REMARKS BY

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NATIONAL SCIENCE FOUNDATION

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Research Administrators

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I wish to thank Eric Rude and the Executive Committee of the National Council of University Research Administrators for inviting me to address you this morning. I am pleased to have this opportunity to discuss some concerns in science, mathematics, and technology education that bear both on our national supply of scientists and engineers and on the importance of promoting public understanding of science and technology.

The title of my talk is "Communicating Science: Is It Worth the Effort?"

Let me state emphatically that my answer is YES.

I am convinced that the critical issues of precollege education in science, mathematics and technology must be dealt with in the best ways we have available to us. And if what is available to us is not effective, we must create and invent approaches that are effective.

I believe that meaningful, collaborative efforts among academic institutions, the private sector, and government must be launched immediately in order to build on the current national concern about science and math education. I would like to illustrate that by symbolically mixing three different chemical solutions in this cylinder. (Mix reagents of the Briggs-Rauscher Oscillating Reaction)

[BZS comments about the interesting things that happen when true collaboration takes place. Periodically the audience oohs and aahs about the sequence of color changes.]

In October 1983 the National Science Foundation reestablished the Directorate for Science and Engineering Education. Both the Administration and Congress provided NSF with funds to help revitalize the teaching of science and mathematics primarily at the precollege level. I think George Keyworth's statement in the April issue of IMPACT indicates the Administration's concern. He notes that "Our first priority was...to address the immediate problem of enough professional scientists and engineers...But we know that some pressing problems won't be adequately

addressed this way. We're far less able to train people in the classroom, and that problem haunts us from the universities right down to elementary school."

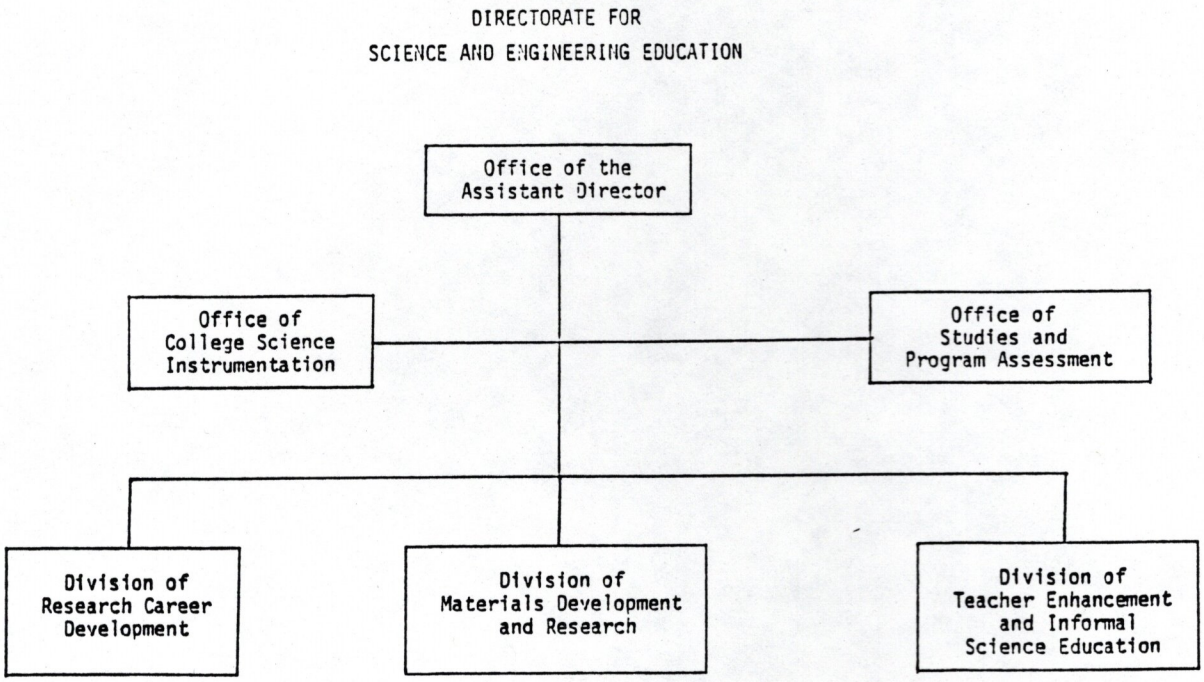
In late June of this year I assusmed my duties as permanent assistant director of the Foundation for Science and Engineering Education. We have established a meaningful organizational structure to help use our funds effectively and where they can do the most good.

[Show 3 slides and discus briefly the functions in each unit. Indicate the following funding levels for fiscal 1985:

Division of Research Career Development	$ 27.3M
Office of Studies and Program Assessment	2.2M
Office of College Science Instrumentation	5.0M
Division of Materials Development Research	38.1M
Division of Teacher Enhancement and Informal Science Education	40.5M
Total	$113.1M

$82.0M appropriated + $31.1M Carryover]

Slide 1:


DIRECTORATE FOR
SCIENCE AND ENGINEERING EDUCATION
Office of the Assistant Director
Office of College Science Instrumentation
Office of Studies and Program Assessment
Division of Research Career Development
Division of Materials Development and Research
Division of Teacher Enhancement and Informal Science Education

Slides 2 and 3:

Directorate for Science and Engineering Education

Division of Materials Development and Research

- Improved Instructional Materials
- Improved Methods of Teacher Development
- Applications of New Technologies
- Research in Teaching and Learning

Division of Teacher Enhancement and Informal Science Education

- Honors Workshops for Precollege Teachers
- Local and Regional Teacher Development
- Presidential Awards for Excellence in Science and Mathematics

Teaching

- Informal Science Education
- Information in Science and Mathematics Education

Division of Research Career Development

- Graduate Fellowships
- Minority Graduate Fellowships
- NATO Postdoctoral Fellowships
- Advanced Institute Travel Awards
- Presidential Young Investigators

Office of Studies and Program Assessment

- Studies on the Conditions of Precollege Science and Mathematics Education
- Analysis and Interpretation of Available Data

Office of College Science Instrumentation

- Scientific Equipment for Undergraduate Colleges
- Undergraduate Laboratory Development

I strongly believe that we now have a situation which is more critical and more consequential than what we had in the immediate post-sputnik era. For one thing, there are more of us now in the United States than there were 25 years ago. So, the sheer magnitude of the problem in terms of having more students to teach and needing more qualified teachers is one

difference. Of course, we must have an adequate number of scientists and engineers coming through the pipeline if we are to maintain our economic strength, national security, and advanced technological society. The most consequential difference between now and 20 - 25 years ago is that we live in a more technological society than we did in the post-sputnik era. And it is the science and math education of the non-specialists that requires our special attention.

We must involve scientists and engineers in projects which lead to improved quality of science, math, and technology education at all educational levels. We must bring together scientists, engineers, and educators to apply results of new research from the cognitive sciences area. We know more about learning now than what we knew 10 - 15 years ago. In teaching science, engineering, and mathematics we should be aware of how the learner acquires knowledge and mastery of physical concepts and mathematical manipulations. It is absolutely essential that scientists and engineers become more involved in the science and math that their children are learning in school.

The education enterprise in this country is a trillion dollar operation. NSF currently has a budget of about $100 million for education programs. How can we possibly solve the nation's problems in science and math education with such funds? Obviously, we can't. What we <u>can</u> do is play a strategic leadership role. The federal role is one of leverage in terms of working with educational institutions, both public and private, <u>and</u> with the private sector to provide meaningful opportunities for teachers to upgrade their knowledge of the subject matter, to learn how to adapt or even adopt new educational technologies to strengthen their teaching, and to have continuing education programs dealing with both subject matter content and pedagogy. NSF can help catalyze existing <u>good</u> programs and can also help initiate new programs in collaboration with educational institutions and the private sector.

With the advice and assistance of industrial leaders, I intend to appoint an industrial scientist on my staff at NSF. Such a person would help in establishing policies to foster productive collaboration among

colleges and universities, industry, local and state education agencies, and NSF. This collaboration would be aimed at enriching, enhancing, and strengthening education in science, math, and technology at all levels.

Let me now read excerpts from an announcement of a meeting which is to be held in Houston. It is the type of meeting which our proposed private sector liaison person would be helping organize.

> "Houston will host an important meeting of the representatives of education, business, government and the community at the Statewide Conference on Building Excellence through Partnerships in Education at the Westin Galleria November 29 and 30.
>
> "At a time when the Houston Independent School District and other school districts throughout the states are grappling with the challenge of raising educational standards, The Houston Chamber of Commerce, the Governor's Office, The University of Houston, VOLUNTEER: The National Center for Citizen Involvement, National School Volunteer Program, Tenneco Inc., and The White House Committee for Private Sector Initiatives to sponsor an outstanding conference which should help to provide important solutions.
>
> "A blue-ribbon group of speakers will participate, including Governor Mark White, Mayor Kathy Whitmire, Chamber President Louie Welch, University of Houston System President Charles Bishop, Special Assistant to the President - White House Office of Private Sector Initiatives James Coyne, Tenneco Chairman James Ketelsen, President of VOLUNTEER - Ken Allen, Executive Director - National School Volunteer Program Daniel Merenda, and HISD General Superintendent Billy Reagan.
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> "During the two-day meeting, some 400 educators,

> government officials, and business peopele will examine how schools can best utilize partnerhsips with companies and other organizations to improve and enrich educational programs. Experts from throughout Texas and other locations will present case histories of successful partnership programs, and attendees will have the opportunity to exchange information with their counterparts in other cities and towns."

Our organization at the precollege level is focused on several areas. We have a Division of Teacher Enhancement and Informal Science Education, which provides support for a variety of teacher training efforts -- both pre-service and in-service, and for out-of-school programs related to museums, zoos, the television media and other nonacademic organizations. In addition, we have a Division of Materials Development and Research, which provides support for development of instructional materials for use in teacher training and with students at the precollege level, as well as support for research on teaching and learning in science and mathematics. We also have an Office of Studies and Program Assessment, which will monitor the status of precollege education, support a variety of studies related to this, and integrate data on education from various sources.

During this fiscal year, we are emphasizing the elementary and middle school/junior high school years, although not to the exclusion of high school. We strongly believe that it is in these early years that the foundation is laid for later interest in mathematics, science and technology. U.S. elementary schools are woefully lacking in good math and science teaching in the elementary years. By the time student reaches high school, he or she has generally lost interest in these fields. We hope that we can find a way to have some effect on the training experiences of elementary school teachers, to try to reinvigorate the teaching of mathematics, science and technology at this level.

I urge you as individuals and as organizations to find out about and become involved in the National Science Foundation's education projects in the Directorate for Science and Engineering Education. We very much need

the active participation of research and practicing scientists and engineers and of professional societies representing them in the development of instructional materials, in teacher training, and in developing and carrying out our goals in science education.

I am encouraged by the numerous national exemplary programs that have been undertaken in science and in engineering.

--The Association of Science-Technology Centers (ASTC) is working with AAAS to create a pool of scientists and engineers willing to volunteer time at a science-technology center. Five Centers have been selected as a pilot project, and over 1000 scientists and engineers have volunteered to act as consultants, speakers, exhibit designers, and museum members. The five Centers are the Cranbrook Institute of Science in Michigan, the North Carolina Museum of Life and Science in Durham, the Museum of Science and Industry in Chicago, the New York Hall of Science, and the Capital Children's Museum in Wasington, D.C. The Association of Science-Technology Centers has also developed a traveling exhibit for museums on "Light and its Properties," which will be seen by one million visitors in about 15 Centers.

--In New York State, the state Industrial Arts Association has been involved in a project called "Futuring," which over the last three years has involved hundreds of educators, engineers, business and industry personnel, legislators and others. A k-12 technology-based program is being developed through which the Association (which is now changing its name to Technology Education in New York State) hopes to contribute to all persons' technological literacy. It is being accomplished through an activity-oriented, laboratory-based approach.

I am most encouraged by the exemplary programs that the chemical industry continues to support. For example, in June of 1983 the Institute for Chemical Education was established at the University of Wisconsin-Madison with the help of several companies including DuPont, Exxon, Shell, UpJohn, Syntex, and others. The aims of the Institute include revitalizing the teaching of the chemical sciences at <u>all</u> levels by engaginig the collaboration of industrial scientists, precollege teachers, college and university

faculty in developing instructional materials and in dissemination activities such as summer courses and in-service workshops. The Institute and its far reaching programs will be successful through sustained support from industry and government. The private sector has a deep interest in the chemistry education that its future customers receive in both formal and informal educational settings.

Shouldn't there be similar institutes in other disciplines? Why not an institute for mathematical education, one for physics education, one for biological sciences, one for engineering, or one for science and math education at K - 8 levels?

Industry continues to have a leading role in supporting a wide range of educational activities. The program "Search for Solutions" is sponsored by the Phillips Petroleum Company and is very effective and widely used. The Monsanto publication "The Chemical Facts of Life" is an excellent pamphlet that is widely distributed throughout the country. The Westinghouse Talent Search has a long and rich tradition of recognizing excellence. DuPont's Aid for Educaton program has long supported institutions and as new needs developed, DuPont responded by supporting minority programs and by supporting education at the precollege level. Polymer science workshops for high school teachers were sponsored this year by DuPont and by Shell.

But school science and technology courses cannot provide all the science information citizens will need throughout their life to understand a changing world. All of the many reports issued over the past several years agree on the importance of the public's understanding of science and technology. We live in an age when every new car uses a computer chip to control the ignition. Every newspaper contains articles about toxic waste disposal, use of pesticides, food additives, nuclear power and genetic engineering.

Not too many years ago society generally believed that technology would find ways to solve all our problems. The promise of technology is great. However, absolute faith in technology is foolish. New research and technological innovations bring negative impacts, no matter how positive their

overall consequences might be. Our tasks as scientists and engineers extend beyond research and transmitting knowledge. For example, chemists must also strive to inform and educate the public who do not fully appreciate the important role chemistry plays in both their personal and working lives. Problems of population, food, fuel, pollution, can be solved if we prepare our students and the public-at-large to live in a world full of chemicals whose properties and effects are understood.

Our major concerns must include not only survival, but the quality of life. We must emphasize that science and technology can lead to either improving the quality of life or destroying it. This is one of the reasons that the National Science Foundation, for the past 25 years, has provided support for informal science education activities. As we reach agreement and support on the need for a strong program of science education for all students, we have also begun to recognize the importance of informal, out-ofschool learning. Most people, most of the time, learn most of what they know about science and technology outside of school.

I submit that our greatest challenge is to extend learning opportunities so that all individuals can continue to expand their knowledge and understanding of science. Improving science teaching is crucial, but it's not enough. Our adult population also needs to learn new science concepts. We need not only skilled scientists, engineers and technicians, but managers and decision makers who understand the nature and implications in their fields. And we need a citizenry that can follow and weigh the progress and implications of science and technology--a public whose interest and enthusiasm can last beyond the momentary thrill of a moon landing or a Saturn fly-by. I guess the space shuttle lift offs and landings have become almost routine and perhaps their success is taken for granted.

Science centers and museums attract phenomenal attendance--almost as many people attend science museums as all other museums combined. The total attendance of 150 million per year is equal to the box-office attendance of baseball, football and basketball combined! Why? Because they give people meaningful experiences that appeal to the senses, emotions and intellect.

In Lansing, Michigan, Impression 5 received a grant to design and build an interactive exhibit entitled "Playground Physics." This exhibit will be duplicated for use in other museums and in schools across the country.

The New York Zoological Society has developed two imaginative life sciences modules for middle schools. They have carried out extensive teacher training programs to integrate classroom teaching with experiences at a zoological facility. Again, the program can be used in many different zoological facilities in cooperation with local schools.

The Chicago Museum of Science and Industry has opened a permanent exhibit on "Everyday Chemistry." One of the features is several chemical reactions and demonstrations, controlled by microprocessors, but set in operation by visitors. In developing these demonstrations, my associate Rodney Schreiner, of the University of Wisconsin-Madison, and I have aimed at enabling the visitors to see color changes and chemiluminescence, identify organic compounds by smell, and feel the heat released from reactions. About four million people visit this museum every year. If only one percent of this total visit the chemistry exhibit, then 40,000 people will get a brief exposure to chemistry. This is more people than any one in teaching will reach in classes in a lifetime!

It is part of the business of our professional societies to encourage and support better science reporting for the public. However, we cannot leave these kinds of efforts to our professional societies alone. Those of us responsible for teaching and research in the sciences and engineering must take on the added responsibility for informing and involving the public, for it is our research that is news and we're the ones who can explain it. We have to learn how to communicate through the media and how that differs from communicating with fellow scientists and engineers.

In addition to the institutional efforts, I believe that each scientist and engineer must take on some individual responsibilities aimed at improving education and public understanding of science in our local communities. I ask each of you to ask your colleagues in the science and engineering departments to commit some time to consider the following four

challenges:

1. Spur your professional organization local section to conduct expanded programs in technology and engineering education. Be specific in what you suggest and help implement the project. In addition to programs to recognize outstanding students and teachers, you could offer a mini-course at the local high school or your local section could adopt-a-school; tutor students or become a mentor; establish an extra-curricular science, or computer club at your local high school; help develop an exhibit or film and lecture series for your local library or museum.

2. Make a presentation to 6th, 7th, and 8th grade students in your area. Emphasize the process of science and engineering, and the benefits of both to society. Those are the years when life-long attitudes toward science and engineering begin to develop.

3. If you are active in a local civic or service organization plan an engineering or science program. It takes a little imagination and a lot of commitment, but it will strengthen science and engineering education at the local level and increase public understanding and support.

4. Take an editor or a newspaper reporter out for lunch. Let them know about your interests and concerns, especially as it relates to science and technology coverage. Your talk to the local Engineering Association might make an Op Ed piece in your local paper.

There has never been anything dispassionate about the scientist's or engineer's search to unravel the mysteries of the universe. I am reminded of a quote by Nobel prize winner Harold Urey. It was 40 years ago that he said, "To those of us who spend our lives working on scientific problems, science is a great intellectual adventure of such interest that nothing else we ever do can compare with it. We are attempting to understand the order of a physical universe vast in extent in space and time and most complicated and beautiful in its detail."

It's up to us to convey that excitement, that wonder, and that

dedication. It demands our best efforts.