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UNEDITED TRANSCRIPT OF THE REMARKS OF
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Thank you very much, President Gassman. I want to salute you for the excellent role that you have taken in continuing to have the American Chemical Society lead the professional societies in the area of science education. For your enlightened leadership, I would like to present you with a token of appreciation, come on back here Paul. [Dr. Gassman is presented a green glow stick] -- (applause) You are the second president I know, who wants to be known as the "Education President". And I want to wish you the same success, as I have wished President Bush. (applause)

I'm pleased with the opportunity to be speaking at this Presidential Plenary Session of the 199th National Meeting of the American Chemical Society. Especially on the 20th Anniversary of Earth Day, Happy Earth Day Everyone. (applause)

My message today deals with both education and the environment. As the Nation marks the 20th anniversary birthday, I can think of nothing more important than education to successfully address the complex problems related to the global environment. Education

of the scientists of the future, continuing education of the scientists of the present, and most importantly, education of all citizens. Citizens not only of this great nation, but citizens of the world. For what is at stake is not only the quality of life in Boston, or the quality of life in the Commonwealth of Massachusetts, or the quality of life in the United States of America, but the quality of life on the Planet.

It is appropriate for all of us to examine and to affirm the real reasons for which we are concerned about the supply of scientists for the 21st Century. These reasons not only relate to our national security, to our economic security, and the to effective democracy that we belong to, but they are based on our convictions that all citizens of the planet must be enabled to fulfill their human potential. And that, can happen only if the integrity of the planet is preserved and is protected. In the words of former Secretary of State, George Schultz, "if the sovereignty of the planet is maintained". That is why we need both a good supply of scientists and a supporting citizenry that can appreciate the benefits from the advances in science and technology as well as deal responsibly with their potential hazards.

What threatens the planet is not only lack of regulations for controlling pollution, for curbing deforestation, and for dealing with ordinary and with hazardous waste. The biggest threat is

from irrational behavior on the part of societies, their leaders, and the individuals who belong to them. It is through education in general, and especially through education in science and technology, that we have a fighting chance to maintain the sovereignty of the planet.

Since behavior, for the most part, is a manifestation of attitudes and beliefs, we must devote a good deal of our intellect to develop a healthy societal environment which will influence attitudes and which will help our citizens avoid being bamboozled into making foolish decisions.

What we must be after is: rational behavior as individuals and as societies. I submit to you that if we had, as we don't have right now, but must have, a mathematically literate society, a numerate society, then we would not see the recent proliferation of state lotteries. I know these lotteries generate revenue, some of which in some states goes to support education and to cleaning up the environment. But I am talking about the basis upon which this revenue is generated. If the citizens of a state are only interested in generating revenue, regardless of how it is obtained, then why don't they pass a referendum enabling their state to go into the drug business!

Our literacy in science and mathematics reflects our values as a society. What we care about, what we believe in, how we treat

each other, and how we treat our environment.

This is the context of the rest of my remarks and pronouncements. To our international guests and colleagues, I extend an invitation to join in scientific and social endeavors, which will lead us all, to a hospitable global environment and to nationhoods where freedom prevails and where people are enabled to fulfill their human capacity.

What I'd like to do now, with your permission, is move over to the overhead projector and discuss some of the issues from the viewpoint of the National Science Foundation, with respect to the theme of this Presidential Plenary Session.

This [Figure 1] display represents the expression of interest in the natural sciences and in engineering of a population of 4 million U.S. high school sophomores, which happened to be the population in 1977. Of those 4 million high school sophomores 750,00 expressed an interest in the natural sciences and in engineering; when they got to be seniors the number dropped to 590,000. ONE YEAR LATER, the number dropped to 340,000, a 40 percent drop in just one year! In 1984, 206,000 received a bachelors degree in science, mathematics, and engineering: 61,000 enrolled as graduate students; 46,000 received a masters degree in 1986; and in 1992 fewer than 10,000 will get the Ph.D degree in science, mathematics and engineering. This is the so called

"science personnel pipeline".

As you can see, there is a great deal of leakage in this pipeline! My friends, it's not only leakage, it's a hemorrhage in terms of the loss of talent, not only to this nation but to the human race. Talent that can be devoted to improve the human condition.

It doesn't take a mathematically literate person to figure out that a small change in the slope up here will have a tremendous effect down here. But, the level of mathematical literacy across the country is so low that it does take a mathematically literate person to figure that one out! Speaking of mathematical literacy, I am reminded of the story that most of you, if not all of you know. It's about the student athlete who was having trouble maintaining his scholastic eligibility and his coach went to the professor and pleaded with the professor to help the student get through the course, otherwise the football season would be lost and the team would not be able to go to a bowl game. The professor agreed to give the student a special examination. The coach asked if he could accompany the student to examination. The professor agreed. At the appointed time they both came to the professor's office and the professor proceeded to ask the student questions. The first question was, "What is the square root of 16?" The student answered, "4". The coach was heard to be saying, "Oh, please give him another chance, please give him another chance." (laughter) Not too long

ago, I told this very same story to an audience of lawyers, (laughter) their reaction, unlike yours, was dead silence. (loud laughter) About 23 seconds later, someone was heard chuckling in the back row, he had taken out his pocket calculator!...(very loud laughter; applause).

When I speak of mathematical literacy and science literacy, I mean literacy for all segments of the population. Not only the for the ones who are college bound, not only for the ones who are going to become chemistry majors, but for lawyers, journalists, business people, and all voters!

In looking at this display, it is so easy to see only the dark part of the display. And that is what most of us do: simply, look at the "pipeline". What we must do is look at the entire display: both the dark area and the white areas. The white area represents the rest of the population. Our fellow citizens who should be literate in, and appreciative of science.

This display shows, in a very distinct fashion, the twin mission of the National Science Foundation. The first part of our twin mission is to increase the flow of talent into careers in science, mathematics and engineering. And the second part of our twin mission, is to see to it that the public at large is literate in science, mathematics and engineering -- is appreciative of what those of us in the sciences do and hopefully

supportive. In fact, I'll tell you what -- I'm willing to settle , in the short run, for having them to be tolerant for what we do. (laughter)

We in the science rich-sector of our society (this dark area in Figure 1) owe something to the science-poor sector of our society. Who is the science-rich sector of our society? Colleges and universities, parts of industry, and the national laboratories. Who is the science-poor sector? Everyone else. We have a responsibility to all citizens. If you believe, as I do, in a free America. If you believe in the democratic institutions upon which this country was founded and continues to exist, then you will join in a national effort to see to it that we have literacy in science, math, and technology for <u>all</u> citizens. Not only for those who are in the dark area of this display. There are many reasons as to why we ought to be concerned about this problem. Let me mention to you one crass reason. The people out here (in the white area of this display) pay for what the people in the dark area want to do.

It is fairly well understood, and even agreed to, that the battle is lost not in the sophomore year in high school but earlier. This is when the students vote, this is when they express their opinions. That is why the National Science Foundation has been heavily focused, at the middle school levels and the elementary school levels. However, that's where we don't have chemistry

courses; that's where the disciplinary demarcation lines disappear and that's where we, as chemists and chemical engineers, have got to show up on that playing field and see to it that there is quality education at the middle school level and the elementary school level in science. We want to try to help develop a positive attitude toward science and that, of course, will help recruit more individuals into careers in chemistry, the other sciences, mathematics, and engineering.

I want to leave this slide up the longest because I want it to be imprinted in your memory banks. It represents the entire issue that faces us. You know, in this country we have a huge federal deficit, and we have a big trade deficit; but, we don't have a brain deficit! We want to develop talent, that's the business that we're in, talent development. I'll come back to that point in a moment. To develop talent we have to focus not only on the best and the brightest, but we have to, in addition, put a heavy focus on the <u>bottom half</u> of the student population. For once again, if you <u>do</u> care about the quality of life in our society, then you will care about joining forces and seeing to it that <u>all</u> segments of our society are enabled to fulfill their human potential.

I want to show you this same display of 4 million high school sophomores, but by gender [Figure 2]. This looks like an unsymmetrical champagne glass. And of course, in chemistry, we

love symmetry. What we would like to do is to make this display symmetrical. There are two ways in which that can be done. One of them is unacceptable! (laughter) What we have to do is to prevent this tremendous leakage of talent among females. Let us not forget when we look at a display such as this one, that the people out here (in the white area) need our leadership and need to benefit from what we in the dark areas do, scientifically and otherwise.

Next, I show you the same population of 4 million high school sophomores by majority and underrepresented minorities [Figure 3]. This is a very sad commentary about our ability as intellectually rich people to recruit and to retain talent that exists in this country. Now some of you are going to say, "But I'm a chemistry professor", or, "I'm and industrial chemist, and I don't know much about recruiting and retaining minorities, or women for that matter, into careers in science." "All I want to do is to write another proposal to the National Science Foundation so I can get another NMR machine so I can go about doing my own research." Yes, I want you to write another proposal to the National Science Foundation, to do precisely what <u>you</u> want to do to fulfill <u>your</u> human potential. But, I also want you to remember the context in which you are able to do that and I also want you to remember the taxpayers who have provided funds for you to carry out your research projects and to support your graduate students.

What I am talking about is the future and how we must start developing immediately a national will and a national strategy to address those problems that face us. We must pursue our twin mission with determination and we must have coherent national plans. And as we plan for the future, we should glance in the rear view mirror and see what we did in the sixties, seventies, and eighties. We should only glance in the rear view mirror. Most of us have a tendency to dwell looking in the rear view mirror and think about only what we did in the sixties, seventies, and eighties. But as you have heard today, from Betty Vetter, the demographic picture is changing and we have to be resilient, sufficiently resilient, to deal with those issues. We have to be inventive and creative in pursuing our twin mission. And we have to be invincible in our will.

I have some specific recommendations. Since I have had the benefit of previewing Paul Gassman's talk, and Betty Vetter was kind enough to share with me a copy of her talk. I have decided to make some specific suggestions to various groups in terms of what not only can they do but what they ought to do.

I'll start with the American Chemical Society. Suggestion number one is to expand the efforts of the education division of the ACS. Also to strengthen the operations of the division of chemical education. To widely broaden the national and local

section programs ranging from National Chemistry Week to the recognition of high school chemistry teachers. Now those are easy suggestions to make because that is what is going on right now. In addition, I ask the American Chemical Society, the Members of the American Chemical Society, to work with middle school and elementary school teachers, to share with them the joy that we have in doing science, to help them nurture the curiosity that their students have, the curiosity that they have about the chemical world that we live in. I ask the ACS to help lead national curriculum developments at the undergraduate level, especially the first year college level. You know what we need for the first year course in chemistry? We need a chem study type of an approach. Not chem study per se but a chem study type of an approach. I also ask the ACS and its members to be concerned about the curriculum at the high school level in chemistry. I also ask you not to feel so good, as I do, about ChemCom Of course we want to feel good about ChemCom. But we can't put all our eggs in one basket. We need to expand that effort. In this connection, I believe in the Proctor and Gamble approach to life. You put out five to six high quality soaps and you let the market choose. That's what the ACS needs to be doing. Help put out five to six alternatives in the curriculum area so that the school systems, so that colleges and universities can choose from among those high quality offerings. I ask the ACS and the ACS members to support and participate in the AAAS Project 2061 and the National Science Teachers

Association companion project calle^ Scope and Sequence. They need the chemistry content of ' ır efforts to be beefed up and we, as ACS members, must help do that. I also ask the ACS to continue to inform the Congress about the national needs in research and in education. I can't tell you how proud I am, or how proud I was last year, of the testimony that the ACS presented before the Congress on the National Science Foundation budget for the Chemistry Division and for the Directorate for Science and Engineering Education. Since the Congressional hearings are not over with yet, I'm unable to tell you how proud I am this year, but I hope, Paul, in due time, I'll be able to make the same statement publicly as well as privately, as I just did, about Clayton Callis's testimony last year.

Two more suggestions to the ACS. Some of you may remember that in 1984 the ACS came up with a report called the Yankwich Report in Education. Where are we in terms of the ? of that report? And where is the 1990 version of that report? And finally, I ask the ACS leadership to help influence other organizations, such as the National Academy of Sciences, to see to it that the intellectual prowess of this nation devotes a fraction of its effort to deal with those science education issues at all educational levels.

Let me shift quickly and make some suggestions for those of you, my colleagues, who are from industry. Number one, expand the

support for major reform efforts in science education. Not only should you urge your companies to become actively engaged in supporting the Presidential Young Investigators, but also to support undergraduate faculty and high school teachers, so that they can pursue their intellectual activities in cooperation with industry. Second suggestion, I ask that you participate in forming alliances and coalitions with school systems and with institutions of higher education. See to it that in our school systems there are standards and that those standards are achieved. See to it that no school in this country can use any excuse for not offering a chemistry course and not offering a chemistry course with a laboratory component. We want courses in chemistry, not courses about chemistry. I ask our industrial colleagues to help infuse ideas into other business organizations, such as the local Chamber of Commerce, such as the U.S. Chamber of Commerce, so that the interest that they have now in helping solve the problems of science education can be continued. I also ask our industrial colleagues to continue to influence national policies in science and in science education. And finally, I ask our industrial colleagues to continue to be responsible in informing the public about chemistry, about chemicals, their benefits, their safe handling, and their potential hazards.

Not that I want colleges and universities to be off the hook. That's the next group I would like to speak to. There is little

doubt in my mind that in the next five to ten years there will be a huge influx of funds coming from the Federal Government and from the business sector, to colleges and universities, to address the problems in science education at the undergraduate level and at the precollegiate level. The question that I have for all of us is, are we ready, are we prepared to take on the task that will be passed on to us? So my first question to my academic colleagues is one of readiness and preparedness to take on the responsibility that will come our way. The second comment has to do with cultural changes that are beginning to take place at our institutions of higher education. You know there are many universities in this country called research universities and I want to read to you, very shortly, a comment made by a president of one of those research universities that speaks of the culture and the culture changes that must take place at our research universities. But first let me get to my second point about changes in the culture. If you, my colleagues who teach at our colleges and universities, will immediately <u>stop</u> taking pride in weeding out so many students at the freshman and sophomore years of college! We are in the talent development business, we are <u>not</u> in the business of weeding out students. Look, all colleges and universities take a lot of time and put a lot of effort to select the students. In fact, some of the colleges are accused by the Justice Department of having formed a cartel to control admissions! So what do we do, we proceed to immediately flunk them out and discourage them from going on into careers in

science.

With your permission, let me read an excerpt from what the President of Stanford University said on the 5th of April to his institution. He was talking about what we must do.

> "The first has to do with the attention we give to our students and especially with the centrality of undergraduate education. The joint product character of our enterprise has long been a source of strength to us, teaching and research are both important but the relative weight has shifted over time as the relatively new term 'research university' suggests. It is time for us to reaffirm that education, that is, teaching in all its forms, is the primary task and that our society will judge us in the long run on how well we do it."

He goes on to say,

> "I close this passage of painful but well meant criticism by quoting a distinguished colleague, deeply knowledgeable about Stanford and full of love for it. When asked what he thought our most serious problems might be, he said, quote, 'Just one, I would wonder whether this excellent research oriented faculty in this splendid student body, with its diverse interest, haven't drifted toward a kind of unwritten agreement, You don't bother us too much, and we won't bother

you too much either.' Kennedy's closing quotation I would like to share with you now, is, "I believe we can have superb research and superb teaching too, and in support of that proposition, I offer the example of the pertinence, programs, and countless individual colleagues who have excelled in both. We need to talk about teaching more, respect and reward those who do it well, and make it first among our labors. It should be our labor of love and the personal responsibility of each one of us."

May I make one more suggestion for our academic colleagues to think about? And that is to look at the outcome of the educational process. What do I mean by that? We should ask ourselves the question, what does it mean to be the holder of a bachelor's degree from the University of Wisconsin-Madison, or from Clemson University, or from Penn State University, or from the University of Minnesota? What does that mean? I know it means that we have fulfilled the requirements for graduation, but what does that really mean? And if concern about curriculum is not a primary concern of the faculty, I don't know who else is going to be concerned about it.

I'd like to take just two more minutes and talk about the Federal Government because nobody is off the hook in this area, and specifically about the National Science Foundation and the kinds of things that we are attempting to do. What we need is a

national strategy with a set of goals and some standards. And what about the components of change and reform that we have to go through. These components relate to content, they relate to staff and staffing, they relate to the conditions of learning, that includes among other things, whether or not we have chemistry courses offered without a lab component. We need to be concerned about gobernance issues and we need to be concerned about resources, both human resources and financial resources.

You know, not too long ago, the President and the Governors agreed on a set of goals. It's a remarkable accomplishment in the history of this country and these goals include making the U.S. number one in science and math by the year 2000. ome snicker at that goal. Instead, what we have to do is join in making a very serious attempt to achieve that goal; otherwise, it will become an empty goal.

What are the national goals we need to deal with? They have to do with student achievement, with teacher qualifications, again with the environment for learning, and with the quality of the curriculum. That is the responsibility that those of us in the science rich sector have to be concerned about: the quality of the curriculum, but we don't won't want to develop high quality curriculum material and put them on the shelf. We want to be concerned about the effectiveness of the curriculum not just the efficiency of processing students who sign up for one course and

then they move on to the next course. We need to be concerned about the outcome. We have to be accountable for the outcome. Of course, we need national standards. Not federal standards, national standards for each grade level, for K-16. It's a continuing interest on our parts; it is a seemless web and we need to engage in setting those standards for a whole variety of reasons. By the way, some people misunderstand a bit when I talk about standards. I talk about establishing standards and helping students achieve those standards. Not to use those standards as a gate to lock people out. Go back to my example about the freshman and sophomore years experience of our undergraduates.

We need to have the cooperation and the collaboration of the research universities, the comprehensive universities, four year institutions, yes, two year institutions, the private sector, the states as political entities, the school systems; we need to have the political leadership at the state level, the governors, we need to engage the Education Commission of the States, the chief state school officer, the chief commissioner of higher education; we need to work with pertinent school superintendents, the kinds of people that we, the people of chemistry, have not been terribly good at working with in the past.

That's why I only want us to only glance in the rear view mirror as we think about the future. We need to be looking at the states as entities. School systems, communities and parents,

rich source institutions, teacher sources, human service agencies, national resource organizations, that's you Paul, that's the ACS, that's all of you, all of these groups have got to work together in order to achieve the kind of changes that are required.

And so what is the NSF strategic role in all of this? The NSF strategic role, and here the words, as the rest of my words, are chosen very carefully. We want science literacy for ALL students. We want the best preparation for careers in science and in teaching science. We want to increase representation; we support experimentation, we're interested in generating change, fundamental, comprehensive, systemic change, NOT incremental change. Incremental change is not going to work. When you have incremental change the sum of the parts does not add up to the whole. We want to assist in the implementation, and that's what the National Science Foundation funds are for, to assist in the implementation and see to it that we have a national major strategic effort that can solve the problems that face us. For unless we do that, it is not possible to solve the problem that deals with increasing the flow of talent into careers in science, into careers in mathematics, and into careers in engineering.

So, I want to close by making two observations. First, often in situations such as this one, I get accused of preaching to the choir, because you are all convincved, I hope, of this. You know

what, my friends, I am preaching to the choir. Do you know why? Because, I want the choir to sing! And I want the choir to sing out loud and in harmony. Because the people outside that dark segment I showed you before on that first display, don't hear us with a uniform voice. What I'm interested in is increasing support for research at the National Science Foundation and increasing support for science education. I am talking about strategies that will give us a new and better pie, not only strategies that we have now to divide the present pie.

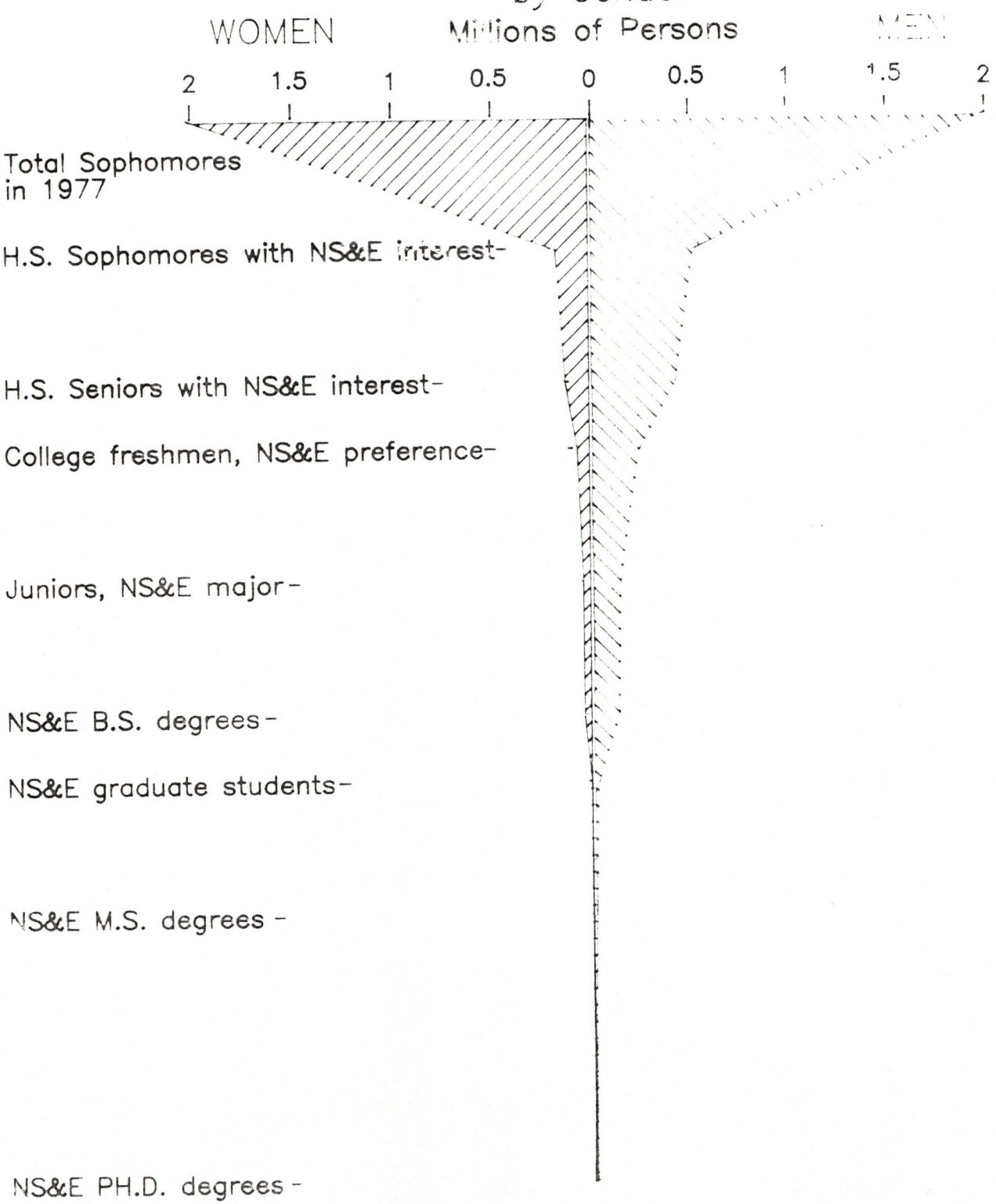
I'm reminded, in all of this, about the story that showed up in the Wall Street Journal early last year. It was about a conversation between a Polish economist and an American economist. And it went like this, the American economist asked his colleague, "How do changes take place in the Polish economy?" This was before the great changes that started taking place in Eastern Europe. And the Polish economist said, "Why there are two ways in which changes take place. One is the natural way and the other one is the miraculous way." The American economist said, "Oh, what is the natural way?" He said, "The natural way for change is when the Angels descend from heaven and bring about change in our economy." The American said, "That's the natural way, then what is the miraculous way?" He said, "the miraculous way is when the Polish people themselves decide to do it!"

Have I made my point? Have I made my point about the need to

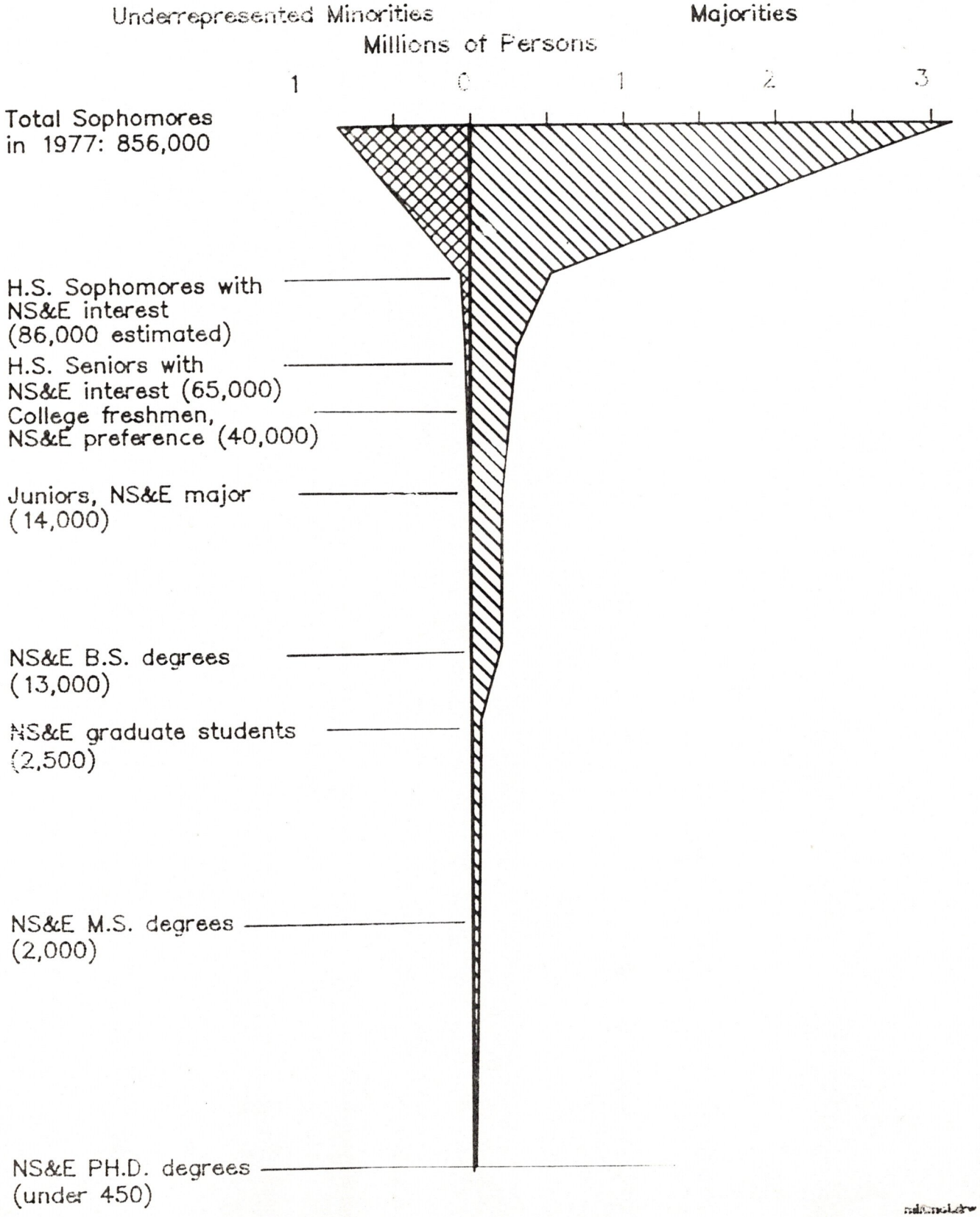
rally so that the research horizons, that we all yearn for, can be reached through increased literacy, not only for those who are going to become scientists, chemists, chemical engineers, but for all citizens in our society.

Thank you very much.

Persistence of Natural Science & Engineering Interest by Gender



Participation in Natural Science & Engineering Interest by Ethnic Group



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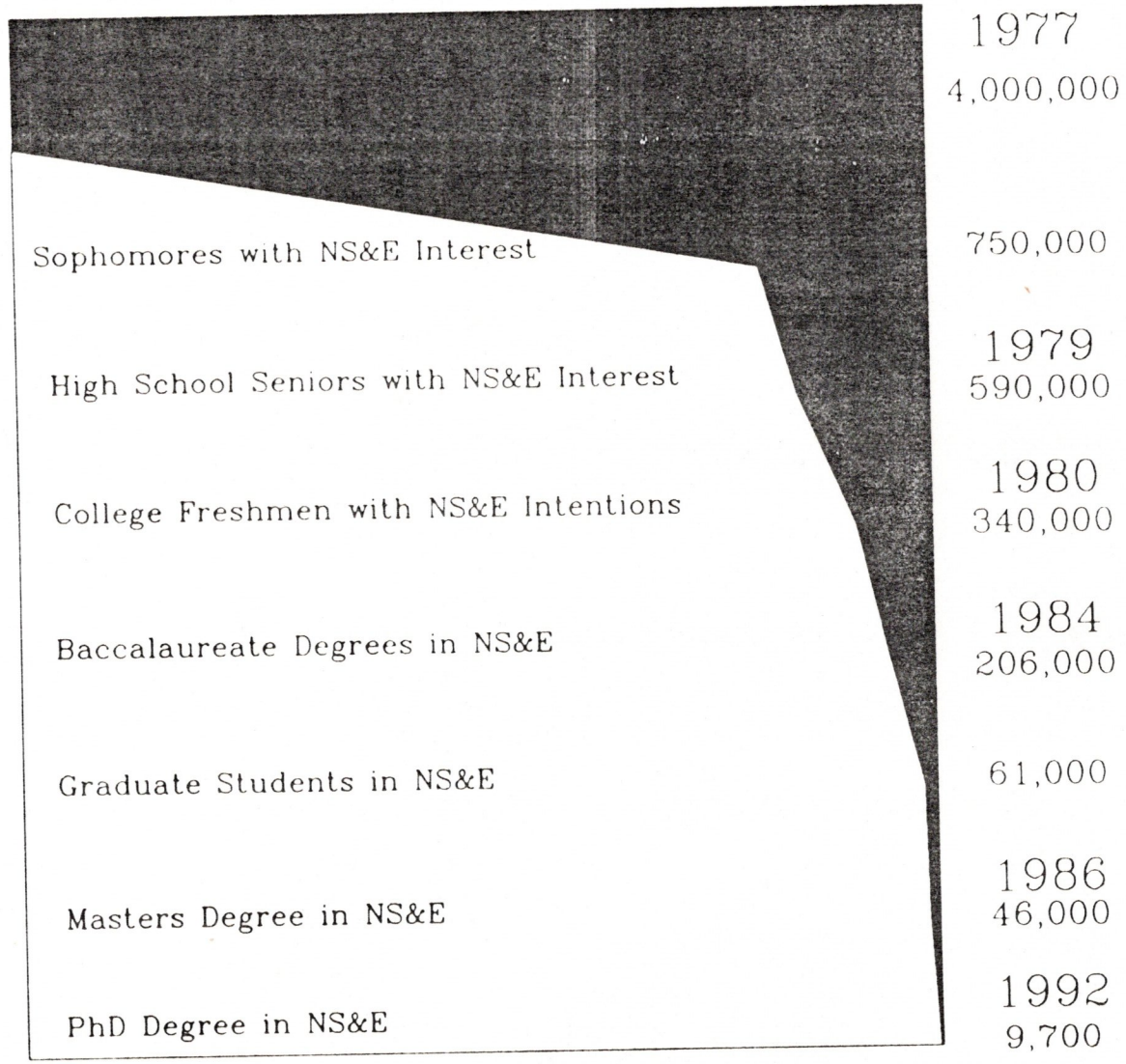

(The Pipeline)