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ABSTRACT

The Technology Education Act contends that technological literacy is a basic skill that should be taught in the public schools. This bill would authorize funding for fiscal year 1987 for model programs. Local educational agencies, state educational agencies, and institutions of higher education would be eligible for grants to establish demonstration programs. This act promotes the teaching of technology as part of the secondary curriculum and provides for teacher training, the development of new courses, and emphasizes hands-on experiences of technology principles. Statements contained in this report of the hearing before the House Subcommittee on Elementary, Secondary, and Vocational Education include those from: (1) Forrest Brummett, Past President of the Society of Manufacturing Engineers; (2) Paul DeVore, Professor of Technology Education, West Virginia University; (3) Thomas Hughes, Associate Director of Technology Education, Virginia Department of Education; and (4) John D. Rockefeller, IV, United States Senator from West Virginia. (ML)

THE EDUCATION TECHNOLOGY ACT

HEARING

BEFORE THE

SUBCOMMITTEE ON ELEMENTARY, SECONDARY, AND VOCATIONAL EDUCATION

OF THE

COMMITTEE ON EDUCATION AND LABOR HOUSE OF REPRESENTATIVES

NINETY-NINTH CONGRESS

SECOND SESSION

ON

H.R. 3102

HEARING HELD IN WASHINGTON, DC, FEBRUARY 19, 1986

Serial No. 99-145

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THE EDUCATION TECHNOLOGY ACT

WEDNESDAY, FEBRUARY 19, 1986

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON ELEMENTARY, SECONDARY
AND VOCATIONAL EDUCATION,
COMMITTEE ON EDUCATION AND LABOR,
Washington, DC.

The subcommittee met, pursuant to call, at 9:30 a.m., in room 2175, Rayburn House Office Building, Hon. Augustus F. Hawkins (chairman of the subcommittee) presiding.

Members present: Representatives Hawkins, Kildee, Boucher, Owens, Fawell, and Gunderson.

Staff present: John F. Jennings, majority counsel; Nancy Kober, legislative specialist; and, Andrew Hartman, Republican legislative associate.

Chairman HAWKINS. The Subcommittee on Elementary, Secondary and Vocational Education is called to order. The hearing this morning of the subcommittee is on H.R. 3102, the Technology Education Act. This bill was introduced by our colleague on the subcommittee, Congressman Boucher. The legislation would authorize $3 million for fiscal year 1987 and such sums as may be necessary for fiscal year 1988 for model demonstration programs in technology education.

The purpose of these programs would be to develop knowledge in students about technology and its uses. Local educational agencies, State educational agencies, and institutions of higher education would be eligible for grants to establish these demonstration programs.

I commend Congressman Boucher for highlighting this need by requesting this hearing this morning. I would like to welcome also to the hearing our colleague from the other body, Senator Rockefeller who has introduced a companion bill.

At this time, the Chair would like to yield to our distinguished colleague on the subcommittee, Mr. Boucher, for his statement which he may wish to make at this time.

Mr. BOUCHER. Thank you very much, Mr. Chairman. I appreciate your agreeing to hold hearings today on H.R. 3102, the Technology Education Act, which will recognize that technology literacy is a basic skill that should be taught in our Nation's public schools. The proposal that is before us today will be a step toward unlocking the mysteries of technology for our children and preparing them for the challenges that lie ahead.

I think as the testimony we will receive today will reveal, industry has a demonstrable need for personnel who are acquainted with

modern technology, personnel who can bring technical solutions to bear on real world problems which business is presently facing.

The private sector today is spending substantial sums training its newly hired employees to comprehend and implement technology. This diversion of dollars to basic skills training is injuring our international competitive position. Our principal competitors in technical fields enjoy the availability of a pool of technically trained students who are well equipped with the skills their American counterparts are presently lacking.

This training in countries, such as Japan, Germany, and France, is conducted through the public school system at public expense, and therefore, I suggest, Mr. Chairman, that adoption of this measure will enhance the competitive position of American industry in the world market.

The bill, as you've indicated, provides matching funds for up to 10 demonstration projects in technology education at the intermediate, high school, and university levels. In view of the fact that this is a relatively new field, the act also provides matching funds to be used for curriculum development. I think the need for this measure will be well demonstrated by the witnesses who appear before us today, and with you, I look forward to receiving that testimony.

I also want to take this opportunity to extend my very special appreciation to Senator Jay Rockefeller of West Virginia for taking the time to be with us today. He is the sponsor of companion legislation in the Senate, and I'm very much looking forward to working with him as we pursue passage of these two bills. Thank you, Mr. Chairman.

Chairman HAWKINS. Thank you, Mr. Boucher. Next, we would like to call on the Honorable Jay D. Rockefeller, U.S. Senator from West Virginia, for whatever presentation you may care to make at this time. Also, I understand that he will introduce one of the witnesses after which I will ask the other panelists to join the panel, but first, let us hear from our colleague from the Senate, the Honorable Jay D. Rockefeller.

[Prepared statement of Senator John D. Rockefeller IV follows:]

PREPARED STATEMENT OF HON. JOHN D. ROCKEFELLER IV, U.S. SENATOR FROM THE STATE OF WEST VIRGINIA

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Mr. Chairman and Members of the Committee, it is a great pleasure to be here today to testify on behalf of H.R. 3102, the "Technology Education Act". As chief sponsor of the companion bill, S. 1823, the " Technology Literacy Act", I am grateful for the opportunity to appear before you and present my views on this important issue.

Over the years, this distinguished Committee has shown time and again its commitment to improving and maintaining excellence in our country's educational system. This Committee can take pride in its many accomplishments and its foresight in identifying new educational challenges. During the last few years, for example, mathematics and science have become a key priority in the education of our children. Thanks to legislation which emphasized the need to strengthen our scientific base, we have developed new curricula, trained qualified teachers and increased the exposure of our children to mathematics and science at an early age.

Today, you have once again proven your concern and foresight by holding this hearing in recognition of the importance of training our youth in technology. As the Carnegie Foundation noted in a recent report, we are running the risk of jeopardizing this country's economic security by raising a "technologically illiterate" generation.

In my view, we are facing an unprecedented challenge to our economic prosperity. We have to build our future prosperity in an increasingly technological world where many talented nations compete effectively. Therefore, it is imperative that our country, which led the world into the age of technology, maintain its edge and provide its children with the skills they need to compete and prosper.

Experience has shown us that, although technology goes hand in hand with scientific and mathematical knowledge, it may develop from a practical need and an imaginative mind. It is this talent for innovation and the ability to find technological solutions that we need to instill in our students if we are to compete in the world market and enhance our own future. I believe that teaching students about technology, its impact on our culture, its place in our history and its promise for the future will go a long way in achieving this goal.

This is the purpose of the "Technology Education Act". This bill promotes the teaching of technology as part of the secondary curriculum, making students knowledgeable and comfortable with technology at an early age. Furthermore, the "Technology Education Act" provides for teacher training, development of new courses and emphasizes hands-on experience of technological principles.

In order to implement these ideas, this Act establishes a program of grants for the development of model demonstration projects in technology education in secondary schools.

For those of us who represent traditionally underserved areas, this bill provides a thoughtful solution by requiring an equitable geographic distribution of the demonstration projects. Just as importantly, it insures the commitment and interest of the local educational agencies by placing limitations on the amount of Federal assistance, thus requiring that the cost of the projects be supplemented using other non-Federal contributions.

One of the most appealing aspects of the "Technology Education Act" is that it promotes the national dissemination of all the research, coursework, development, training materials and practical knowledge acquired in the demonstration projects. New technology education programs will directly benefit from this information and the original investment will pay off very quickly.

Mr. Chairman, in these times of economic austerity and budget deficits, it would be irresponsible on my part not to acknowledge that H.R. 3102 and S. 1823 call for appropriations of $3 million in fiscal year 1987. Although this amount is minute compared to what we spend on other, perhaps less worthy programs, it is crucial that we carefully monitor where we spend money and why.

Every Member of Congress will have to make tough decisions establishing their spending priorities. Education---at the federal level, to supplement and enrich the efforts of the states---is fundamentally important. A world-class education system is central to our nation's economic destiny, and right now, our education system---once the envy of the world---has fallen behind Japan's and several Europeon nations at the primary and secondary level. Well-designed expenditures for innovations in education are critical investments. If we sacrifice these critical investments, we will be shortchanging our children and endangering their economic future.

I recently ran across an article by Ernest Boyer called "A Perspective on Education". In it Mr. Boyer says:

> "The issue is not computers. The issue, rather, is the changing of our society, driven by a technology revolution that is an fully important as the industrial revolution over 100 years ago."

I agree with this assessment. We are living a technological revolution which our country helped to create. We cannot sit back and watch it go by. We must improve this country's innate ability to tackle new challenges by giving our children the tools they need: the technical skills to compete in the 21st century. The "Technology Education Act" is far from the whole answer, but I hope it will serve as the catalyst for a national debate on the critical need to enhance our children's grasp of technology.

Again, I am grateful for the opportunity to express my support for the "Technology Education Act" and to praise Congressman Boucher for his leadership on this issue. Thank you very much.

Senator ROCKEFELLER. Mr. Chairman, first of all, let me say that throughout my relatively brief public career, I have read many times about you individually and all the things that you have accomplished for this country, and I would hardly be able to even begin to say anything without saying how honored I am that you yourself are chairing this meeting, and that I have a chance to speak before you.

I think there are a handful of truly great Americans on the political scene at this time, and if I may be so bold, I would like to suggest that you are one of them. The things that you've done through your Committee for Education and all of its ramifications in many other areas is something which has impressed me for many, many years, and I feel compelled to say so, sir. You'll excuse me if I begin with that.

Also, I am very honored to be kind of coworking this with my colleague from across the line in Virginia. In fact, Mr. Chairman, West Virginia had the temerity to secede from Virginia. Had I known that Congressman Boucher and I might have been colleagues, I would have resisted that effort at the time, but there were other forces at work, and I was not around nor was the Congressman to collaborate on such matters.

In any event, his House Resolution 3102, the Technology Education Act, and the one which I have sponsored in the other body, S. 18238, the Technology Literacy Act, are, in fact, the same, and I think as Congressman Boucher indicated himself, the need is so self-evident, that it hardly bears the need for testimony from another Congressman, although it surely will from my colleague from West Virginia University who I will introduce in a moment.

Over the years, this committee has been in the forefront of bringing the problems of our country's education to the forefront, as have many other groups—private and public—across this country. We have, as Congressman Boucher has indicated, an unprecedented challenge from overseas. I have just returned from several days in South Korea, Japan, and Hong Kong. I went to school, Mr. Chairman, in Japan for a number of years, learned its language, thought I knew its ways, but was once again stunned by what they are achieving with the prosperity, the ways in which they are cleaning our clock through their own hard work, certain trade deficiencies on their part and certain lack of aggressiveness on our part, particularly with respect to education generally, but technological education most particularly.

We have done work in this country on math and science, and I think it's beginning to pay off, but I must say that their emphasis in those countries on education is awesome and one which we have to repeat. There is, as you very well know, outside of Tokyo a number of miles, a city in which there are literally thousands of Ph.D.'s, interdisciplinary, who do research of all different kinds. They are sponsored by the government and by industry in a cooprative manner. Labor, management, industry work together there. Technology, innovation, patents, reaching for the stars in the very best sense is something which is a part of the ethic of Japan.

Korea is not far behind. Thirty years ago, they were eating bark off of trees, and today, they're cleaning our clock in some other fields, and pretty soon, they may be cleaning Japan's clock, and,

again, technology is the key, the emphasis on education, the ethic of education and the emphasis on it in the home and in the school. The Japanese young people go to school on Saturday, so they don't have to worry about are they going to watch or not watch "Miami Vice" at 10 on Friday evening. There is no question of that, because they're going to be in school on Saturday. They're doing homework, and part of what they're preparing for is a very thorough and complete sense of their technological environment. They have grown into it comfortably. They excel at it extraordinarily, and they are ahead of us by almost all measurable identifications.

I have a symbol that I brought back, Mr. Chairman, which is most unimpressive if one looks at it literally, but impressive if one thinks about it. It's a pair of scissors which is made of something called plastic which we understand, the bottom, but the top is something called advanced ceramics.

It would be my judgment, and I don't know whether my colleage, Paul DeVore, will agree with me, but it will be my judgment that within the next 5 to 15 years, that we will be seeing jet engines, car engines, instrumentation, machinery and many other things being made of something called advanced ceramics.

It's just simply ceramics with high technology fibers introduced into it. This is a coming matter. This is a Japanese pair of scissors. We are either going to compete and be there when advanced ceramics begins to overwhelm our steel and aluminum industry or we're not. Our plastics industry, the Corning's, the General Electric's and the MIT's and the Penn State's and others are either going to have the research, West Virginia University is either going to have the research to compete with the Japanese for what is now a pair of scissors and what 10 years from now might be a General Motors automobile or we're not, and that's called technology, and the instinct for it and the thirst for it.

That, I believe, is what Congressman Boucher's bill is all about. That is, I believe, what mine is all about, and I might just close, Mr. Chairman, in saying that Dr. Boyer who is a very good friend of mine said that the issue is not computers which is where our sense of technology is. The issue rather is the changing of our society driven by a technology revolution that is fully as important as the industrial revolution over 100 years ago.

Congressman Boucher and Senator Rockefeller have not introduced budget busters. They have introduced sensible bills which modestly implement programs which are meant to lead by example and cause other high schools and colleges to do what it is we propose that a select few number do.

I think they are important bills. I strongly support Congressman Boucher's bill as does, I assume, Dr. Paul DeVore who I will now introduce with your permission, Mr. Chairman.

Dr. DeVore is recognized around the world as an authority on technology education which is the subject of this bill and the subject of the national crisis, and he has frankly championed all of this long before I, at least, had ever even known there was such a crisis.

It's my honor to introduce Dr. DeVore today, not only because he brings and enlightened view to this discussion, but because he does his work at West Virginia University, and I am very proud of that

as I am of him. He's a member of that faculty, and he has been responsible at West Virginia University for the development of new graduate programs in the study of technology. And so, Mr. Chairman, with particular thanks to you and to your colleague, Rick Boucher, I would like to introduce if I might, Dr. Paul DeVore.

Chairman HAWKINS. Thank you, Senator, and welcome Dr. DeVore. May I interrupt merely to again express the appreciation of the committee to you, Senator Rockefeller, for the appearance before the committee this morning. We understand that you do have urgent commitments elsewhere, and we certainly want to use this opportunity to release you, as it were, from further appearance before the committee. With that, may I again thank you for your generous remarks that were personal at the very beginning, quite unexpected, but the chair is certainly appreciative of them.

May I, therefore, again thank you for your appearance, and you may remain as long as you think desirable, but we also understand that you do have other urgent business. May I also at this time call to the witness table Mr. Thomas Hughes, Jr., the associate director, technology education, Virginia State Department of Education, and Mr. Forrest Brummett, chief engineer of the Allison Division of General Motors from Martinsville, IN.

Gentlemen, we welcome all three of you, and with that, Dr. DeVore, we will now return to you and again welcome you and ask you to proceed with your remarks. May I indicate that all of the statements as presented will be entered in the record without any change, and we would appreciate it if the witnesses would then devote their time to the highlights of their statements leaving such time for the other members of the committee to question you so as to bring out some of the more relevant facts that they may have some interest in.

Dr. DeVore, you are the first witness.

STATEMENT OF DR. PAUL DEVORE, PROFESSOR, TECHNOLOGY EDUCATION DEPARTMENT, WEST VIRGINIA UNIVERSITY

Dr. DEVORE. Thank you, Mr. Chairman. I'm just reflecting on how much of an honor it is to be here this morning. I suppose even though the topic is technology and education about technology, it seems to me that the thing that I hold most dear, and not to overplay it, but to appear as a witness, as a citizen before a committee on education in the U.S. Congress is a true honor, primarily because I have as an emotional aspect a great attachment to freedom and democracy, and my remarks are set in that framework.

I think my remarks, which you have copies of, and which I'm not going to read, I'm merely going to cite the highlights of, as you requested, and I would support Congressman Boucher's early statement there. I think all of that I agree with, and I hope what I'm going to remark about briefly will reinforce that as well as those remarks of Senator Rockefeller.

The key points that I think are relevant to this legislation and its importance have to do with the resources of society. Of course, we will continue to be a democracy and have a quality society so long as all people participate effectively in that society. I think

right now, we have many of our people who are disfranchised from that society. They look healthy, they dress well and so on, but intellectually they are not competent in understanding what is happening internationally to us on the world market.

We have great social costs to maintain some of those people on welfare or with job training and retraining, and we have in West Virginia and throughout this country many small communities that no longer are what we might call viable, because the people within them are not able to understand what is happening to them, and they are not educated in the technologies in order to move ahead into new business ventures, new small industries, et cetera, to support themselves in a productive way.

Congressman Boucher mentioned the competitive potential of this country. I think it's a great tragedy. It's manifested in our deficits, et cetera. We no longer have that productive edge in the basic industries. We have lost many of those industries, and I have outlined that in my statement of what we have lost, and it's certainly not a secret to anyone in this hearing of the demise of some of our major industries that employ thousands and thousands of people at high wage levels.

Many of our employment opportunities today in this country are in less than full-time employment, part-time employment in fast food industries and things of that nature, but we do not have the productive base.

I think another key point to me, having a son who just finished a tour of duty in the Air Force, and listening to some of the problems that they have, has to do with the national defense potential. If we are truly going to have a citizen base from which to contribute to our national defense, we have to have people who are technologically literate.

The great sums of money that will be required to man a large defense, to try to retrain these people, and some of them are not even retrainable, because they don't have the base to start from. They don't have the knowledge in the technologies, and it's a very complex body of knowledge that we have today.

So the world has changed, and we've had a number of impacts, and I can cite those very briefly, but these changes will continue to occur. Any time you change the food potential of a society or the energy conversion potential of a society or the information base of society or the way you control your tools and machines within society, the computerization of this, the numerical control, the so-called intelligent automation that we have today in our society, we change the base of that society, and therefore, we change the intellectual needs of the people who participate or produce in that society.

Most of us can cite the programmable computer and the transistor as the base for this new generation, but the new generation is still out there and new inventions and new developments will come along. So we have some coming on the scene, for instance now, which will have a great impact on the new technology in the future, the biotechnologies. A new means of manufacturing new products, producing new products in society will come out of this biotechnology industry, and Senator Rockefeller cited the whole area of ceramics. Those of us that have been reading in that field

understand that they will be coming out with a new automobile engine that will be ceramic based rather than metal based.

It's an increasingly complex world, and I think the reason that I support this legislation has to do with democracy and technology, the survival of the democratic process. I have a quote in my presentation here that comes from Thomas Jefferson, and he says,

> I know of no safe depository of the ultimate powers of the Society but the people themselves. If we think them not enlightened enough to exercise their control with a wholesome discretion, the remedy is not to take it from them, but to inform their discretion by education.

I think that is what the two bills, the one by Congressman Boucher and the one by Jay Rockefeller are concerned about, to inform our people and to make us a more productive and quality Nation. Thank you, Mr. Chairman.

Chairman HAWKINS. Thank you, Dr. DeVore.

[The prepared statement of Dr. Paul W. DeVore follows:]

PREPARED STATEMENT OF DR. PAUL W. DEVORE, PROFESSOR, TECHNOLOGY EDUCATION, WEST VIRGINIA UNIVERSITY, MORGANTOWN, WV

Chairman Boucher and members of the Committee, I am Paul W. DeVore, a member of the faculty of the Department of Technology Education at West Virginia University. I have appended a copy of my rēsumē to the statement prepared for the Committee.

Introduction

The Impact of Technological Illiteracy on the United States

It is an honor for me to have the opportunity to contribute to this hearing on H.R. 3102, the Technology Education Act of 1985. I compliment you on your foresight in introducing legislation which has the potential of addressing a problem of increasing importance to our society; the technological illiteracy of our people. This growing illiteracy affects our nation in several ways. Today there is:

1. An increasing drain on the resources of society by citizens unable to function effectively or contribute in a meaningful and productive way to their society in an increasingly technological world.
2. A loss of competitive economic potential by United States' businesses and industries unable to obtain employees capable of functioning effectively in the highly complex, ever changing, technological envi[illegible]s.

3. A lessening of our national defense potential during times of national emergency, when citizens who should be able to contribute are unable to do so because of their lack of knowledge and know-how in the technologies, and

4. A growing number of citizens disfranchised economically as well as politically from participating effectively in the governance and management of their communities, states, and nation because of an increasing technological component in the society.

The World of Today and Tomorrow

We are no longer an isolated nation. We live in an interdependent ever-changing world, a world of accelerating industrialization, continuing population growth, widespread malnutrition, increasing depletion of non-renewable mineral and energy resources, and a deteriorating environment.

Our futures are linked directly to the rest of the world. The world is interdependent whether the context is the environment, raw materials, energy supply, finished products, food supply, or knowledge and know-how. The advent of television and communication satellites and the resulting rising expectations of people throughout the world, coupled with the advent of the microprocessor and its potential for accelerating the pace of technological change portend a future far different from the present.

Technological change has been a constant in the civilization process. The difference today is in the pace and magnitude of the changes brought about by a more complex, highly abstract technical means.

In less than eighty years the United States has changed from an economy based primarily on agriculture, to a society based more and more on communication and information technologies and service type businesses. Today, the United States is no longer competitive in heavy industries, and faces extensive competition from other nations in the development and production of computers, machine tools, construction equipment, automobiles, textiles, electronics and home appliances. Our mounting and continuing trade deficits are manifestations of these events.

Major changes in the civilization process have come about when human potential has been altered through changes in the technical means of a society; technical means which provide:

1. a more stable food supply
2. new and better materials
3. alternative forms of energy
4. a more efficient means of energy conversion
5. a more efficient means to:
   (a) collect, (b) store, (c) transmit, and
   (d) process information and
6. a better means to control tools, machines,
   and technical systems.

The latter two categories of technical means, the development of more efficient means to collect, store, transmit and process information, and the creation of better means to control technical systems, are of major importance today and are the variables that are currently altering the nature of societies throughout the world.

Two major developments form the core of the information systems and control revolution of the last quarter of the twentieth century. These

developments are: (1) the creation of programmable electronic computers and (2) the invention of the transistor in the late 1940s. The computer has provided the capability to manipulate and transform information; the transistor the potential for small and reliable sensing and control devices so essential to the high-speed automatic collection and processing of information. The fusing together of computer technology and communication technology has given birth to the creation of information systems and intelligent automation which have altered and will continue to alter the nature of our society.

Within the next decade or so it is highly probable that a new form of technology, biotechnology, will have as great or greater impact on society than has the computer and the transistor. Biotechnology is not new. For centuries wines, beers, vinegar, various foods, solvents, ethanol and various drugs have been produced by knowledge of the behavior of microorganisms. The new biotechnology is much more sophisticated and uses knowledge about the interior of cells to direct and manipulate to produce desired outcomes. The potential for altering the way we produce food, convert energy, provide health care and produce materials is significant. So too are the questions which the new forms of biotechnology raise with respect to values, errors and failure.

Human Factors and Technological Change

In earlier times our technical means were not as complex and sophisticated. Most technical means could be understood by the average citizen and control was vested at the local level. Today, the increasing complexity

of our technical means and the interlinking of multiple subsystems increases the potential of disfranchisement of more and more citizens.

New and more sophisticated technical means increase the gap between technological growth and human understanding. The same is true economically, socially and politically. In a high technology society the inequalities between the haves and the have nots increase in direct relation to their ability to participate in and contribute to the creation, use and management of the new technical means.

Technology, Democracy and Education

It may be that the most important reason for pursuing the goal of technological literacy among our citizens is the very survival of our democratic form of government. Freedom is an issue of control. Today, with the disfranchisement of vast segments of our population because of their ignorance of the technical means that gives shape and order to our society, we are in danger of losing our precious democratic heritage.

If we are to remain as free citizens and control our own destiny in a democratic and increasingly technological society, then it is necessary that we gain the knowledge and understanding necessary to control our technical means and direct and use these means to attain agreed upon social purposes. To do otherwise will bring about a society controlled by a technical elite, an elite knowledgeable about the technical means and with the potential of controlling it for their purposes.

To alter this possibility and protect our freedom, we must remember that a technological society is a knowledge society that requires a new form of literacy if all citizens are to function effectively as informed, responsible members of society.

Thomas Jefferson recognized the need for intelligent citizens in the proper functioning of a democratic society.

> I know of no safe depository of the ultimate powers of the society but the people themselves; and if we think them not enlightened enough to exercise their control with a wholesome discretion, the remedy is not to take it from them, but to inform their discretion by education.

The ever present danger today is that the complexities of our technical means not only raise the level of comprehension and know-how required of the average citizen to participate effectively in society; they also increase the probability of less involvement politically. Thus by default, technological illiteracy will promote the demise of democracy and place in control an elite group of people who by their knowledge and know-how control the technical systems and thereby the processes of public and private life, nationally and internationally as well.

Conclusion

H.R. 3102, the Technology Education Act of 1985, and the companion Bill S.1823, the Technology Literacy Act of 1985, provide the means to initiate programs to address the problems associated with technological illiteracy in the United States.

This problem has been recognized by many national commissions, committees and individuals and many meetings and reports have been held.

The proposed legislation is the first positive effort that holds the potential of initiating direct action to solve the problem of technological illiteracy.

I congratulate you on your initiative and offer my continued support.

Thank you, Mr. Chairman.

statement (2)

Outline of Testimony of Dr. Paul W. DeVore
Before the House Subcommittee
on
Elementary, Secondary and Vocational Education
Regarding H.R. 3102,
The Technology Education Act of 1985
February 19, 1986

Introduction

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Chairman HAWKINS. The next witness is Mr. Thomas Hughes, Jr.

STATEMENT OF THOMAS A. HUGHES, JR., ASSOCIATE DIRECTOR, TECHNOLOGY EDUCATION, STATE DEPARTMENT OF EDUCATION, RICHMOND, VA

Mr. HUGHES. Thank you, Mr. Chairman. I am president of the International Technology Education Association, and I am employed by the Virginia Department of Education in Richmond as an associate director for technology education.

One of the principal architects of our Constitution, Thomas Jefferson, stated that an educated citzenry is the only safe repository of democratic values.

Jefferson's life and work provided an example to all of us who live two centuries later, that we need a broad understanding of the relationship between technology and society.

In a report released last week by Jon Miller of Northern Illinois University, he addressed the issue of technological illiteracy. He noted that the technologically literate person should understand how basic technologies work, which aspects are changeable and which are not, and some of the impacts and implications of major technologies. The technologically literate person should understand that in democratic societies, citizens can have some say in which technologies are advanced and which are restrained. He conducted a random study, an assessment of 2,000 people across the Nation on 10 items reflecting his point of view of what technology education is.

His telephone interview assessed the level of understanding in technical terms, technological problems and issues. His results were 16 percent of the people knew 2 or less of the items; nearly 50 percent knew 3 to 5 items, the average being 4.4; about 32 percent knew 6 or more of the items; and, only 2 percent of the total were able to score 9 or 10 on the index.

His study concluded that young Americans just emerging from their formal education are not as likely to be technologically literate as somewhat older adults. The question then, why should the Federal Government be involved in an act such as this? We would cite the report by the National Science Foundation, Educating Americans for the 21st century which makes these points.

Technological literacy needs to be a part of general literacy. In a sense, we're speaking of basics in education, and we are identifying the knowledge and understanding of technology as basic. It needs a Federal involvement as a stimulator for a new and much needed form of literacy that knows no State boundaries.

Technological literacy in a great democracy such as ours requires a voting population that is knowledgeable about the uses as well as the abuses of technology. Recently in the Smithsonian Journal, there was a statement, quote: "We believe that the genius of the future lies not in technology alone, but in the ability to manage it." The Carnegie Foundation Report on the American high school made several references, a few we need to cite.

One, we recommend that all students study technology. The history of man's use of tools, how science and technology have joined, and the ethical and social issues, technology has raised. We are

frankly disappointed that none of the schools we visited required a study of technology. The need for Federal involvement is largely a sense of urgency to educate the generations of students regarding their nature and use of technology that will enhance their ability to exercise their rights as citizens in a fast changing society. The need is universal. It is not a State or local issue. It is basically an appeal for literacy in a technological society.

Technological literacy is a requirement for living in this and future years. Boyer in his book titled High School, made the statement that: "Ignorance of technology is becoming the ultimate self-indulgent luxury." You might ask specifically how we see this helping American education. It will strengthen in our school systems the total curriculum by providing schools with new forms of student involvement with the basics of math, science and communications and direct application with modern technological innovation. It will provide the profession with the opportunity to promote the best known strategies for integrating the basic discipline into a holistic form of education, rather than a current disjointed subject approach to education.

The act will play an important role in broadening the school curriculum to include what has been called the new literacy as well as the new basics. For the teachers, this act will provide the first major thrust toward developing teachers capable of providing a viable program in technology education.

The act will provide for the developing and communicating of model programs that could be implemented by the profession. It would provide for leadership development through institutes, workshops and in-service programs. It would provide for a broad-based upgrading of teachers through a network of institutes and workshops.

For the students, there is a dire urgency to increase the students' knowledge of technology. The great urgency is not computer literacy, but technological literacy, the need for students to see how society is being reshaped by our inventions, just as the tools of earlier eras changed the course of history.

Technological education as advocated by the International Technology Education Associates, provides the student with practical applications of mathematics and science, thus increasing their understanding and capabilities and those disciplines as well.

This act will stimulate the profession to develop materials and programs that would enable the student to broaden his or her understanding regarding potential careers and the broad field associated with technology, and there are many new emerging ones.

Such legislation will contribute to the development of programs and instructional materials that can enrich the students' daily interaction with technology as a user, a consumer, a worker and as a citizen.

It will be useful in the development of programs that would strengthen the individual student's technical skills relative to his or her employment in industry, business or government. In conclusion, we would like to cite again from the report, Educating Americans for the 21st Century.

The nation that dramatically and boldly led the world into the age of technology is failing to provide its own children with the intellectual tools needed for the 21st

century. Already the quality of our manufactured products, the viability of our trade, our leadership in research and development and our standards of living are strongly challenged. Our children could be stragglers in a world of technology. We must not let it happen. America must not become an industrial dinosaur. We must provide our children more than a 1960's education for this 21st century world. We must return to the basics, but the basics of the 21st century are not just reading, writing and arithmetic. They include scientific and technological literacy, the thinking tools that allow us to understand the technological world around us. The United States must provide all its youth a level of technological education that is the finest in the world without sacrificing the American birth right of personal choice, equity and opportunity.

Thank you.

Chairman HAWKINS. Thank you, Mr. Hughes.

[Prepared statement of Thomas A. Hughes follows:]

PREPARED STATEMENT OF THOMAS A. HUGHES, PRESIDENT, INTERNATIONAL TECHNOLOGY EDUCATION ASSOCIATION

One of the principal architects of our constitution, Thomas Jefferson, stated that an educated citizenry is the only safe repository of democratic values. Jefferson's life and work provided an example to all of us who live two centuries later that we need a broad understanding of the relationships between technology and society. To lead full lives and to be participatory citizens in the twenty first century, we must have an understanding and appreciation for technology. This understanding and appreciation is sometimes called technological literacy.

Peter Drucker defines technological literacy as "an understanding of technology and its dynamics, the opportunities it offers, and its impact on product and process, markets, organization structure and people." He went on further to say that "Technology is not about tools, it deals with how Man works."

A GROWING NATIONAL CONCERN: TECHNOLOGICAL ILLITERACY

A recent National Science Foundation Poll of 1992 adults reported in the February 14, 1986 issue of U.S.A. Today, found that only 19 percent of us understand how a telephone works, 24 percent know how computer software operates and 31 percent can accurately explain radiation. The findings may mean that not enough of us can apply technology to solve concrete problems, says study author Jon D. Miller of the Public Opinion Laboratory of Northern Illinois University at DeKalb. Of 10 questions measuring technical literacy, respondents knew the answer to an average of 4.4; 16 percent scored 2 or lower; 2 percent scored 9 or 10.

Currently, there is no national consensus on the importance of technology education to provide technological literacy for all citizens. Likewise, this lack of national agreement has transcended state and local interest and responsibility to provide it. The maintenance of the United States scientific and technological capacity requires superbly educated mathematicians, scientists, engineers, and technologists. This has been vividly brought to our national attention recently with the tragedy of the Space Shuttle Challenger.

As the total number of 18-year-olds in the population continues to decrease into the 1990's, the percentage of high school graduates entering preprofessional, college-level courses in science and engineering must increase to meet future manpower needs. In addition, to meet the country's needs for excellence, creativity, and innovation in its scientific work, we must develop and utilize the talents of all Americans, including women and minorities. Data from a number of sources have documented declining student achievement in mathematics and science, as indicated by declines in:

- science achievement scores of United States 17-year-olds as measured in three national assessments of science (1969, 1973, and 1977);
- mathematics scores of 17-year-olds as measured in two national assessments of mathematics (1973, 1978); the decline was especially severe in the areas of problem-solving and applications of mathematics;
- mathematical and verbal Scholastic Aptitude Test (SAT) scores of students over an 18-year period through 1980; and

- students prepared for post-secondary study. Remedial mathematics enrollments at four-year institutions of higher education increased 72 percent between 1975 and 1980, while total student enrollments increased by only seven percent. At public four-year colleges, 25 percent of the mathematics courses are remedial; and at community colleges, 42 percent are. (National Science Board, Commission on Precollege Education on Mathematics, Science, and Technology.)

In the early part of the 1980's a host of national commissions conducted studies which resulted in reports on the status of education in the United States. The 1983 Carnegie Foundation for the Advancement of Teaching report, "High School: a Report on Secondary Education in America," contains the following statements.

> We recommend that all students study technology: the history of man's use of tools, how science and technology have joined, and the ethical and social issues technology has raised. (p. 110)
>
> We are frankly disappointed that none of the schools we visited required a study of technology. (p. 111)

The president of the Carnegie Foundation stated in his book, High School (1983), "...Ignorance of ... technology is becoming the ultimate self-indulgent luxury." The National Science Foundation report, Educating Americans for the 21st Century (1983), states that

> "Technological literacy needs to be a part of general literacy ... In a sense we are speaking of 'basics' in education, and we are identifying the knowledge and understanding of technology as basic."

Technological literacy in a great democracy such as ours requires a voting population that is knowledgeable about the uses as well as the abuses of technology. A recent ad in the February (1986) Smithsonian journal stated the case in the statement, "We believe that the genius of the future lies not in technology alone, but in the ability to manage it." (pp. 27, 79)

A NATIONAL NEED FOR TECHNOLOGICAL LITERACY

Technology is a part of everyone's daily life. Even so, most people do not even begin to comprehend the complexity of our technological society. Yet, a key to understanding problems among nations, communities, and individuals can be found through our actions in producing goods and services. The needs of today demand useful inventions, productive research, efficient production, quality workmanship, and personalized service. All these will provide the excellence for which we strive in today's complex world.

Yet, how close are we to achieving these goals? Few can fully comprehend the daily news, perform routine technical activities, or appreciate an engineer's breakthrough because they lack technological knowledge. In fact, many rewards of everyday life are withheld from those who do not have minimal experience in applying technology.

To ensure our nation's place as a leader in an ever-changing technological world, we must develop our human resources. The study of technology as a part of education should provide experiences that instill insight, drive, and efficiency. A goal of the classroom and laboratory instruction should be to produce leaders who are

confident and have a sense of controlling their own destiny. Ethics and academic excellence should be melded with thought processes, self-renewing attitudes, and the search for substance and meaning in producing informed citizens-- our nation's future. We must educate people to think and act from a technological perspective, for therein lies our strength.

Federal involvement is needed as a stimulator for a new, much-needed form of literacy that knows no state boundaries. This need for Federal involvement is largely a sense of urgency to educate the generations of students regarding the nature and use of technology that will enhance their ability to exercise their rights as citizens in a fast changing technological society. The need is universal. It is not a state or local issue; it is basically an appeal for literacy in a technological society.

WHAT IS TECHNOLOGY EDUCATION?

Technology education is the curriculum area in the public schools which provides technological literacy to all students. It is, however, a relatively new curriculum area and not all states have technology education programs in place. States such as New York, Wisconsin, Illinois, Indiana, Texas, Ohio, and Virginia have been pioneers in designing and deliverying courses in technology education. Technology education is becoming a new basic subject area in the schools.

Technology Education can be defined as the comprehensive school curriculum area which has an action based instructional program which is concerned with technology, its evolution, utilization, and significance; with industry, its organization, personnel, systems, techniques, resources, and products; and their combined social and cultural impacts.

The curriculum of technology education acquaints all persons with their technological environment so they can make rational decisions about their own lives on a day-to-day basis and eagerly participate in controlling their own destiny.

Recognizing the individual's native potential for reasoning and problem solving, for imagining and creating, for constructing and expressing with tools and materials -- from which technology and industry spring forth -- technology education capitalizes on this rich potential and develops content and experiences to contribute to the growth and development of human beings commensurate with their potential. Thus, technology education is a basic and fundamental study for all persons, regardless of educational or career goal.

As a result of taking this curriculum in schools, technology education can help the student to:

- know and appreciate the importance of technology.
- apply tools, materials, processes, and technical concepts safely and efficiently.
- uncover and develop individual talents.

- apply problem-solving techniques.
- apply other school subjects.
- apply creative abilities.
- deal with forces that influence the future.
- adjust to the changing environment.
- become a wiser consumer.
- make informed career choices.

Technology education should be implemented at all levels in the schools. At the elementary school level, grades K-6, the goal for technology education is learning reinforcement and technological awareness. Orientation and exploration are the goals for technology education at the middle school or junior high school, grades 6-9. The primary purpose of technology education at the high school, grades 9-12, is preparation in technology.

Students who go through an articulated technology education program should be prepared for any one of three possible career goals as they graduate from high school. As a result of taking a technology education program in grades K-12, the student may wish to enter college as an engineering, scientific, architectural, or technical baccalaureate degree major. Another career path is for a technology education student to pursue a vocational career after graduating from high school. (This may also be done in high school if appropriate vocational courses are offered.) Finally, a student may take technology education for general education purposes to make him or her better prepared to live in a technological world.

Hopefully, by taking a technology education program in grades K-12, students will have a quest for lifelong learning.

WHICH PROGRAM IN THE PUBLIC SCHOOL CAN BEST PROVIDE TECHNOLOGICAL LITERACY?

The technology education profession has within its ranks a number of creative educators who have pioneered the development of programs that have won the praise of some of America's foremost educators. These are pilot programs that deal directly with the substance of technological literacy, i.e., (1) the historical role of technology in human development, (2) the relationship between technological decisions and human values, (3) the benefits and risks of choosing technology, (4) the changes occurring in current technology, and (5) an understanding of technology assessment as a method for influencing the choice of future technologies. (p. 74, NSF Educating Americans for the 21st Century, 1983) These are programs that may be directed toward a variety of levels of student ability. They are programs that have been piloted in the sod of public schools. They are programs that address the needs of citizens in a highly technological democratic society where such understandings are basic for all. The great need is the resources as well as the vehicles (institutes, teacher education, teacher re-education, the curriculum materials and the kind of educational leadership) to promote as well as infuse these programs into the educational system on a broad scale. This we feel would be a fundamental objective of legislation such as the Technology Education Act. The groundwork

by our profession has been done by creative, forward-looking professionals who need the help of this Act -- to refine, to further develop software, and to provide for a new age of enlightenment for our teachers and the future citizens they serve.

WHY IS THERE A NEED FOR FEDERAL LEGISLATION TO PROMOTE TECHNOLOGY EDUCATION?

The Technology Education Act (HR 3102) will play an important role in broadening the school curriculum to include what has been called the "new literacy" as well as the "new basics." It will strengthen the total curriculum by providing the schools with new forms of student involvement with the basics of math, science and communications in direct application with modern technological innovation. Also, the Act will provide the profession with the opportunity to promote the best known strategies and vehicle for integrating the basic disciplines into a holistic form of education rather than the current disjointed subject approach to education.

This Act will provide the first major thrust toward developing teachers capable of handling a viable program in technology education. The Act will provide for the developing and communicating of model programs that could be implemented by the profession. It would provide for leadership development through institutes, workshops, and inservice programs in the area of technology education aimed at technological literacy. In addition, this legislation would provide a broad-based up-grading of teachers through a network of institutes and workshops.

There is a dire urgency to increase the student's knowledge of technology. "The great urgency is not 'computer literacy' but 'technological literacy,' the need for students to see how society is being reshaped by our inventions, just as the tools of earlier eras changed the course of history." (Boyer, E.L. High School, p. 111) The Technology Education Act will stimulate the profession to develop materials and programs that enable the student to broaden his/her understanding regarding potential careers in the broad field associated with technology. There are many such new emerging fields. Such legislation will contribute to the development of programs and instructional materials that can enrich the student's daily interaction with technology as a user, a consumer, a worker and a citizen in an advanced technological society. The Act will be useful in the development of programs that strengthen the individual student's technical skills relative to his/her employment in industry, business and the government.

Universities will also benefit from the passage of the Technology Education Act. It would stimulate new interest and renewed vigor in universities that have lacked the resources to move into new and innovative programs in this area. The Act could provide the impetus, as well as the resources to establish the necessary linkages between the universities, the secondary schools, as well as the business and industrial interests of the area or region in which they are located. This legislation will provide a much needed shot-in-the-arm for those institutions selected for involvement in the development of elements

of the program. The Act could provide the resources for curriculum revision and adjustment in the universities, which could ultimately impact on the quality of teaching personnel for the secondary schools serviced by such institutions. The work of the universities supported by this Act could be spread to other institutions through the dissemination of programs, materials, and strategies on an organized basis. The development of technology education program models at the university, as well as the secondary school level, will be a good potential from such an Act. And finally, this legislation will stimulate the universities to move into new and innovative approaches to the education of citizens for the 21st century with its technological requirements.

GRAMM-RUDMAN

Citizens and lawmakers who favor the Gramm-Rudman ammendment argue convincingly that continuing federal deficits will mortgage our children's future. Yet, if cutbacks or sequestration which is proposed in Gramm-Rudman is allowed to work, many of the same children will be denied the educational programs necessary to realize their own potential and the economic ability to pay off whatever debt we have with them.

Unfortunately, the Gramm-Rudman legislation places 73 percent of the federal budget in FY86 or $702 billion dollars in exempt status. This causes the remaining 27 percent, in which educational programs such as the proposed Technology Education Act, in a potential priority cut area. In the meantime, such items as defense and entitlements are allowed to expand. The Department of Education

assistance to local school districts constitutes only .007th of the federal budget.

Can the United States, which is falling behind as the leader in a technological world, afford not to fund an Act which could provide our children of today with the intellectual and technological skills which they need to compete in the 21st century?

While Korea, Japan and other countries acquaint their students with the latest technological breakthroughs, our kids are being taught yesterday's technology. We are running the risk of jeopardizing this country's economic security by raising a generation of technologically illiterate' citizens." Senator Jay Rockefeller, D-WVa, warns that "It is not an exaggeration to say that our future success as a nation -- our national defense, our competitive position in world trade, our national prosperity -- depends on our ability to provide the education and training needed for millions of citizens to master advanced technology."

As Charles Kettering so aptly said, "My definition of an educated man is the fellow who knows the right thing to do at the time it has to be done." Congress, like the educated man doing things, should provide funding, even in the era of deficit reduction, for technology education for the future youth of America. Kettering went on further to say that "We should all be concerned about the future because that is where we will spend the remainder of our lives."

SUMMARY

This testimony has presented a need for the passage of the Technology Education Act (HR 3102) in Congress. America's public education system is lagging dangerously behind recent technological developments. We are running the risk of jeopardizing this country's economic security by raising a technologically illiterate generation.

If passed, the Act would establish a series of demonstration projects to promote technology education at test high schools around the country. Through these projects, students would learn about key technological break-throughs in history and its promise for the future. They would also practice putting their math and science skills to good use through "hands-on" experience with technological principles. It would also create special courses and teacher training programs in technology education.

America, which has such a rich history as a country which led the world into the technological age, must educate our children to be technological leaders and pathfinders for tomorrow.

Chairman HAWKINS. The next witness will be Mr. Forrest Brummett, chief engineer, Allison Division of General Motors. Mr. Brummett, we welcome you.

STATEMENT OF FORREST D. BRUMMETT, CHIEF ENGINEER, ALLISON DIVISION OF GENERAL MOTORS, MARTINSVILLE, IN

Mr. BRUMMETT. Thank you, Mr. Hawkins. It's a pleasure to be here and have this opportunity. It's been my pleasure the last 2 years to travel around the world as president of the Society of Manufacturing Engineers with its 80,000 members worldwide, and to review some of the technological accomplishments of other countries.

I'll not go into detail on some of those countries, but I would like to cite one specific area in Israel that I had the opportunity to critique their facilities. It was the Israeli Aircraft Industries Corp. They have 23,000 employees there of which over 18,000 of those employees are technical people or graduate engineering type people.

As we began to review the technology that they had available, one of the directors of the program said,

> Mr. Brummett, we're going to take a look at the technology that's in the shops. You will not see the kind of computers with the names that you're familiar with, the Digitals, the IBM's, the various other, Computervision and so forth.

He said that the reason for that was that each engineer builds their own computer. They do this for two reasons, one because they understand the computer, and they know how to utilize it, but they also know how to improve upon it. Now that's creation of technology.

Much of this technology begins in the lower school areas of most of these countries, and as pointed out by Mr. Rockefeller a few moments ago, they go to school much longer than our people do and discuss, and they're brought up about technology in the very lowest grades.

This is not done here in the United States, and it's of great concern to me that we are losing our technological edge in this country that we've had for so long over the years. We've developed a technology and other countries have taken that technology and implemented it. The kind of people that we're looking for in industry today are not available. The kind of people that have an appreciation and knowledge of technology coming out of the universities are not available. They are being taught by faculty people who have not had the opportunity to update themselves on curriculum development in technology, and therefore, their students reflect this kind of knowledge and learning.

When they come into the industries today, then we spend major amounts to try to train these people. We have a training program at Detroit Diesel called College Graduate in Training. This program takes 2 years, and it means that is just the beginning for an individual who, even though they have a degree in engineering, cannot really implement technology until after those 2 years are up. Many times it takes longer.

These kinds of costs, of course, are detrimental to our position in the marketplace, having to wait that long a term before people can

become productive. That's a very critical issue, I think, that we need to address. The training costs, as I mentioned, are outstanding. Every industry is trying to put together training a program. We're not good at that. That's not our field, but many of the training programs that we initiate do not become very productive. They're better than nothing, but we need to have individuals come to us who had some technology training and awareness throughout their elementary school systems and, of course, through college.

The leader of the world in economics in the future will be those industries who have done research and development in the area of technology and in manufacturing. Those people will lead the world, and many of us know today that our country is fast becoming an information and service country, much unlike what we used to do to the Japanese and some of the other countries, like in Mexico. We used to send our component parts there to be assembled. In the future, they will be sending their parts, as they have already begun to do to this country to be assembled, and we will be more in the service sector than in the creation of new technology because of our lack of education at all levels.

Very few people realize the impact of technology on their lives. I think this is very important, that the public sector has very little awareness of how technology impacts their lives. To cite one example, one specific example, on November 9, 1965, one small relay went out in an electrical center in Ontario, Canada, and it thrust the northeastern part of this country into total darkness. Thirty million people or more were out of a way to prepare their dinners, stoplights, everything came to a screaching halt. Now that was technology creation, but it was a detriment.

Technology can also be a destructive device as well as a positive device. People need to know the importance of these kinds of programs and be aware that they need to understand how things work and how complex our society is getting. The complexity of day-to-day activities in industry today require individuals who are analytical, clear thinkers, people superior in personnel skills, who can get along and work within the environment as a team, and produce changes in technology and have an awareness of the need to create new technology, because therein lies the potential growth and leadership of this country.

Future requirements of the secondary school system that this bill will provide, pilot programs, demonstration programs if you will, and hopefully that will introduce new techniques of teaching technology. In the past, we've heard a lot of information about more science, more technology, more math and science in the schools, and the teachers and the educators come back and say we are going as hard as we can go now with the funds that we have available. But, there are new ways to do this, new ways to utilize the computer, new teaching techniques, such as role playing, such as simulations, that can teach a lot more to a student in the area of knowledge than in the area of memorization.

In the area of memorization, it's not retained. When knowledge is taught, the bigger percentage of the knowledge is retained, if students really understand the total function of how technology is applied and how it impacts their lives.

It's very difficult many times to get the media to come out and to publicize your technical conferences, because they don't understand it. They have very little appreciation for it, and they don't think that it's newsworthy, but if they knew how much that technology was impacting their lives, regardless of what facet they're in, what career path they're in, they would have more appreciation and give more time, I think, to technology development and what's going on in the world of technology.

Another example I would like to cite which is very important and very dear to most of us is the manufacture, if you will, of human body parts. There are over 1,300 human body parts today being manufactured, and this is because of new technology. In just a very few months, maybe years, there will be tiny TV cameras that blind people can see, and this is being done today, and people have already seen visions through these tiny TV cameras in their eyes, people who have never seen before. It's a miracle, the ability to do things that we have never done before.

It affects people's lives very directly. This is a good example of what advanced technology can do for us. There is a great need to begin this at the baseline which these two bills are directing, the baseline of technology, to begin the growth of technology education and knowledge and awareness at the elementary level on up through the colleges and universities which will make great strides for implementing technology in industry and the funding from these bills coming from the Government is a very good way to do that.

In the past, to cite another example of where we were in the early 1900's, about 92 percent of the population in this country was engaged in agriculture. Today, less than 4 percent of the population is engaged in agriculture, and we can produce more food than the world could possibly use.

This is where we are in manufacturing and in technology, but we need Government seed money. We need programs supported, not only by Government, but by industry and the academia, and we need to work together collectively to do this, because industry needs to step up to their role and provide guidance and counseling and funding to these kinds of programs, and they need to exchange their executives with faculty people, bring the faculty people into industry and give them an opportunity to see what is going on in the real world of activities.

I have the opportunity to be on the task force for the State of Indiana, to implement some science and technology and to determine new areas where we can implement technology and create new technology which will create jobs. Technology is looked upon as a negative, because we're automating our plants, and they're talking about releasing people. Well, these people are being retrained, and we at General Motors have a great interest in retraining these people that can be retrained and place them in the environment, because we know that it's very important that everyone who can work has a job to do. I support these two bills in every way possible, and I am in support of my company, General Motors,

and also the Society of Manufacturing Engineers, and, again, thank you very much for this opportunity.

Chairman HAWKINS. Thank you, Mr. Brummett.

[Prepared statement of Forrest Brummett follows:]

PREPARED STATEMENT OF FORREST D. BRUMMETT, DETROIT DIESEL ALLISON DIVISION, GMC, PAST PRESIDENT, SOCIETY OF MANUFACTURING ENGINEERS

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What once was recognized as the unique genius of America is now slipping away from us and, in many areas, is now seen as only a "second rate" capability. Unless action is taken now, this country is in real danger of being unable to regain its supremacy in technological development and economic vigor. First, all Americans must understand the serious implications of the problem; and second, we must dedicate ourselves to national and local actions that will ensure a greater scientific and technological literacy in America. Senate Bill #S-1823 and House Bill H.R #3102 will provide major opportunities to zero in on these solutions.

New and innovative technological concepts have brought about a clear awareness and recognition of the need for the secondary schools and universities to produce an abundant supply of "hands on", "real world" "applications oriented", individuals that more adequately meet the needs of today's industries. As industry moves toward the factory of the future, with its total integration of systems and common databases, it will be necessary to employ individuals with superior interpersonal skills who work well in the team concept of problem identification and resolution. The basics of the twenty-first century must include: communication skills, problem solving skills, scientific and technological literacy - in other words, the thinking and creative tools.

The greatest threat to economic survival in this country is industry's inability to employ people with technical knowledge capable of implementing current and new technology. We are in desperate need of personnel trained with sharp analytical skills and the ability to think through complex technical situations. These individuals are not currently available from the educational institutions.

Industry spends vast sums of money today in training personnel to implement technology, which further deteriorates their potential of competing in the international marketplace. In many foreign countries such as Japan, Germany, England, Korea, and France, this training is done in the educational system with highly qualified faculty and all of these programs are nationally funded. In comparison, industry training costs are ten times the cost of adequate training programs in the schools and the end result is less than desirable.

This means updating and improving the technology curriculum and providing the most modern lab facilities and teaching methods available. In addition, the faculty must be given the opportunity for updating their skills as new technology emerges and as current technology changes. Herein lies the need for interface between academia, industry, and government.

The quality of industrial technology education is not only an individual problem, it is a national problem. Technological advancement and world economics, together, determine the leadership positions of countries in our world today. As a nation, we have to address the problem of providing enough adequately trained personnel to guide our industrial growth. This effort has to include government, industry, and academia in a partnership designed to support industrial technology education at all levels.

Much of the new technology and most of the applications of existing technology are being developed outside the schools. This can only be changed through programs targeted toward "real world" technology education systems.

Because the American culture is distinctly characterized as technological, it becomes the function of our educational system to give every student an insight and understanding of the technological nature of the culture. This is what H.R. #3102 and S-1823 bills will eventually provide through demonstration programs of technology education. All persons must be knowledgeable of their technological environment so they can make rational decisions about their own lives on a day-to-day basis and participate in controlling their own destiny.

Technology has done more to change the way we live than all other forces. Much of this technology is organized by industry. While science has made enormous contributions by providing us with "truth" or "what is", technology has made its impact by providing us with "know how", or a knowledge of efficient and appropriate action. While technology is as old as the earliest artifacts that have left their historic trail, it has been moving ahead with prodigious and startling advances. Today, Science and Technology are moving forward in parallel paths. Each feeds the other and enables more advances as problems of our era are creatively solved.

We are rapidly moving from a "smokestack economy" typified by people working at assembly lines in factories to an "information age". Dominant, in this age, is a "new industry" which utilizes the technological developments of computers, lasers, computer-aided design, computer-aided manufacturing, new materials, new processes, new management techniques, and new communication and transportation systems. Emphasis is now being placed on productivity, efficiency, conservation, and quality, as compared to the past quest for quantity.

As technological development continues at an accelerated rate, it will become increasingly more difficult for people to understand these changes. Something must be done to prevent us from becoming a technologicaly illiterate nation. It is absolutely necessary for all people to understand technology if they are to function as citizens in their roles as voters, workers, employes, and family members. A concentrated effort is essential to educate the citizens of our nation to better understand technology and its impact on their lives. Only then can technology be controlled and contribute to advancing our way of life.

A fundamental mission of our educational system is to increase each person's ability to comprehend and apply the concepts of industrial and technological systems. This mission can best be accomplished by Congressional approval of H.R. #3102 and S-1823 bills.

One prime example of how technology impacts people's lives is the production of over 1,300 artificial human body parts. Medical replacement catalogs provide artificial joints, fingers, toes, tongues, computerized limbs, natural organs such as heart, liver, cornea, lungs, kidneys, bone marrow, and pancreas.

Health care experts estimate that in the United States last year, between three million and four million artificial body parts were implanted, including more than 85,000 artificial hips and 50,000 artificial knees. Worldwide, 280,000 more people each year owe their lives to cardiac pacemakers, according to BIOMEDICAL BUSINESS INTERNATIONAL, an industry trade journal. By 1990, analysts believe about 850,000 pacemakers, annually, will be sold worth almost four billion dollars.

Skin banks, eye banks, ear banks, and organ procurement systems are as much a fixture of the medical scene as blood banks. Eventually, we could see a person where 30% of his body weight could be transplanted, or artificial organs. If this person was paraplegic too, then there could be a computer strapped on his back, making the muscles in his legs work.

By most industry estimates, sales of artificial organs and implants may bring into the economy more than 1.5 billion dollars each year. Treatment of end stage kidney disease which largely involves kidney transplants or dialysis, last year, cost the Federal Government two billion dollars under its public insurance programs. This cost may reach four billion dollars by 1990. The orthopedic manufacturing business on joint and bone replacements was worth, roughly, 200 million dollars last year and is expected to grow 15% annually. To satisfy the demand for artificially manufactured hearts, alone, eventually may require 50,000 units each year.

In summary, much of our abundance is a matter of our technical competitiveness in the international marketplace. We are on the verge of losing our technological edge if concerted action isn't taken to produce technical proficient personnel for industrial employment capable of creating and implementing technology in the areas of communications, manufacturing, transportation, and construction. It is of equal importance to develop an awareness of the impact technology has on individuals' lives and to provide the public sector with knowledge about technology, its evolution, systems, techniques, utilization in industry and other fields, and cultural significance.

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A key to the nation's economic survival is technological progress, but it may be threatened unless the public's fear and lack of knowledge is overcome. Technology is a human endeavor and thrives when it is part of a culture that values and understands it, and knows how to shape it into human needs.

H.R. #3102 and S-1823 are well written bills, clear and precise in their definitions, applications, implementation, and scope. As a representative of industry and an 80,000 member Manufacturing Engineering Society, I will support this vital legislation in any way possible.

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QUESTIONS

For: Forrest D. Brummett

SENATE BILL #S-1823 HOUSE BILL H.R. #3102

1. What are the critical issues of technology education from an industrial viewpoint?

2. What type of personnel does industry need to compete in the international marketplace?

3. How does the lack of quality technology programs at the secondary school level affect the Engineering institutions?

4. What is a prime example of how technology affects peoples lives?

5. Are there any significant industrial technology pilot programs available today?

6. How does the Society of Manufacturing Engineers support industrial technology education in the secondary school systems?

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OUTLINE

I. The critical issues of the United States' potential for losing its technological edge.

II. The type of personnel Industry needs to implement current and future technology applications.

III. Industrial training costs for technical personnel.

IV. The importance of technology to the United States' economic growth and survival.

V. The impact technology has on individuals' lives.

VI. Future requirements of the secondary schools' industrial educational programs.

VII. The importance of the public sector's awareness of technological education.

VIII. Human body parts - prime example of advanced technology.

IX. Summary - Support of both bills.

Chairman HAWKINS. May the chair commend all three of the witnesses for the manner in which they've presented their prepared statements. I think you have been very articulate in presenting the highlights of the statements, and I think that you possibly have invoked quite a few questions from the members of the committee. May I first of all yield to Mr. Boucher, the author of the bill, who may wish to question you at this time.

Mr. BOUCHER. Thank you very much, Mr. Chairman. I want to join you in commending the witnesses for their outstanding testimony this morning. Mr. Brummett, I was particularly interested in several of the things that you said, both in your oral summary and in your prepared statement.

You indicate in your prepared statement that it costs industry about 10 times as much to provide technology education to new employees as it would cost the public school system to provide that same education and that the results as required by industry for that expenditure of 10 times for what it would cost the public sector are less than satisfactory.

Tell me, if you would, why it costs 10 times as much for industry to provide that training and why the results are less than satisfactory.

Mr. BRUMMETT. Number one, we had to provide the facilities. We had to set up training rooms and build facilities to do this, and we also have to buy equipment which we don't have, and in many cases, we have to utilize our own people who are highly paid engineers in some regard to do the training, to do the instructing. It's either that or bring in consultants at a very high rate of cost to do the training.

Sometimes it's not the kind of training to individuals who have come out of college who have decided maybe at the sophomore level in college that they want to become a manufacturing engineer. They have no basis and no background in many cases and appreciation for technology down through the lower grades. So their scope is very minimumal, to say the least.

So that individual, even with the training we can give them in the real world, is sometimes very unsatisfactory, and it takes years of training on the job to bring this person up to scope.

Mr. BOUCHER. So I think your overall point is that it's just much more efficient and produces a far better result if this kind of training is provided in the public sector by elementary, secondary and even graduate schools than it is for the employees to be trained once they're hired by the industry themselves?

Mr. BRUMMETT. Exactly, exactly. We need to have a strategic plan, if you will, to bring students from elementary positions right on up through the system, not to dictate to them that they should go into technology or into transportation or communications or manufacturing, but should have the opportunity and the know-how of how those areas affects their lives. Of course, communications can be utilized in any kind of area that you would go into or any kind of career pathing that you would go into.

Mr. BOUCHER. I think you make another very interesting point when you say that there is a substantial drain on industrial resources in having to provide the funds necessary for this kind of

training and that that, in turn, tends to erode the competitive position of those very industries in world markets.

Can you give me some indication of what the dollar volume of those training costs for all American industries is on an annual basis?

Mr. BRUMMETT. It would be almost impossible to do that, but it's in the billions of dollars, the billions of dollars. General Motors spends millions and millions of dollars in doing these kinds of training programs. It's very hard to coordinate a central or standard program with all the divisions of a company. Each company has their own techniques and requirements for specific skills in their particular operations. IBM is a great example. I think they spend some $180 million a year on just training their salaried work force alone. When you're training individuals who are supposed to be out producing on the job, you not only lose their salaries, you lose their input for the total time.

To give you a good example of that, I have about 25 of my top engineers today who are taking courses in Toguchi which is a Japanese statistical process control which is very important in manufacturing today, to do it right and do it right the first time.

Those individuals are not producing in the area of implementing technology. They're not doing their job, so it's very hard to measure the loss of their productivity when they're going to school, but it's a must. It's something that they have to have, and it's something that cannot be required on the campuses or at the high school level.

Mr. BOUCHER. Do you notice that there are any technology education programs in place in the public schools today, and let me add to that, does your organization of professional engineers provide any kind of assistance or guidance to the public schools in conducting such programs?

Mr. BRUMMETT. Yes, we do. The Society of Manufacturing Engineers has an endowment program, and we've given away over $2½ million so far. Most of it has been our own funding, to give to colleges and universities as seed money, if you will, to implement new programs and new technology.

A year and a half ago, December 1, 1984, I came to Washington, DC to receive recognition from President Reagan on one of our programs in the secondary school system where we had proposed grants to set up pilot programs on changing their curricula into a new technology development program at that level, and being close to where I work, I bring these faculty people in and take them through our facilities, put them with our people and showed them what we were doing, and the kinds of people that we were going to need, not only in the next 4 or 5 years, but in the next 10 to 15 years, because that's when those individuals will be coming into our industry to go to work.

This program at Avon High School near Indianapolis, IN has got a model program and pilot program that they've initiated based on a grant that we gave them from the Society of Manufacturing Engineers. So there are many good programs going around the country.

Indiana has initiated a pilot program in their school system to implement the teaching of technology, but if basically funding is

the major problem to get these programs off the ground, of course, then we're always dealing with the change. People resent change, and it's very difficult to change curriculum that's being taught and has been taught for years into the new techniques of teaching and the new technology that's required.

Mr. BOUCHER. I think it's very commendable that your organization has done that. I suppose that those who might be inclined to oppose this measure would look at that example and say that you're providing $2½ to $3 million in funding, or at least have in one instance, and that we're proposing a very modest expenditure of $3 million, at least for the first year, to set up pilot programs through this bill. Those who oppose the measure might suggest that since the private sector is already doing this, why is there a need for the Government to intrude and to supplement that effort, and what is your response to that?

Mr. BRUMMETT. Well, there are very few opportunities for the society to do these kinds of things, and, of course, most of our effort is concentrated in engineering at the campus level as well, but those are just small amounts of money. What we need is the backing and support of industry and Government, because we can only do so much at the local level, and these programs are splintered around the country. They need to have an overall togetherness, if you will, or standard to run these programs. I can't quote the number of high schools available, but there are hundreds of high schools available that need this kind of assistance and this kind of help. But, it needs to be an organized approach, it needs to be a national approach, like has been done in Japan, Germany and France and some of the other countries, England, where their programs work so well in the cooperation of academia, industry and Government.

Mr. BOUCHER. Mr. Brummett, I thank you very much. My time is about expired, but I do have one question I would like to pose to Mr. Hughes, and that is, could you describe the infrastructure that exists in the public schools today through which technology education services could be delivered in the event that this legislation is enacted?

Mr. HUGHES. Yes, sir, we have programs at the elementary level. They're very small. The biggest enrollment, and most students are served, at the middle or junior high school level. Throughout our Nation, when you look at secondary education which would take in from grades 7 through 12, there are probably 45,000 industrial arts, technology education teachers. We have the potential to reach a number of students that way. In terms of the proposal of how to deliver a technology education program, I believe present here is a publication titled "Technology Education: A Perspective on Implementation."

Mr. BOUCHER. This is the document to which you're referring?

Mr. HUGHES. Correct, and that has in it a proposal on how to deliver such a program.

Mr. BOUCHER. I assume it would be delivered through existing vocational educational departments and industrial arts departments primarily, is that right?

Mr. HUGHES. Primarily through industrial arts departments. Now, there's a distinct difference there between industrial arts and