical Educational Material (CHEM) Study and the Chemical Bond Approach Project; and by the work in biology of the Biological Sciences Study Committee.

Science Service's extensive program with its local science fairs and its International Science Fair, and with its more than 25,000 youth science clubs having over three-quarters of a million members, is making an important impression on a national and international basis.

### New Centers Rising

New centers, with dynamic concepts for imparting knowledge of science, are beginning to rise. The Pacific Science Center is an outstanding example. The Lawrence Hall of Science, in Berkeley, holds great promise, being in part a national research institute on the teaching of science at all levels. The new Hall of Science of the City of New York is also incorporating programs to assist the schools in the improvement of science teaching. All of these fine centers also provide science learning opportunities for the public at all age levels. . . .

I should like to touch on one other subject that is pertinent to the matter of public understanding of science, and it involves the scientists themselves. Science long since has departed the ivory tower, as any researcher can testify who has been called to a Congressional hearing. I believe there is wide appreciation among scientists of the value of public understanding of what the scientist is doing.

Scientists have been among those who have taken the lead in many efforts to improve public understanding. The ethical code and the culture of science, however, often inhibit the efforts of scientists in this field. I would hope that senior scientists might help to break down needless inhibitions among their students and junior colleagues. I would hope that senior scientists would encourage those among their juniors who have a talent for popularization to cultivate that talent in acceptable ways.

In conclusion, I offer my congratulations to this community for contributing, through the Arches of Science Award and the Pacific Science Center Foundation, to one of the most important educational problems of our time. I believe that we are only at the beginning of the Scientific Revolution.

As this Revolution accelerates, so will our dependence on the processes of science and technology. We can expect change to be swifter and more profound. The decisions we must make will increasingly involve science and applications of new knowledge. Wisdom in self-government requires that we as a people know more and still more about those processes of the Scientific Revolution that deeply affect our lives.

Let our learning, however, not be only a duty. For in the learning, I am sure, larger numbers of us will come to enjoy the rich experience of seeing the wonders of our environment through the revealing eyes of science.

INVENTION

# Current U. S. Patents

➤ THE FIRST disclosure of a simple, inexpensive test for pregnancy using chemicals came when the U.S. Patent Office granted patent 3,278,270.

The purely chemical method for detecting pregnancy has been tested so far on 8,000 women. It is 95% to 97% accurate, an improvement of some five percent over the most accurate method now in use.

The chemical pregnancy test should emerge from the clinical research stage to the market within one or two years. The test is hopefully the forerunner of one that any woman could use at any time in her own home to determine whether or not she is fertile on a particular day.

Although the pregnancy detection method will be available only to doctors at first, it is hoped to make it available to the public in kit form soon after that. In both cases the test is registered under the trade name, "Am I?" Cost is estimated to be one-eighth of a cent each.

Many chemical compounds can be used to make the pregnancy test. The results are indicated in several ways, including color, cloudiness or heat, depending on the chemical used. Being able to feel the heat generated by the chemical reaction means that blind persons can detect a reaction with the same accuracy as the sighted.

The most accurate and the most easily detectable results are obtained when pyran aldehyde, dihydro pyran, dihydro furan or some of their chemical relatives are used. The preferred method is to add the testing compound to a tube containing urine from the woman who wants to know whether or not she is pregnant.

If there is a color, precipitation or heat reaction, the woman is pregnant. No reaction indicates no pregnancy.

The test is most accurate during the second and third months after conception. The method was developed by Eric T. Fossell, who is a graduate student in organic chemistry at Yale University. Mr. Fossel assigned patent rights to Unimed, Inc., Morristown, N.J.

As in all other pregnancy tests, only when a baby is born, or aborted, is the method counted as accurate. Hospitals cooperating in the clinical study are all on the East Coast.

Now that the patent on the chemical test method has been granted, medical journals are expected to publish results of the clinical experiments within six months.

### Black and White Produce Color

The effect of color is produced using only black and white parts when a moving shutter and other elements are combined as outlined in patent 3,278,-182, awarded to George Wright Lescher of Nashville, Tenn.

Mr. Lescher found that the color effect is observable when light is diffracted at and around areas where light intensity is changing rapidly. One device for generating subjective color from black and white parts consists of a fast-moving foreground shutter rotating continuously in front of an element that is dark on one side but light gray on the side illuminated from the rear.

### Other Interesting Patents

A method for prospecting for oil using changes in infrared radiation detected from an airplane flying over promising terrain earned patent 3,278,-746 for Gideon Fiat of Los Angeles, Calif. Mr. Fiat assigned rights to himself and to Bill Noel, also of Los Angeles. Both men do business as Ormad Systems.

A device for counting meteoroid particles in space that will help engineers design the lightest possible space shielding to protect manned satellites from bombarding dust particles earned patent 3,277,724. Inventor John F. Lundeberg assigned rights to The Boeing Company, Seattle.