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REMARKS BY
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Thank you very much. I really appreciate the opportunity to be here tonight. I have a number of things that I would like to share with you. But first let me tell you I am very pleased to see so many familiar faces and also some other faces that are becoming familiar. I have had the special privilege of having known so many of you for some time now in a variety of settings, and I am pleased that the President of an institution not represented here today has become a program officer at the National Science Foundation. That's Russell Aiuto who, until recently, served as President of Hiram College.

We are in the process of continuing to recruit staff to come to the National Science Foundation because our responsibilities have been increasing and the demands are such that we need all the expertise that we can find. It's also important to recognize that some of you, and some of your colleagues, should consider coming to the National Science Foundation to serve in a capacity on the staff because we do need that help. These issues that I will raise with you tonight will strongly suggest that we need the best help that we can find. To the extent that it was possible a couple of years ago Truman Schwartz, himself, came to the Foundation on this task. So we have good relationships at NSF with a variety of institutions represented here.

I am also especially pleased to see Allen West in the audience because not only did his father teach me chemistry, but he also taught my father chemistry at the U/B. It's always an emotional moment for me. It's a tribute to the influence that teachers have on students. I want to recognize that by giving you, Allen, this symbolic lightstick in memory of your father who showed me and showed my father the light.

I have some strong convictions that will come across in my presentation tonight. And I have some strong concerns that will also come across tonight. So I want to tell you about one conviction, one very important conviction; namely, that you and the institution that you come from can make a difference--a very big difference--in terms of dealing with the multitude of problems that we will discuss tonight and throughout the conference. And so I will be issuing a variety of challenges this evening, some of them are to be taken up on a personal level, or an individual level, some of them are to be taken up on a departmental level, and some of them are to be taken up on an institutional level. And I will leave it up to you as to which ones belong where. But I will not leave it up to you to leave any of them out. They all are important issues, difficult issues, that require your talents and the talents of your colleagues to help us deal with the very difficult situation that we face in this country.

In my judgment the situation that we face now in the United States is by far more critical and more consequential than what we faced in the immediate post-Sputnik years. It is so for a variety of reasons. Let me quickly mention three of those reasons. First, the population of the United States in the past 30 years or so has increased by about 50 million people. To put that number in perspective, that happens to be the approximate population of all of Great Britain. So there's the increase in the population. What does that mean? That means that we have more students to teach and we need more qualified teachers to teach them. The emphasis is on qualified. Some of the data I will show you in a moment are cause of alarm for us in terms of our ability to produce those qualified teachers. That's the first reason, which is basically summarized by thinking about the scale change that has taken place in the United States and the kinds of adjustments that our institutions must make, sluggish as they may be in making adjustments, to deal with those changes on a scale that this country has not experienced before.

The second reason as to why the situation is more consequential and more critical now than it was 30 years ago or so is that for our country to retain its international pre-eminence in the global economy, in science and technology, in the humanities, in the arts, in all walks of human endeavor, we must have a good supply of scientists and engineers coming through the educational system. And that's what NSF, as you know, set out to do in the immediate post-Sputnik era. All the curriculum development activities, all the teacher institutes at the precollege level, all the undergraduate activities, were aimed at providing that good supply of scientists and engineers, and to a very large extent NSF succeeded in that regard. What I'm saying now is that you've got to maintain the flow, you've got to keep a good supply of scientists and engineers coming through the educational systems. And again, some of the data that I will show you shortly causes us to be alarmed about our ability to do this.

The third reason, in my judgment the most important of all three reasons, as to why the situation now is more consequential and critical than 30 years ago or so is that we now live in a much more advanced scientific and technological society than we did back then. It's the education in science and in technology for the nonspecialist that we have to pay attention to. We need society at large not only to enjoy the benefits of those advances in science and in technology, but to be able to cope with potential hazards of those advances in science and in technology. We need to have an educated citizenry that is able to deal with very complex questions and very complex situations that we have not faced before. We need an educated citizenry who can distinguish between astrology and astronomy. We need an educated citizenry that understands the complex issues related to animal rights, we need an educated citizenry that can deal with the ramifications of the advances in nutritional sciences, we need a citizenry that can handle pollution control questions at the local level, questions of pollution control at the state level, at the national level, at the global level, because it's the health and well being of the planet at large that is in question. We need to have, basically, a scientifically literate citizenry that we, in the scientific community, we in the educational community, can deal with and can lead and can interact with.

The gap between those who are engaged in advancing science and technology and the rest of society is widening. We are no longer in the age of specialization, we are now in the age of subspecialization. And scientists and technologists who are subspecialists do a very good job communicating with each other, through a variety of settings. But very frankly, they do a poor job communicating with nonsubspecialists, especially with the public at large. So the issue of communicating science and communicating technology to the public at large is very important. And I would like to define that by referring to it as having scientific literacy for the population at large and technological literacy.

One of the challenges that I want to spell out very, very clearly to this group and to our colleagues is how we define scientific literacy. What does it mean? It sounds like a catchy phrase we can use. What does technological literacy mean? By the way, society by and large does not distinguish between science and technology. That's maybe all right, and maybe not all right. I don't know. But I ask you to think about it. I ask you to think about the attitudes that people have toward scientists and the images that they have of scientists . And perhaps some of those images are related, not to the science per se that goes on at our undergraduate laboratories and graduate laboratories, but to the technology that they experience. So that's one point that we ought to focus attention on in terms of recognizing that there is a problem that deals with advances in science, in technology, and the importance of communicating the implications of those advances to the nonscientist.

It's been suggested that perhaps because of this emphasis on the subspecialization that is required in order to excel in a certain field, that those subspecialists themselves may be scientifically illiterate and they may be contributing to the increased lack of communication between the scientific community and the rest of the population.

Let me just make one other point in this connection about the situation that we face. Let me summarize it this way. We need more scientists and engineers coming through the educational systems and we need a supporting environment for those scientists and engineers to do what they would like to do to pursue highly intellectually rewarding ____. In this connection I usually give an analogy that some of you have heard ~~this~~ before. The analogy comes from sports. Just like we have professional baseball players, professional football players, professional hockey players, and so on, we also have sports fans. And you know that without those sports fans the entire professional sports enterprise would be nothing. And that's not an exaggeration. So what we need are science fans. We need science fans to be physically fit, we don't want them to just sit in the stands. We need them not to become scientists, you understand, but we need them to develop an understanding of what scientists do, the complexity of the issues that scientists deal with, and the benefits that advances in science and in technology have provided us.

Now in audiences like this one that analogy doesn't go very far so let me try another one that perhaps strikes your fancy better. We need good orchestra players and we need audiences who can appreciate the performers. I don't want to dwell on this point any more, I think I have made my point.

By the way, it is the responsibility of the scientific community to communicate science to the nonscientist. It's not the responsibility of journalists, it's not the responsibility of lawyers, it's not the responsibility of the colleges of education that produce teachers. Why isn't it their responsibility? Why is it our responsibility?

The answer is very simple. It is our science that needs to be communicated, not somebody else's. It's the excitement that we have about doing something; it's the challenge of doing something that we best of all can communicate. That is why we must be inventive, creative, in finding ways to communicate science to the nonspecialist.

Let me now share with you very quickly some of the data that cause us to be alarmed. These data for the most part may have been seen by a number of you. I want to talk for a moment about some quantitative information and then get to a discussion of some qualitative issues.

The first thing I want to talk about is the number of 22-year olds in the country, shown on this transparency, from 1959 through the year 2010. The number is declining as you can see.

I want to quickly point out that this is not a projection. This is a fact, and it's a fact that we can't do anything about it even if we all got busy right away. It's a situation that will not take care of itself. Now, if you look at the enrollments in kindergarten, first grade now, you will see that in due time we will have a situation that can be dealt with. So this is an intermediate range kind of problem. It's not a short-term problem. I'll talk about a short-term problem shortly. It's not a very long-term problem either because we are talking about 12 - 13 years down the line.

This is the number of 22-year olds born in the United States, and that's a distinction that I think will help us deal with some of the issues that we need to deal with. What are the consequences of this? Well, the consequences of course have to do with the number of people who get a bachelor's degree in science and in engineering.

Let's take a look at this. This shows the bachelor's degree production rates for natural science and engineering, so mathematics is included here. And outside of computer science you see that number is about 4% of the total of 22-year olds in the country. It's been very constant, hasn't changed much. Computer science experienced a very rapid surge, as you see there, but this was followed quickly by a decline. So, if you assume that the production rates for current 22-year olds in the country will stay at about 4%, and if you then remember what we showed in the first transparency--that the number of 22-year olds is going down--then you can begin to do the simple arithmetic (actually it's not arithmetic, it's math) and you recognize that we are going to have a problem in terms of potential shortfall in the number of bachelor's degree holders in the natural sciences and in engineering.

Let's look at some production rates showing the expected effects of freshmen intentions. Again, the labels here are important. It is the intentions as expressed by freshman. Then again these are sorted out--computer science by itself and the natural sciences, including mathematics and engineering. The slope was upward for a while, but it's going down again. Now the reason I emphasize intentions is that you and I know very well that freshman who express an interest in science, in math, in engineering, many times end up getting a degree outside of science, math and engineering. In other words, there are people who start out with an intention of going into science and engineering, and they end up then getting a degree in a different area. Not vice versa. How many prebusiness majors end up getting a degree in physics, or chemistry, or biology, or geology? It is a one-way transition. The other one is a forbidden transition, if you'll pardon the jargon. So, we need to be concerned about that situation too.

Let's look at the effects of the 22-year olds on the Ph.d. production rate. It doesn't take too much thinking and analysis to understand what this hump here is due to. Just look at it and remember that there are great societal forces that influence education and that education also influences society. In fact education can be a great force to influence society. So what's that hump do? What does that _________ do from the early 60's til 1970? What happened in the 60's and 70's? (audience: Sputnik, federal funding,....) Think of great societal forces, not just disciplinary forces. The baby boom is one thing. But how do you influence what the baby boomers do? (Vietnam) What about Viet Nam? Student deferments. Think about that as a possible explanation for this. When did the draft end? When so many of the people in this room had the potential of getting a deferment and going to graduate school. When we had the National Defense Education Act fellowships, when we had all kinds of federal programs that dealt with this. When the draft ended something else happened. So this may be a valid factor, and it may not be. I simply suggest to you to think about it.

Let's talk for a second about the cumulative shortfall in bachelor's degree holders between now and the year 2000. This is based, again, on that 4% production rate I told you about and on the number of 22-year olds. And it's projected that we will be short nationally about 430,000 holders of bachelors degrees in the natural sciences and in engineering. So of course if we are going to have that kind of shortfall at the bachelor's degree level, it's going to have an effect at the Ph.D. level because there is only a very small handful of people who go on to get a Ph.D. without having a bachelor's degree. And so an examination of this transparency shows that by the year 2004, we will have roughly a shortfall of about 8,000 Ph.D. holders in the natural sciences and in engineering. And factored into this is the population of foreign students who get degrees in the natural sciences and engineering. People like myself, who come to this country and for good reasons stay in this country, and who enjoy the wonderful hospitality and the magnificent opportunities to pursue higher training. It's the greatest tribute that we have to our educational system, the greatest tribute in the world, that so many people from all over the globe flock to our shores to get training in science and in engineering.

Did you know that 40% of those who are enrolled now in engineering programs are foreign students? 40%. There's nothing wrong with the absolute number of foreign students in this country. But there's something drastically wrong when a fraction of U.S. students ~~with~~ of the absolute number of U.S. born students who go on into engineering. The data are similar for physics, for chemistry, for biology, for geology, and so on. So that's a problem that we have to deal with. And by the way, those foreign students, such as myself, who come here receive their precollegiate education elsewhere. And those students who receive their precollegiate education in this country are opting not to go into science and engineering careers on a scale that is demanded by both the growth in the population of this country and also by the growth in our economy.

So that's the series of pieces of information that you might want to keep in mind.

Let me just show you another one here because this is going to hit us hard very quickly. Within the next 10 years 40% of those of us who teach at institutions of higher education will retire. And the competition between industry and academe for talent at the Ph.D. level will increase. Now that's going to be helpful to the salary situation and that's a welcome development. But it's not going to be helpful for the overall welfare of the country. And if you look at this situation it projects a great deal of information. The information about academia is very straightforward; business and industries is straightforward too. Other includes national labs and people like myself who are working for the government, just to give you an idea of what these entries refer to. And it shows the replacements and it also shows the new positions that are needed. It's a cause of alarm that we ought to be aware of.

Let me now quickly shift gears and talk about where these various scientists and engineers are going to come from. And what we can do about the education of the next set of scientists and engineers as well as the education in science and in technology of the rest of the population.

I want to put some things in perspective here. By looking at the persistence of natural science and engineering interests from high school through the Ph.D. degree level. You take a population of 4 million high school sophomores in 1977, which is the actual number, and I want you to notice that under 10,000 of those end up getting a Ph.D. degree. I want you also to notice that about 200,000 get a bachelor's degree in the natural sciences and engineering. And about 46,000 get a master's degree in the natural sciences and in engineering. And I would like you to think about the role that your institutions play in educating those who get a bachelor's degree in the natural sciences and engineering, some of whom go on to get a Ph.D. degree at a major research university. I sincerely want you to think about the role that colleges like yours can play in this area here. And don't tell me that's not your problem to deal with, because the graduate students have to come from some place.

Now, if you and I know which one of these 4 million are going to be getting Ph.D. degrees, or bachelor's degrees, then perhaps we can do something about training them and guiding them. But we don't know which ones they are. Therefore, we have to be concerned about the quality of science and math education, not only in our own departments, in our own institutions, but in the high schools of this country. And as you well know, the problem that is shown on this transparency ~~where~~by this slope, a terrible slope here, is not where the real problem is. The real problem is at the middle school level and at the elementary school level. And that's where some of you, my colleagues, are going to say "I don't even know how to start doing anything at the middle school level or the elementary school level." And you know what, I believe you.

But I also believe that you can be inventive and you can be creative in finding ways that you personally are comfortable with to deal with that problem. That you, on a departmental basis, can deal with that problem. That you, on an institutional basis, can deal with that problem.

One of the difficulties in dealing with that problem is that there are no disciplinary demarcation lines prior to the sophomore year in high school. There's no chemistry course, no physics course; there's general science, earth science, some biology. There's lots of mathematics all the way across the board. So the real challenge for us, if we really care about our mission--which is education--is to see what we can do, what we can contribute, at the pre-high school level. And if your entry to that activity is through the high schools fine, do it.

This is a very serious problem that we have to deal with. It is our problem, not that of people who go on to get degrees in education. It is our problem because we must influence the way in which those teachers are trained. We must influence the way in which those high school sophomores who opt not to take science and mathematics and engineering as a career, we ought to _____ with their education in science and in technology because they are going to influence the way in which we do science, in which we do education at our colleges and at our universities. And let me say something that's very, very obvious. The major research universities focus on these 10,000 students, they do a good job, they do an excellent job.

If you want to deal with the chemistry majors that you have every year, do it, do it well. Do undergraduate research. Undergraduate research is a powerful educational tool for those who go on to careers in science and engineering. And we need those people. But what about the lawyers that graduate from Macalester College? What about the business leaders that graduate from Macalester? I'm not just picking on Macalester here. Should they not have a liberal education that includes science, should that science be different than the one that the science major takes? I don't know. That's a question that we have to think about.

I'm bothered with the narrow reference to research colleges, as I am bothered by the narrow reference to research universities. Do you know how many undergraduates are enrolled at the so-called research universities?

Let me move on and talk about another problem we have to deal with. Look at the same population of high school sophomores. Why do we look at the population of high school sophomores? Because that was the time that they were asked to express their intentions. The study was not done prior to the sophomore year in high school. As any mathematically literate person can tell you, those slopes are not the same and they mean something different to us. We need to focus attention on the participation of women in careers in science, careers in mathematics, careers in education. That would basically change this slope here. But don't forget that the rest of the population is way down here. Don't forget about the rest of the population. So, the two things I have tonight are that we need more scientists and more engineers, and we need to educate the nonscientists, nonengineers, in science and in technology.

That's the situation with respect to gender. You know, those of us in the scientific community have not had a distinguished record of attracting women to go into careers in science. So whatever it is that we've been doing for the past 10 years, and 10 is a small number, we have to think about that and we have to try to find ways to not only attract women to go into careers in science, but retain them once they are attracted. So we need 3 [two] strategies. We need an attraction strategy, a recruiting strategy, and a retention strategy. We need to allot, and we can do more in the retention area, fellowships programs, scholarships, and so on. Recruiting is something else. And that's _______.

A similar problem, if you have to be aware of it, has to deal with undergraduate ________. By the year 2,000, 80% of those who have entered the workforce will be women and minorities. You know that's only 12 years down the road. 80% of those who enter the workforce will be women or minorities. We need a technologically capable workforce, so we need to work ont the development of successful ways to change this slope here too.

We need another _______. Within the next 25 years the population profile in America will become such that 45% of the population will be minorities, up from about 5 - 15% that it is now. So the population profile is changing. We in the educational establishment, or the educational institutions, need to be doing something about _______. You know 40% of the students enrolled in secondary schools are at risk students. They are at risk of dropping out. They're going to be numbers in society that we will live in in the next several years. I want to be sure that I can get along with my fellow citizens. It's important for us to be aware that _______.

Something else that I need to point out--recruitment and retention strategies for women and for minorities are not one and the same, they are different. In fact, recruitment and retention strategies for Blacks are different than those for Hispanics. Recruitment and retention strategies for Hispanics in the Southeast are different than those for Hispanics in the Southwest. So we need to be aware of these kinds of problems. Notice that I'm choosing geographic locations far away from the _____ because I don't want to get into a specific ______ situation here, but I think you understand what I'm trying to say.

______ situation that has to do with the quality of the pool of students that we have in the United States. I'm showing you the results of a couple recent surveys, and I have chosen these examples only from the sciences, although they apply to mathematics as well.

This is the result of the U.S. students, fifth graders, performance on the international science achievement test. I'd like you to pay attention to a couple of items here. It involves the ranking of these countries as well as the range of this course. At the fifth grade level all the students in all the different countries took the same test. (It was agreed upon by the organizer of this study and they took the test, of course, in the appropriate language, but it was the same test.) This was where the fifth graders in the United States ranked.

At the ninth grade the science achievement rankings are those. You and I would like the situation to be like this. But it isn't. But you know what? We can make it happen. And if you don't believe we can make it happen, then we're still in a different ______. Isn't this why we are in education? Because we think. Not only do we think, we are convinced that we can make a difference. That's what education is all about.

Finally, I want you to see the _______ rankings here at the ninth grade level. Again, all the students took the same exam, not the one that was given to fifth graders, but a different one for the ninth graders, but the same situation develops. Why do I show you these? Because the fifth graders in a few years are going to be enrolling at Macalester College and a few other colleges that are represented here. That's the pool that we're drawing from.

Then we get to the situation where we talk about students taking a second year of science at the 11th grade or 12th grade level, the so-called specialists in this study, people most likely to be taking advanced placement physics, advanced placement chemistry, advanced placement biology. People who get a 3 or 5 from the advanced placement test and when they get to a university like Wisconsin are exempted from taking freshman physics. This is where the United States ranks. This is not our average run-of-the-mill student, we are talking about our good students, our best students. Again, I want you to look at the overall ranking, and also look at the range of the scores. That's the picture in physics. See the picture in chemistry. This is where the chemists rank. Again, look at the range. And not to prolong this tortuous story, this is what the picture looks like in biology. You know, I'm sure you know, more students take biology in this country than any other science.

I don'\t believe for one second that the talent in this country is any different than it is anywhere else in the world. Yet these data suggest that there is something in our society, something in our educational systems, that we have to pay attention to. I know this sounds like a gloom and doom story and to a certain extent it is, but I want you to know that I am optimistic, very optimistic, about changes. I have no doubt whatsoever that we as a nation have the capacity to deal with those difficult questions. The real question I have is do we have the national will to deal with those questions? Do we have the determination? Do we have the leadership that comes from colleges and universities to deal with those problems?

Let me quickly show you another set of data that were released very recently. This is called "The Nation's Report Card." This is what you got in your packet, you got a reproduction of this. This is the whole report, with all the questions, sample questions, and so on, and it was at a variety of levels. Let's just get a _____ identified here. It ranges from 150 to 350, that's the label for the level, knows everyday science facts and understands simple scientific principles, applies basic scientific information, analyzes scientific procedures and data, and ______ specialized scientific information. Nine-year olds, thirteen-year olds, and seventeen-years from 1969 to 1986. It's a good news/bad news story. The good news is that we have made some recoveries. The bad news is that the magnitude of the recovery does not match the magnitude of the decline. Let's take a look at this table, again, that's reproduced from the report, and you see that the changes are not all that great. For Level 250 to 13-year olds, the number went up a little bit, but the other two numbers, at the 350 level for the 17-year olds, the numbers went down a little bit, quite a bit actually, if you think about the population sample that we are talking about.

The results are broken down a little further by looking at the achievement of two groups of minorities--Hispanics and Black students. The news is good. The trend is upward, the ____ is in the right direction. But that performance is still below that of the white students. Can we do something about that? Can we do something about the minority students in Minneapolis/St. Paul? Can we do something about the minority students in Chicago? Can we do something about the minority students in smaller population areas? My answer is yes, we can. But the real question is "what?" and "how?" and that's part of the challenge that we in the educational institutions have to deal with.

Let me shift gears here and show you, in a slightly different way, the universal concerns that we deal with. And how it is divied up, at least the way we think about it at the National Science Foundation. Basically the boxes on the left tell us that we have to deal with curriculum and materials, we have to deal with teachers, we need to deal with students, and of course institutions and facilities as well. And then we have preschool, we have school, college, graduate, postgraduate, and we have continuing professional education. We have to deal with citizens of large ______; informal science education is a wraparound that involves everybody out of school. And the blue lines basically show the same kind of data as before in terms of the narrowness of the ____ population that we deal with at every level. It is so narrow at the postgraduate level it doesn't show on this. But this represents the universe that we have to deal with. And don't misunderstand what I am saying, we have to continue to focus on that narrow area, no question about it. We need scientists and engineers of high quality that continue to come out of our graduate schools, that continue to come out of our undergraduate institutions; but we also need to be concerned about where they come from and what happened to them before.

Let me now show you a couple of graphs that are familiar to you in view of the National Science foundation and the funding picture that we have at NSF from year 1, 1952, to fiscal year 1989, where the support for research is shown in the blue line, the support for science and engineering education is shown in the red line, and the sum of the two is shown in the green line. I need to talk to the artist who produced this to be sure that the appropriate colors are used so that when you add them up they add up to the right colors, they don't _____. That's the picture for the NSF history in terms of our funding.

Let me show you that same picture in a slightly different way. By clustering the years in 3-5 year periods, and looking at the support for science and engineering education, you see the fraction of the total pie. And of course the Sputnik years, the post-Sputnik years are quite prominent. During the early 1980's, when my part of the NSF was shut down, the support was focussed only on those graduate fellowship activities that are housed in my part of the NSF.

I'll show you the same data as in constant 1988 dollars, because that is also revealing, and you see that for the most part the overall NSF budget from the early 60's to the late 80's has been about the same. But the distribution within that is different. This distribution, this peak here, and what happened here, overall it is the same, and this is going down and something else is going up, or something else went up and this went down.

The point I want to raise here is something that underlies everything I have been talking about so far. Namely, our value system. What do we believe in and what do we believe is good for our society? It's not only the manifestation of our will in terms of dollars, but in terms of the emphasis that we place in our educational institutions on science and engineering education activities and on research activities.

The next thing I want to show you is the details of the support for science and engineering education activities by level. That is the precollege level, the undergraduate level, and the graduate level, where the fellowships are supported. The dip in 1982, of course, represents the great shutdown that took place. You see now in Fiscal Year 1989 we are at $171 billion, the highest level we have ever been at. It is a remarkable recovery from 1983. And I am very proud of that. I think we have begun to make some headway in dealing with those problems.

You will also notice that the distribution is different in terms of funding that is available. Now I looked up all the institutions represented here tonight in terms of funding from my part of the NSF. And I want you to know two things: first, I am pleased that there were so many institutions represented in terms of the awards that we have made for precollegiate activities and for undergraduate activities. I am very pleased with that. But I am terribly unhappy about the level of support that has gone to these institutions. You send in proposals, you have received some awards, you know about our success ratio in terms of awards made to proposals submitted. It's not very high, overall across all of the science and engineering education part of the NSF, it's about 20 percent. The peer review system that we not only believe in, but practice, and the judgment of my staff, in making recommendations for grant awards is such that 50 percent ought to be supported. But we don't support 50 percent, we only support about half that.

Let me show you the same data in constant 19__ dollars. And you remember that one of the things I said earlier is that the population has increased in the past three years by about 50 million people. In constant 1988 dollars we are about 1/3 of where we used to be. So I ask you again to think about the value system that we have in this country and how we can influence it.

I want to make two points very, very clear. Money is not the measure of everything. So I don't want you to think that I am only focussing on funds as a single measure, it's not that. It's an indication of something. That's the point I want to be very clear about. The other point I want to be clear about is that these scores I showed you before about international comparisons and so on, they are only one indication of the problem. We have lots of good students in this country, we have lots of good teachers, but yet we need to be paying attention to what these scores are telling us.

I want to show you just one more piece of information because this is of interest to you and because I know you and your representatives have helped us get to the situation that we are in now. You look at the increase in our budget by the three educational levels in 1987, there was over a 70 percent increase in our budget, and the precollege area has enjoyed the healthiest of those increases. The undergraduate activities have come a long way since 1987. And as you know, there are some other undergraduate activities funded outside of the Science and Engineering Education part of the NSF. The graduate fellowships support shows a decrease here, it's actually a consequence of a management plan that is going into effect that simply delays the payment of fellowship funds until after the beginning of the following fiscal year. So that's an administrative bookkeeping problem that has its own consequences which we need not get into right now. But there is no decrease in the number of fellowships that we have; in fact we are going to double those numbers of fellowships.

Now the last thing I would like to share with you now is a question that I am often asked. I am often asked the question "Why does the NSF provide support for science education activities? Why do the federal agencies provide support?" And I say that it's the same reason that NSF has for providing support for research activities, and most people say "Well, that sounds OK." But a few people ask what is that reason? Why do we support research and education in science and in engineering?

There are three reasons for it: The first reason is that it is good for our national security. Whether we like it or not, more than half the scientists in this country are engaged in defense related activities. It's a fact. If you don't like it you might want to change it. But it's there. We can dwell on each of these reasons, but we won't because of the time element. The second reason as to why we provide support for research and education is that it is good for our economic good. Again, we can debate that and discuss that. The third reason is that we do it because we believe in the effect of democracy that we want to maintain, which by the way, is threatened. All of our democratic institutions are threatened. If we continue to have a decline in our economic ability, there will be one in our national security ability too. Now these are the three reasons that are traditionally given for the support of science research and science education. And as is my habit in settings like this, I would like to ask those of you who are scientists, mathematicians, and engineers a very personal question. The question is: "Did you go into science because it was good for our national security? Or because it was good for our economic security? Or because you wanted it to be in an effective democracy? Did you? You went into science for a lot of personal reasons, Not the least of which is enlightenment. You are curious about the world that we live in. About natural phenomena that occur. You are curious about how different gadgets around us work. You wanted a ____. You also wanted to have the joy of learning. You wanted to have some fun in the best sense of the word, not in some cheap thrill fashion. That is why we went into science. That is the challenge of the problem to be dealt with. The intellectual stimulation, the emotional fulfillment that results in what we do in research, in teaching. That is why we did it. Some of us went because we wanted to get a good job. Maybe we didn't have enough information about the pay scale. There are a whole bunch of other reasons.

You know when I go up to Capitol Hill to talk to Congressmen, Senators, and their staff, if I were to tell them we should support research in education activities because we wanted to have some fun and we wanted to be personally enlightened, they will laugh at me just like some of you are beginning to smile. But if I go up there and tell them we want support for those other reasons, I connect. You see what the problem is. That we in the scientific community, we in the educational community, have? It's the problem of communicating science, communicating our concerns about science. We do science and science education for all of these reasons. But we have to be careful about communicating the concerns that we have.

I want to show you _________ by way of just a couple minutes of a video tape that comes from a fairly distinguished institution of higher education in this country. It's a video tape of a study that was conducted at that institution and, fortunately, it is not one of the institutions represented here. Let's just watch this tape as we think about the whole slew of problems that I have shared with you. I will just show you a couple minutes of this. Work in progress October 8, 1987, it's a year old. (Tape starts)