UNEDITED TRANSCRIPTION OF REMARKS GIVEN BY

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DEVELOPING A NATIONAL WILL TO ENHANCE THE QUALITY OF SCIENCE EDUCATION IN AMERICA

Well thank you very much Derrick. It's delightful to be with all of you especially at this Biennial Conference. Since I went to Washington four years ago, I was forced to miss the previous two conferences, so it's a special treat for me to be here this morning. I had planned, very frankly, on staying for most of the conference, unfortunately I have to leave first thing tomorrow morning and so I will be here all day today and hope to visit with as many of your as possible both at National Science booth this afternoon and also at the University of Wisconsin booth as well.

It is indeed a pleasure to be here away from the combative atmosphere in Washington. It is a pleasure because, once again I am among colleagues, friends, and supporters. It is very, very important for all of us to recognize that the National Science Foundation is blessed by having on its staff a significant number of people who are chemists, people who have come to NSF and either have stayed at NSF or served for a period of time there, a year or two, and it is indeed my privilege to be associated with those individuals. You will meet three of them later on this morning.

What I would like to do is share with you some very important convictions and opinions about the status of science education in this country. I'm going to do this rather rapidly so that I don't end up being shackled by my own shackle. I'll share with you some important dimensions of what the country faces and will call on you to be very active participants in dealing with the issues, the critical issues, that the country faces in science education, but not only in science education, in the general education arena as well.

In my judgement, the situation that we face now is by far more critical and more consequential that what we faced in the immediate post-Sputnik era and it is so for many reasons. Let me quickly share with you three major reasons. The first one is that 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 prospective, that turns out to be approximately the population of Great Britian. So the increase, the delta, has been about 50 million people. What does that mean, that means that we have more students to teach and we need more qualified teachers to teach them. We need more qualified teachers at all educational levels as we will see very shortly. The first reason is the change in scale and we have to make adjustments because of that change in scale. The second reason is that for our country to maintain its international preeminence in the global economy, in science, in technology, in the arts, in the humanities, we need to have a good supply of scientists and engineers coming through our educational systems. By the way, that's what NSF set out to do in the immediate post-Sputnik era. All the teacher institutes, all the curriculum reform developments were aimed at increasing the supply of scientists and engineers. And to a very large extent, NSF succeeded in that regard. What I am saying is that we now have to maintain that and some demographic data that I will share with you very shortly are cause of alarm to all of us, and casts some doubt about perhaps our willingness to maintain having a good supply of scientists and engineers. The third reason as to why the situation is now more critical and more consequential that what it was in the immediate post-Sputnik era, and in my judgement, the most important of all three reasons, is that we now live in a much more advanced scientific and technological society than we did back then. It is the education in science and technology of the non-specialist that we have to pay very special attention to. We need to have an educated citizenry that can distinguish between astrology and astronomy. We need to have an educated citizenry that understands the complex issues of animal rights. We need to have an educated citizenry that understands issues related to pollution control. We need to have an educated citizenry that understands the complexity of issues in nutrition. We need an educated citizenry that is able to deal successfully with chemicals, drugs specifically. Otherwise the citizenry that we belong to maybe bamboozled into making foolish decisions. We need to work very hard at seeing to it that all of us are scientifically literate.

So the mission of the National Science Foundation, now-a-days, is a dual one. The first one is to see to it that the scientific personnel, the so called pipeline, is adequately staffed and adequately maintained. Seeing to it that we have a good supply of scientists and engineers coming through the educational system. And the second one is to see to it that we have an educated citizenry that is supportive of what the scientists and engineers want to do. The way I put this sometimes to have the citizenry at least be tolerant of what the scientists and engineers want to do. The issue of scientific literacy, in our case, literacy in chemistry is a very important one that has to be addressed head-on. In this connection, I'd like to give an analogy, and as with all analogies, at best they are poor but I think this one helps make the point. This analogy comes from sports. Just like we have professional basketball players, professional baseball players, professional football players, professional hockey players, etc., we also have sports fans. Without those sports fans, the entire sports enterprise would be nothing, and you know that's not an exaggeration. So that's what we need. We need scientists and engineers and we need science fans. We need to cultivate the development of active participation on the part of science fans. We want the science fans themselves to be physically fit. We want them to be scientifically literate. If you don't like that analogy as some people don't, let me offer another one. We need good orchestra players and we need audiences that appreciate what the performers are doing. This is what we mean by scientific literacy and engaging all the population into being more involved and more literate in understanding science and technology. Now it's not quite clear to me that we all are in agreement as to what constitutes scientific literacy. In our case, in chemistry we are not even clear on what that is either. So, an immediate task before us is to help articulate what is meant by being literate in chemistry. Does it mean memorizing a bunch of facts and recognizing what is in the periodic table? Does it mean that or does it mean more than that? So I call upon each one of you to give very strong consideration to this issue so that we can move the question from being one to which we call attention to a question to which we can act on by helping define what is meant by scientific literacy.

The remaining of my remarks this morning will deal with two issues. One has to do with quantity and one has to do with quality. For quantitative considerations, I want to share with you now some information about demographics. On the first slide, you see a graph of the number of 22-year-olds in the United States from the year 1959 to the year 2010. These data are not projection data, these are actual data, these are the facts. There isn't anything anybody can do about changing them even if we all got started right away. So this is a situation that we have to live with and it clearly shows that the number of 22-

year-olds born in this country will be declining through the year 2010. This has very serious consequences in terms of the number of individuals who will go on to get training in science and in engineering. On the next slide, you see the natural science and engineering bachelor's degree in science production. Again, from beginning in the year 1959 and running through 1988. We sorted computer science because it was a rapidly emerging field. An important thing to remember about all these slides is I'm showing you not only the exact numbers themselves, but the general shape of the curves that I'm sharing with you. So this is the situation as it is now at the bachelor's degree level in natural science and engineering. Natural science of course includes mathematics. This is the production rate showing some adjustments in terms of production of bachelor's degrees in science and engineering. It's about 4 1/2 percent basically of the total population that we're talking about in this regard. Let's skip this one here and go on to the next one. If you project through the year 2000, using the rate of production in 1983 or 1982 of BS degrees in science and engineering and you look at the number of 22-year-olds as I showed you before. The cumulative short-fall in terms of holders of BS degrees in science and engineering is estimated to be about 430,000. That's the cumulative short-fall in terms of the demands that the country needs based on the projection rate for 1983. This of course has other consequences beyond the bachelor's degree level. If you look at the Ph.D. degree production from the year 1960 through 1986 you see what the general shape of the curves looks like. One doesn't have to speculate too much in terms of explaining that big bump in the early 70's - I'll leave that for you to think about as to why we had that tremendous rise in the 60's, in the 70's, and what has happened since then. So that's the Ph.D. degree production in the natural sciences and engineering. I'll get to production rates in chemistry very shortly. The available positions for natural scientists and engineers for the year 2004 shows a tremendous need on the National basis. It won't be very long before Ph.D. recipients will be competed for between academe and industry. It's estimated that within the next ten years 40% of the present faculty will go into retirement and it's also estimated that the industrial demand for highly trained scientists and engineers will be increasing as I have been telling you here. Looking at this in terms of the short-fall at the Ph.D. level, we have a tremendous situation that requires a great deal of attention of our part. It has been suggested that one way of dealing with this situation is to recruit an allow more foreign students to come to the United States and to stay in the U.S., and as you can imagine, I'm all for that. Having come to America in 1957 from my native country of Lebanon, and having enjoyed the tremendous hospitality and tremendous opportunities that are available in this country. I think that's something that should be continued. The issue is not what to do with foreign students, the issue is what to do with the fraction of U.S. born students who are choosing not to go into science and engineering careers. About 60% of those enrolled in engineering colleges now are foreign students. That's a situation, which in itself is alarming because on a fractional basis, it indicates that fewer U.S. students are going into engineering. There is nothing wrong with the absolute number of foreign students coming to America, it is the greatest tribute that we have to our educational institutions, especially at the graduate level. But there are serious problems that we need to deal with at the undergraduate level and at the precollegiate level as I will share with you very shortly.

Let's take a look at a situation now where we consider the persistence of natural science and engineering interests in the high school sophomore population. Looking at a population of about four million high school sophomores in the year 1977. By the year 1992, we see almost 10,000 will be receiving a Ph.D. degree in the natural sciences and engineering. That's tremendous drop in terms of the needs that we have projected for 1992 and beyond. You see from this graph very clearly where the interest fades, it's immediately after the high school sophomore level. In fact, what we believe very strongly, we at the National Science Foundation believe very strongly is that the interest declines even before the sophomore year in high school and that's why a good size of our activities now-a-days are focused at the middle school level and the elementary levels both in science and in mathematics. But the persistence are not available below the sophomore year. Those are, as the title indicates, the persistence of natural science and engineering interests as expressed by high school sophomores. Now, when you look at the consequences of this in terms of gender, this is what the picture looks like. As any mathematically literate person can see and should be able to interpret, this situation is such that requires very targeted attention be given to women and to see to it that the opportunities available to women are increased. The problem is basically one of recruitment and then also of retention. The recruitment of women into science careers is an issue that we need to work very hard on. The retention is another issue that we should work very hard on too. The same picture, a similar picture can been seen if one looks at the underrepresented minorities, blacks, Hispanics, Native Americans, and you see that the situation is in such a shape that it requires our immediate attention. Why does it require our immediate attention? Because within the next 25 years, the population profile of this country will be such that, at least one-third or maybe 40% of the population will be minorities. The population right now is about 12 to 15 percent blacks, but within the next 25 years, a tremendous change in the profile in the population will be taking place. We in the scientific community, we in chemistry have not done a good job in recruiting and retaining either women or minorities to be our colleagues and that's an area we have to pay very, very special attention to. Looking at the two combined together, women or minorities compared to the majority, again as I've said the shape of these curves are pretty much the same and that we need to be looking at and trying to deal with very carefully.

By the year 2000, 85% of those who will enter the work force in the United States will be women or minorities. That's only 12 years away and that's why we have to see to it that we have a good training for women and minorities to go into science and to go into engineering. At the same time, we have to be sure that those who do not go into science and into engineering are literate in science and are literate in engineering. The questions that we deal with basically are questions that I classify in terms of societal value systems. I want to get to this point very shortly. I said I want to take you to this quick tour of quantitative consideration and then also qualitative considerations and that's what I want to continue with right now. Look at the production of bachelor's degrees in chemistry. Most of these data were published in C&E News very recently but the ones I'm showing you are slightly different from what you saw in C&E News because they include the production of degrees from all institutions not only ACS approved institutions. The lower portion where the short bar graph data are displayed is the minorities situation in this case. For the most part, it has not only been very low, but steadily low. This is the picture of the master's degree level, one ought to keep in mind the actual number of individuals who are receiving those degrees. This is what it looks like at the Ph.D. degree level. Once again, look at the minority data near the bottom of this graph. In a related area to chemistry, chemical engineering, this is what the picture looks like. Very sharp variations and most recently downward variations that are quite alarming. This is what it looks like at the master's degree level, and this is what it looks like at the Ph.D. degree level in chemical engineering. Again, one has to look at absolute number that is in question here. So these are the data as the quantitative data that I wanted to share with you.

I want to shift now very quickly to talk about the quality issue. I want to share with you, in case you haven't seen them, the results of the recent international survey of science achievement that was published in March of this year comparing 15 to 17 countries at various grade levels. In the first piece of information I show you where the U.S. ranked among these countries at the 5th grade level. The same test was given to all 5th graders, of course in the appropriate language. The same test was agreed to by all the countries who participated in this study. This is where the United States ranked. If you want to influence people to go into science, if you want to influence people to be appreciative of science, this is where we need to begin. Because from here on, the situation is not as healthy as one would like it to be. At the 9th grade level, this is where the U.S. ranked. Now, you and I would like the slide to be upside-down but it isn't. This is indeed where the U.S.A. ranked in this international science achievement. By the time you get to the 11th grade and 12th grade levels, by the time you get to those grade levels where students are likely to be taking advanced placement chemistry, advanced placement physics, advanced placement biology, the so-called specialist in this study, this is what the situation looks like. The physics specialist, people most likely to be taking advanced placement physics, people who are likely to go to colleges and universities and be exempted from taking college physics, this is where the U.S. ranked. This is the picture in chemistry. This is the picture in biology.

Now I don't believe for one second that the talent in this country is any different than it is elsewhere around the world, yet these data show that there is something in our educational system, something in our society that we ought to be paying very special attention to. I have no doubt about our capacity as a Nation to respond to what is required. I have some doubt about our will to deal with those issues.

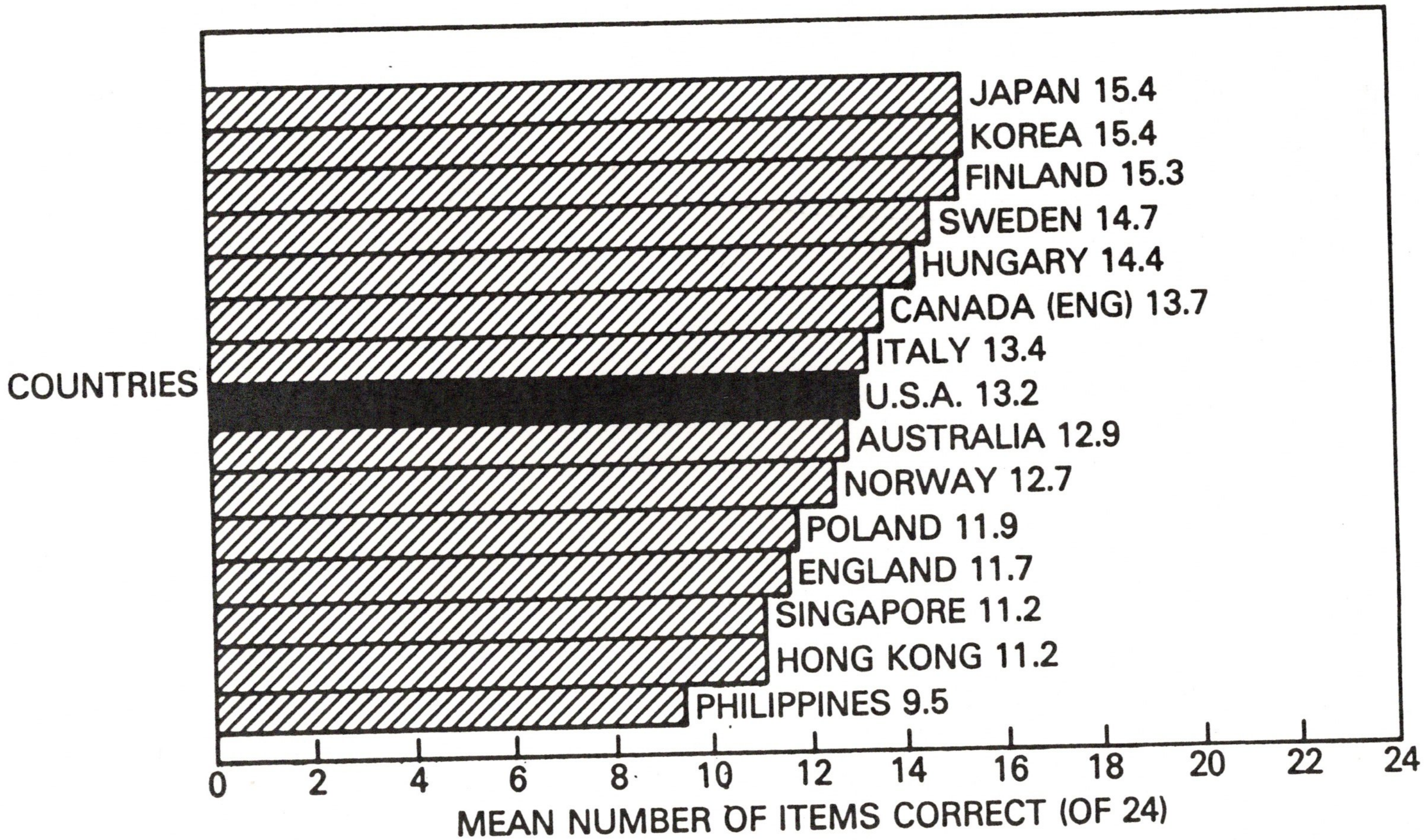
Education in the United States is a diverse and complex arrangement. It is controlled for the most part at the local, or entirely in fact, at the local and state level. The role of the Federal government is to stimulate and to motivate action and to call attention to the problem so that they can be addressed successfully, in fact, indeed solved successfully. That's what NSF is attempting to do. The issue before us at this conference, the issue before us as professional scientists and professional educators is two fold: How can we communicate the excitement that we have about chemistry to potential chemistry majors and other science majors? That's the first dimension and the second dimension; How can we communicate the excitement that we have about chemistry and toward chemistry to others who are not going to become chemists and who are not going to become scientists. That is really the question that is before us.

This happens to be an election year and all the candidates are talking about eduction. Candidates at the local level, at the state level, and at the National level. All the candidates are talking about excellence in education. Do you know anyone whose not for excellence in education? I do and you do to. It's our job to help define what's meant by excellence because we are the custodians of knowledge in chemistry and in the chemical sciences. We must communicate our concerns about standards of excellence in our school systems, standards of excellence in our colleges and universities to all individuals in our society. That's what we should be doing now. You should not confine expressing your views about quality in education, in science education, to the privacy of the voting booth in November. By all means, vote, but do not confine the expression of your views to the privacy of that booth. I urge you to communicate your concerns as quickly and as effectively as possible. We have serious problems that we must deal with. Serious problems in urban school settings, serious problems in suburban school settings, and serous problems in rural school settings. Serious problems at the elementary level, at the secondary level, and at the undergraduate level. It is important that we put our efforts in a very targeted fashion at all of these levels. It is extremely important that we do that otherwise we risk, we take the risk of becoming a second rate nation very quickly. The impact of Sputnik was such that it mobilized the Nation to act rapidly. The impact of economic competitiveness is much slower in terms of mobilizing us to act rapidly. We have to really develop very quickly a National will to enhance the quality of science education throughout America. This requires a personal commitment as well as an institutional commitment and both commitments can be done. I just said just awhile ago there is no doubt in my mind about our capacity to deal with these issues but there is some doubt, which can be removed, about our willingness to deal with those issues.

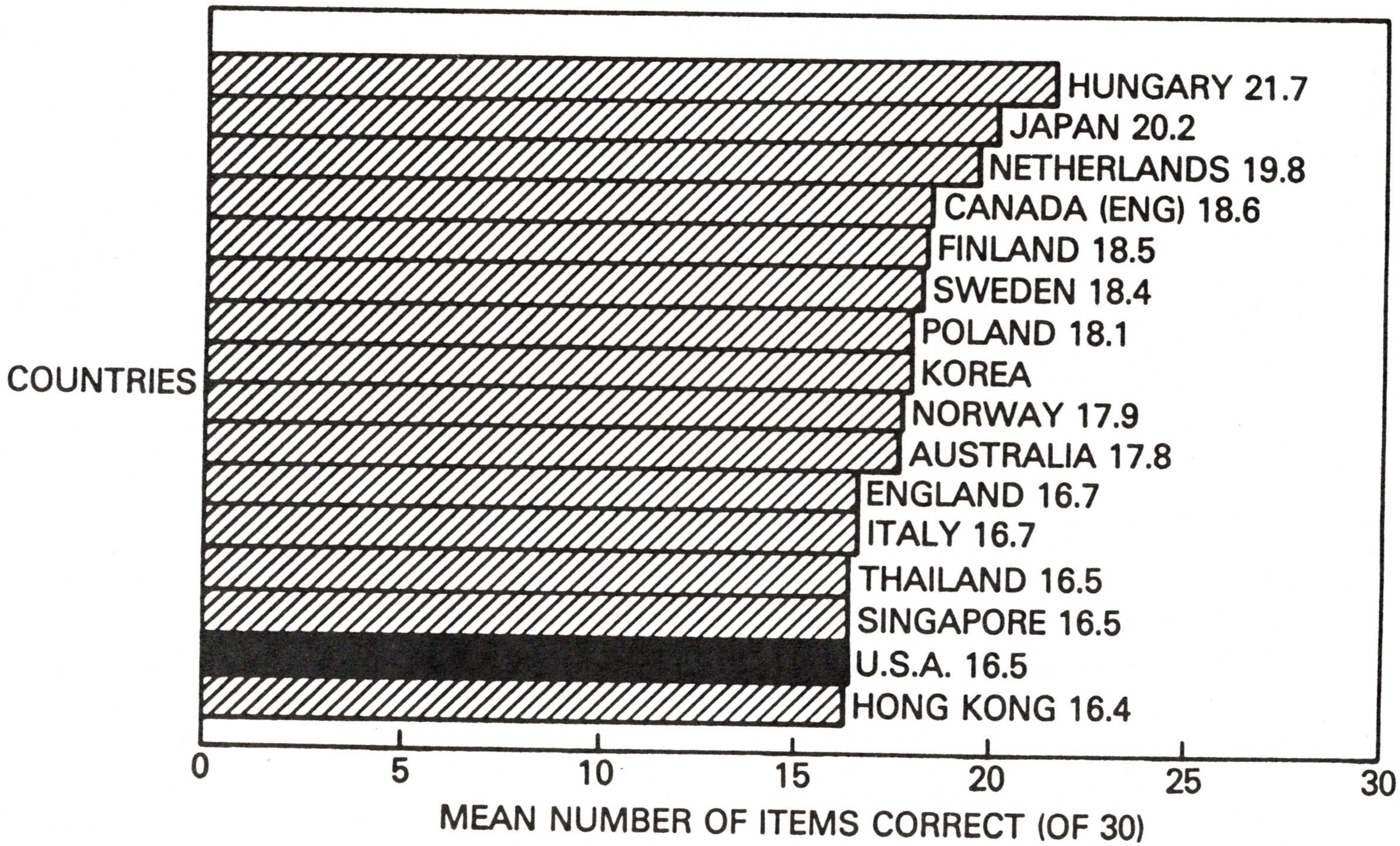
I'm often asked the question, "Why does the National Science Foundation provide support for science education activities?" and I say why it's the same reason that the National Science Foundation and all Federal agencies provide support for basic research. And most people nod their head and say "that sounds okay." But a few people ask, "What is that reason? Why does the NSF provide support for education and for research?" Well you know that traditionally there are three components to the answer. Let me go through them very quickly. The first is that support for science research and support for science education is provided because it is good for our National economy. I won't dwell on any of these points, let me just mention them very quickly. The second reason is that it's good for our National security. And the third reason is that it is because we want to live in an effective democracy. Those are the three traditional reasons that are offered in answering that question. Now I want to ask each one of you a very personal question, right now. Did you go into chemistry because it was good for our National security? Or did you go into chemistry because it was good for our National economy? Or did you go into chemistry because you wanted to be a part of an effective democracy? You probably went into chemistry for personal reasons, not the least of which is personal enlightenment. You're curious about the world, the chemical world that we live in and you wanted to satisfy that curiosity. You wanted to make some sense of the world that we live in. You wanted to enjoy understanding the explanation for a variety of questions that you might have had. You wanted to have fun in the best sense of the word in terms of understanding what it is that we deal with in our chemical world. Now if I were to go to Capitol Hill, as I do every now and then, and testify before the Congress and say we need support for basic research and for science education because we want to have personal enlightenment and we want to have fun, and we want to have joy of learning - I'll be laughed at just like some of you are chuckling right now. But if I go up there and talk about the first three reasons - people will listen. Do you see what the problem is that we in the chemistry community have in terms of communicating chemistry to non-chemists? That is the problem. Of course we do chemistry for all of those reasons and that's why we have to be very forceful in articulating those reasons and in pushing them forward so that we don't allow our society to deteriorate economically, scientifically, technologically, and we do not allow our fellow citizens to be less appreciative of what we do in science. It's very, very important that we do that. It's important that we do it because great advances in research are taking place. Most faculty members now engaging in research activities are specialists in sub-fields. They communicate about their specialties with one another very, very successfully. But they don't communicate with the rest of the population very well. It has been suggested to me that perhaps among the most scientifically illiterate people are those sub-specialists because they are so narrowly focused, as they should be, on the research that they are doing and they don't pay any attention, or enough attention, to communicating science to the non-specialists. That's what chemistry educators ought to pay very special attention to, the communication of science because we are dealing with a question here that has to do with the value system that we have in our society. Can we tolerate mediocrity? Can we live in a society where by activities are condoned? Do you think if we had good mathematics literacy in this country that we would have this proliferation of lotteries across the states. And don't tell me that's the job of the math teachers. It is our job to communicate what we mean by our value system toward education and toward the quality of life that we have in our society. I'm coming close to the end of my allotted time here and I want to show you a two minute clip of a video tape that was done at Harvard University very recently. The rest of this video tape, along with other video tape material will be shown at the NSF booth beginning this afternoon. So if you can roll that tape now.........(PROJECT STAR video).... Stop it here. As I said, I invite you to see the rest of it in the NSF booth where this video tape and other video tapes will be shown as well. I want to wind this up by telling you something about the NSF budget because there I could say something which is accurate that we do have a dollar or two to work with. I know many of you are recipients of grants. Let me look at the, very quickly, the history of the NSF science and engineering education budget since 1952, the first year when the NSF was established. As this pie-chart shows, the fraction of support for science and engineering education, well it shows it very clearly, I don't need to comment about it. I showed this slide to a colleague of ours who happens to be a Nobel Prize winner in chemistry and he said, "I've heard of the land of the rising sun but this looks like the land of the sinking darkness." This is the, pardon the jargon here that we're using, NSF obligations, that's the dollars that NSF has awarded in constant 1988 dollars. SEE stands for Science and Engineering Education and the research activities the sum of these two curves is the top purple curve that you see there. Let me show you these in a slightly different version and you may remember seeing this graph in Science Magazine not too long ago.

The NSF budget since the mid-60's or so, has fluctuated a little bit. Now we are back, again in constant '88 dollars, where we used to be, but you notice that has happened with modifications in the support that going to science and engineering education. When we talk about science and engineering education specifically, this is the picture as it looks now for graduate fellowships support, for undergraduate activities - and you'll hear some more about undergraduate activities from Bob Watson very shortly. He's the Head of the Office of Undergraduate Science, Math and Engineering Education, and then the rest of the activities for precollegiate concerns. You'll hear about them from Ethel Schultz and Dorothy Gabel. You see we have made a remarkable recovery since the great shut down of the early 1980's and we're all very proud of that. In fact, we are now at the highest level we've every been in terms of support for science and engineering education. I want to put that into perspective by showing you what these numbers look like in constant 1988 dollars. You see we are less that what we used to be in the hey-day. Again, the distribution is shown for the three educational levels. We have a very strong commitment to deal with science education at the undergraduate level and at the precollegiate level. I want to call your attention to two reports that just came out. One is called EDUCATING SCIENTISTS AND ENGINEERS: GRADE SCHOOL TO GRAD SCHOOL and the way in which you obtain information about getting this report will be at the NSF booth. Also, there will be a handout at the NSF booth that tells you how to get copies of this video tape I was showing you a clip from. If you want to, it also tells you how to get a copy of the test, the international test that was administered on the international level last year. Because looking at those questions, you will see that they are not as complicated as one as imagine them to be. They are questions that should be answered very, very successfully. Before I get shackled here, let me just show you very quickly, what the chemistry data, the support of chemical, chemistry from science engineering education looks like. It's only under 10%. 1988, we are not quite done with 1988 yet so the fraction will be going up but it's important to know that unless you send us a proposal at NSF, we cannot make an award to you. I think that's the zeroth of grantsmanship. So I want you to remember that - I'd like to see more involvement on the part of chemists in science education activities. I think the involvement has been good. Has it been excellent, has it been good enough? I don't think so, I think more is required. Thank you very much.

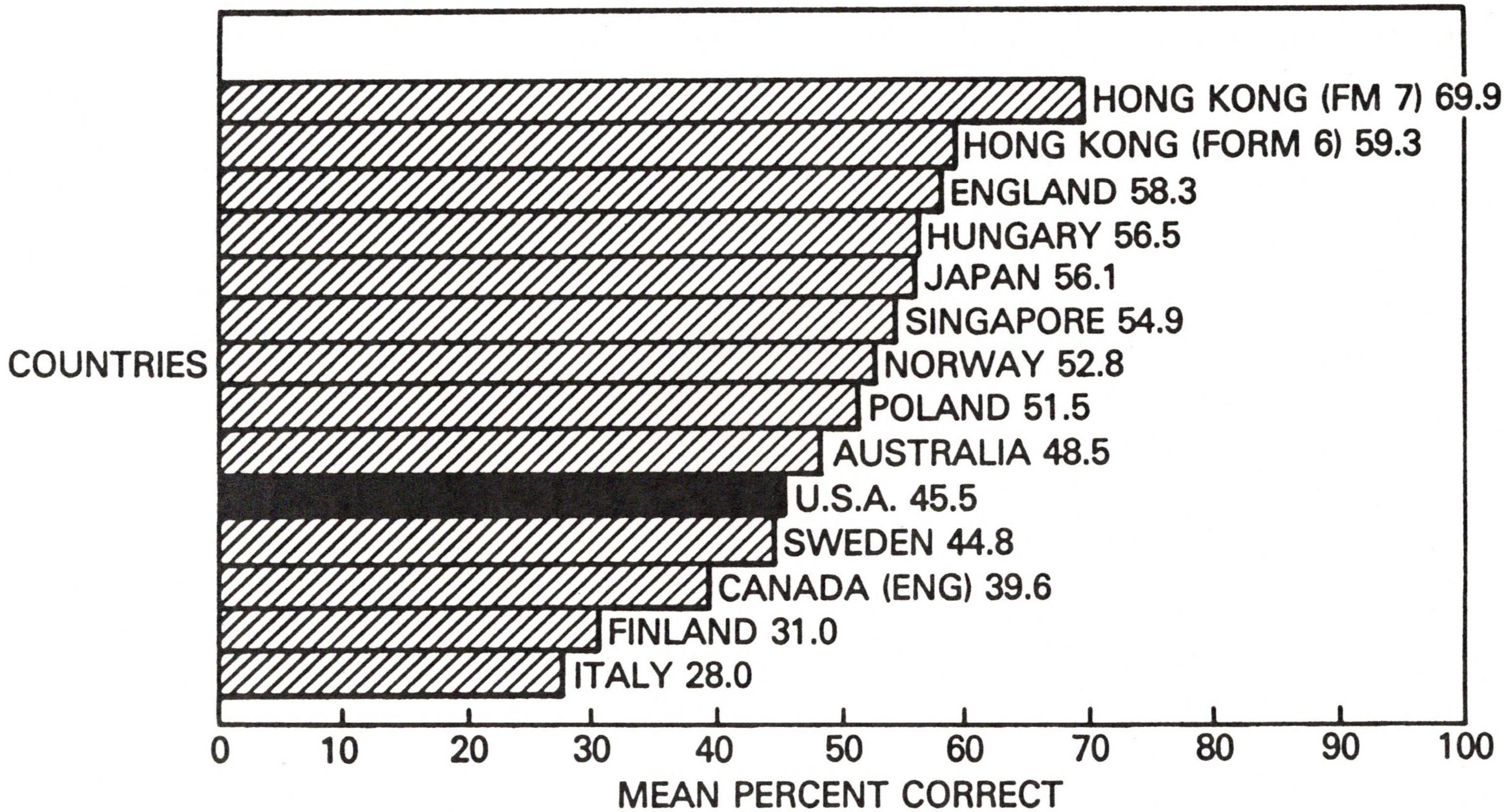
GRADE 5 SCIENCE ACHIEVEMENT IN 15 COUNTRIES



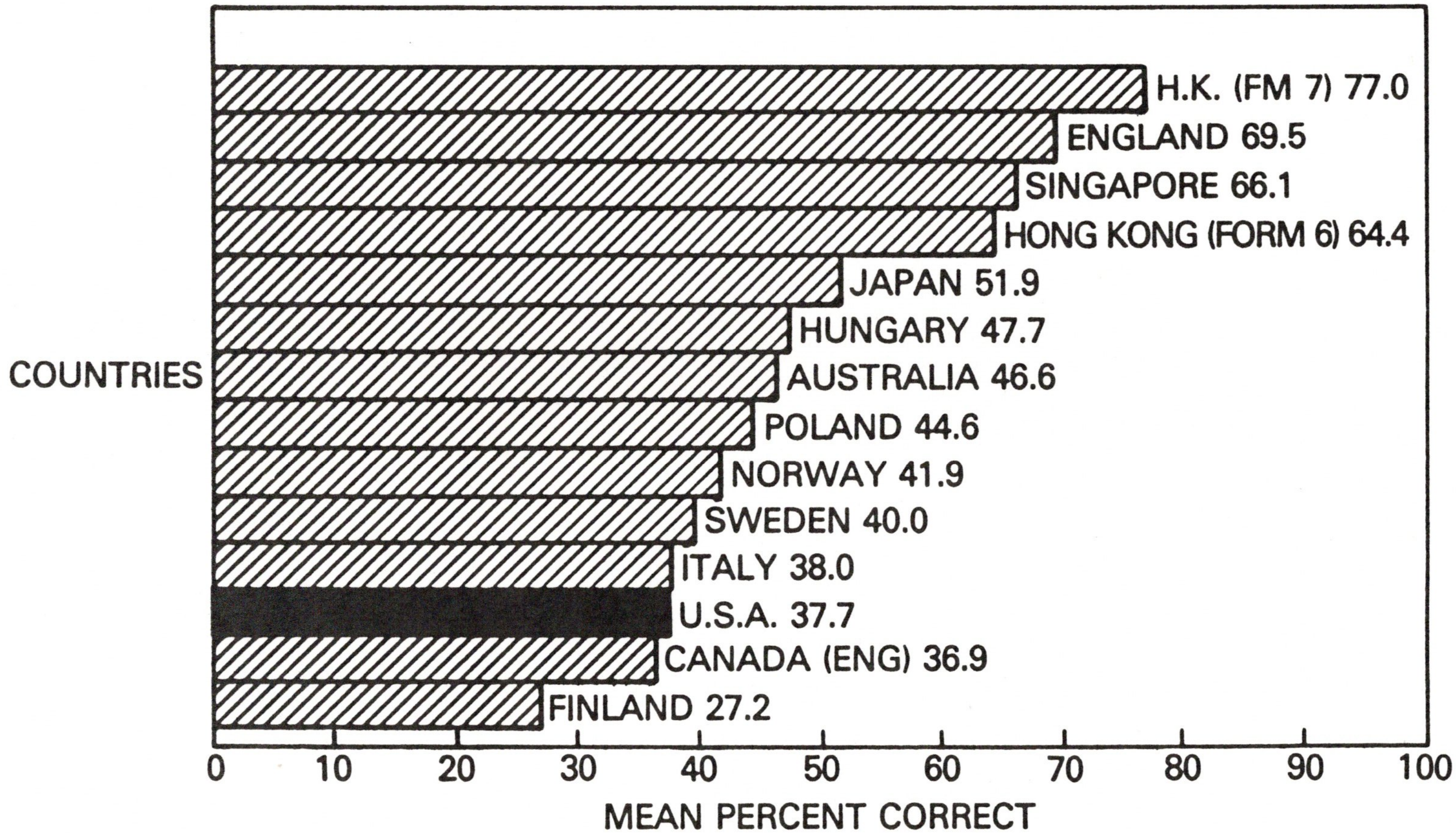
GRADE 9 SCIENCE ACHIEVEMENT IN 16 COUNTRIES



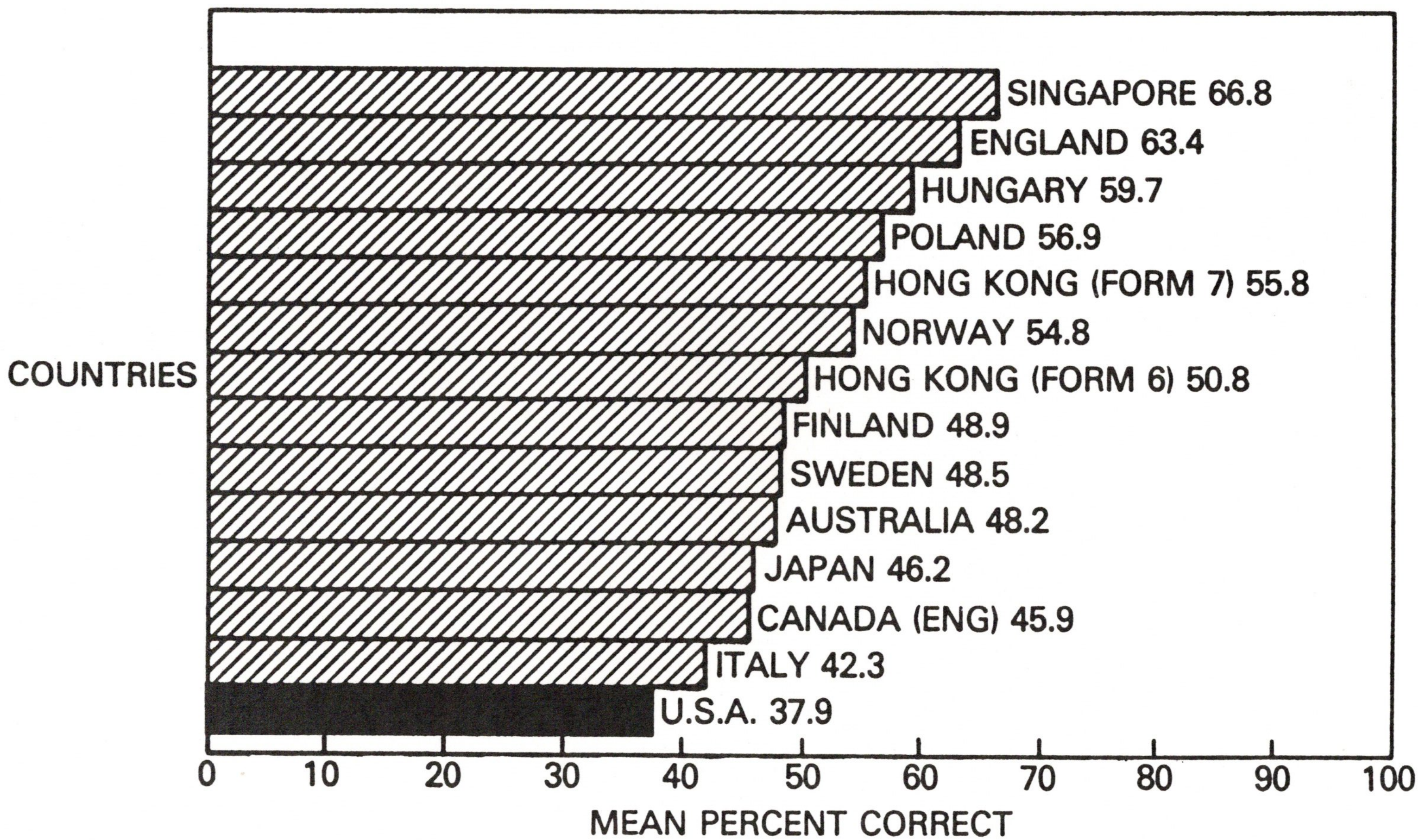
PHYSICS SPECIALISTS
(MEAN PERCENT CORRECT)



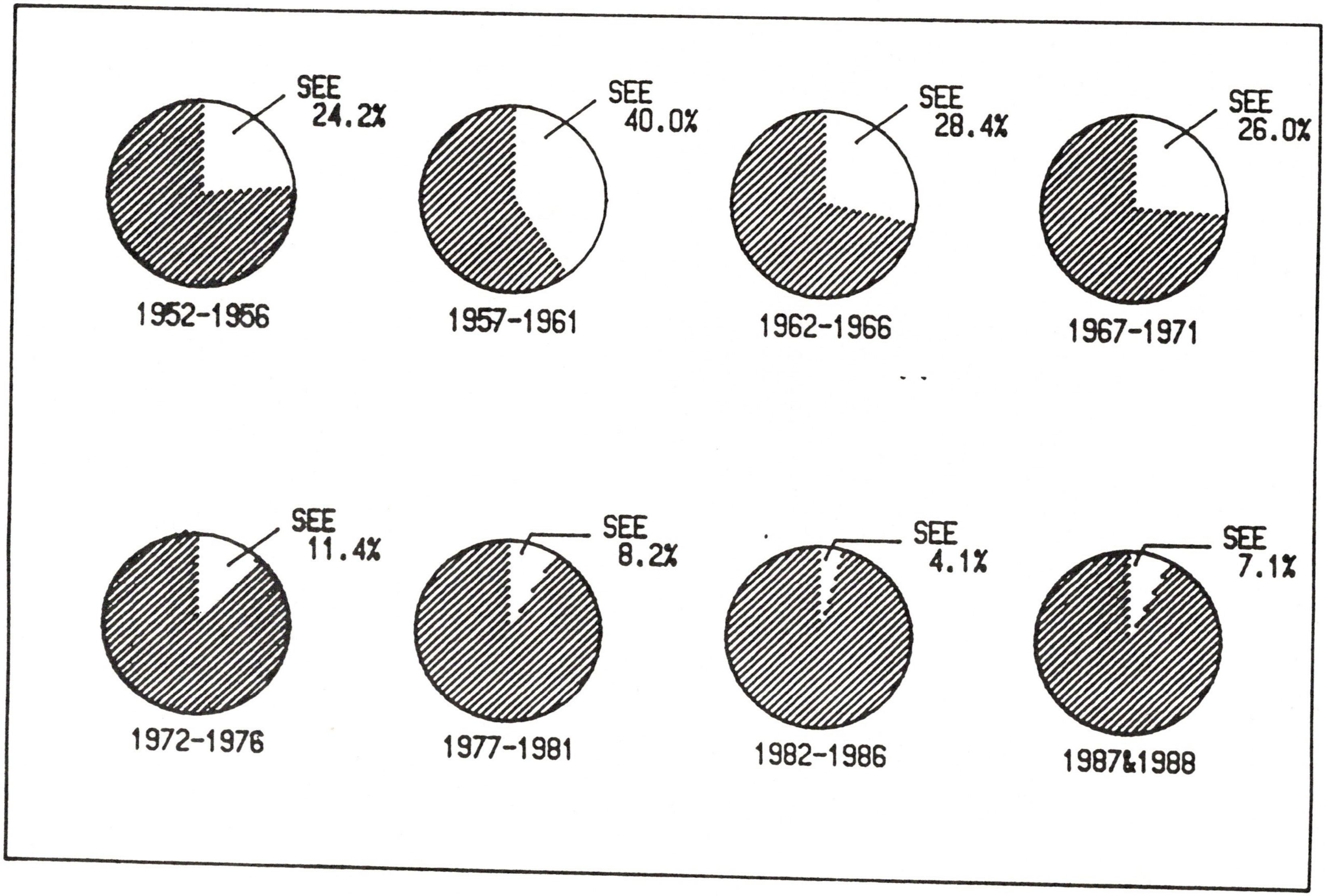
CHEMISTRY SPECIALISTS (MEAN PERCENT CORRECT)

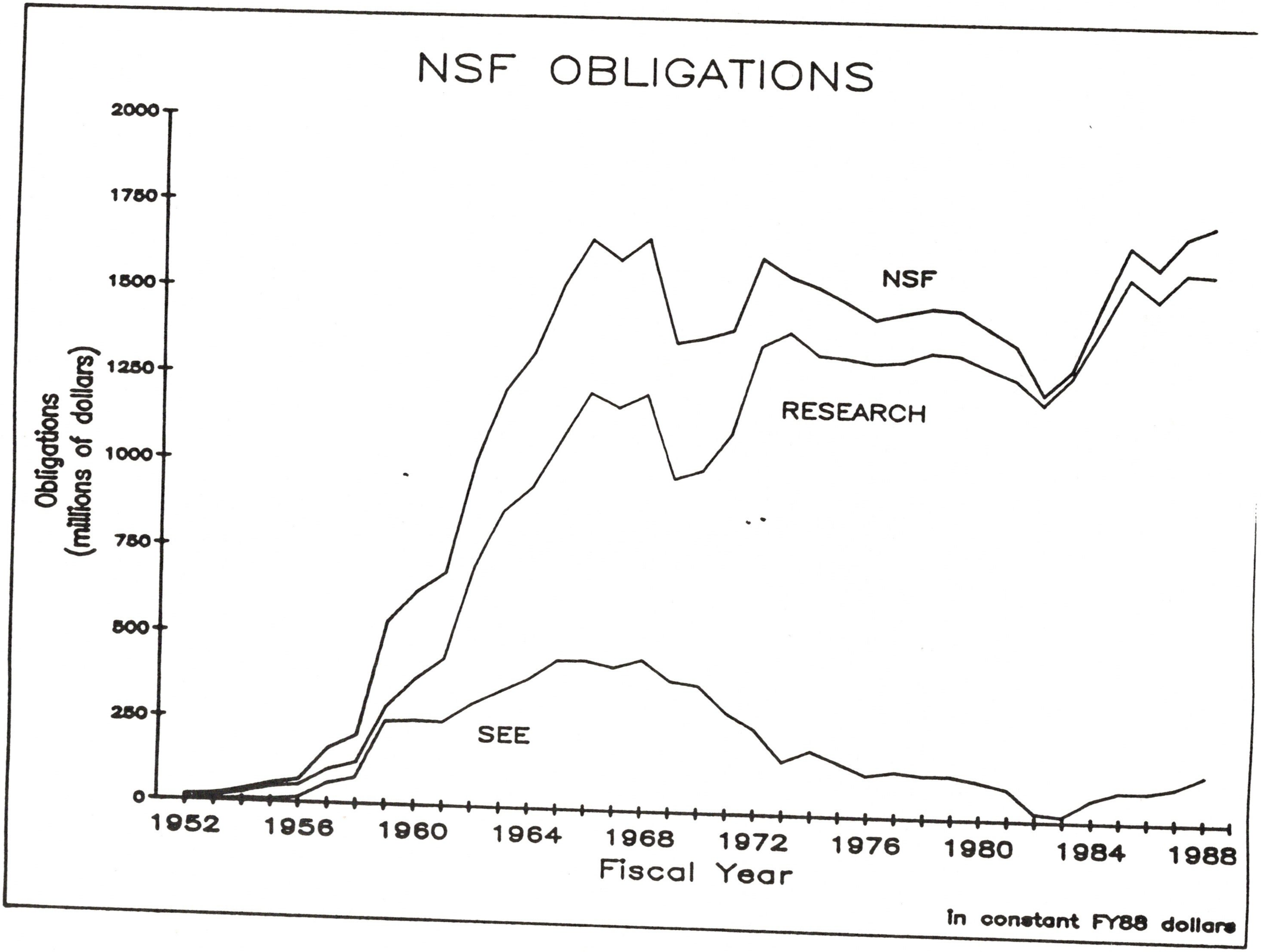


BIOLOGY SPECIALISTS
(MEAN PERCENT CORRECT)

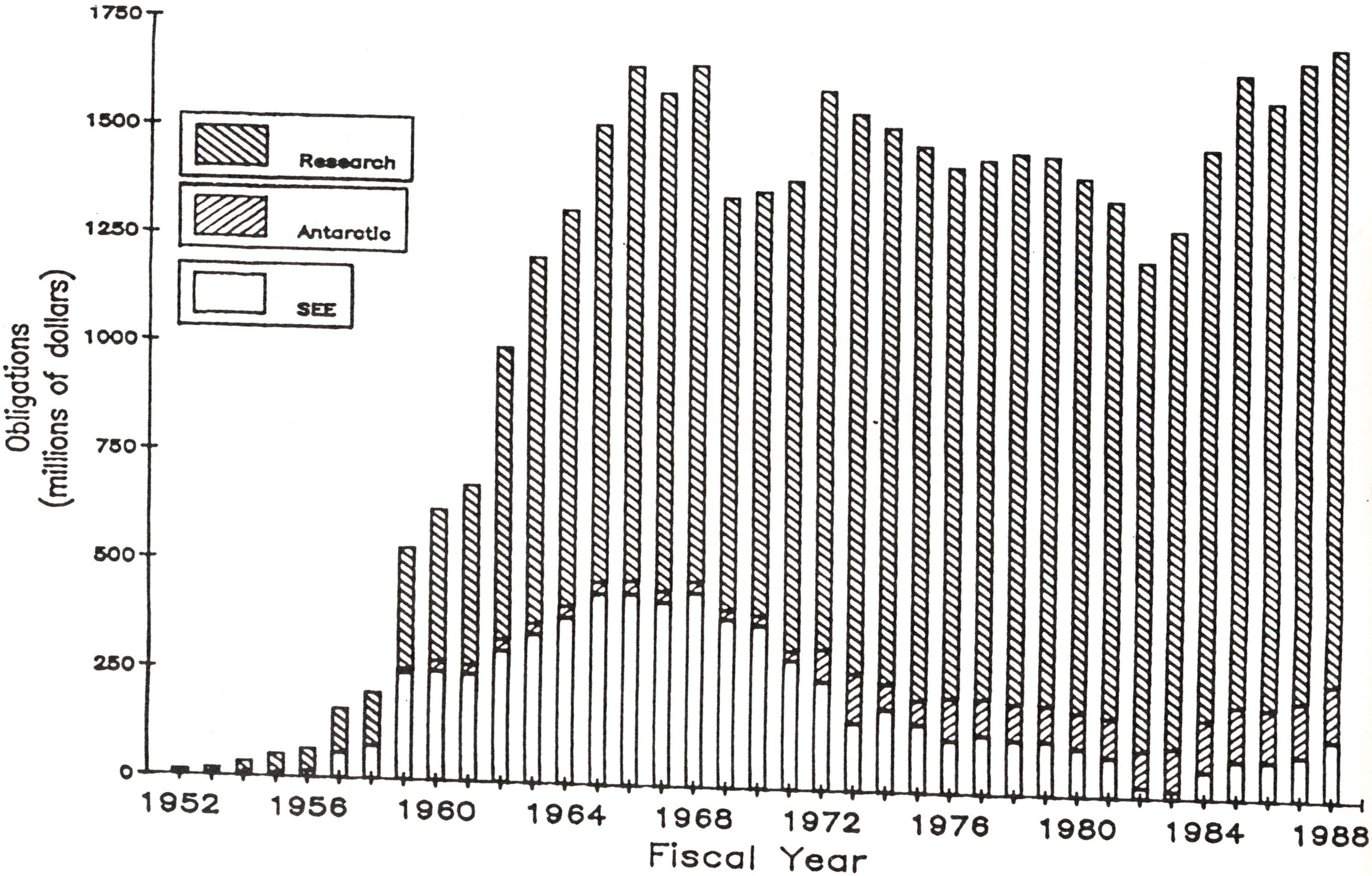


Obligations for Science & Engineering Education
as percent of NSF Budget

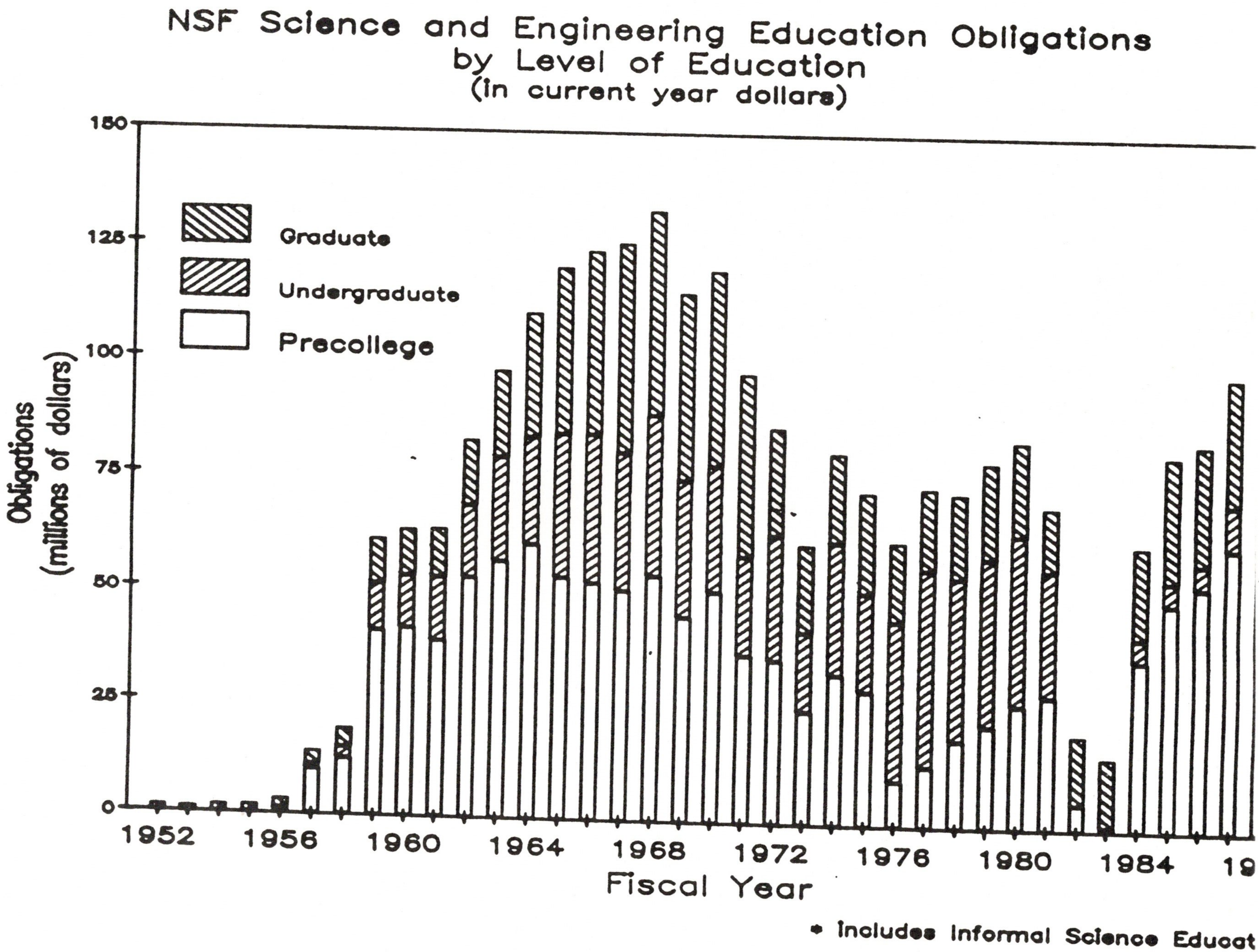



NSF OBLIGATIONS
Obligations
(millions of dollars)
2000
1750
1500
1250
1000
750
500
250
0
1952
1956
1960
1964
1968
1972
1976
1980
1984
1988
Fiscal Year
NSF
RESEARCH
SEE
In constant FY88 dollars

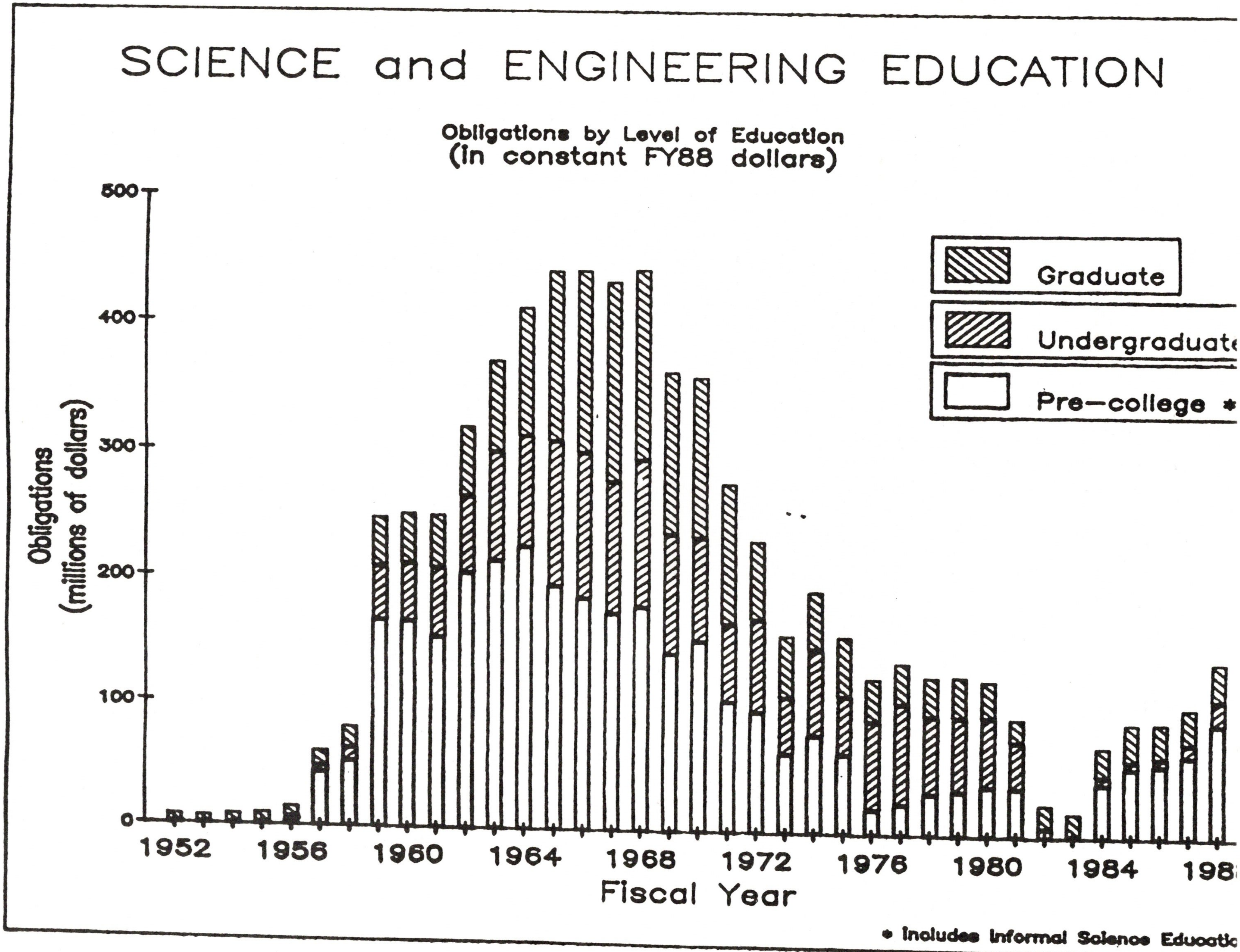
NSF OBLIGATIONS



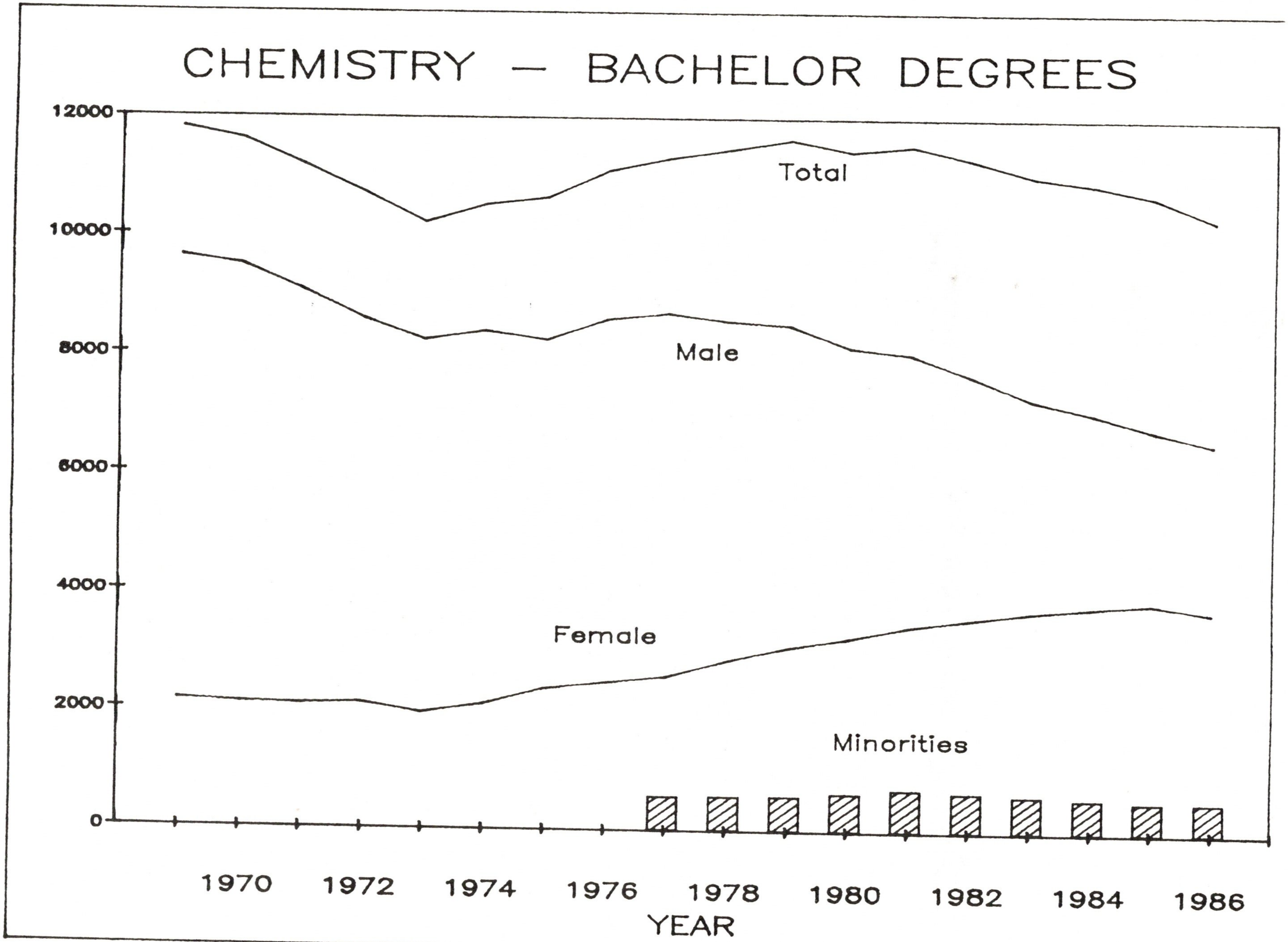
In constant FY88 dollars



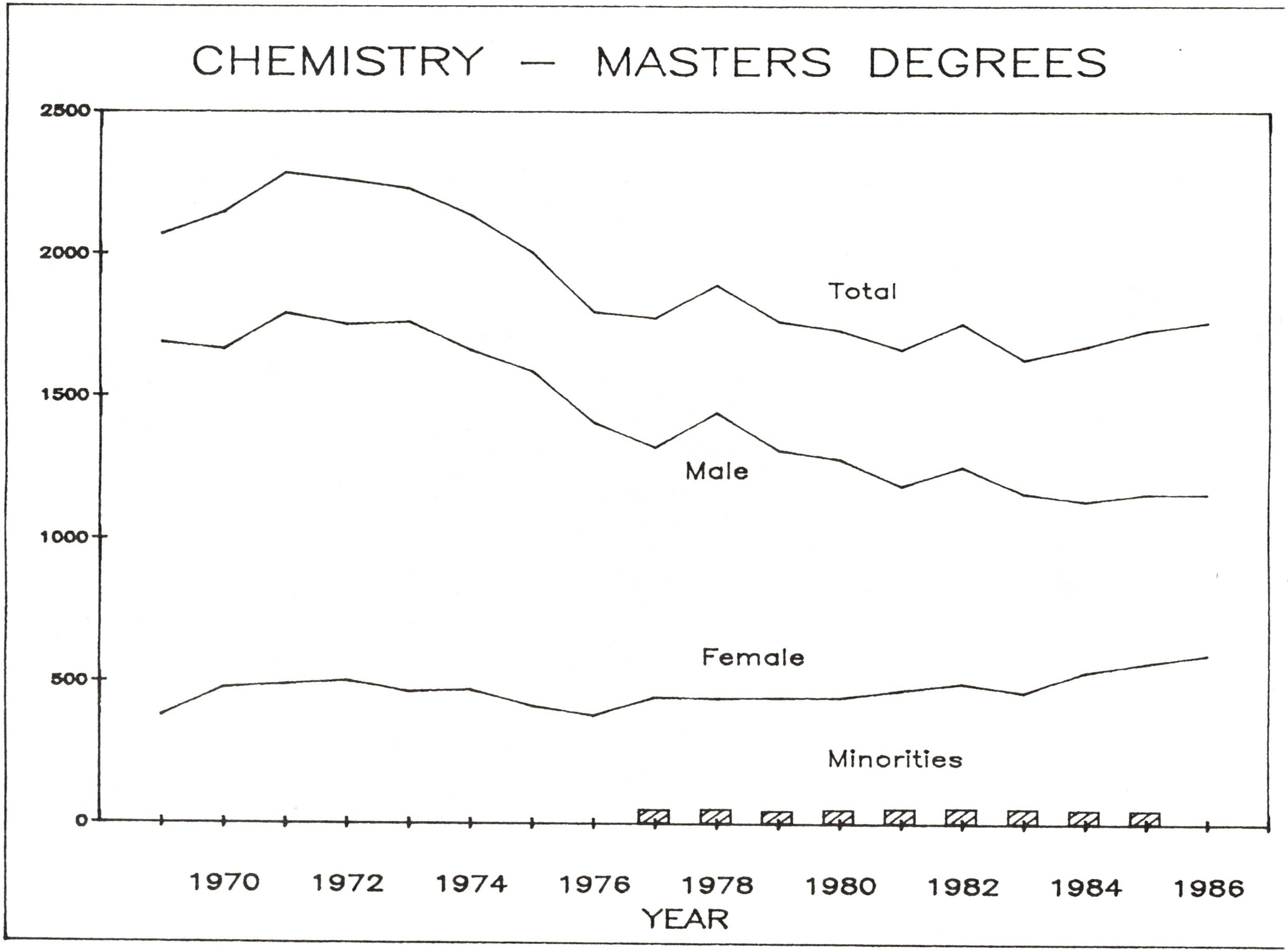
NSF Science and Engineering Education Obligations
by Level of Education
(in current year dollars)
Graduate
Undergraduate
Precollege
Obligations (millions of dollars)
150
125
100
75
50
25
0
1952
1956
1960
1964
1968
1972
1976
1980
1984
19
Fiscal Year
* Includes Informal Science Educat

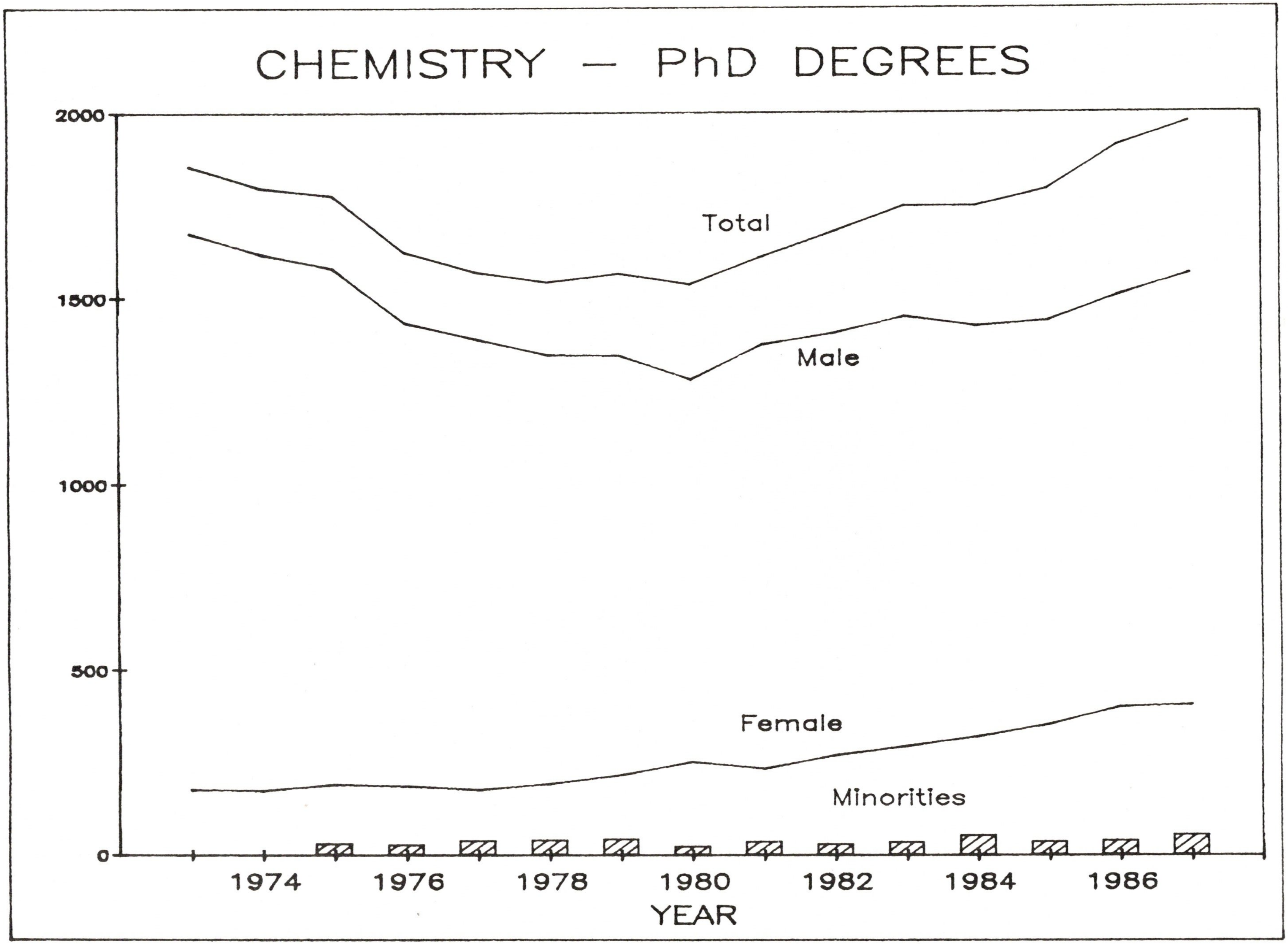


SCIENCE and ENGINEERING EDUCATION
Obligations by Level of Education
(in constant FY88 dollars)
Obligations
(millions of dollars)
500
400
300
200
100
0
Graduate
Undergraduat
Pre-college *
1952
1956
1960
1964
1968
1972
1976
1980
1984
198
Fiscal Year
* Includes Informal Science Educatio

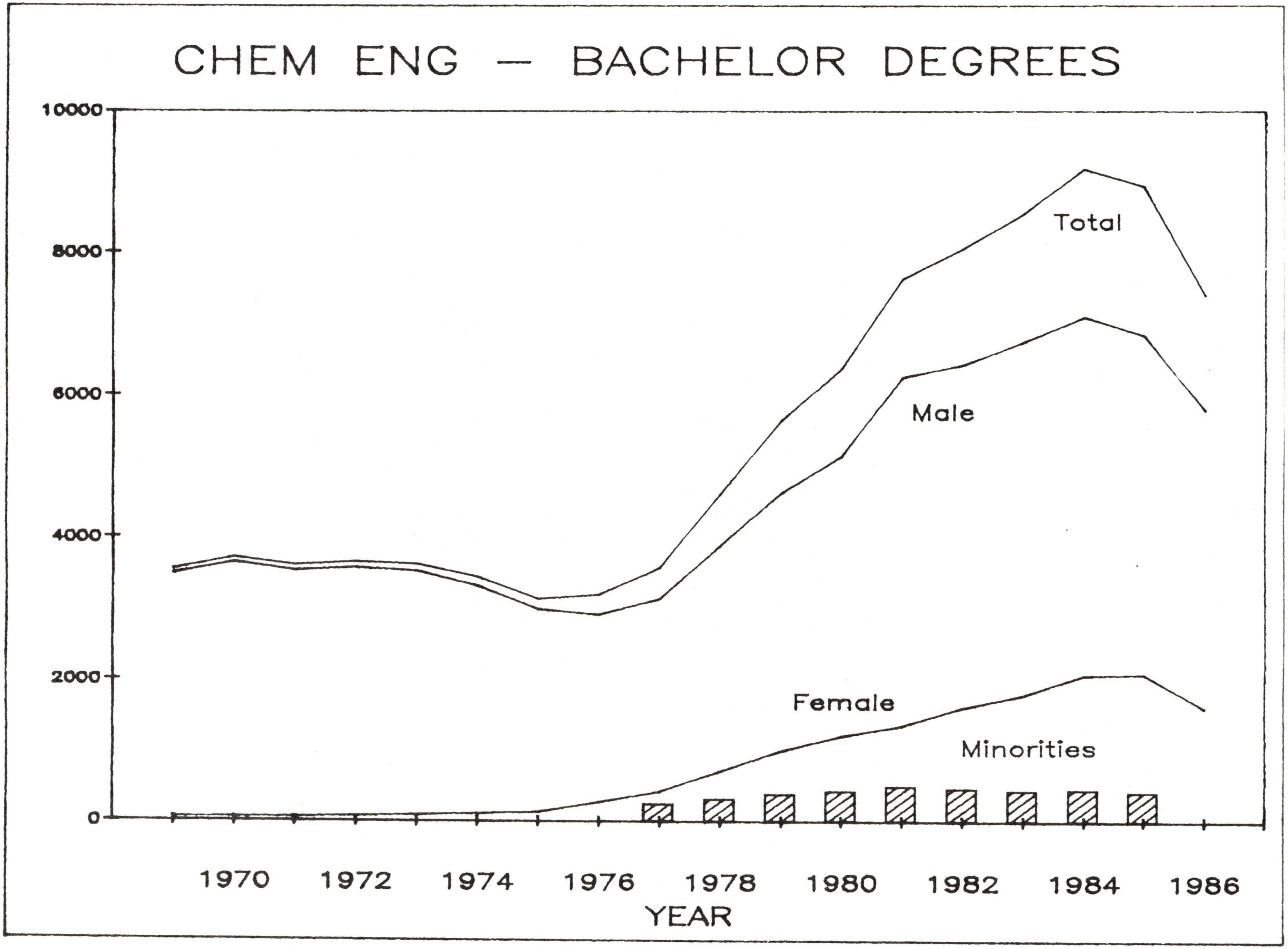


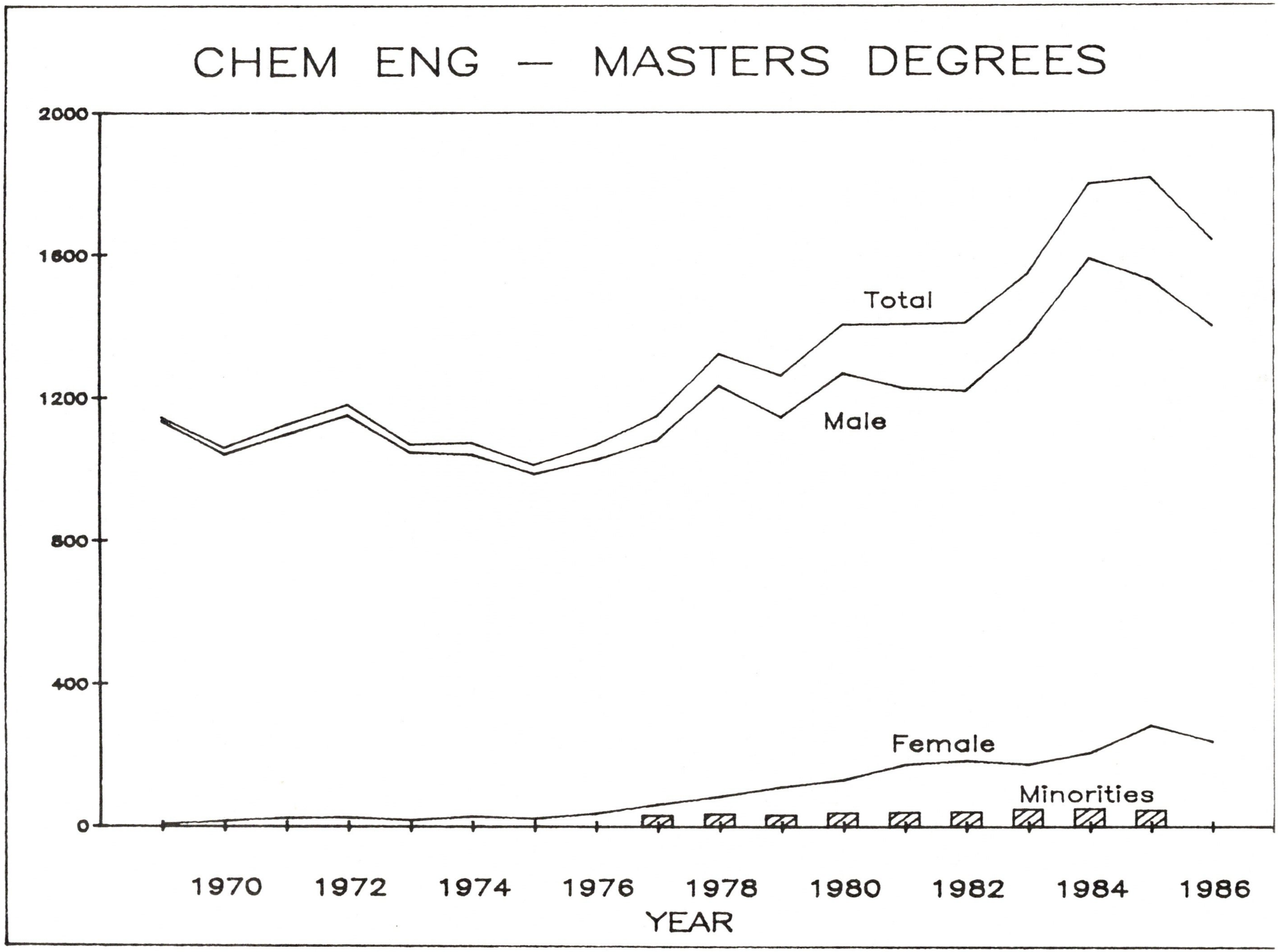
CHEMISTRY — BACHELOR DEGREES
12000
10000
8000
6000
4000
2000
0
Total
Male
Female
Minorities
1970
1972
1974
1976
1978
1980
1982
1984
1986
YEAR


CHEMISTRY — MASTERS DEGREES
2500
2000
1500
1000
500
0
Total
Male
Female
Minorities
1970
1972
1974
1976
1978
1980
1982
1984
1986
YEAR

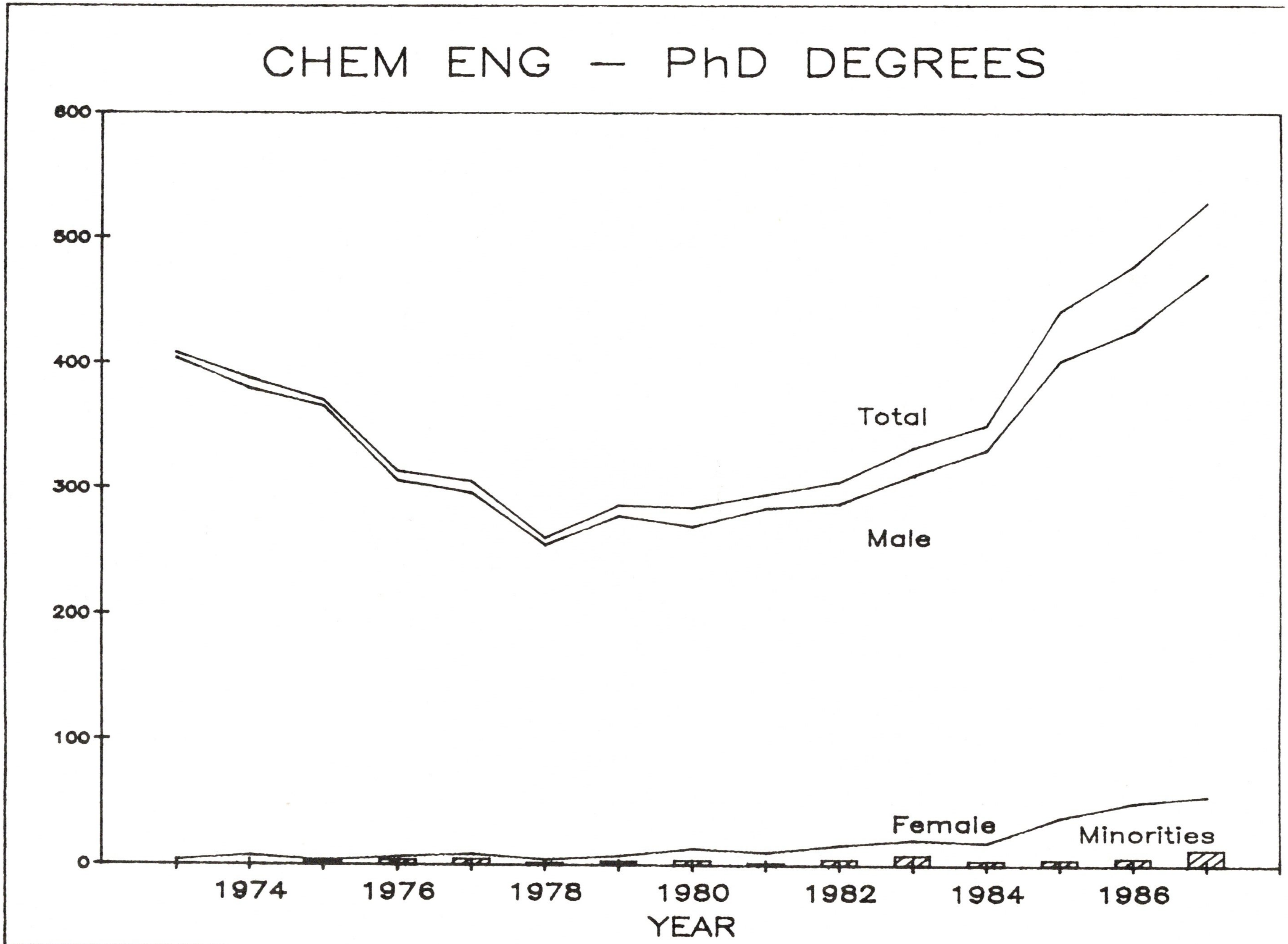


CHEMISTRY – PhD DEGREES
2000
1500
1000
500
0
Total
Male
Female
Minorities
1974
1976
1978
1980
1982
1984
1986
YEAR

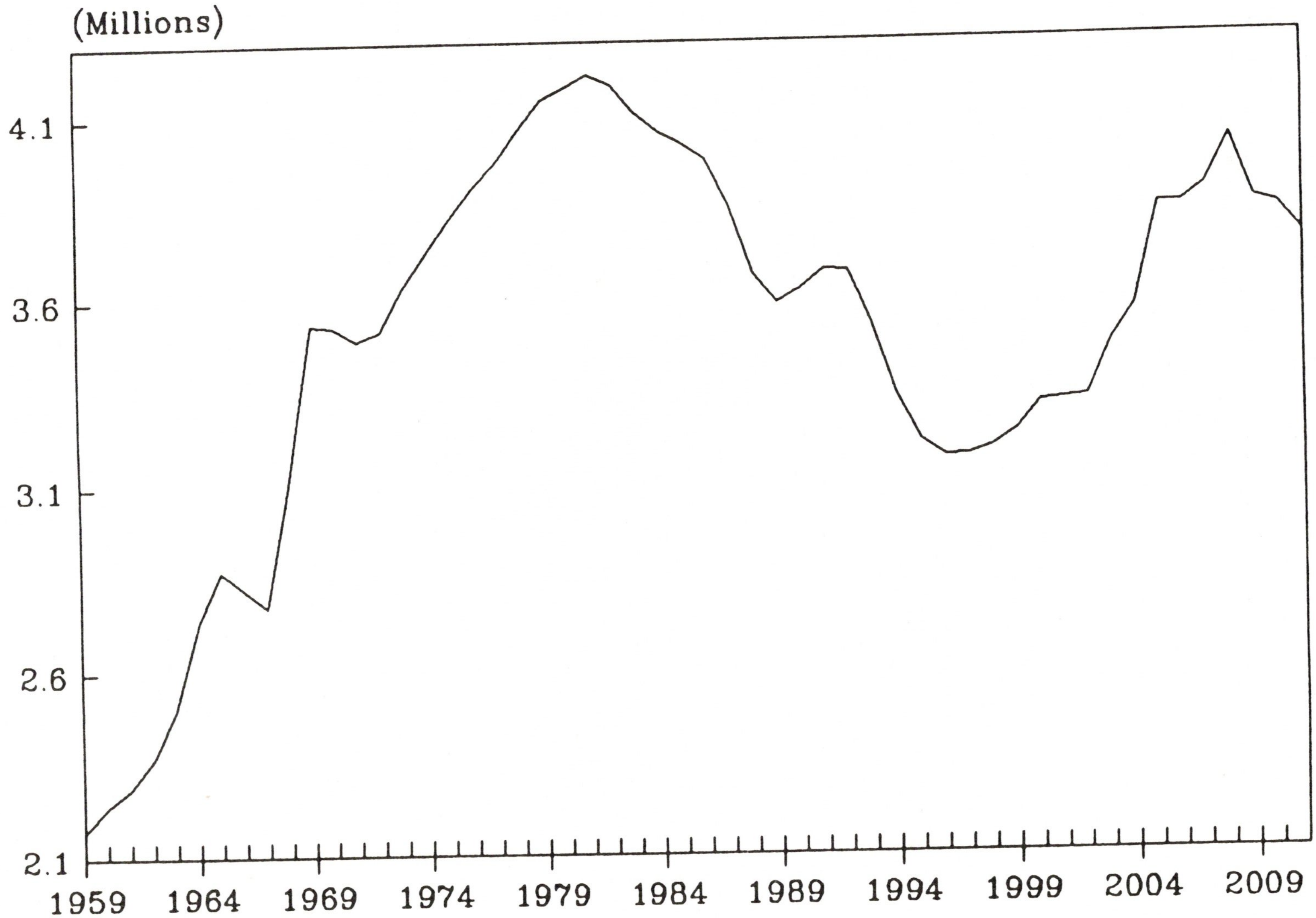

CHEM ENG — BACHELOR DEGREES
10000
8000
6000
4000
2000
0
Total
Male
Female
Minorities
1970
1972
1974
1976
1978
1980
1982
1984
1986
YEAR



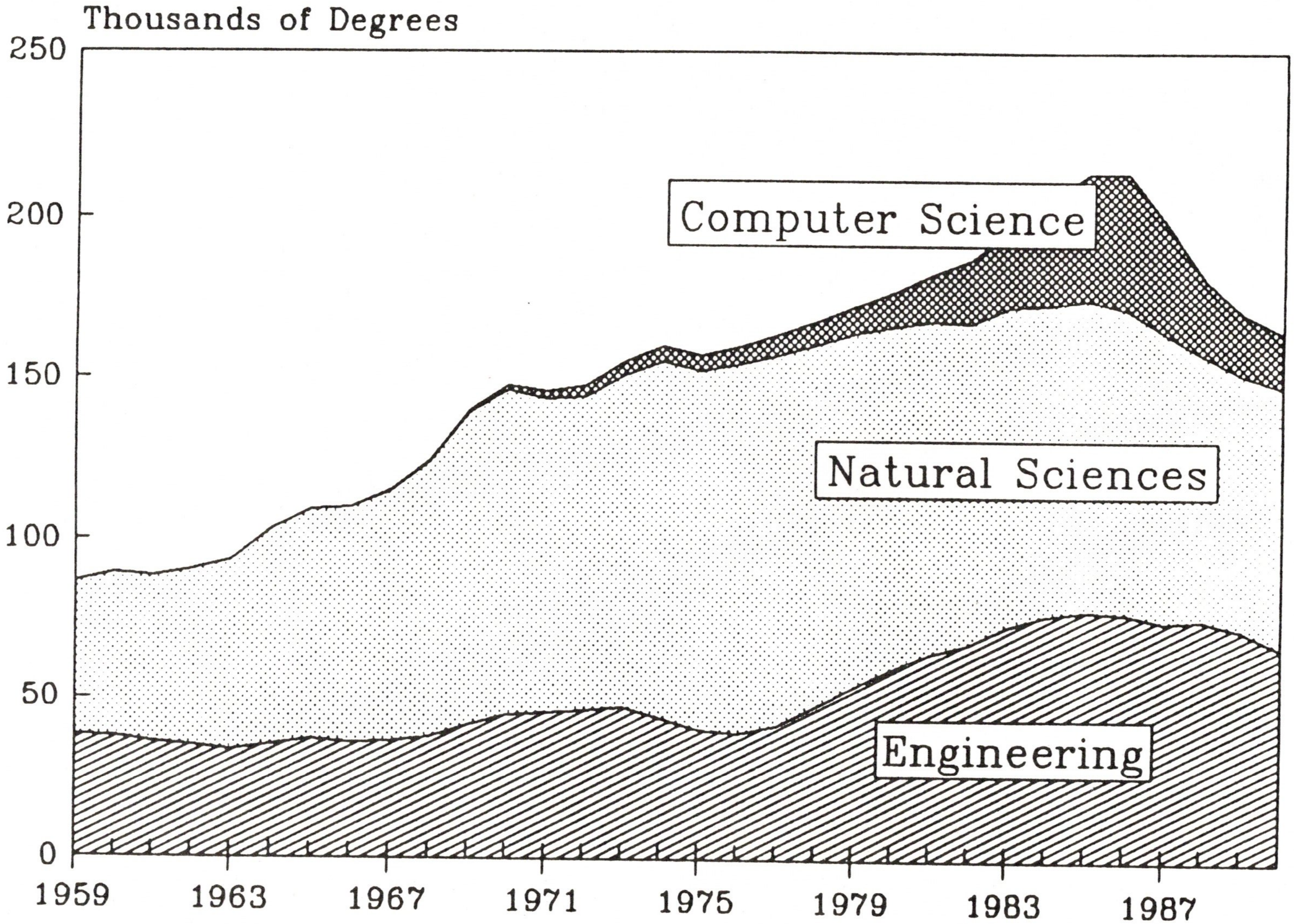
CHEM ENG — MASTERS DEGREES
2000
1600
1200
800
400
0
Total
Male
Female
Minorities
1970
1972
1974
1976
1978
1980
1982
1984
1986
YEAR

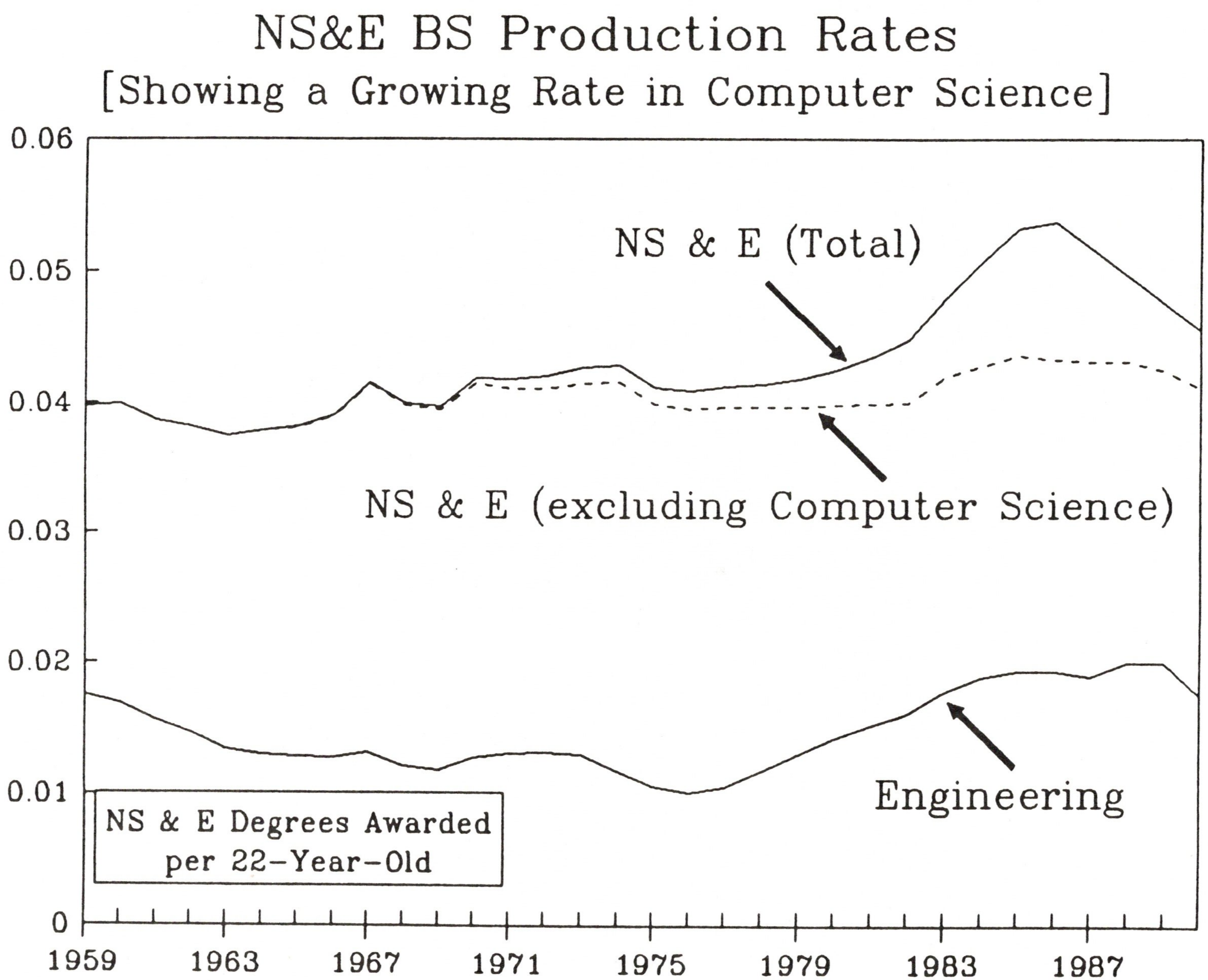

CHEM ENG — PhD DEGREES
600
500
400
300
200
100
0
Total
Male
Female
Minorities
1974
1976
1978
1980
1982
1984
1986
YEAR

Number of 22-Year-Olds in the United States

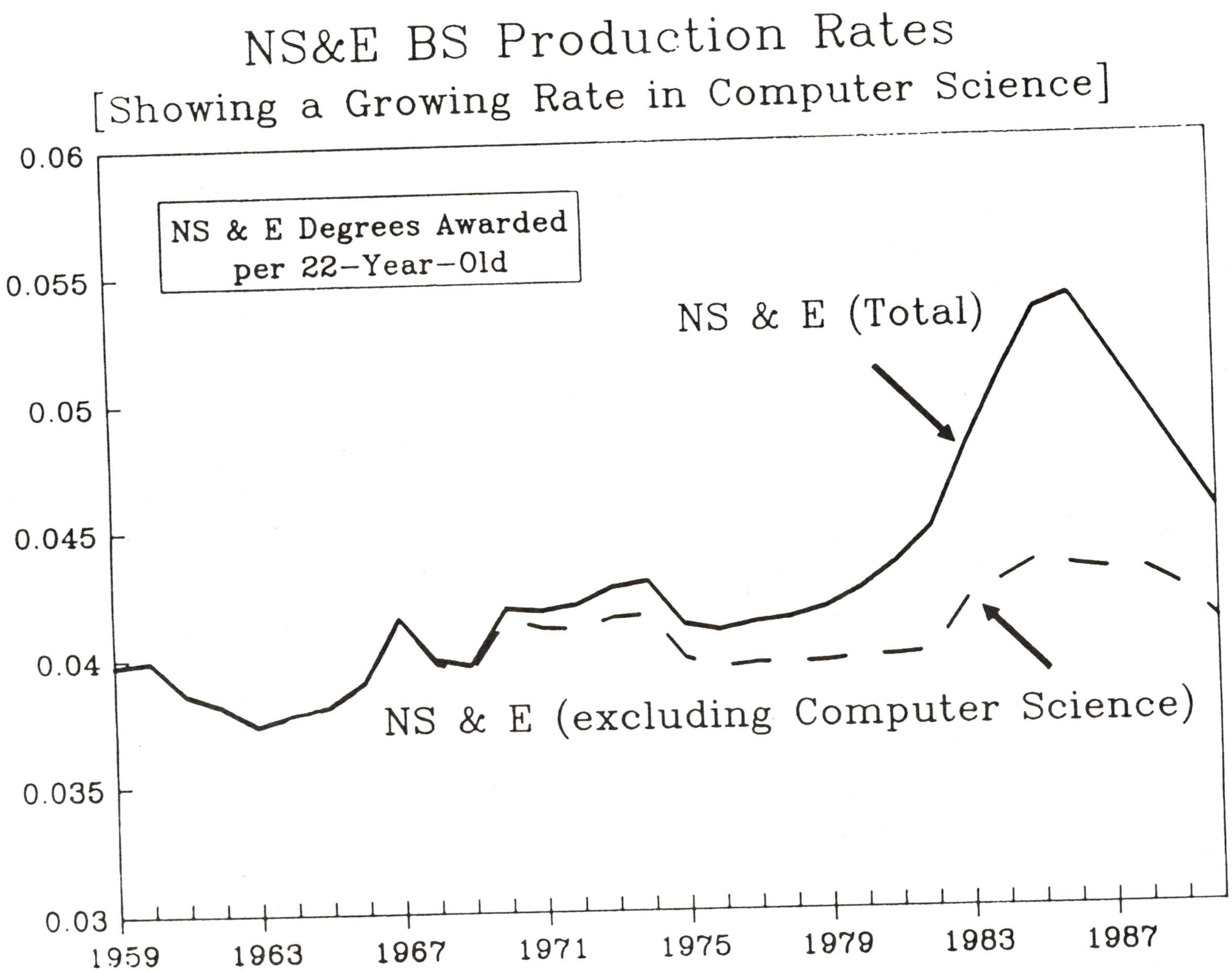


NS&E BS Production
[Showing Expected Effects of Freshman Intentions]

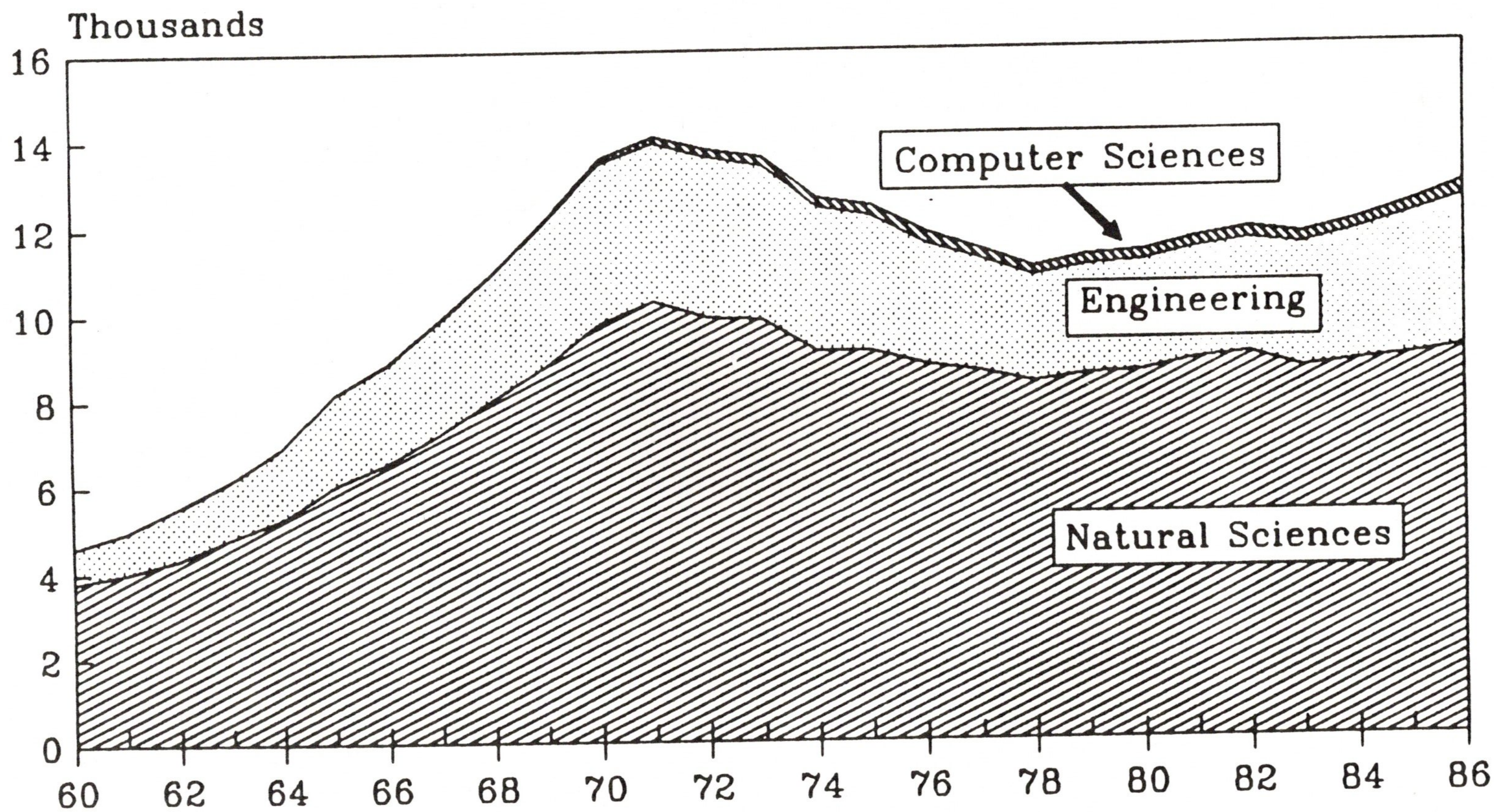




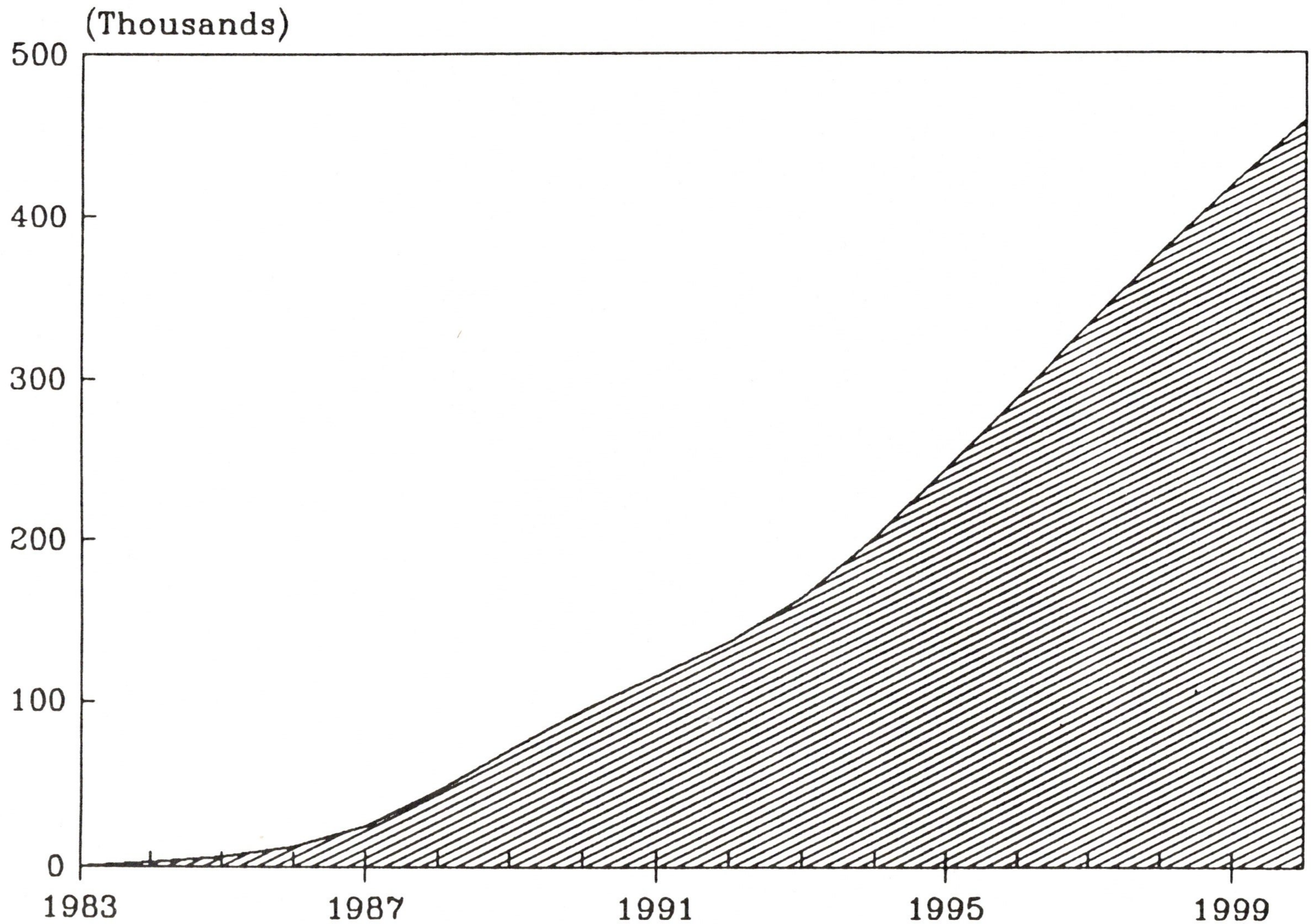
NS&E BS Production Rates
[Showing a Growing Rate in Computer Science]
NS & E (Total)
NS & E (excluding Computer Science)
Engineering
NS & E Degrees Awarded per 22-Year-Old
0.06
0.05
0.04
0.03
0.02
0.01
0
1959
1963
1967
1971
1975
1979
1983
1987


NS&E BS Production Rates
[Showing a Growing Rate in Computer Science]
NS & E Degrees Awarded per 22-Year-Old
NS & E (Total)
NS & E (excluding Computer Science)
0.06
0.055
0.05
0.045
0.04
0.035
0.03
1959
1963
1967
1971
1975
1979
1983
1987

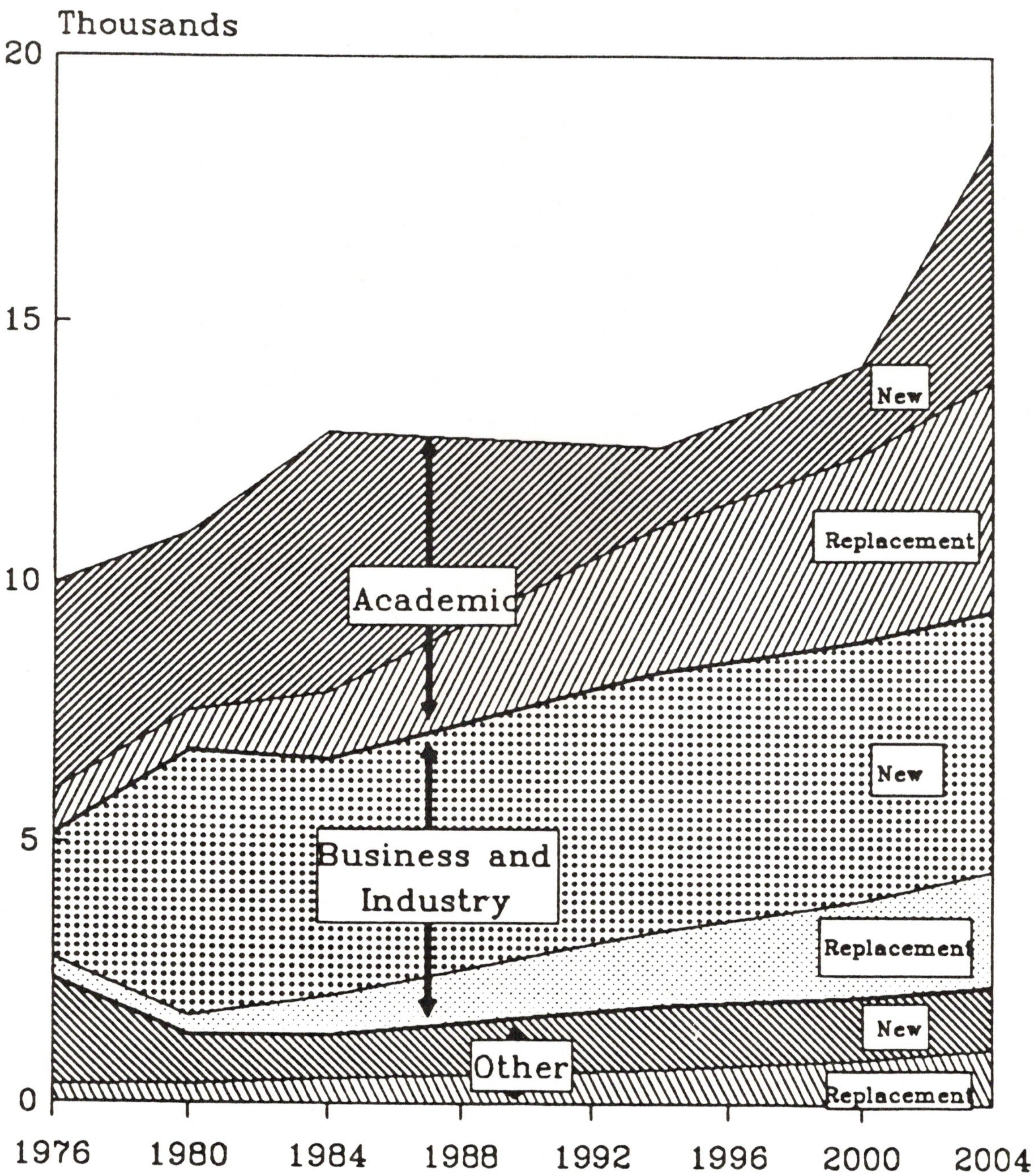
PhD Degrees in Natural Science and Engineering

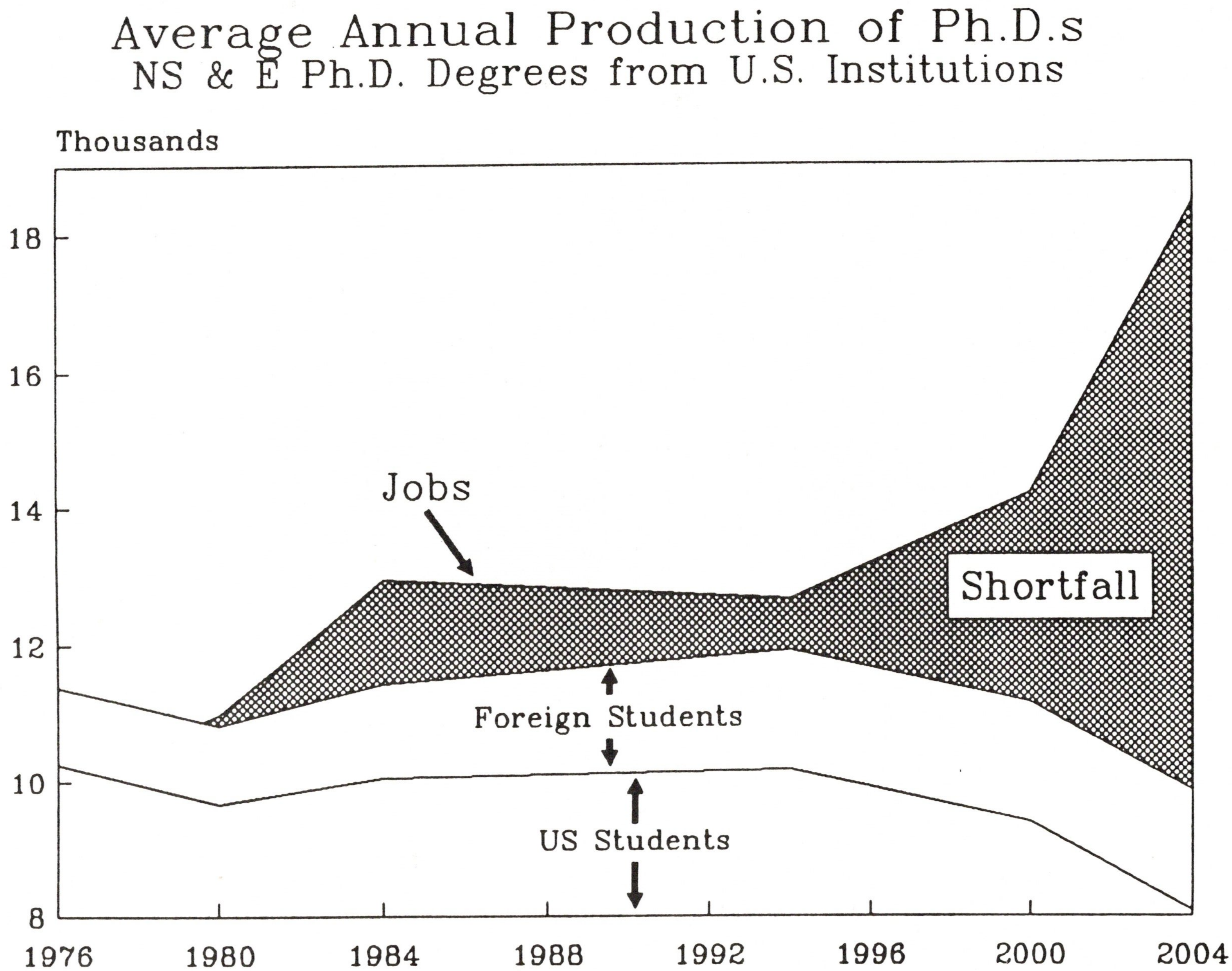


NS&E Cumulative Shortfalls: BS Degrees



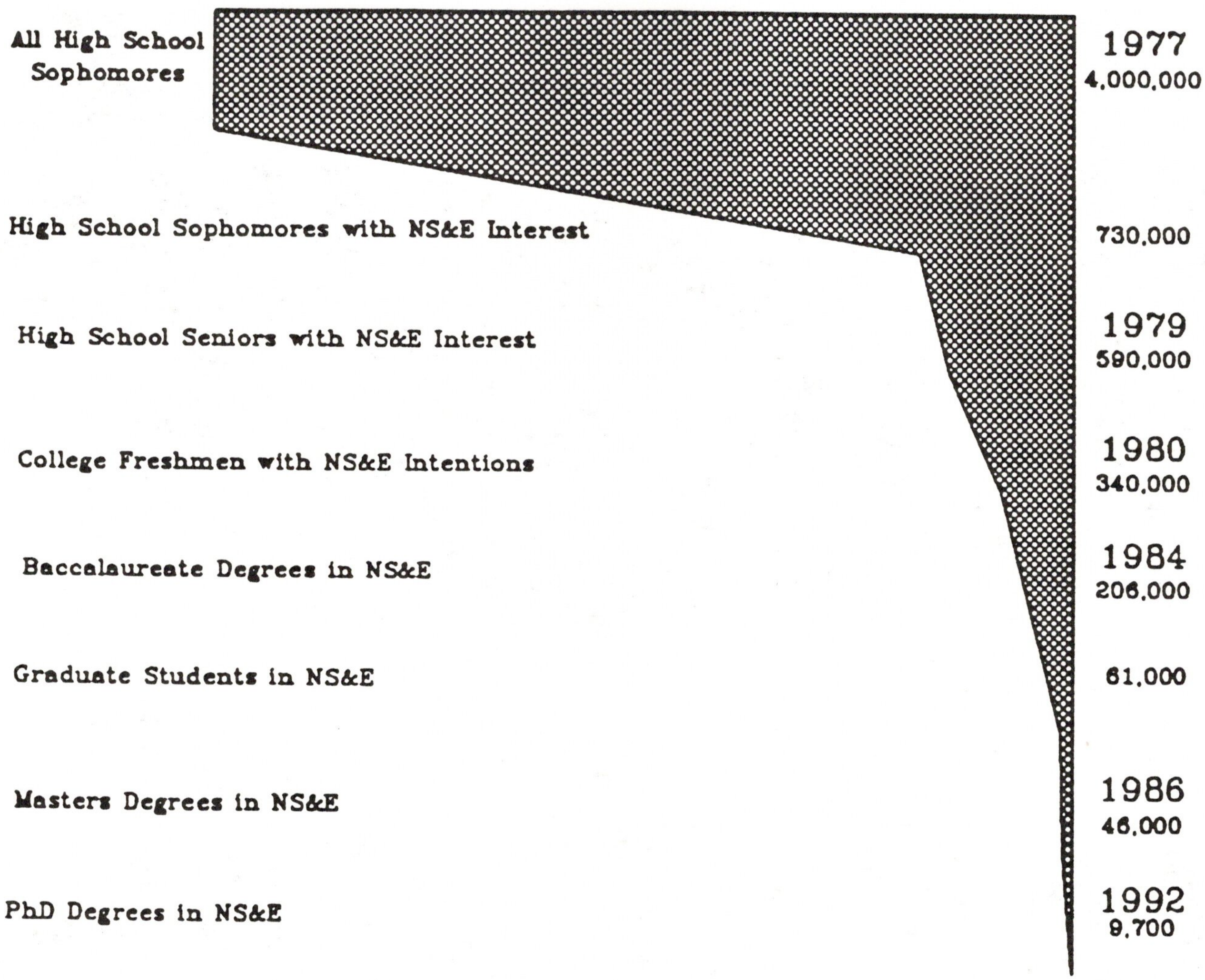
Available PhD Positions for Natural Scientists and Engineers

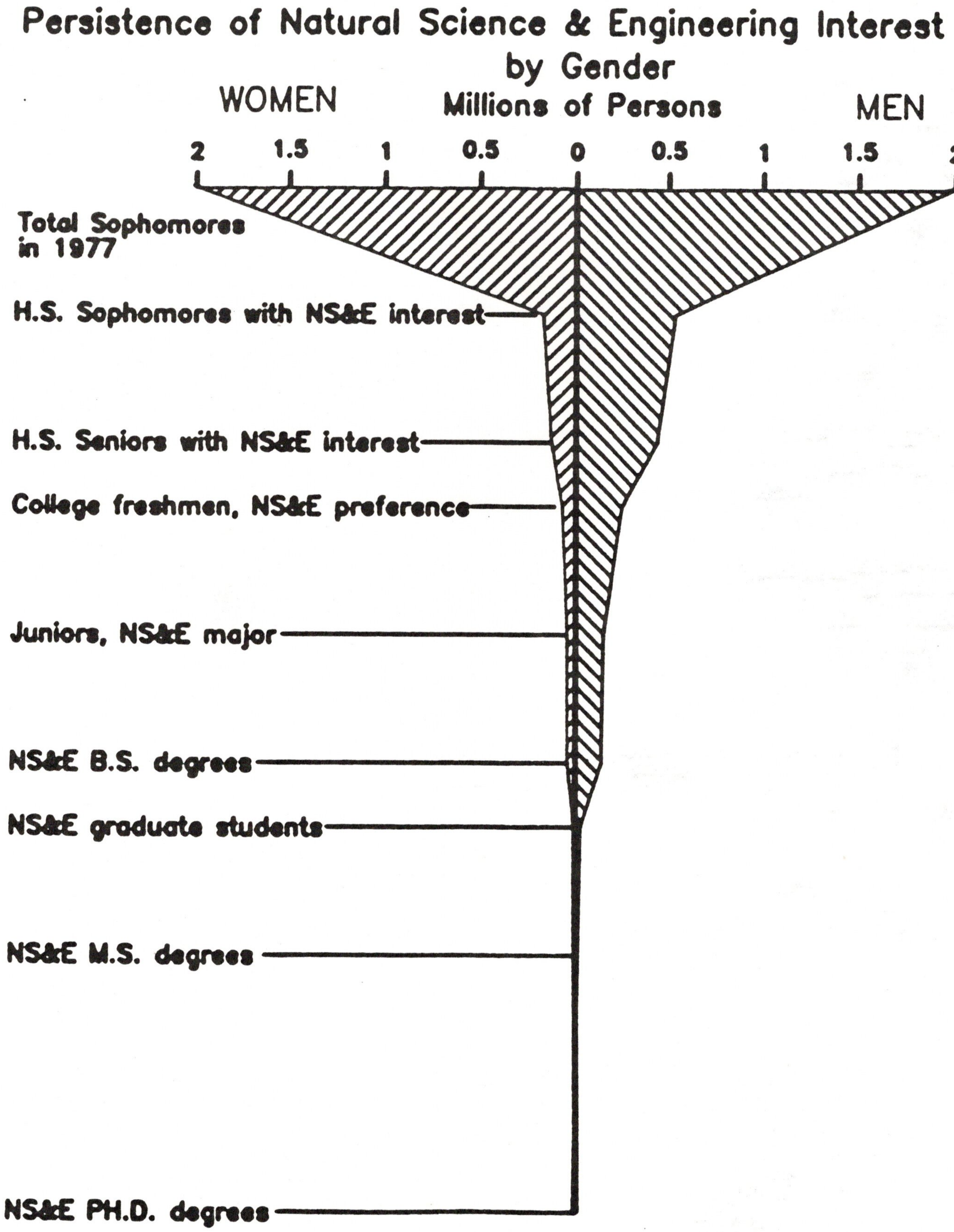


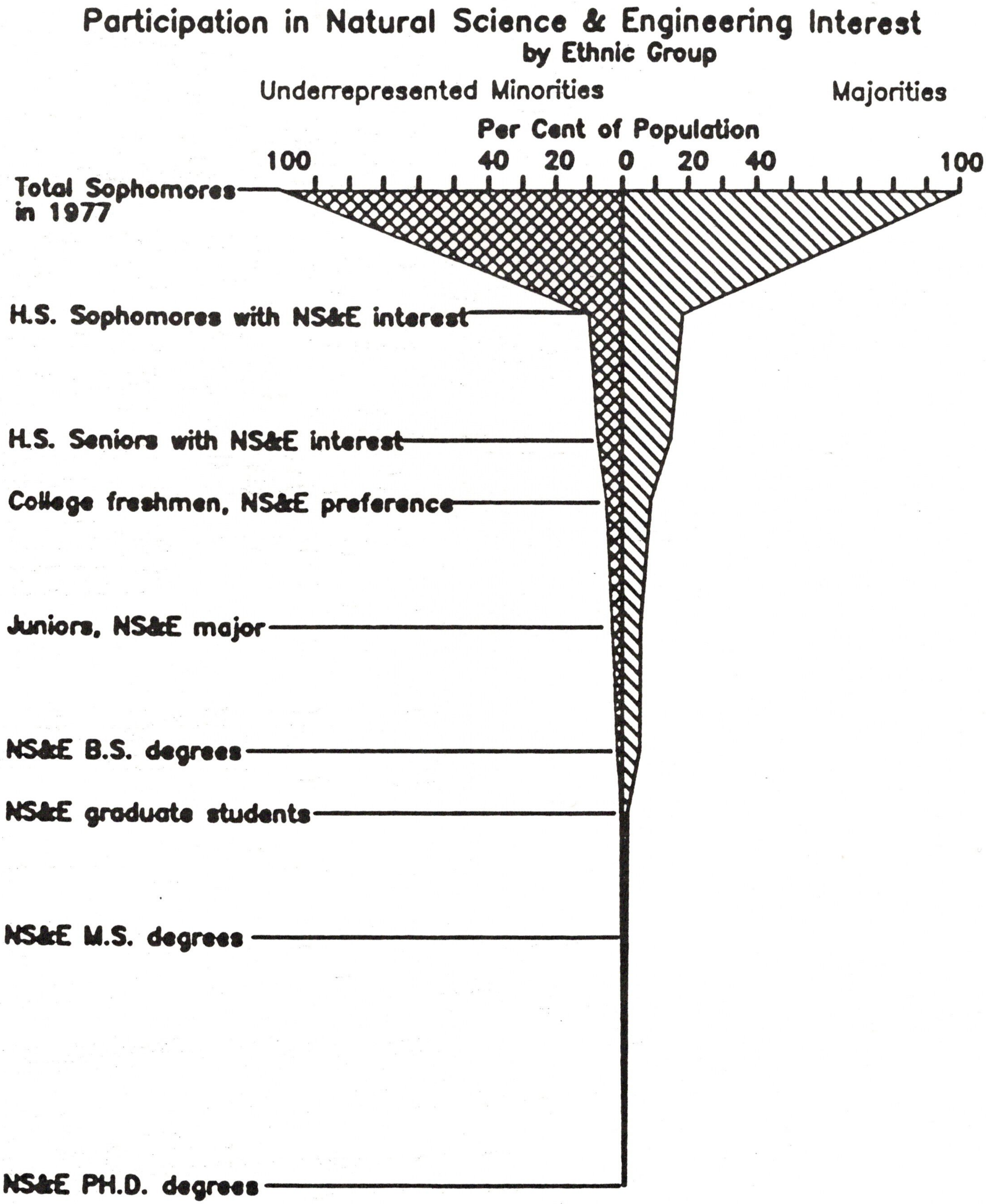

Average Annual Production of Ph.D.s
NS & E Ph.D. Degrees from U.S. Institutions
Thousands
18
16
14
12
10
8
1976
1980
1984
1988
1992
1996
2000
2004
Jobs
Shortfall
Foreign Students
US Students

Persistence of Natural Science and Engineering Interest from High School through Ph.D. Degree

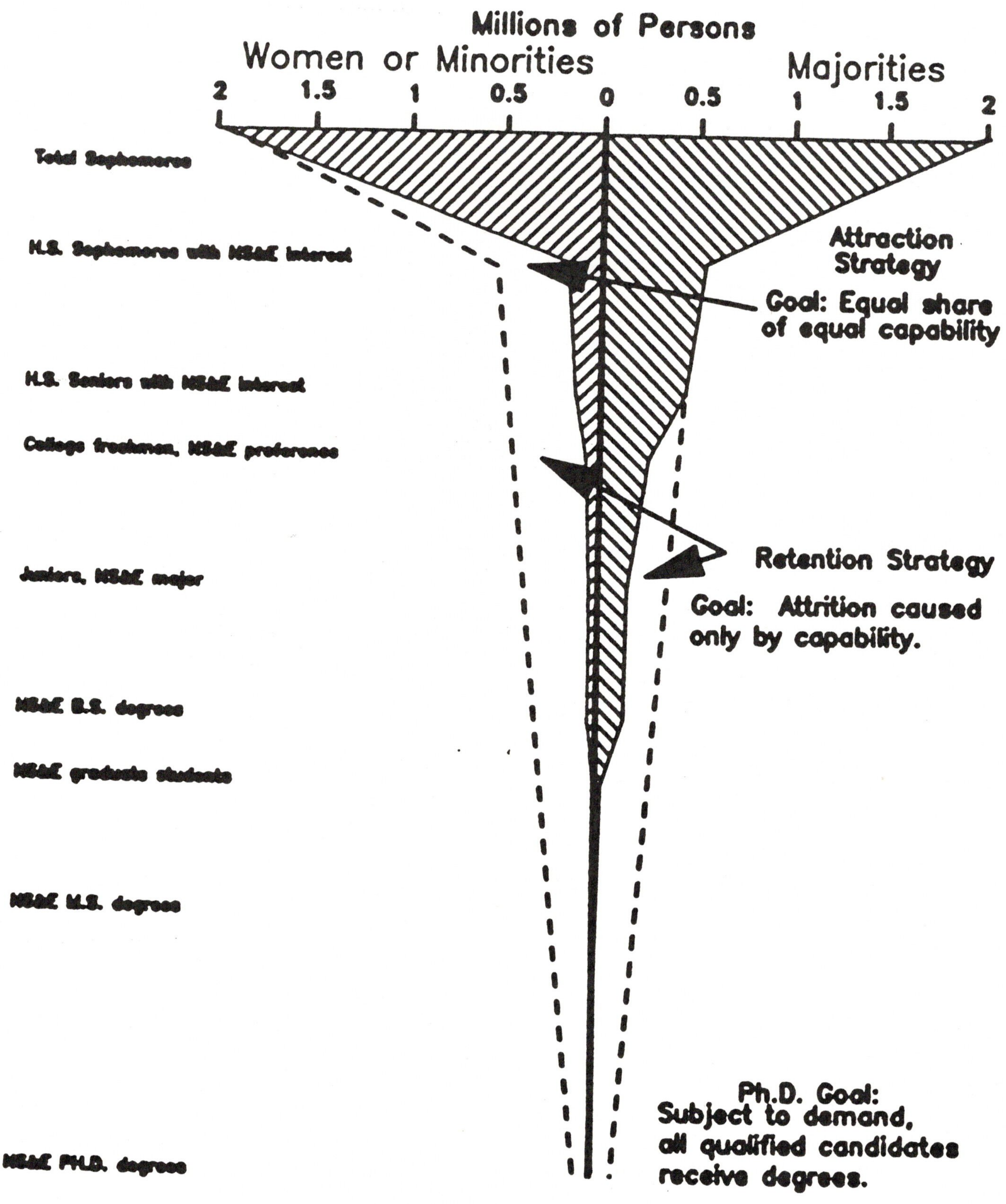
(The Pipeline)




Persistence of Natural Science & Engineering Interest
by Gender
WOMEN
Millions of Persons
MEN
2
1.5
1
0.5
0
0.5
1
1.5
2
Total Sophomores
in 1977
H.S. Sophomores with NS&E interest
H.S. Seniors with NS&E interest
College freshmen, NS&E preference
Juniors, NS&E major
NS&E B.S. degrees
NS&E graduate students
NS&E M.S. degrees
NS&E PH.D. degrees


Participation in Natural Science & Engineering Interest
by Ethnic Group
Underrepresented Minorities
Majorities
Per Cent of Population
100
40
20
0
20
40
100
Total Sophomores in 1977
H.S. Sophomores with NS&E interest
H.S. Seniors with NS&E interest
College freshmen, NS&E preference
Juniors, NS&E major
NS&E B.S. degrees
NS&E graduate students
NS&E M.S. degrees
NS&E PH.D. degrees

Strategies for Maintaining the Flow of Natural Scientists and Engineers



SCIENCE and ENGINEERING EDUCATION

(millions of dollars)

	FY 1986	FY 1987	FY 1988	FY 1989 REQUEST
Precollege	$ 53.4	$ 62.2	$ 89.9	$108.5
Undergraduate	5.3	9.5	19.0	23.5
Graduate	25.9	27.3	30.3	24.0
(New Fellows)	560	560	760	860
Total, SEE	$ 84.6	$ 99.0	$139.2	$156.0

SCIENCE and ENGINEERING EDUCATION

SUPPORT to CHEMISTRY

(millions of dollars)

EDUCATIONAL LEVEL	FY 1986	FY 1987	FY 1988
Precollege	$ 2.29	$ 5.75	$ 5.86
(% to Chemistry)	4.3%	9.2%	6.5%
Undergraduate	$ 1.35	$ 1.98	$ 2.21
(% to Chemistry)	25.5%	20.8%	11.6%
Graduate Fellows	77	63	95
(% in Chemistry)	13.8%	11.3%	12.5%
Total, SEE			
(% to Chemistry)	8.5%	10.9%	8.5%