

THE GOLDEN AGE — OR THE ICE AGE?

by Lee A. DuBridge

There is an old saying among scientists that when one is young he does research and teaches graduate courses; as he gets older, he gives up research and teaches elementary courses; when he gets still older, he gives up science and becomes a historian.

I do not have to explain to which category I belong. But I hasten to add that my ventures into the field of history are neither frequent nor profound. However, when a man has served 40 years or more in a profession, he simply cannot resist the temptation to look back and reflect on all the things that have happened since he was young.

Many people who look back as far in time as I do are pretty likely to say, "Those were the good old days; it's too bad things have changed." My position is the reverse: I believe things are a lot better today than they were 40 years ago, and they are going to be still better in the future. The golden age is not past; it is ahead.

I have, of course, spent all of my professional life in university work—so I must talk primarily about that realm of education. I have also spent my life in science, so I shall also talk principally about that field. However, I think science education represents a typical segment of all education.

When I began my graduate work in physics in 1922, there were scarcely a dozen universities in this country which awarded more than an occasional PhD in that field. Only 55 were awarded in the whole United States that year, compared to nearly 1,000 in 1966. Furthermore, in 1922 practically every new PhD who could possibly do so promptly took off for Europe to study for a year or two in Germany, England, or France. That is where the *real* physics was then being done.

In 1922 only one American had ever received a Nobel Prize in physics—A. A. Michelson in 1907. Europe, on the other hand, was alive with active physicists who were in the midst of the revolution in physics that took place between 1899 and 1930. Americans—with the exception of a handful who had studied in Europe—had almost no part in this great birth of modern physics, which included the discovery of x-rays, radioactivity, the electron, quantum theory, relativity, and all the rest.

Well, things have changed! Now American scientists receive a large share of the Nobel Prizes; they are invited to go for lecture tours in Europe. And the opportunities available to the young American scientists to work and study here at home make him the envy of the world. The famous, or infamous,

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"brain drain" exists today precisely because of this.

However, you might say, at least the American scientist of the 1920's did teaching instead of research—indeed he did! Twenty class hours a week—plus preparation, quizzes, and lab reports. If he did any research at all, it was in the evening and on Saturday and Sunday afternoons. And on a budget of a few hundred dollars a year!

Did we do a good job of teaching then? On the whole, we did not. With very little time to keep up with what was going on in the exploding world of physics abroad, most of us plugged away teaching from the textbooks that had been written 20 or 30 years before—or recently rewritten by those who hadn't learned much in the meantime either.

Those were the good old days, as I saw them. And I don't want to go back.

Winds of change

Fortunately, about 1922 the winds of change began to blow. During the next 18 years American science came of age—just in time to make a spectacular contribution to shortening and winning World War II.

What has happened since World War II is familiar history. Today not a half-dozen, but over a half-hundred American universities are in the forefront in teaching and research in science. Another threescore are doing a good job and are getting better. The American university student now learns as a freshman what modern science is all about. As a senior, he is at the frontiers of his field, reading this week's scientific journals and reports, often doing research himself. His teachers know what they are talking about, for they are active scholars too. The teacher who is using even last year's lecture notes will probably be nailed to the wall by his own students.

About ten years ago, something new began to happen. These same university scholars—who, according to the newspapers, were too busy doing research to bother with teaching—began to worry about the obsolete science being taught in the high schools. And they began doing something about it. In collaboration with the best high school science teachers, they began to revolutionize high school science courses. Soon better prepared high school graduates began flooding the better colleges and universities, who soon found they had to revolutionize—again—their college-level courses. And now the elementary schools are improving their courses too. The spiral is on the way up!

But lest you get the impression that I think the golden age is already here, let me tell you about the darker side of the picture. Yes, in the *better*

high schools and in the *better* colleges and universities a new era has dawned. But not all schools and colleges are the *better* ones. Most, indeed, are not. And in many a school and college the picture is a depressing one. There are understandable reasons, of course. The schools in the slum and ghetto areas find the going almost impossibly tough. The new science curricula find no place there. The hundreds of small, impoverished colleges also cannot attract well-trained teachers and cannot afford modern equipment; hence they do not attract the well-prepared students. They, too, are often caught in a vicious circle.

How that vicious circle can be broken I do not know. Educators are working on it. Everyone knows the importance of good education today. Not everyone knew that 40 or 50 years ago. Today we are all aware of our problems; we are no longer smugly satisfied with the status quo. We have seen that in a remarkably short time the upper third or half of our educational system—both schools and colleges—can be vastly improved. Lifting the lower half will be harder, but we are on the move and we shall surely make progress.

The progress in science during these postwar years has to a large extent depended on a new factor which has entered the picture: the government support of university research and of graduate education, plus the support of high school curriculum improvement and of teacher training.

Need for federal funds

There can be no doubt that government funds have vastly benefited American education in science. But that headaches have arisen, there can be no doubt either. The headaches stem from many sources. Rapidly rising college enrollments have increased faster than either local or federal funds or trained teachers. In many areas we have fallen behind in adequate classrooms and laboratories. Federal funds have helped in science, but not in other areas. Political logrolling tends to divert scarce federal research funds from institutions which can make good use of them to those which can not. Whether we like it or not, graduate teaching and research can not be equally well done in *every* Congressional district. Exceptional people and exceptional facilities are still to be found only in 50 to 75 key universities; they do not exist—*can* not exist—in every small college. Research funds are intended to foster the growth and excellence of American science; they are not benefactions to institutions. Nor should they be converted into hand-outs for everyone.

Right now a real crisis exists in American science.

A freeze, and even a reduction, in science and education appropriations appears imminent—just at a time when substantial additional funds are required. More rather than less money is needed to meet Congressional demands for more “geographic distribution” of science funds.

Yet the new federal budget is not meeting these needs. Many basic research and graduate fellowship budgets are being slashed. Funds for new projects will be hard to find, and promising young teachers and investigators will be frozen out. A real crisis in the progress of science and science education is indeed in the offing. Our golden age is being thus delayed. We may have an ice age instead!

I believe that our educational system is all of one piece. The problems of any one segment pose problems for all. The better students go on to colleges and universities; new teachers must be supplied there; the health of American life and culture centers there. Conversely, higher education benefits from the successes of our elementary and secondary schools; and we suffer, too, from its shortcomings.

In this year 1967 all educators face a common overriding problem, posed by the fact that our nation and the whole world are changing so rapidly. A century ago a student who was lucky enough to acquire an education could be comfortable in the feeling that he now knew enough to last him all his life. The world in which he was living was a moderately static world. At least it was changing so slowly that what he had learned would probably not have been unlearned 10 or 20 years later. Nor would it be necessary someday to be reeducated to catch up with a knowledge explosion.

However, the conspicuous thing about the middle of the 20th century is that the world is changing at an enormously rapid rate. The facts or the “answers” one learns in school today may be of little use in five or ten years. Even though what has been learned is still valid, lots of new things will have to be learned each year to understand and to live in our fast changing world.

This means that the whole purpose and philosophy of education now has to be changed, and, to a large extent, this is the change which has been going on in recent years. The emphasis is no longer on learning facts or answers but on learning the processes by which answers to new problems can be obtained. The question to be asked the student is not “What have you learned?” but “Have you learned *how* to learn?”

There are some educators who seem to feel that the explosion of knowledge means that more and more facts must be crammed into a student’s mind every year and that the number of years during

which the cramming process continues needs to be perpetually extended. Actually, the knowledge explosion has now made it quite impossible for any human being to grasp even a tiny fraction of the sum total of human knowledge. It has even made it impossible for any student to visualize the kind of knowledge he will need to be familiar with once he has left school. The task of the teacher today, therefore, is not to complete the learning process but to start it; not to instill a fixed body of knowledge, but to help the student understand the process of acquiring knowledge; not to encourage smugness in what the student has learned, but to stimulate curiosity about what he must learn in the future.

Now this necessary new attitude toward the educational process is not a trivial matter or one that can be accommodated by small adjustments. Even the quite major changes in the approaches to curricula that have been achieved in recent years do not fully meet this problem of changing attitudes.

Curiously enough, in our graduate schools where the learning process is most advanced, it is precisely this attitude that is well established. The young PhD knows full well that he has just begun a lifetime of learning. He knows enough to know that he knows little. It is often the high school or college student who seems to think he knows it all and that the learning process is now complete! Here is where new attitudes and new approaches are most necessary and, at the same time, most difficult. This is the challenge which teachers and administrators face most urgently. Because it is a large challenge, I say again that this is a poor time for our federal government to lose its interest in the promotion of high-quality education at every level. This is no time for an ice age.

Continuity in education

During the past 14 months, I have been engaged with others in a study which relates precisely to this problem of providing a mechanism whereby continuity in education can be encouraged from elementary grades on throughout life. There is one learning device which provides this continuity—the book. If a child learns to read, learns to love to read, learns to *learn* by reading, he can continue his learning process indefinitely. But in recent years another device for continued learning has been developed, namely, the television screen.

Most of us who view commercial television programs are not greatly impressed with this device as a great aid to education. But a new approach to television has recently been evolving, and it has tremendous untapped potentialities. It is noncommercial, or educational, television, I, and other

members of the Carnegie Commission on Educational Television, have been addressing ourselves during the past year to the question: How can this marvelous technology of television be used as a real educational asset throughout school and throughout life? I should like to describe a few things which the Report of the Carnegie Commission says—and a few things which it does *not* say.

The Carnegie Report does not say that ETV is the panacea for all our educational problems. It does not say that the TV screen is about to replace the teacher, any more than a book replaces the teacher. What we do say is that television is a new and powerful technological instrument with very great educational potentialities which have hardly, as yet, even been tested. And we do say that for educational uses the television technology of tomorrow will surely be even more powerful, more sophisticated, and more flexible than it is today. We also say that the educators of America had better start giving more attention *today* to how this tool can best be utilized to improve our whole educational process and how it can lift the educational and cultural levels of all American people.

We found in our study that there now exist in the United States some 124 noncommercial or so-called “educational TV” broadcasting stations, capable, in principle, of reaching into two-thirds of the classrooms of the nation. Nearly all of the stations broadcast programs for classroom use. Some do little else. Most, however, also broadcast programs for home viewing.

Instructional television

We choose to call the broadcasts for classrooms or other instructional purposes “instructional television” (ITV) and the informational and cultural programs for home viewing “public television” (PTV). Thus, the noncommercial ETV system has both an ITV and a PTV function. Obviously, the two functions are intimately related, and there should be no sharp boundary between them. Both are broadly educational. Both can be a stimulus to learning. If a student learns to love books in the classroom, he can use them all his life. If he comes to see television as an aid to learning, he can use that all his life too, if we provide him with programs which teach and inspire him.

We found, however, that every single ETV station in the land is underequipped, understaffed, and underfinanced. Hence, none of them can render an adequate service. All 124 ETV stations together, plus National Educational Television (NET), have to get along on a total budget of \$60 million a year. The commercial stations and networks spend \$2

billion a year. The local, plus network, programs on an average commercial station represent an expenditure of \$60,000 per station per week. The ETV station figure is only *one-eighth* of that. *Most educational television stations spend less in a whole year than a commercial network may spend on one single program.* This is a shocking situation!

Carnegie Commission goal

We have proposed that federal funds be used partially to close this gap. There will, no doubt, be endless debates in the public press, in the halls of Congress, in the executive branch of the government, on the particular structure and mechanisms which the Carnegie Commission has proposed to meet this goal. Let me restate the over-all goal of the Commission as stated in its report.

“The Carnegie Commission has reached the conclusion that a well-financed and well-directed educational television system, substantially larger and far more pervasive and effective than that which now exists in the United States, must be brought into being if the full needs of the American public are to be served.”

We recommend that the federal government, through the Department of Health, Education, and Welfare, should aid in extending and improving the educational television system, and actively sponsor new research on how television can be more effectively used in the classroom; how it can aid the learning process; how it can stimulate the desire to learn; how it can most effectively aid the teacher; how our educational system can most appropriately use the great power and flexibility of modern television technology.

The Commission further recommends that a new agency be created—a private, nonprofit corporation to be known as the “Corporation for Public Television”—and that this agency should be responsible for similar research into how television can be used as a powerful educational and cultural stimulus in the homes of the nation. We propose that this corporation expend substantial public funds in providing programming for the homes. We hope that the Corporation, in collaboration with the Department of Health, Education, and Welfare, will provide a mechanism and additional funding so that the schools and colleges of the nation, together with strong local stations in every community, can provide both the classrooms and the homes of the nation a new dimension in television, a new dimension in learning. This will mean a powerful tool with which the nation can help to meet the urgent problem of keeping the American people in tune with the world and in tune with life itself.