EDITED TRANSCRIPT OF PRESENTATION BY BASSAM Z. SHAKHASHIRI AT MEETING OF ACCREDITATION BOARD FOR ENGINEERING AND TECHNOLOGY, NOVEMBER 29, 1988

I would like to share with you some concerns that those of us at NSF have about the status of science and engineering education. These are very critical concerns because of their implications not only for science and engineering, but also for the country as a whole.

Before I get into my remarks and show you some pieces of data, I want to take just a couple of minutes to explain the perspective from which the rest of my remarks should be viewed--a perspective that NSF has with respect to engineering education; indeed, education as a whole.

In my judgment, the situation that our country faces today is far more critical, far more consequential than the one it faced a generation ago just after Sputnik. This is so for a lot of reasons; let me quickly mention three:

First of all, in the thirty-one years that have elapsed since the Soviet Union's big "October surprise" in 1957, the population of the United States has increased by about 50 million people--a number that approximates the total population of Great Britain. What does that mean? Well, it means that we have more students to teach and that means we need more qualified teachers at all educational levels: precollegiate, undergraduate and graduate alike. As you will see shortly, we are alarmed about our capacity to deal with that situation.

So the first reason for concern can be summed up as change in scale and the sluggishness of our educational institutions in adjusting to that change. In fact, this sluggishness has been shared by many of our societal institutions, but the education of our young is the topic immediately at hand.

The second reason that the situation is more critical and consequential now than thirty years ago is that for our country to maintain its international preeminence in science and technology, we need to have a good supply of scientists and engineers coming out of the educational system. By the way, that's what NSF set out to do in the immediate Post-Sputnik Era. All the activities that were in the curriculum development area, and all those in the teacher institutes area, every single one was aimed at seeing that the flow of people into science and engineering was adequate. To a very large extent NSF succeeded in that effort, but we have to maintain it, and as I said and as you will see, we have data that give us alarm.

The third reason that the situation is more critical now--in my judgment the most important reason of all--is that we live in a much more advanced scientific and technological society, one that needs a technologically literate populace, a citizenry that 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 make intelligent and rational decisions, as those of us in the sciences and in engineering do. So we need to be concerning ourselves with an educational system that will ensure the general scientific and technological literacy of our fellow citizens.

So nowadays NSF has a dual mission, first, to see to it that we have a good flow of scientists and engineers coming through the educational system, and second, to see that our fellow citizens are appreciative and supportive of what engineers and scientists are doing.

Let me offer an analogy from a field of activity most Americans do appreciate and support: Sports. Just as we have professional football players, basketball players, hockey players, baseball players, etc., we have fans. Without those fans the entire professional sports enterprise would be nothing, and that's not an exaggeration. That's what we need: engineering fans, science fans, in addition to engineering and science professionals. But we need more; we need fans who are intellectually fit, which is a continuation of the analogy, not just sitting in the stands as passive spectators. We need them to be full participants in the activities that take place.

If your tastes do not run to sports, let me offer another analogy: music. There are symphony orchestras, and there are symphony audiences. We need good orchestra players and we need good--which is to say critically informed and appreciative--audiences.

Now, we don't want everyone to be an engineer or a scientist, any more than we want everyone to be a pro footballer or a musician. We just want a citizenry that is appreciative and supportive of what we would are doing in engineering. This is why NSF has the dual mission I mentioned--to guarantee a good flow of engineers and scientists from our educational systems, and at the same time to see to it that the population at large is scientifically and technologically literate.

Let me now discuss with you the alarming data to which I have alluded--data that most of you are familiar with; data that deal with both qualitative and quantitative aspects of this problem that faces us thirty-odd years after Sputnik. I'm going to go now to this overhead projector so I can put up in visual form the information that I have to share with you.

The first piece of information I want to show you **[Fig. 1]** has to do with the number of 22-year-olds in the country. Unlike some of the vu-graphs you will see in the next few minutes, which are projections or estimates, this represents a fact that none of us can do anything about, even if we all got busy right away. What we see here is that the number of 22-year-olds--the age at which people typically graduate from college--will continue to decline through the year 2010. We know that because the class of 2010 was born in 1988.

Over the years covered by this second graph, **[Fig. 2]** from 1959 on, roughly speaking about **4%** of the population of 22-year-olds have been getting a B.S. degree in the natural sciences and in engineering excluding computer science. That **4%** is a good number to remember. For engineering **[Fig. 3]** alone, the corresponding number is under 2 per cent, and that's a distinction that you ought to keep in mind.

How does this relate to expected intentions or declared intentions of freshmen? **[Fig. 4]** We all know that freshmen students declare their intentions to major in science or engineering or what have you, but we also know that many of those who declare their intentions to be science or engineering majors end up getting their degrees in a different area--but not the other way around; in fact, the other way around is like a forbidden transition. Very, very seldom does that happen, which is, again, a cause for concern.

Now, how does this translate to the Ph.D degree level? **[Fig. 5]** Here, you see the data for engineering and for the natural sciences. There are, of course, great societal forces that influence what happens in education, just as education influences greatly what happens in our society.

Consider this growth, which took place in the 60's, peaked in the early '70s and then started declining, and let me ask you to think about some of the causes, such as the deferments that were available to those going to graduate school at the time and the kinds of support they received under the National Defense Education Act, NSF fellowships and so on.

All right; let's take a look **[Fig. 6]** at projected Ph.D. positions in the natural sciences and engineering and their distribution among academe, business, and industry. The group labeled "other" at the bottom refers to people like myself who work for the government or in national labs and the like. This projection shows that there's going to be a great need for scientists and for engineers and that competition between industry and academe is going to get very stiff in the next 15 years, especially since about 40% of the current academic faculty will be retiring. Now this competition is very good for those who receive degrees in this period because salaries will go up, but overall it's not a very healthy situation to deal with.

Tying all this together, using the known number of 22-year-olds and the 4% figure of B.S. degrees that's held pretty steady all these years, it's possible **[Fig. 7]** to project a cumulative shortfall of about 430,000 holders of B.S.degrees in the natural sciences and engineering between now and the year 2000--only 11 years down the line.

At the Ph.D. level **[Fig. 8]** there will be a shortfall of about 8,000 by the year 2004. We have a very healthy population of foreign students coming to this country but so many of them nowadays are going back to their native land, unlike what I did when I came here in 1957. I enjoyed the wonderful hospitality of this country and the magnificent opportunities that are available. But now many students from the so-called developing countries are going back to be part of that development.

You know that the greatest tribute to our institutions of higher education is that students flock here from all over the world to enroll in our graduate programs, and yet somehow, U.S.-born students are not doing the same thing. There's nothing wrong with having a good percentage of the enrollment in our engineering programs be foreign students; nothing wrong at all. What is wrong is the small number of U.S.-born students who are pursing careers in engineering and in the sciences; and the effect on availability of Ph.Ds: As I said, a shortage of about 8,000 in the year 2004.

I spoke earlier of students' declared intentions and how those intentions change over time. Let's look at the persistence of interest in the natural sciences and engineering starting not with college freshmen but with high school sophomores. **[Fig. 9]** In 1977 there were 4 million young people in this age cohort who will be of an age in 1992 to be receiving Ph.D. degrees in the natural sciences and engineering. Four million; and how many will actually become Ph.Ds in 1992? Fewer than 10,000.

We have leakage, so to speak, all along the pipeline. Even at the start of graduate school we still have 6 holders of natural science and engineering bachelor degrees for every 1 who will eventually earn the Ph.D. And it is important to stop the leaks wherever they occur, but the battle is really not won or lost at the high school sophomore level or later, but before that. This is an area where NSF, since 1984, has been trying to focus on, and we'll talk about that in a minute.

These numbers remind us of where we should be focusing our efforts. Certainly we should focus them strongly at the graduate level for retention purposes--to keep from losing them--but also earlier, even pre-high school, we should to be engaging in recruiting strategy and a drafting strategy.

Backing up now and looking at the same population but from two different angles, we see that we don't sufficiently attract talented women **[Fig. 10]** to go into careers in science and in engineering, and we don't attract minorities, **[Fig. 11]** either. These are grievous sins of omission. Women are actually more than half the adult population of the nation, and minorities--regardless of sex--make up 15 to 18% of the national population. This is the situation today; what of tomorrow? The Census Bureau and the Bureau of Labor Statistics estimate that within 25 years the population as a whole will be 35 to 40% minorities.

Obviously, we have not done as well as we should in attracting women and underrepresented minorities to careers in engineering and science. Whatever strategies we have used in the past we ought to learn from, and modify and change them so that we are successful in attracting the really great mass of talent that's available. One datum-point for you to consider: Do you know how many blacks people received a Ph.D. degree in mathematics last year? Fewer than a dozen, in the whole United States--fewer than a dozen blacks received a Ph.D. degree in mathematics. The data for engineering, for chemistry, for physics, for mathematics, for biology all are comparable.

So we have to devise strategies--recruiting strategy, drafting strategy, retention strategy. These are the kinds of things that we ought to be looking at.

Now, we all appreciate that strategies for recruiting and retaining women in the scientific-engineering pipeline are different from strategies for recruiting and retaining minorities. But that is only part of the story: Even among minorities the strategies are different. Hispanics in the Southeast are different from Hispanics in the Southwest. Blacks in the cities are--or may be--different from blacks in other settings, in terms of how we should be approaching them to enter our pipeline.

Let me share with you some other data in point. The field I've chosen is chemical engineering but it could have been almost any field. **[Fig. 12]** This shows bachelors degree in chemical engineering by year from 1969 through 1987. The bar graphs at the bottom show minorities--the number of minorities who have received B.S. degrees in chemical engineering; note the decline in recent years. At the master's degree level, the picture **[Fig. 13]** looks like pretty much the same, (again with minorities dropping out in recent years). At the Ph.D. degree level **[Fig. 14]** the picture looks a little brighter, with a continued up-trend. But do you know why that is? It's because of the foreign students enrolled in our institutions.

Let me switch very quickly to the other end of the pipeline, to a set of data many of you are familiar with and indeed helped collect. This concerns the pool of students whom we must recruit and from whom we will draw the scientific and educational leaders of the next generation.

Just last March a report was released dealing with three surveys of science achievement among pre-college students in the United States and about a dozen other countries. At the fifth grade level, **[Fig. 15]** the United States ranked right in the middle of the pack according to a uniform test of scientific knowledge, with Japan at the top (which perhaps would surprise no one) and the Philippines at the bottom. Look at the relative ranking of the countries, but look also at the range of scores that we're talking about, because sometimes the range is not as large as in other cases. This is the picture in the fifth grade.

At the ninth grade level **[Fig. 16]**--this is in science; the picture in mathematics is very comparable, but this is in science--here's where the United States ranked: next to the bottom. Turn the chart upside down and you and I would like to see the situation like this. You know what? We can make it that way, and I'll talk about that in a second, but this is how it is right now.

Again, look at the relative rankings and range of scores in this next set of transparencies. We'll be looking at the scores of students taking a second year of a science--physics, chemistry or biology--so-called "science specialists", in this study. This is where the U.S. students rank in physics. These students are most likely to be taking advance placement physics. When they go to an institution of higher education such as Wisconsin and they get a 3 or a 5 on the advance placement test, they're exempted from taking freshman physics. So we're not talking about your average, run-of-the-mill student, we're talking about our good student. This **[Fig. 17]** is where the U.S. students rank in physics: fifth from the bottom. This is the picture in chemistry **[Fig. 18]**: third from the bottom, and this **[Fig. 19]** is what the picture looks like in biology: the American team is in the cellar. Do you know that more students take biology courses in high school in this country than any other science?

I don't believe for one second that the talent in this country is different from talent around the world. Yet these data suggest that there is something in our society, in our educational system, that we ought to be paying very special attention to. What's really at stake is the quality of life in our society, not simply the quality of education in our high schools, middle schools, elementary schools, or in our colleges and universities, it's the quality of life.

I believe these troubling pictures can be altered. The purpose for which we want to improve the quality of science and engineering education at all levels is not to beat the heck out of any of those countries that are ahead of us. The purpose is to have our society be prepared to make sensible rather than foolish decisions. That's what we do in engineering, what we do in science. We act in a rational way and we ought to share that with the other people that we live with and with the people who make possible our pursuit of research and education.

I believe if that were to happen then the situation would automatically take care of itself. Those relative rankings are not terribly helpful except that they may make us focus attention on a terrible situation that we in the educational establishment and in the industrial establishment, need to be paying very special attention to.

So far what I have said has sounded like a gloom and doom story--and it is. It is intended to be that so that we can all get our attention focused on the problem. I have no doubt about our national capacity to deal with those complex issues, but I do have a question or two about our national will to deal with them. Such a will, if it does not exist now, can be developed through the collaboration of all responsible factions in our society: people in education, people in industry, people who care about the quality of engineering, the quality of science that takes place in this country.

What's at stake here is not just the quality of life in this country but the quality of life on the whole planet in terms of an educated citizenry becoming appreciative of the complex issues related to pollution control, to understanding the so-called greenhouse effect and a whole variety of others.

About two months ago another report was released by the Educational Testing Service, called The Nation's Report Card in Science. It dealt with proficiency levels, and identified five of them. The study looked at 9,- 13-and 17-year-olds, in their scholastic performance since 1969.

This **[Fig. 20]** identifies the proficiency levels used in the survey, and this **[Figs. 21, 22]** is what the trend looks like. It's a "good news, bad news" story. The good news is that we made some recovery, but the bad news is that the magnitude of recovery did not match the magnitude of decline.

Yet again, this is an area where we can do a lot about changing the situation. The data here **[Fig. 23]** are broken down by ethnic categories and for Hispanic and black students it's a good story: the slopes are all in the right direction, but not the relative position of Hispanic and black students compared to white students. How can we in this society, educated scientists and engineers, tolerate performance of this kind? Can we do anything about it? The answer is yes, we can do a lot, and we'll get to that in a second.

Now let me talk a little about the National Science Foundation picture in terms of what's been going on since NSF came into existence in 1950. What I'm showing you here **[Fig. 24]** is NSF obligations; that's the money NSF has invested in research and in Science and Engineering Education. That's what the SEE acronym stands for. The top line, of course, is the sum of the two other lines. That's the picture in current year dollars. Here **[Fig. 25]** is the same picture in constant 1988 dollars, broken down to the three accounts in the NSF budget: research, the US Antarctic Program, and support for Science and Engineering Education.

You can see that in constant 1988 dollars NSF as a whole has not changed very much since the late 60's. We're about the same level as we were back then. We have a few dips here in the picture actually in constant 1988 dollars. But in actual buying power the share of the NSF pie **[Fig. 26]** devoted to education has changed drastically. Looking at clusters of years, '52 to '55, '56 to '60, and so on, support for education has declined from more than 40 per cent of the NSF budget to less than 8--and in the real famine years, 1981 through '85, Science and Engineering Education's share was just a hair over 4 per cent of the total.

Looking at Science and Engineering Education **[Fig. 27]** broken down into the three educational levels--graduate, undergraduate and pre-college--we also see some remarkable changes over the years, especially with respect to pre-college. Early in this decade, funding for elementary. Middle and secondary school science and engineering education was all but zeroed out; this fiscal year--in current-year dollars, at least--we are at an all time high. But again, allowing for inflation over the years and looking at constant 1988 dollars, **[Fig. 28]** we see quite another picture: Our 1989 pre-college funding is barely back to the amount provided 20 years ago.

I am not minimizing the progress that has been made in the last few years; indeed, we in the Directorate for Science and Engineering Education are very proud of this accomplishment. We are proud of the success we have made with support of education activities in the sciences and in engineering. We are not as proud of the participation of engineers in this activity, but it's beginning to happen. We have several engineers in the undergraduate division: Ed Ernst, an Associate Dean of Engineering from the University of Illinois; Anita LaSalle, formerly with Computer Science at the New Jersey Institute of Technology; Jack Lohmann, Associate Dean of Engineering from the University of Michigan; George Peterson, formerly Chair of Electrical Engineering at the U.S. Naval Academy. Chor Tan, former Dean of Engineering at The Cooper Union is in the career development area.

We are very much interested in encouraging engineers to participate not only in the undergraduate activities but also especially in precollegiate activities, in the pre-engineering areas. We need to be concerned, all of us, about the communication of engineering, technology, science, at all educational levels. We in the scientific and engineering communities do a very good job of communicating with one another, through the literature, through symposia, meetings, what have you.

But we do a lousy job communicating with non-scientists and non-engineers. There are many of us who say, "That's not my responsibility, I just want to do research. Let somebody else communicate engineering and science to the public." I urge you to think about it, about the important role that we in the engineering and scientific community have to communicate our knowledge to others. Why should we have that responsibility? Why should we care? Because it is our engineering, our science that is being communicated. We are the custodians of knowledge in that regard, and we should be very proactive in dealing with that situation.

Look again at those numbers in constant year dollars. **[Fig. 28]** When you take into account the tremendous increase in the population that we talked about before, you realize that on a per capita basis we are at about 1/3 of the level of effort that the numbers themselves suggest.

Now I want to turn to a concern that is of great importance to all of us. It has to do with a question I am asked very often: "Why does the National Science Foundation provide support for education in the sciences and in engineering?" My answer is that it's the same reason that NSF provides support for research in the sciences and in engineering. Actually there are three reasons: first, this support is provided because it enhances our national security; second, it enhances our economic security; and third, we provide support for science and engineering--both research support and education support--because we believe it contributes to an effective democratic society.

You may question or debate the validity of those reasons if you like, but there they are. Now, I would like to ask each one of you a very personal question. Did you go into engineering because it was good for national security, or good for our economic security, or to help forge a more effective democracy? If you're anything like me, you chose your life's work for a lot of personal reasons, not the least of which is enlightenment: you were curious--curious about the world you live in, curious about how things work--things like the microwave oven or the digital clock or the hologram on the credit card, why that hologram flashes all those colors and why it's on the card in the first place--not "just for pretty", certainly. You were curious about things and you wanted to satisfy your curiosity, because the search for enlightenment provided the intellectual stimulation of discovery and discovery led to emotional fulfillment and fulfillment led to joy. There are other reasons people go into science and engineering, of course. Some of us took those career paths because we wanted to get jobs, and there are whole bunch of other reasons.

But when we at NSF go up to testify before Congress on behalf of support for science and engineering education, we don't talk about enlightenment or joy; if we did, in the context of justifying a budget request, we'd be laughed right off Capitol Hill. If we talk about national security and economic security and more effective democracy--which are unquestionably legitimate reasons for funding education engineering and science, we get action. Yet the fact remains that all of us engaged in research and in education in engineering and in the sciences got into it and remain into it for all these reasons--national and economic security and democracy and enlightenment and jobs and joy.

This gets back again to the question of communicating our point of view to others, and to do this effectively, we've got to understand, to be appreciative, of the audiences we're dealing with, and how the things we are interested in affect them. Let's take an example from state-of-the-art medical technology, called magnetic resonance imaging--MRI for short.

Back in the 1940s two physicists, Block at Harvard and Purcell at Stanford, discovered a scientific phenomenon that they called nuclear magnetic resonance. Today this phenomenon, put to work in multimillion-dollar machines in great medical centers, makes it possible to diagnose and localize disease; no one can say with certainty how many lives have been saved by MRI, but there have been many and there will be many more. Do you think that Block and Purcell foresaw life-saving medical machines when they made their discovery nearly half a century ago? The question answers itself.

But more to the point, Block and Purcell did not make their discovery by chance--or if they did it's a reflection of what Louis Pasteur said: "Chance favors the prepared mind." They made their discovery because they were prepared for it through training, through sound scientific education, which is what we are really talking about today. How well prepared will the fledgling scientists and engineers of today be when it's their turn to be discoverers and leaders in the early years of the next century?

I want to tell you about some activities that NSF is engaged in at the undergraduate level--relatively new activities, just about a year old. We have focused on two major areas: revamping the calculus offerings and enhancing the quality of undergraduate engineering education. There have been umpteen reports that have dealt with problems of instrumentation, laboratory improvement, curriculum development, faculty development, problems relating to comprehensive changes that must take place at our institutions. NSF is trying to get back in the picture in terms of a leadership role in all these areas. We have been successful in one thing, the undergraduate engineering curriculum development projects for fiscal year 1988. We will be expanding that effort in 1989.

I want you to know that the Directorate for Science and Engineering Education and the Directorate for Engineering are collaborating to ensure that high quality projects are funded. That's one example of the kinds of things that NSF is trying to do. We made ten awards this past fiscal year. We have been inundated by high quality projects from a variety of institutions across the country in curriculum development only.

In the instrumentation area we have a whole slew of proposals that come our way and we're able to support an increasingly large fraction. They come from engineering institutions of all types, by the way, at major research universities, at comprehensive universities and four-year institutions, as well.

We are trying to foster a kind of a partnership that includes the institutions of higher education, the private sector, and the NSF. In some areas we insist on having a cost-sharing of the projects that we support, but the true nature of this partnership is not in cost-sharing only; it is in the intellectual domain as well. We are especially interested in increasing the number of project directors who are engineers and who deal with issues related to precollegiate activities.

Now, despite everything that I've said here in the gloom and doom area, I want to leave you with the impression that I am optimistic. And why? Because many of the talented persons in academe and in industry are now paying attention to this problem, at the graduate and undergraduate levels and, increasingly, at the precollegiate level.

If I had one appeal to make to all of you, it would be to carry back this message to the various folks that you deal with: No. 1, find out what the NSF opportunities are, and what NSF funding is available; and No, 2, see to it that meaningful activities, meaningful projects are launched in order to successfully deal with this problem we see across the country--the absence of people in engineering and in the sciences.

Thank you.

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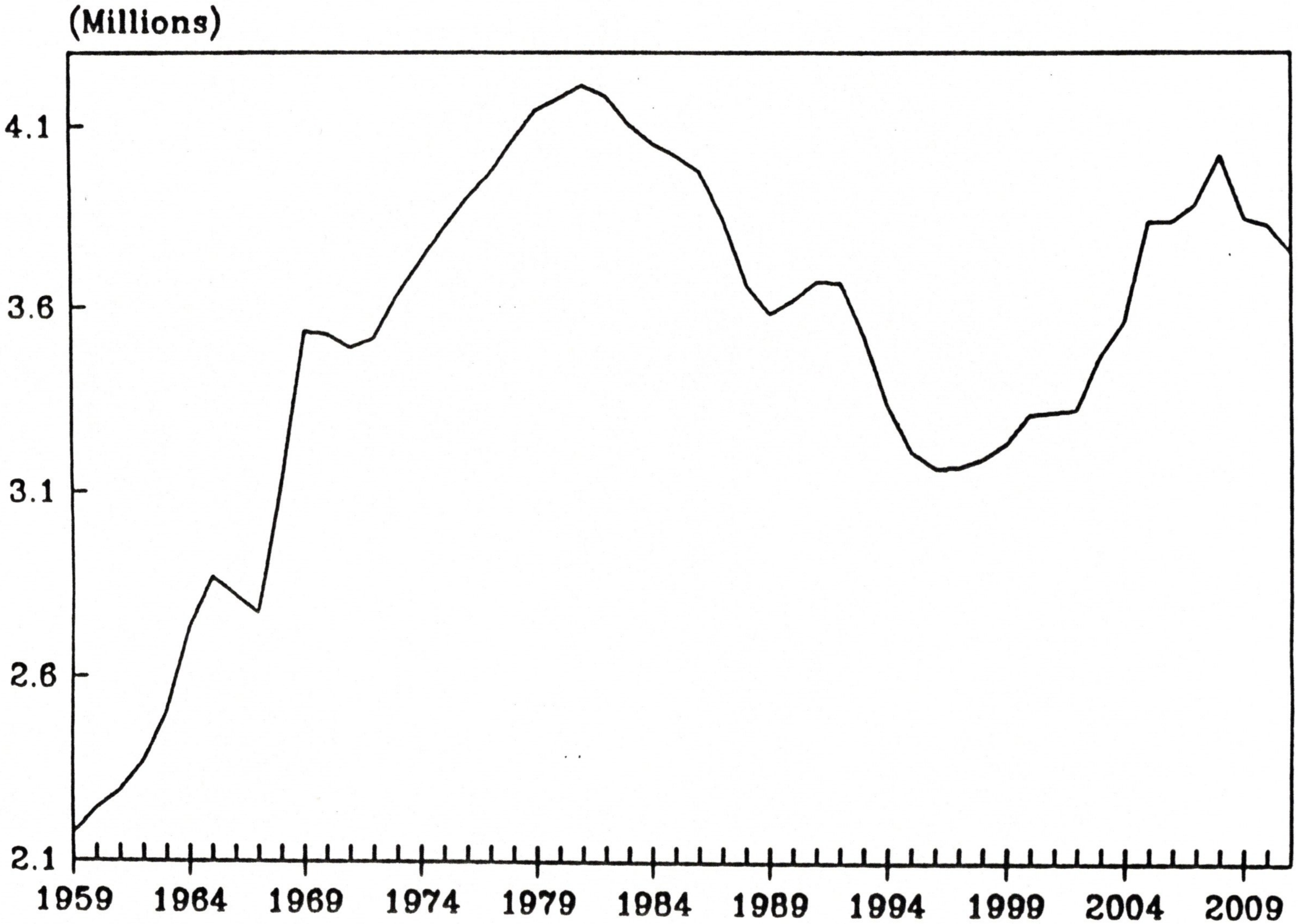
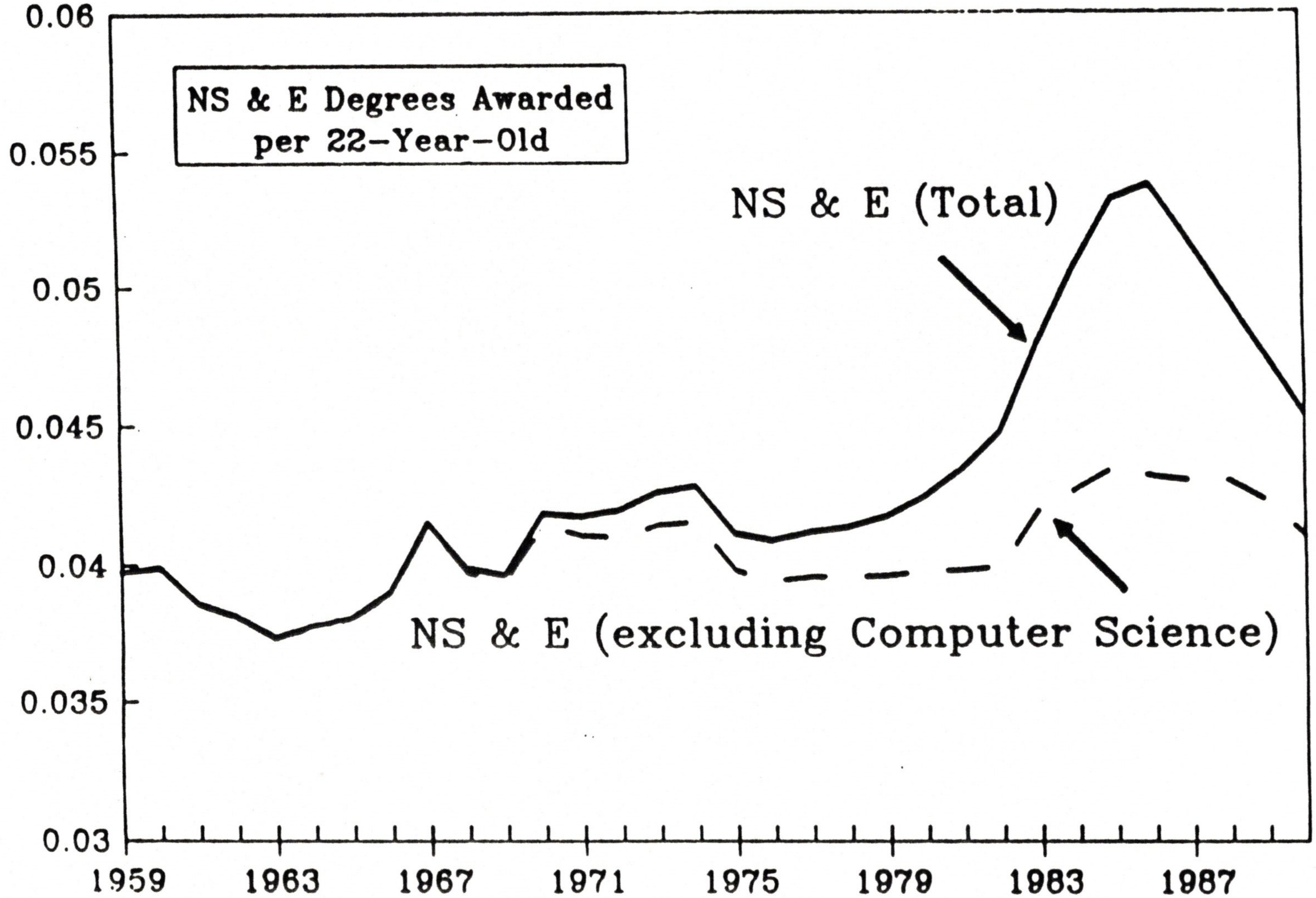
Number of 22-Year-Olds in the United States



2

NS&E BS Production Rates

[Showing a Growing Rate in Computer Science]



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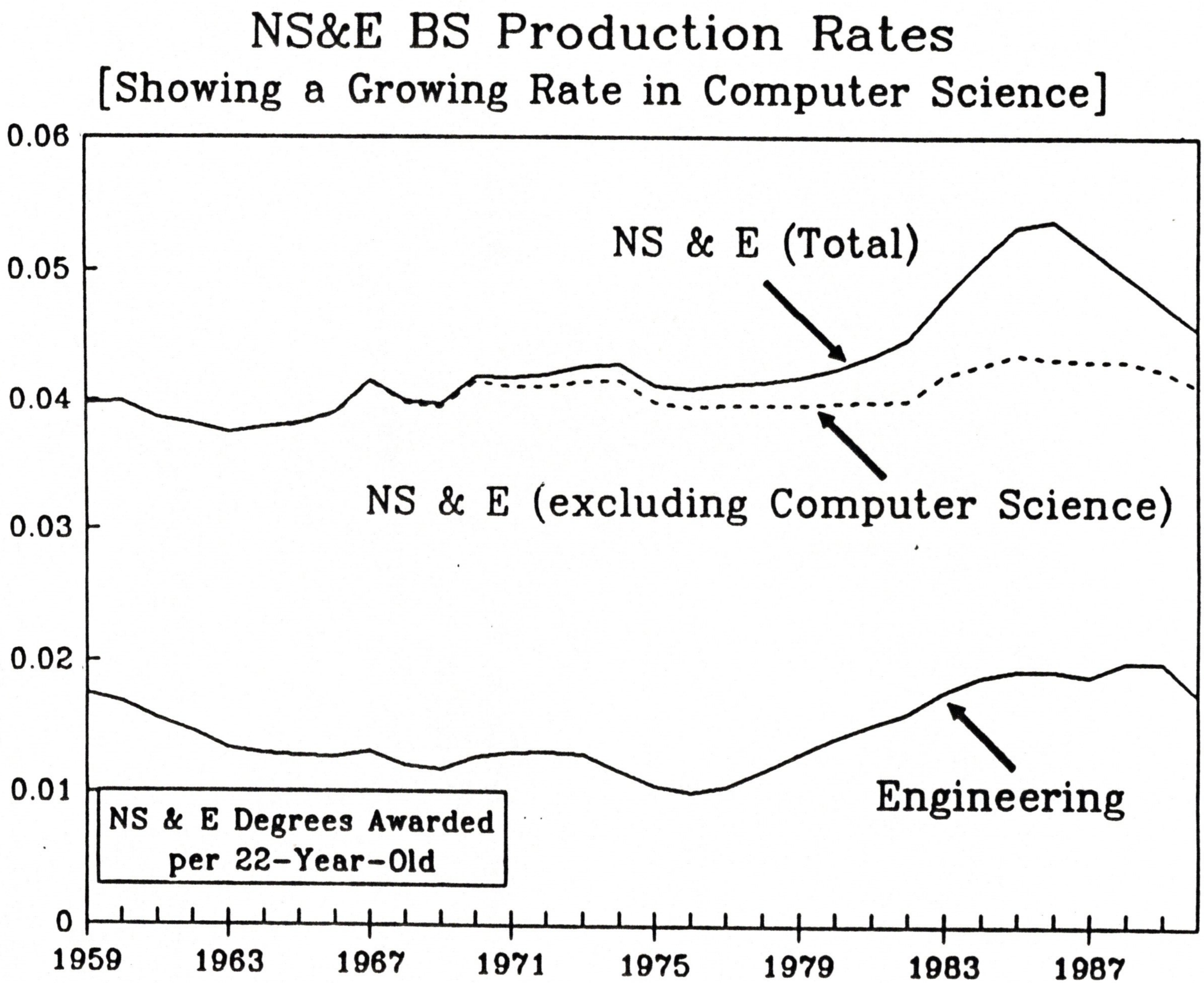
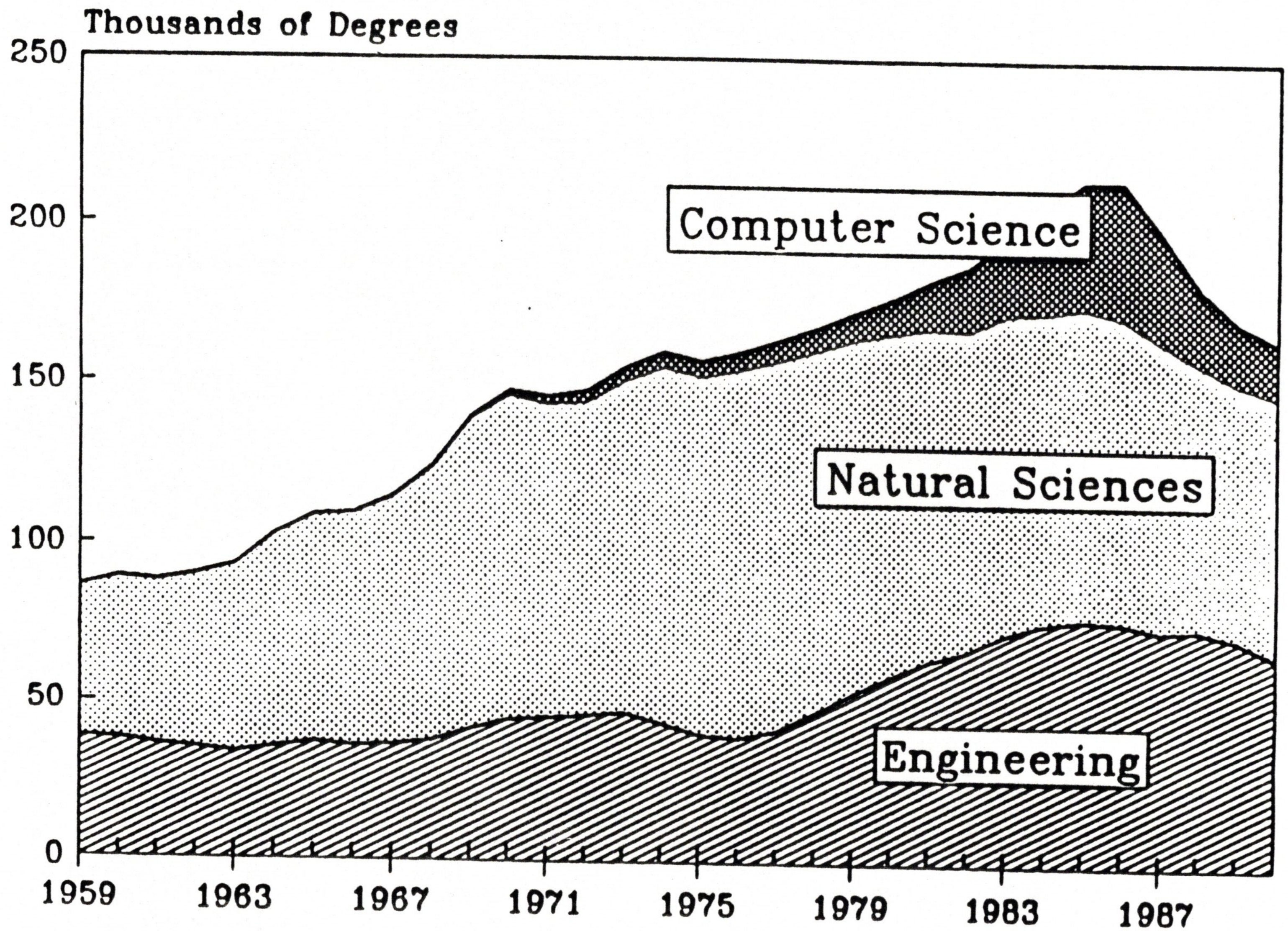


NS&E BS Production Rates
[Showing a Growing Rate in Computer Science]
0.06
0.05
0.04
0.03
0.02
0.01
0
NS & E (Total)
NS & E (excluding Computer Science)
Engineering
NS & E Degrees Awarded per 22-Year-Old
1959
1963
1967
1971
1975
1979
1983
1987

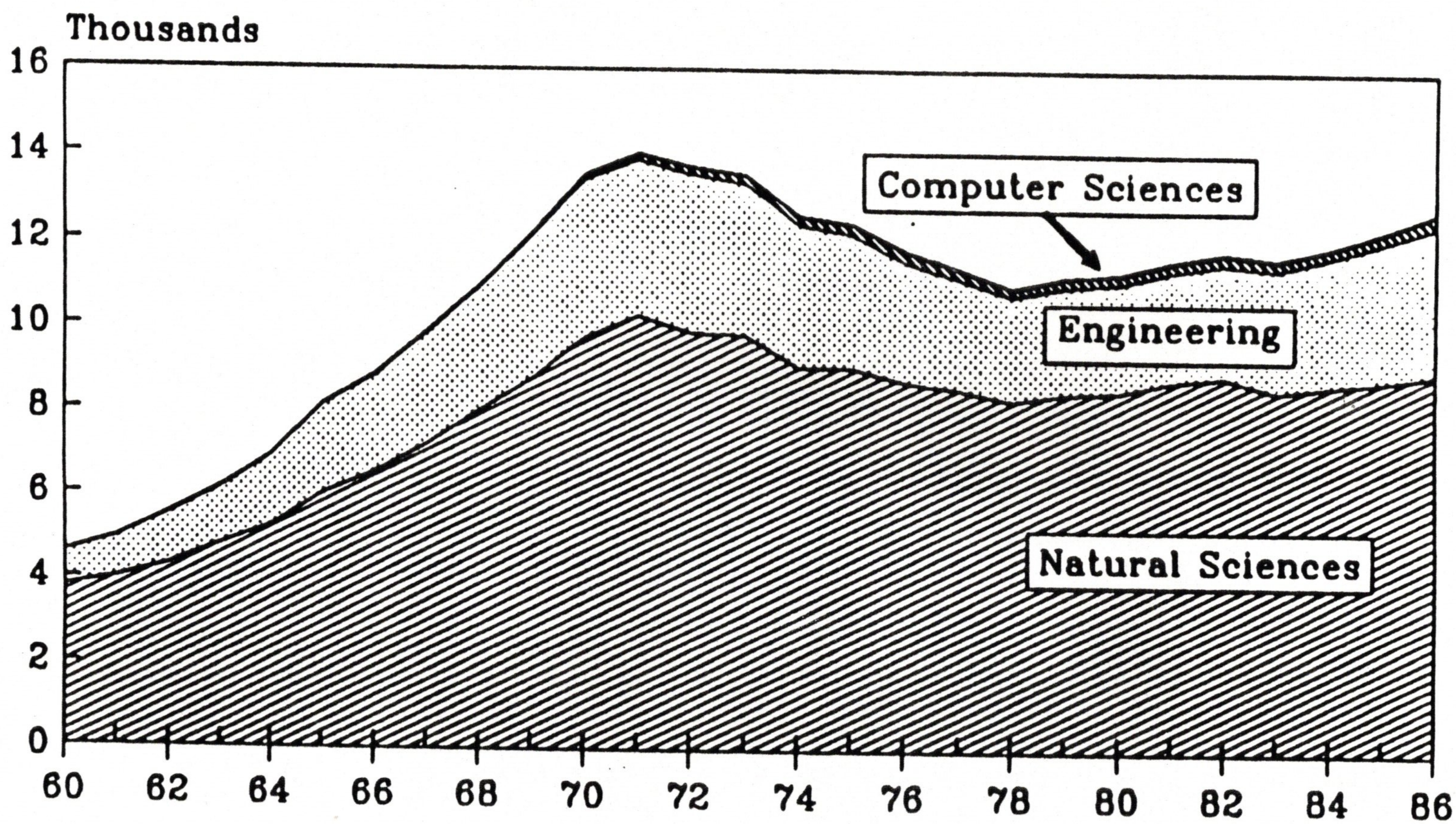
4

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



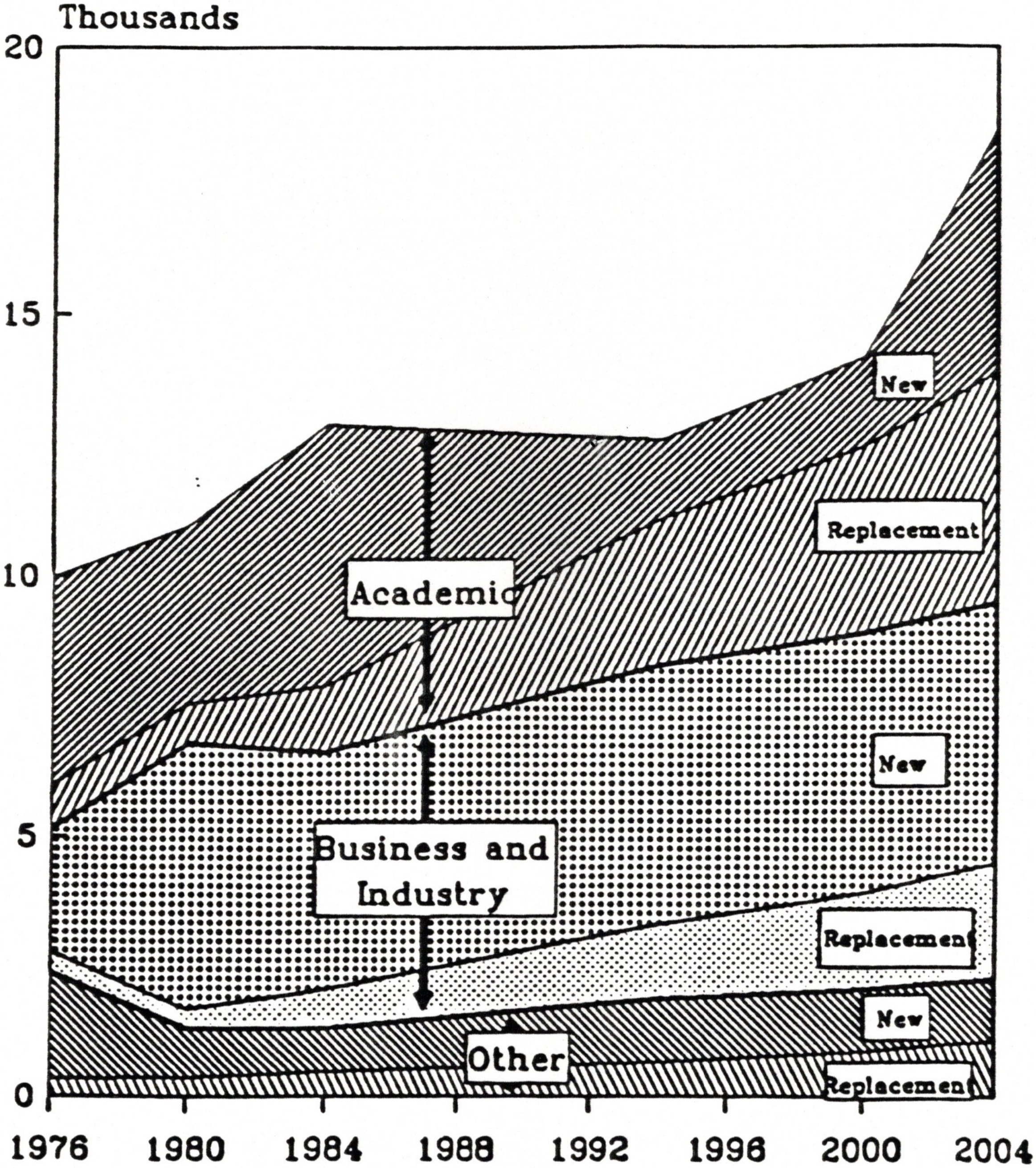
5

PhD Degrees in Natural Science and Engineering



6

Available PhD Positions for Natural Scientists and Engineers



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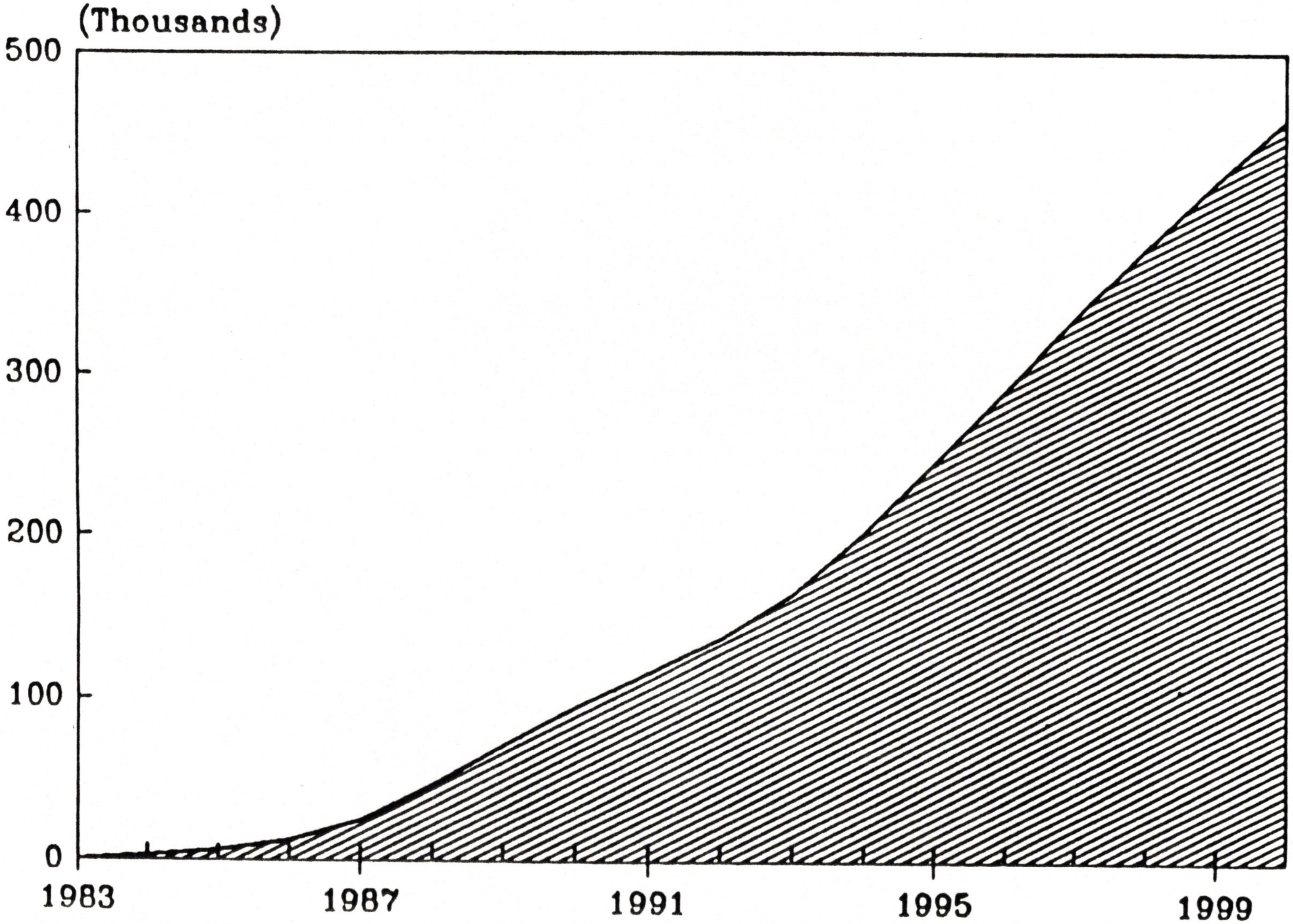
NS&E Cumulative Shortfalls: BS Degrees



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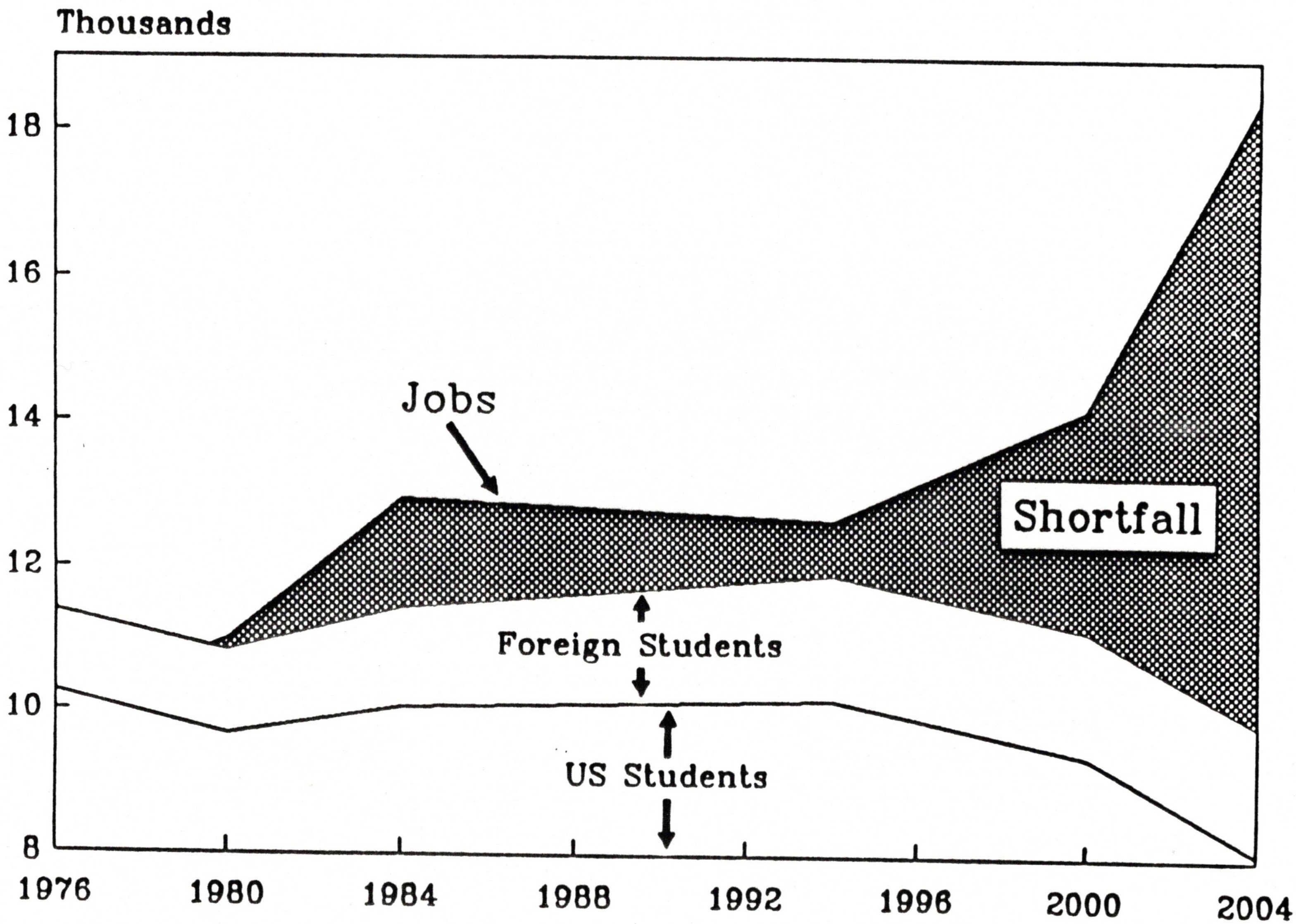
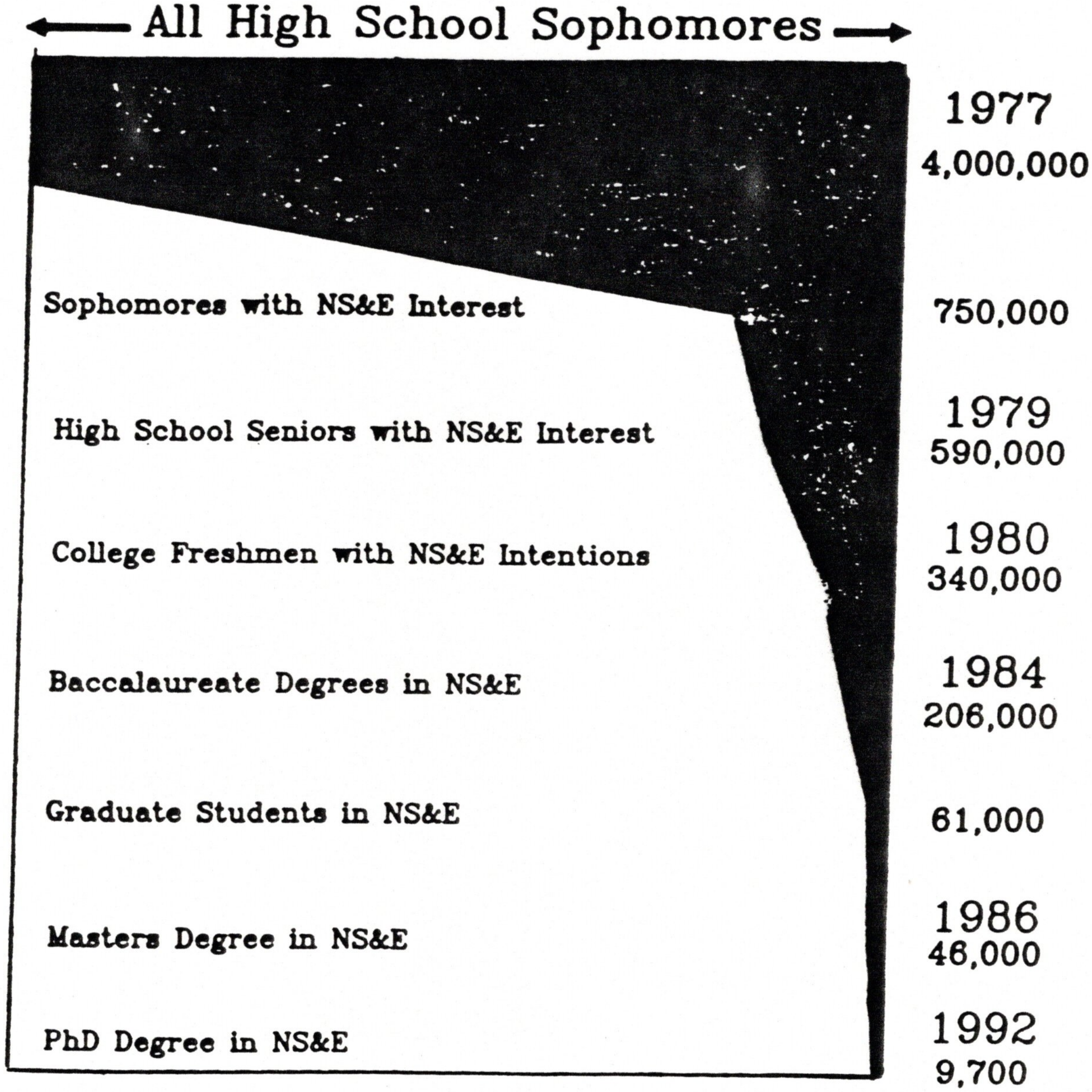
Average Annual Production of Ph.D.s
NS & E Ph.D. Degrees from U.S. Institutions

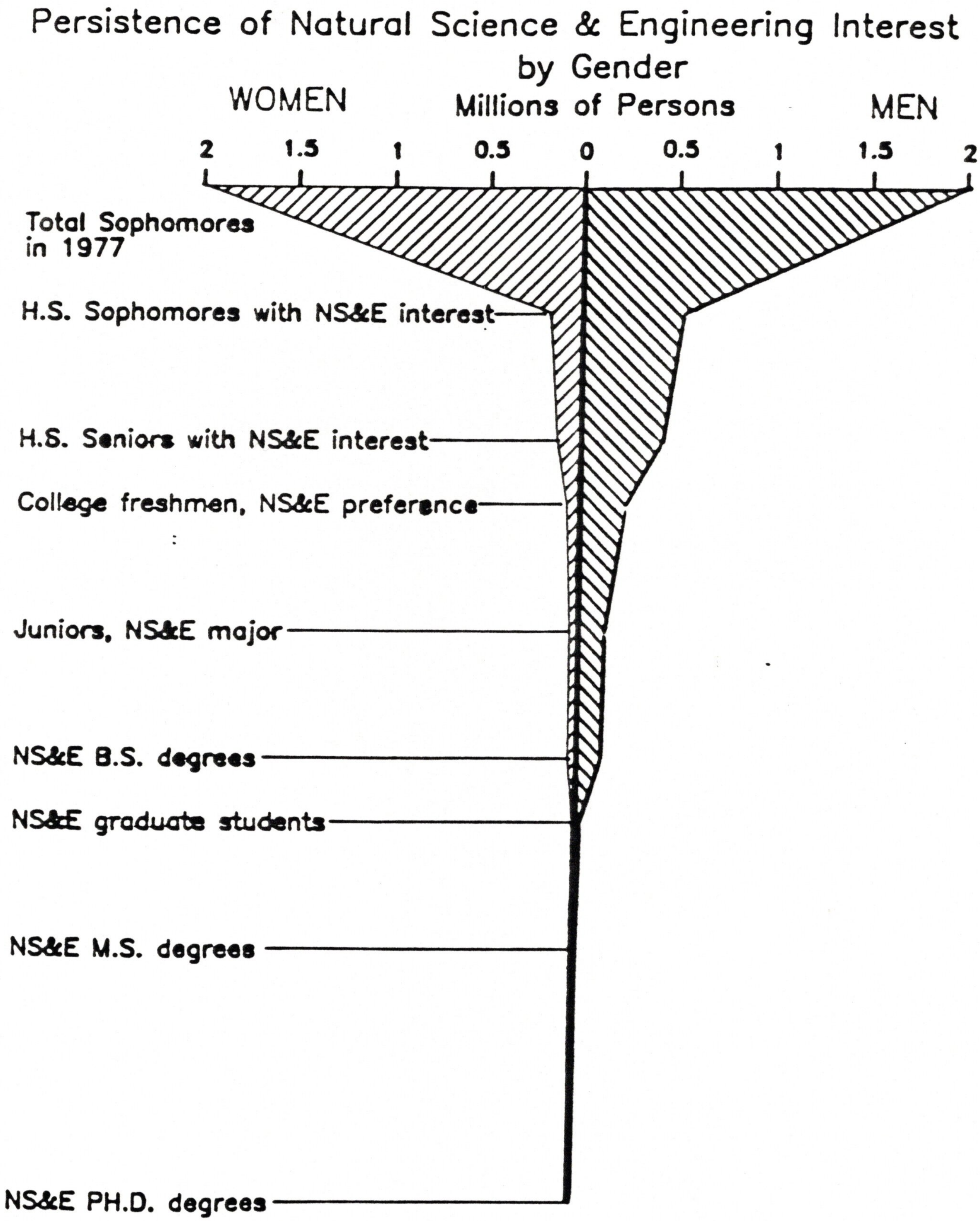


9

Persistence of NS&E Interest from High School through PhD Degree

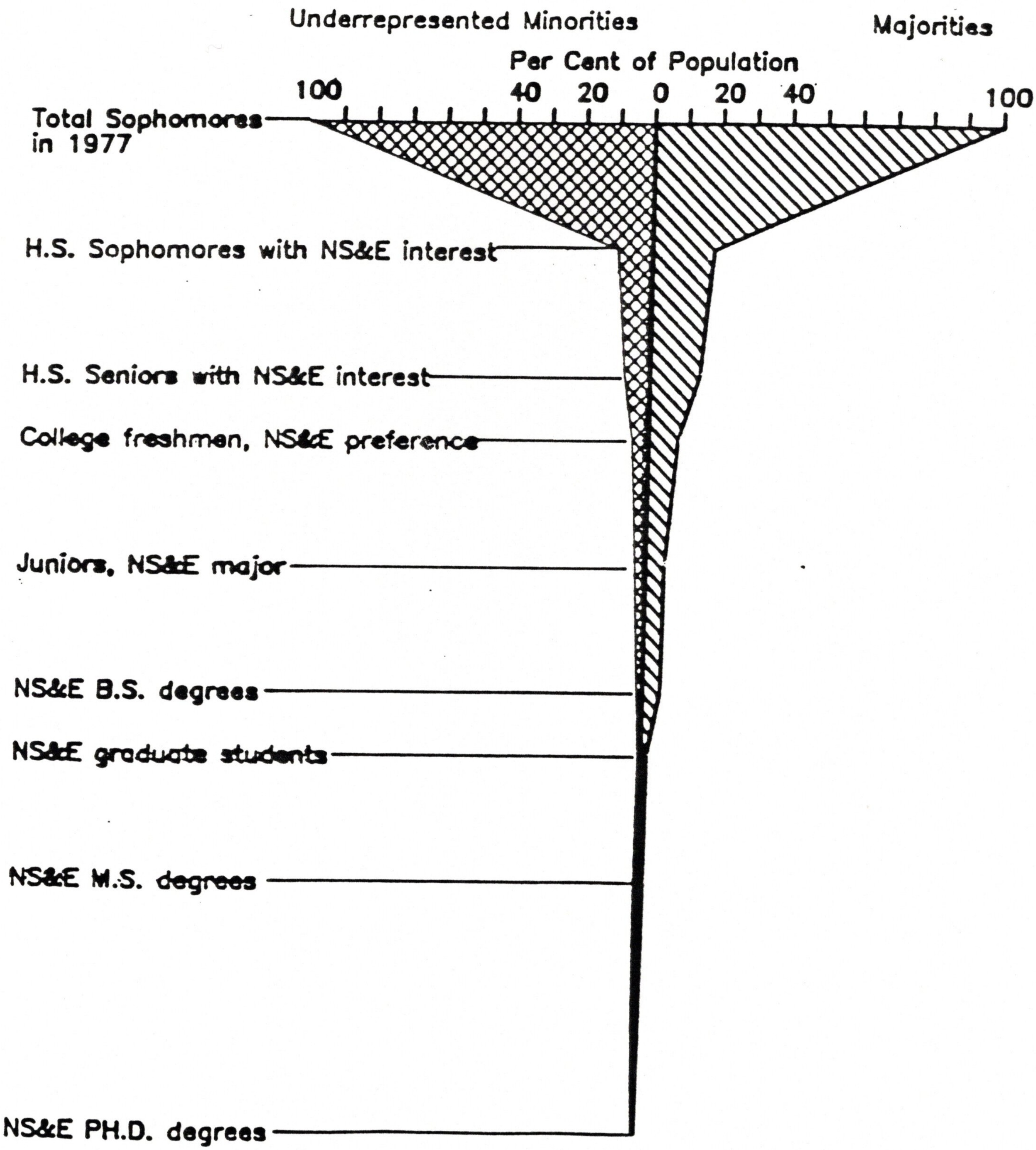


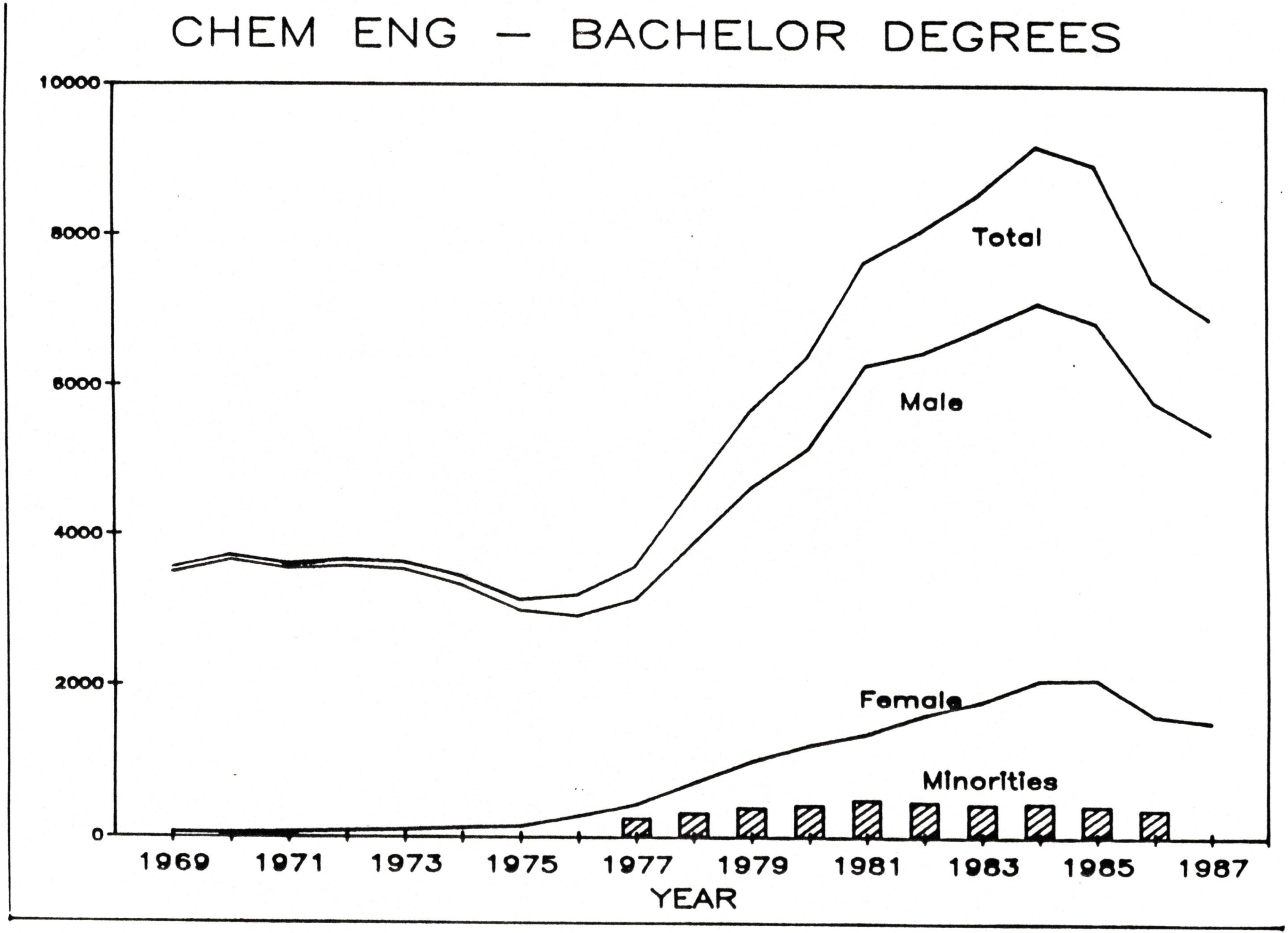
(The Pipeline)


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

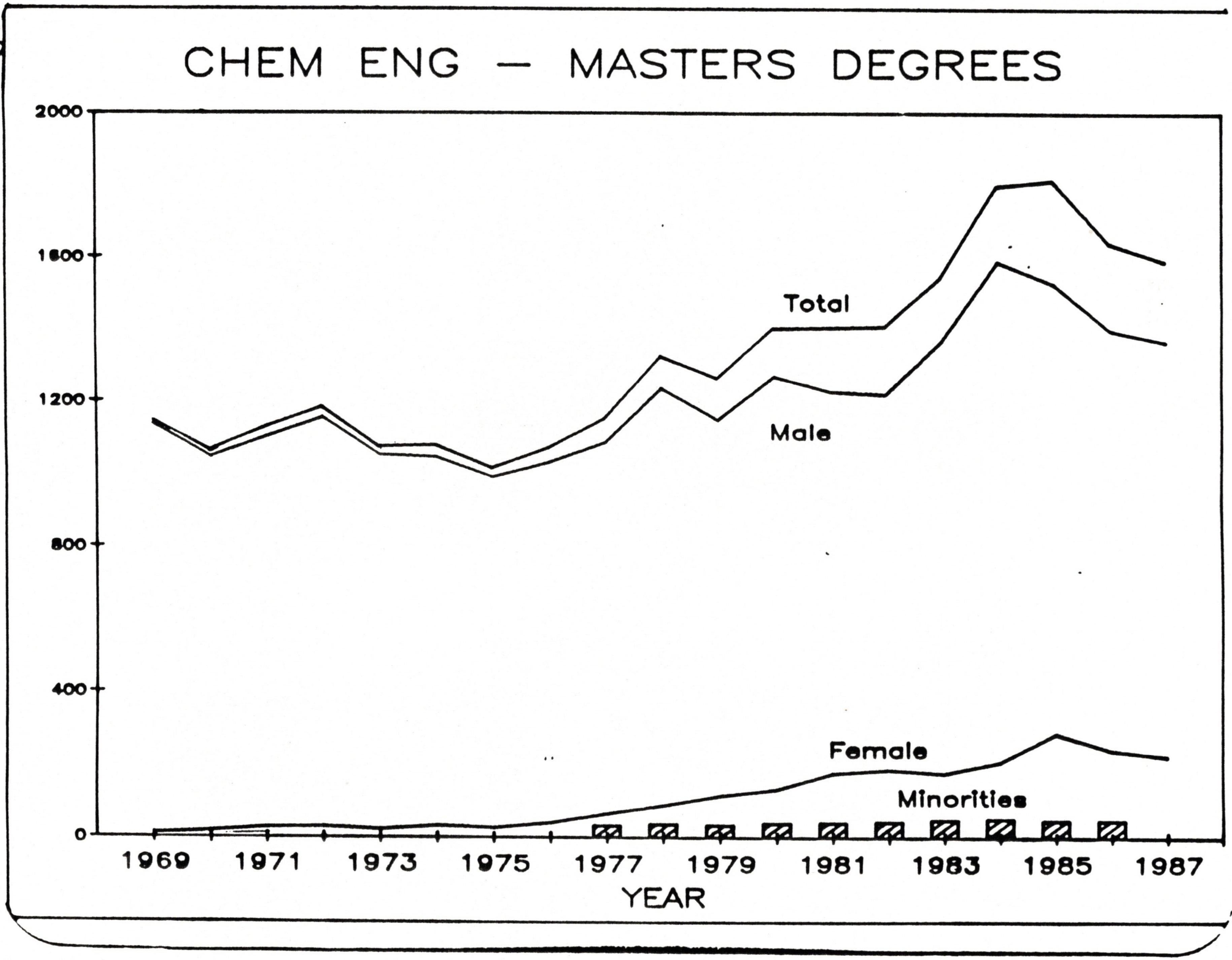
11

Participation in Natural Science & Engineering Interest
by Ethnic Group



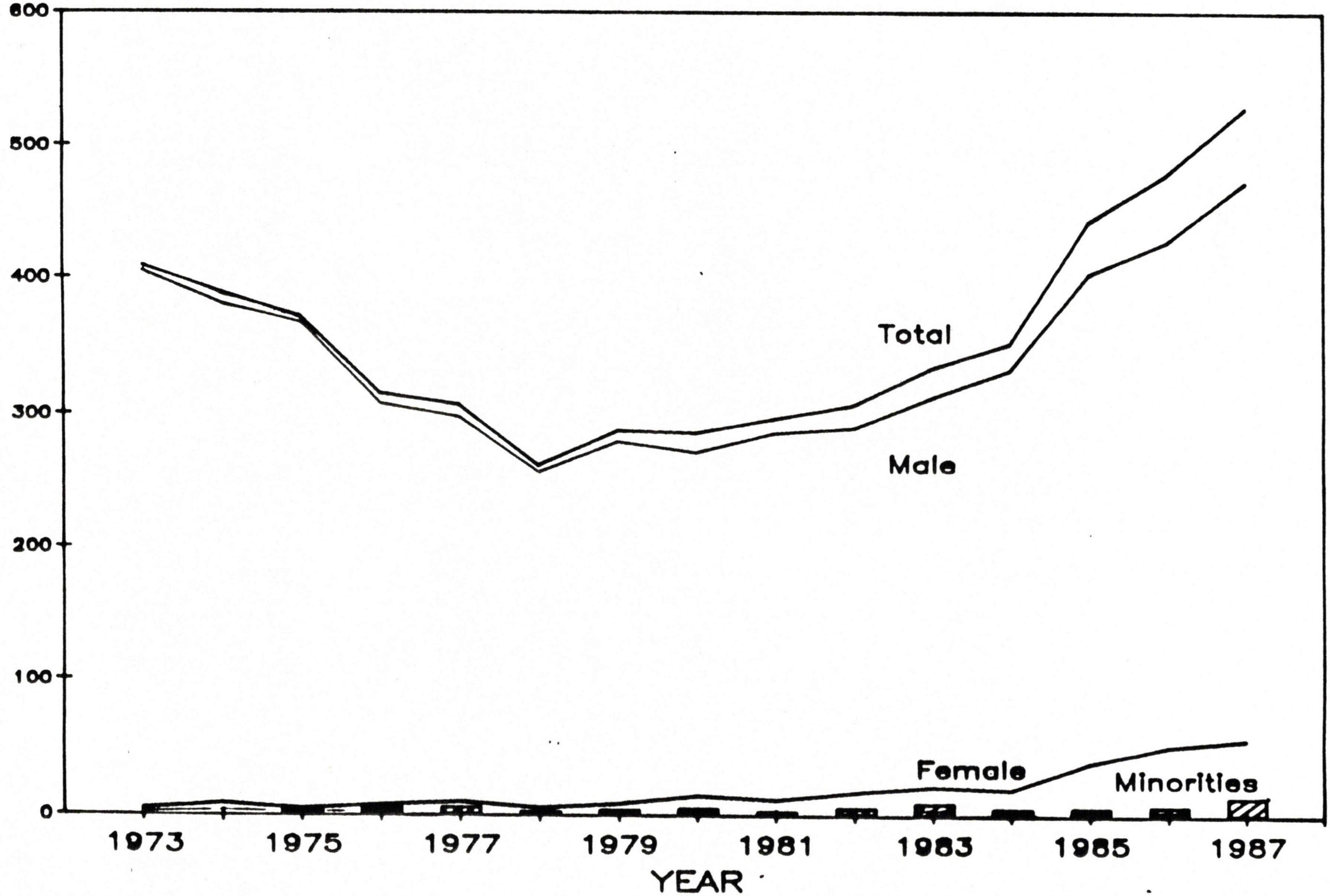

CHEM ENG — BACHELOR DEGREES
10000
8000
6000
4000
2000
0
Total
Male
Female
Minorities
1969
1971
1973
1975
1977
1979
1981
1983
1985
1987
YEAR

13


CHEM ENG — MASTERS DEGREES
2000
1600
1200
800
400
0
Total
Male
Female
Minorities
1969
1971
1973
1975
1977
1979
1981
1983
1985
1987
YEAR

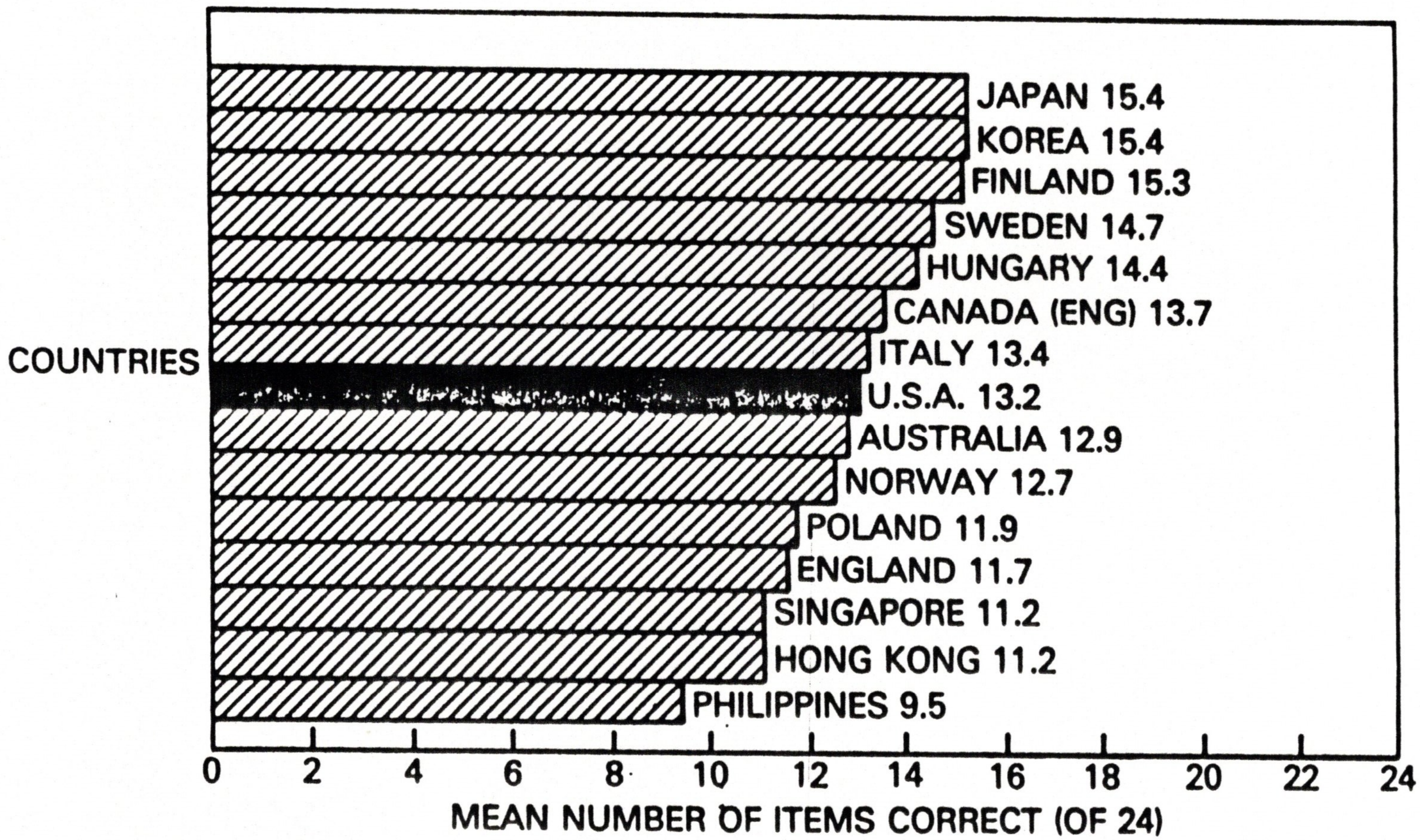
14

CHEM ENG — PhD DEGREES



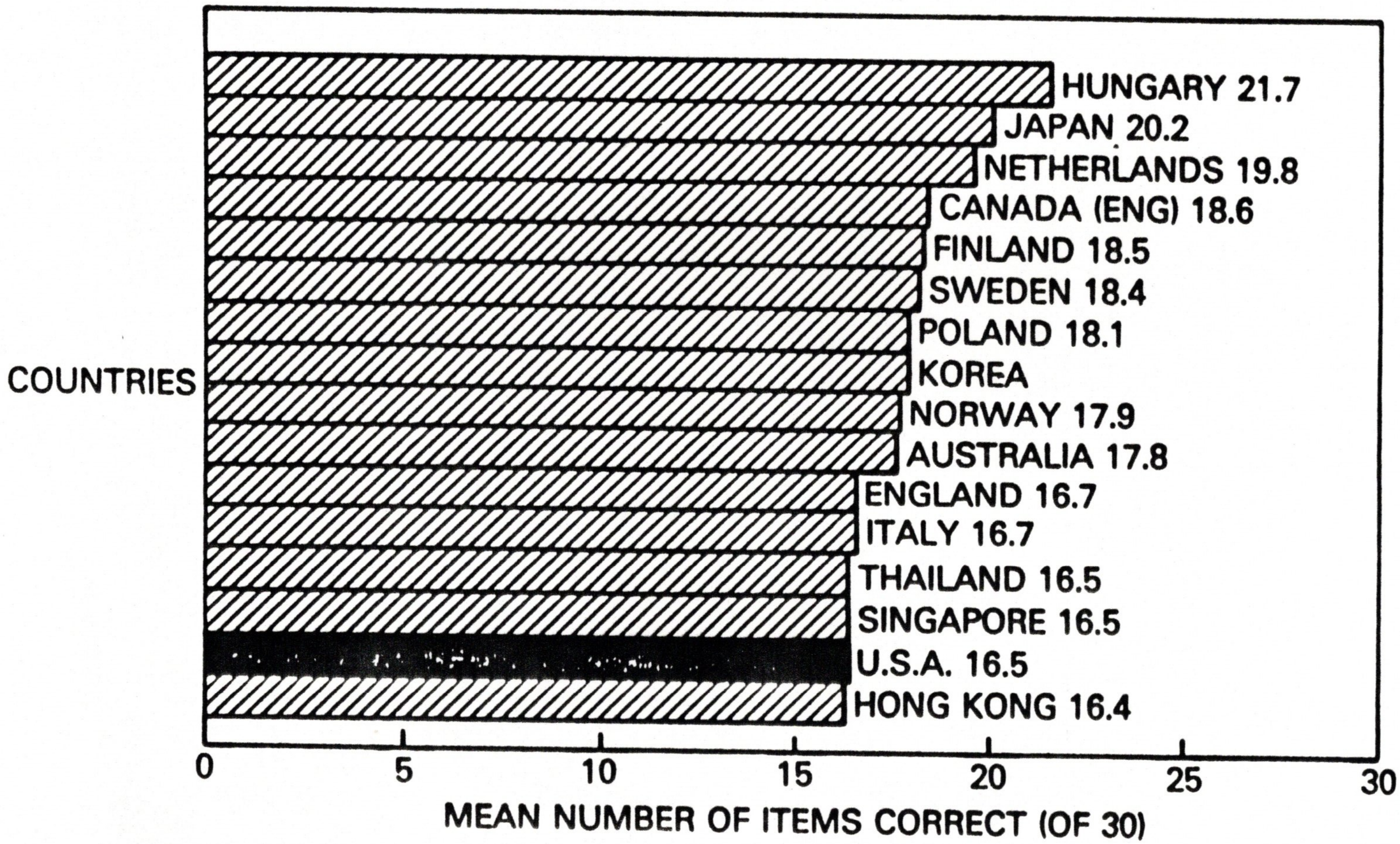
15

GRADE 5 SCIENCE ACHIEVEMENT IN 15 COUNTRIES

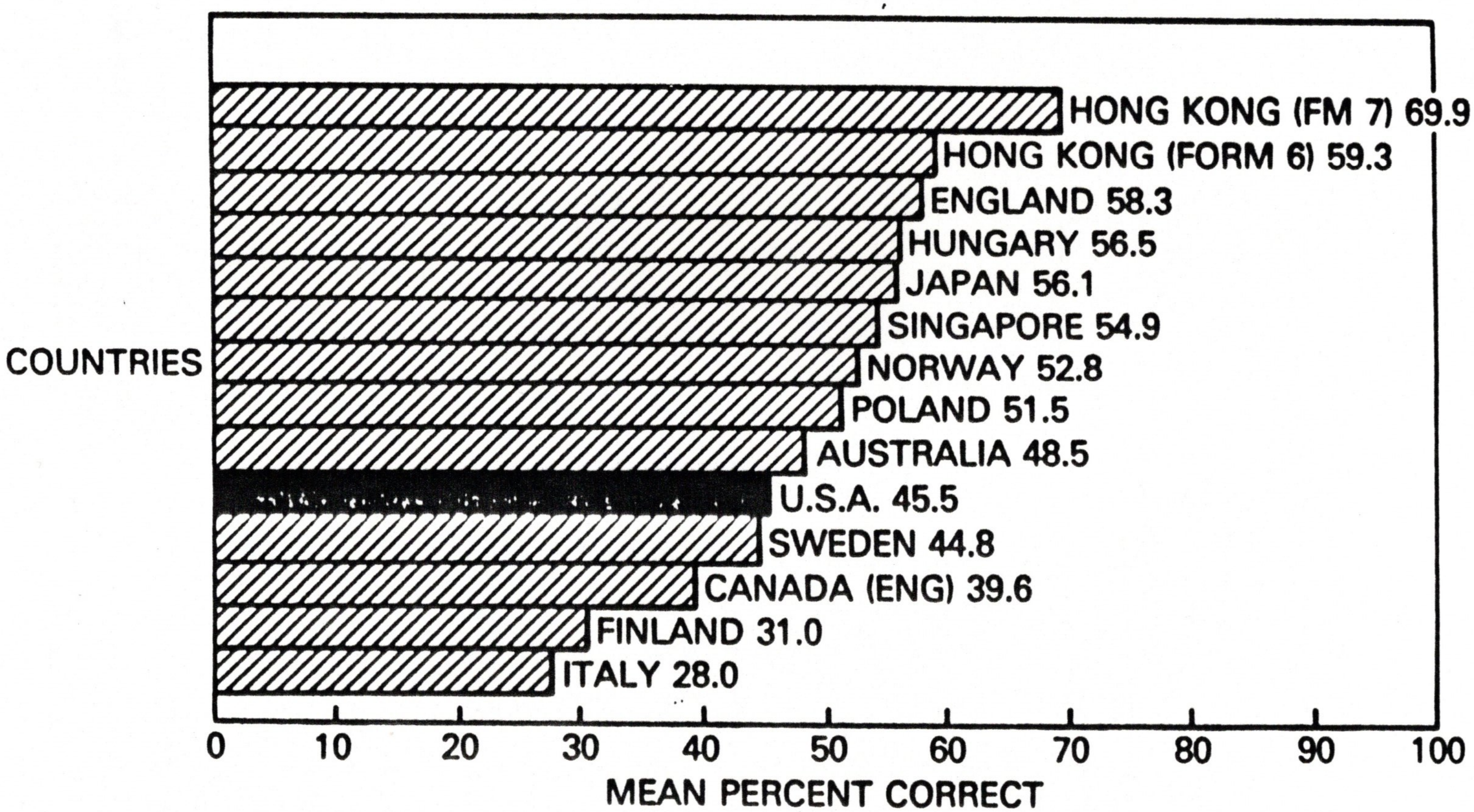


16

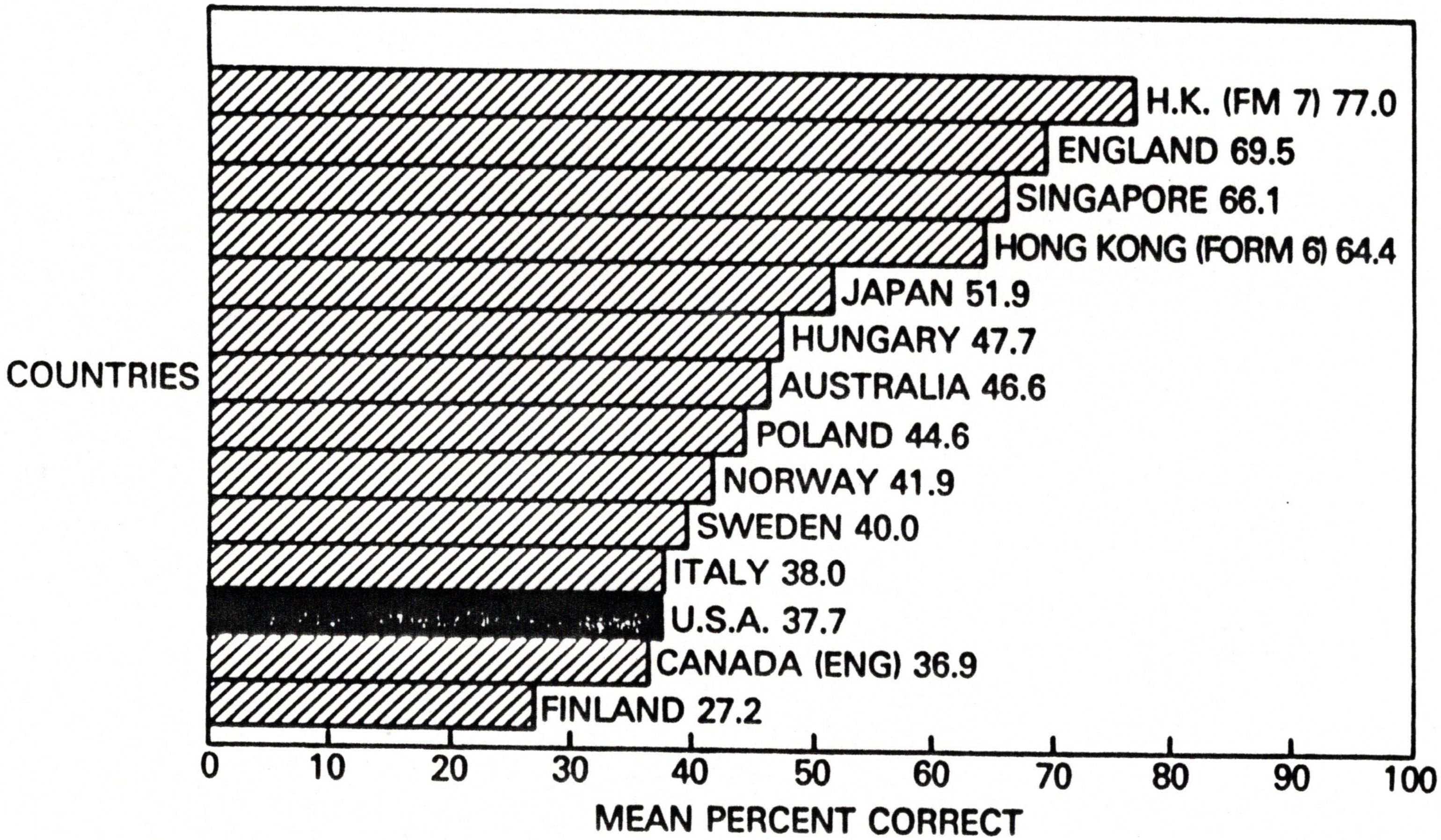
GRADE 9 SCIENCE ACHIEVEMENT IN 16 COUNTRIES



PHYSICS SPECIALISTS
(MEAN PERCENT CORRECT)

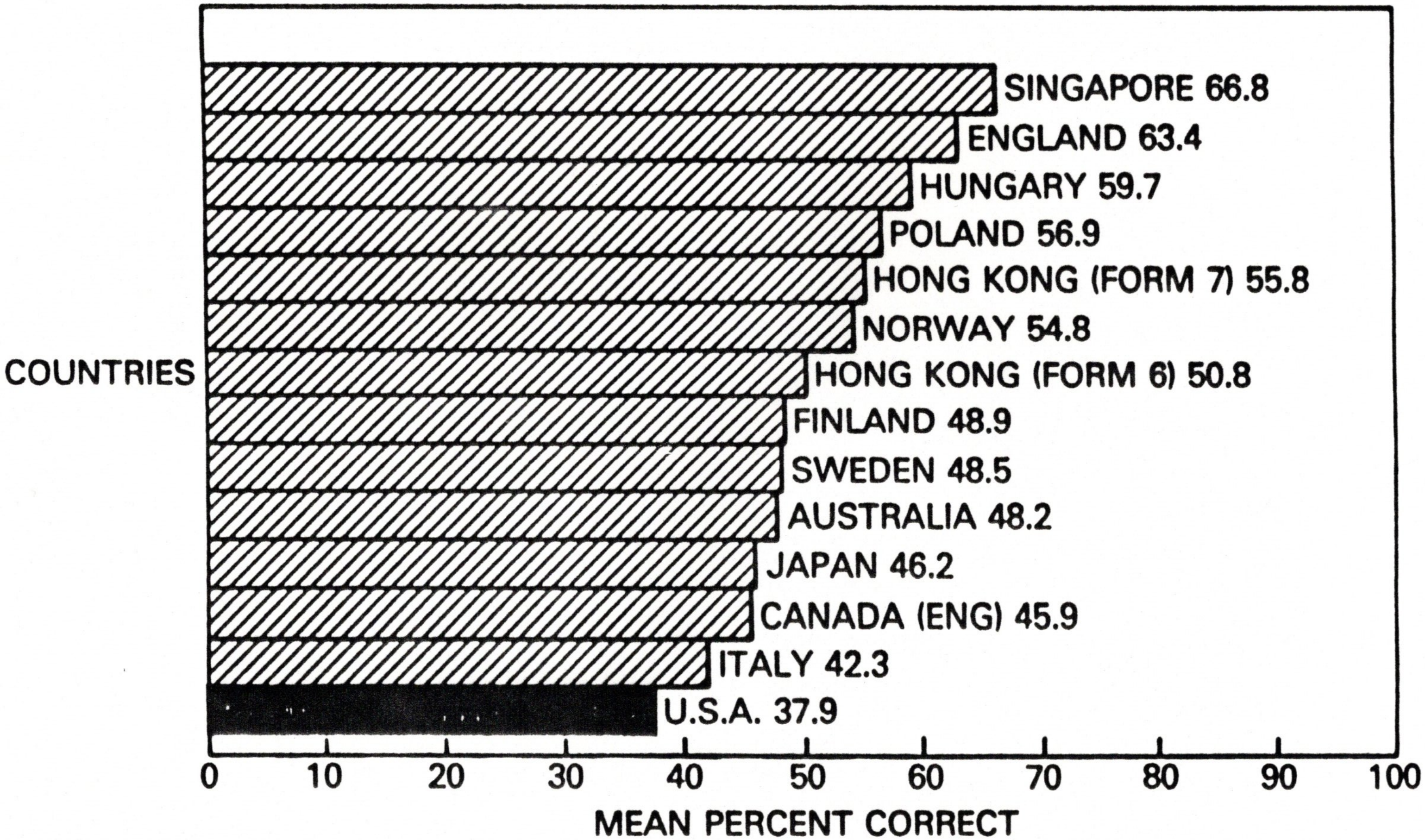


CHEMISTRY SPECIALISTS (MEAN PERCENT CORRECT)



19

BIOLOGY SPECIALISTS (MEAN PERCENT CORRECT)



PROFICIENCY LEVELS

LEVEL 150 — KNOWS EVERYDAY SCIENCE FACTS

LEVEL 200 — UNDERSTANDS SIMPLE SCIENTIFIC PRINCIPLES

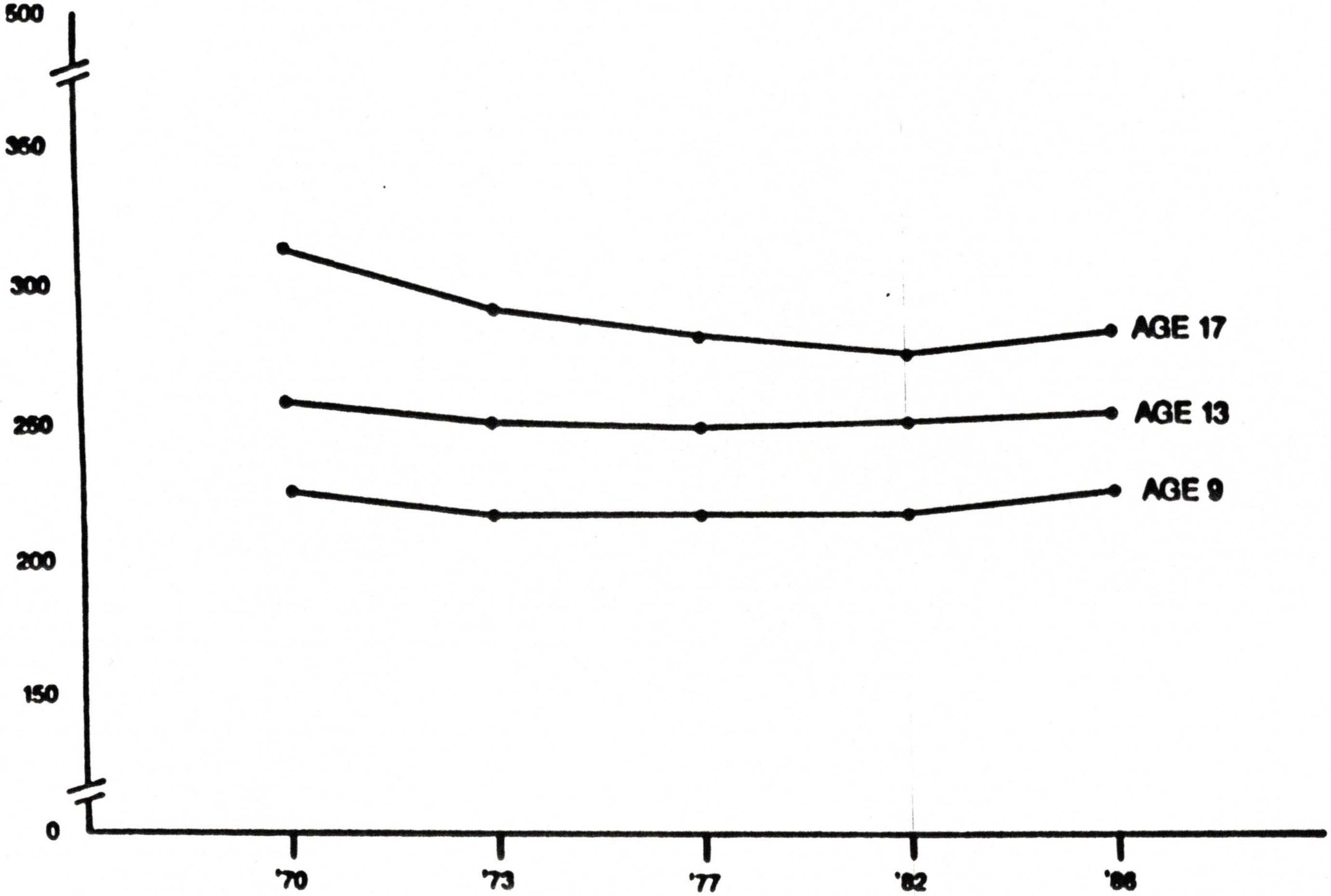
LEVEL 250 — APPLIES BASIC SCIENTIFIC INFORMATION

LEVEL 300 — ANALYZES SCIENTIFIC PROCEDURES AND DATA

LEVEL 350 — INTEGRATES SPECIALIZED SCIENTIFIC INFORMATION

THE NATION'S REPORT CARD naep

AGES 9, 13, AND 17: NATIONAL TRENDS IN AVERAGE SCIENCE PROFICIENCY



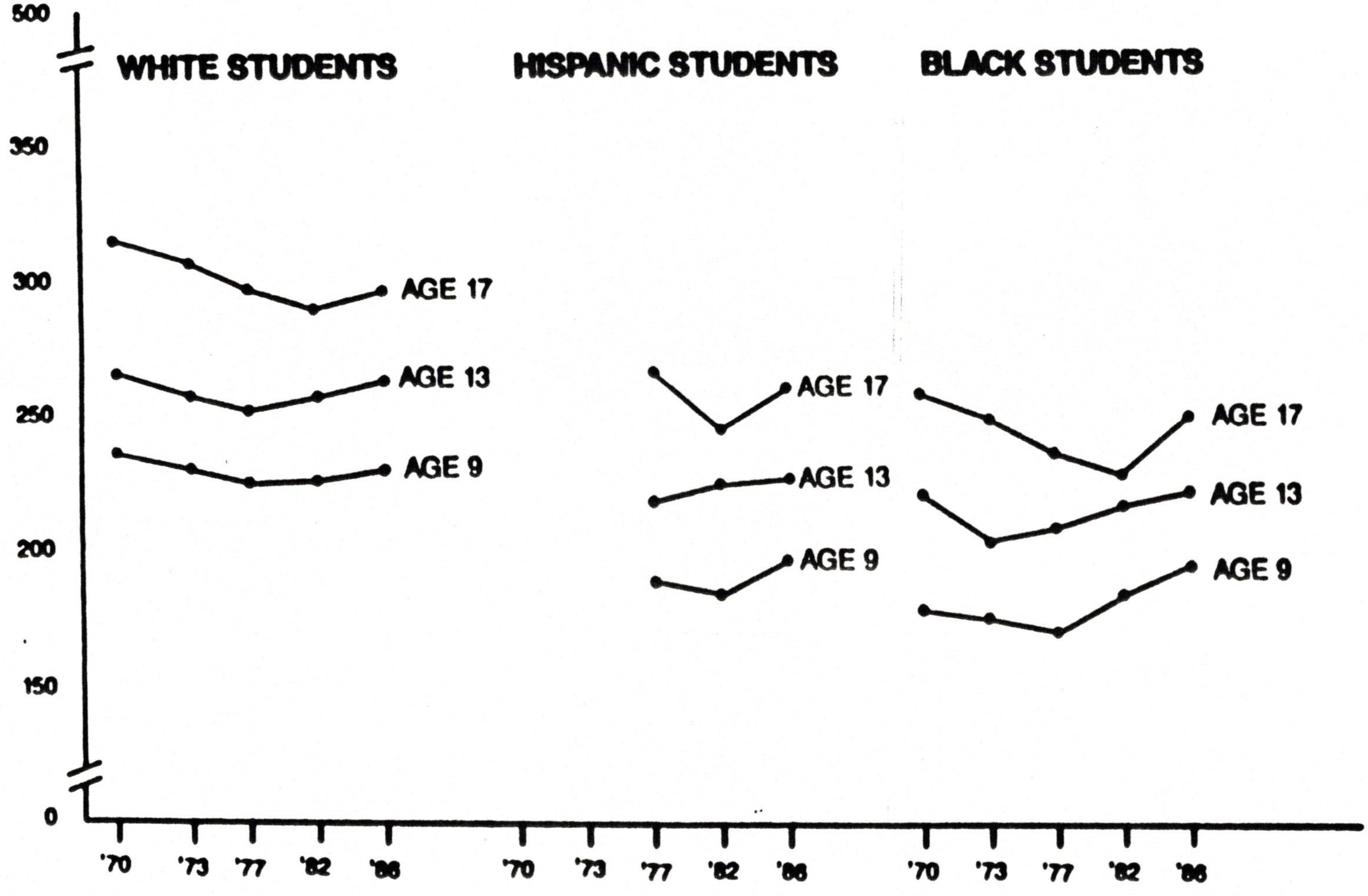
THE NATION'S REPORT CARD naep

AGES 9, 13, AND 17: TRENDS IN THE PERCENTAGE OF STUDENTS AT OR ABOVE THE PROFICIENCY LEVELS

PROFICIENCY LEVELS	AGE	ASSESSMENT YEAR 1977	ASSESSMENT YEAR 1986
LEVEL 150 KNOWS EVERYDAY SCIENCE FACTS	9	93.6	96.3
LEVEL 250 APPLIES BASIC SCIENTIFIC INFORMATION	13	49.2	53.4
LEVEL 350 INTEGRATES SPECIALIZED SCIENTIFIC INFORMATION	17	8.5	7.5

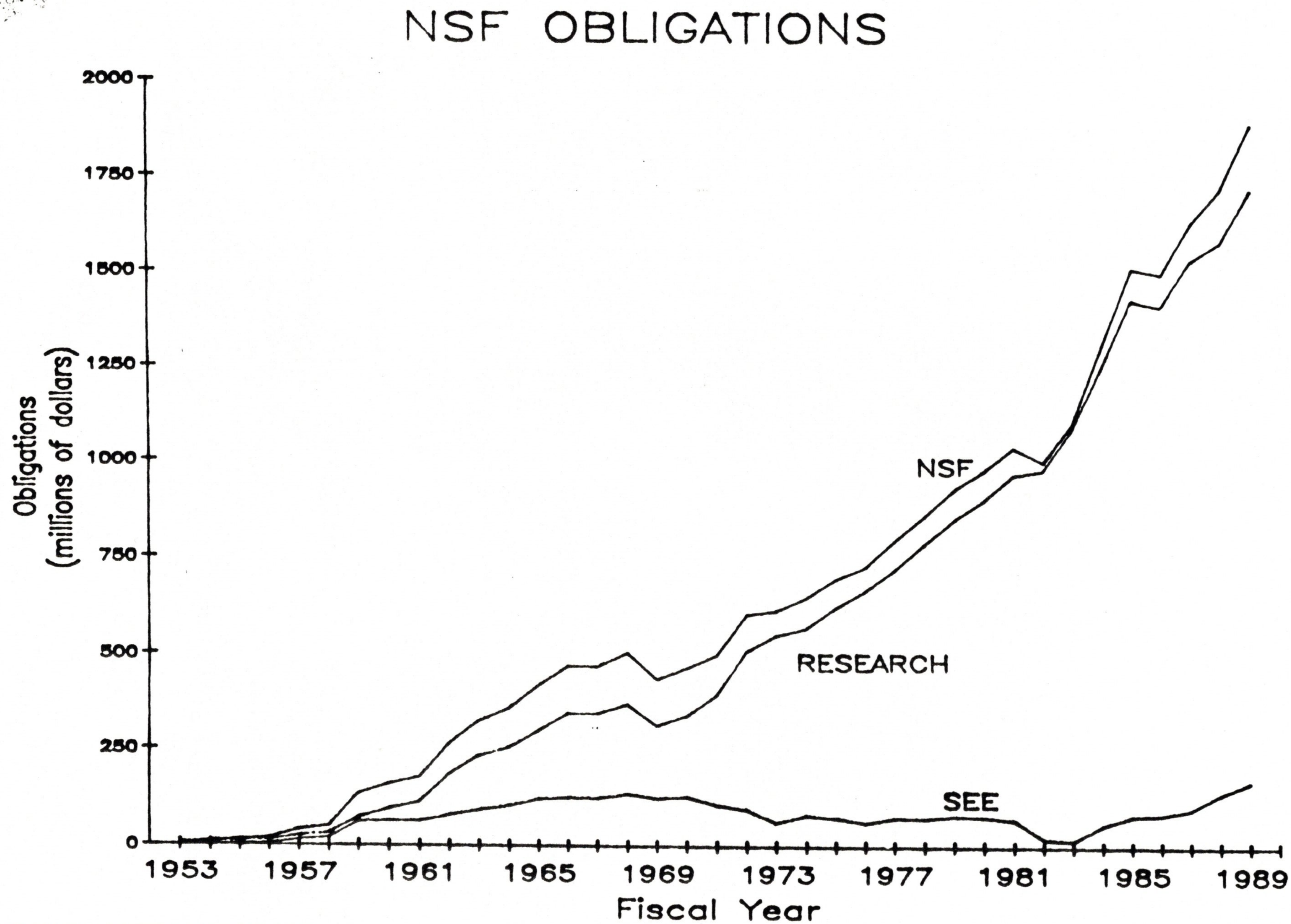
THE NATION'S REPORT CARD naep

AGES 9, 13, AND 17: TRENDS IN AVERAGE SCIENCE PROFICIENCY BY RACE/ETHNICITY

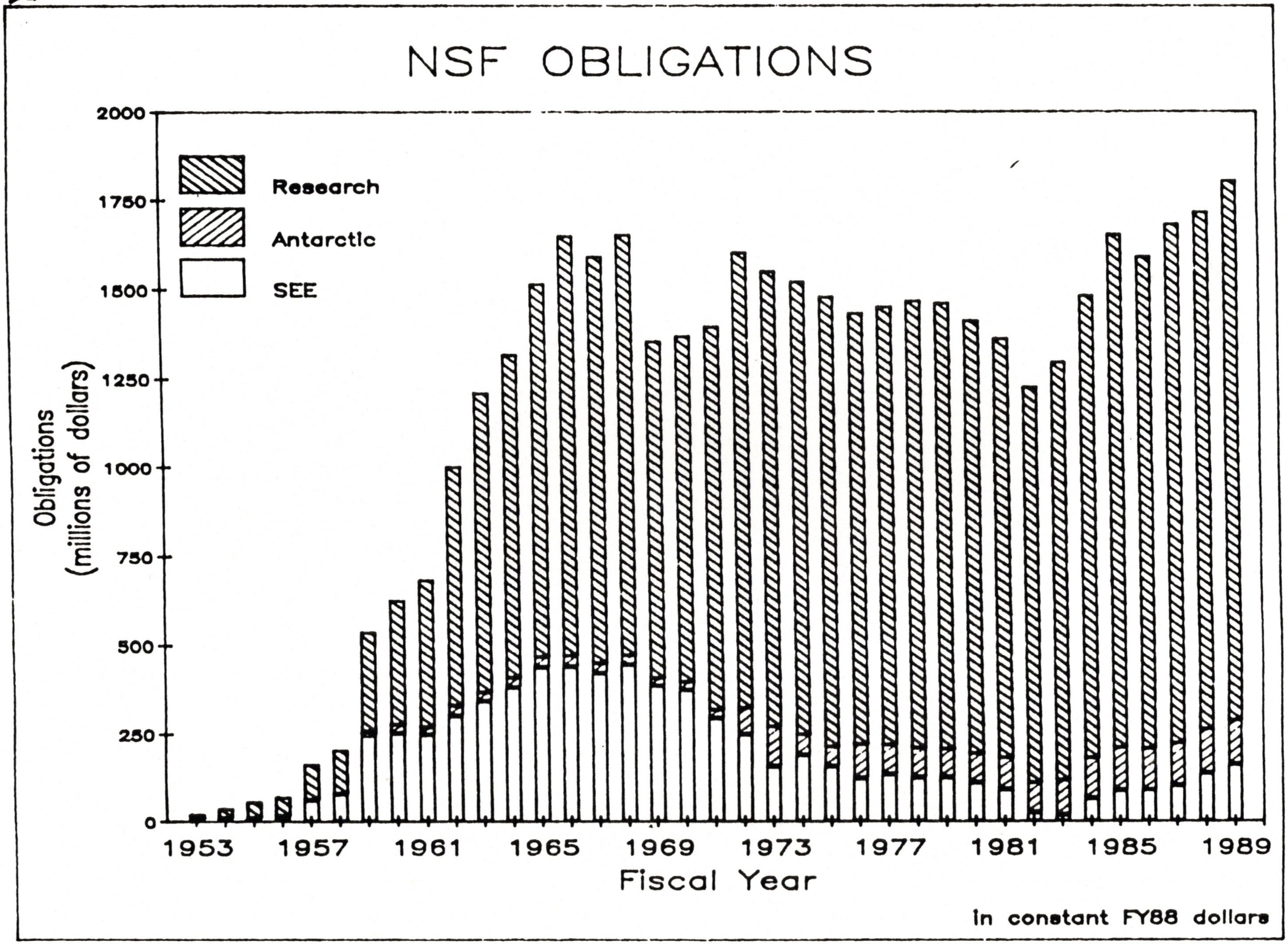


THE NATION'S REPORT CARD naep

24

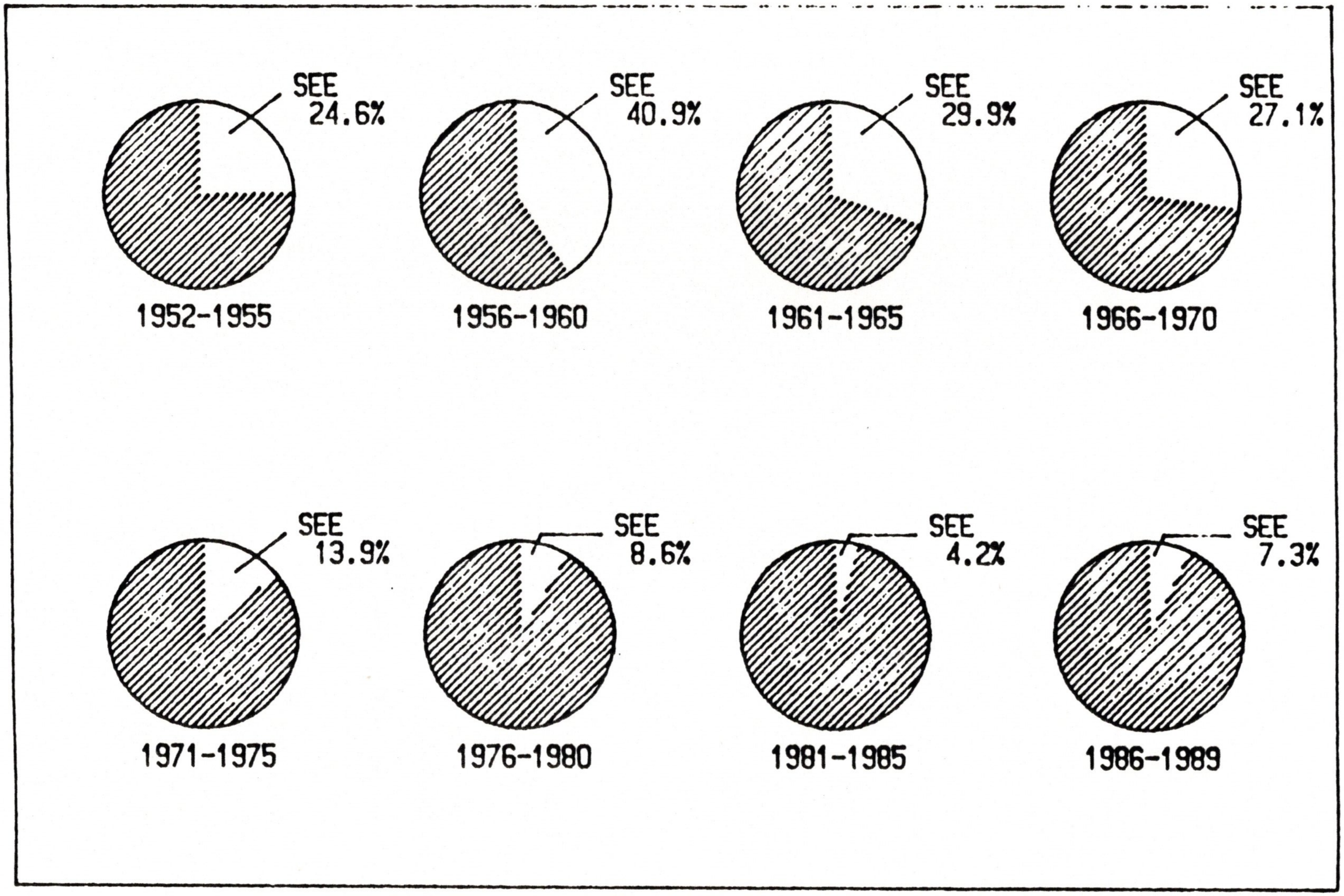

NSF OBLIGATIONS
2000
1750
1500
1250
1000
750
500
250
0
Obligations
(millions of dollars)
NSF
RESEARCH
SEE
1953
1957
1961
1965
1969
1973
1977
1981
1985
1989
Fiscal Year

25

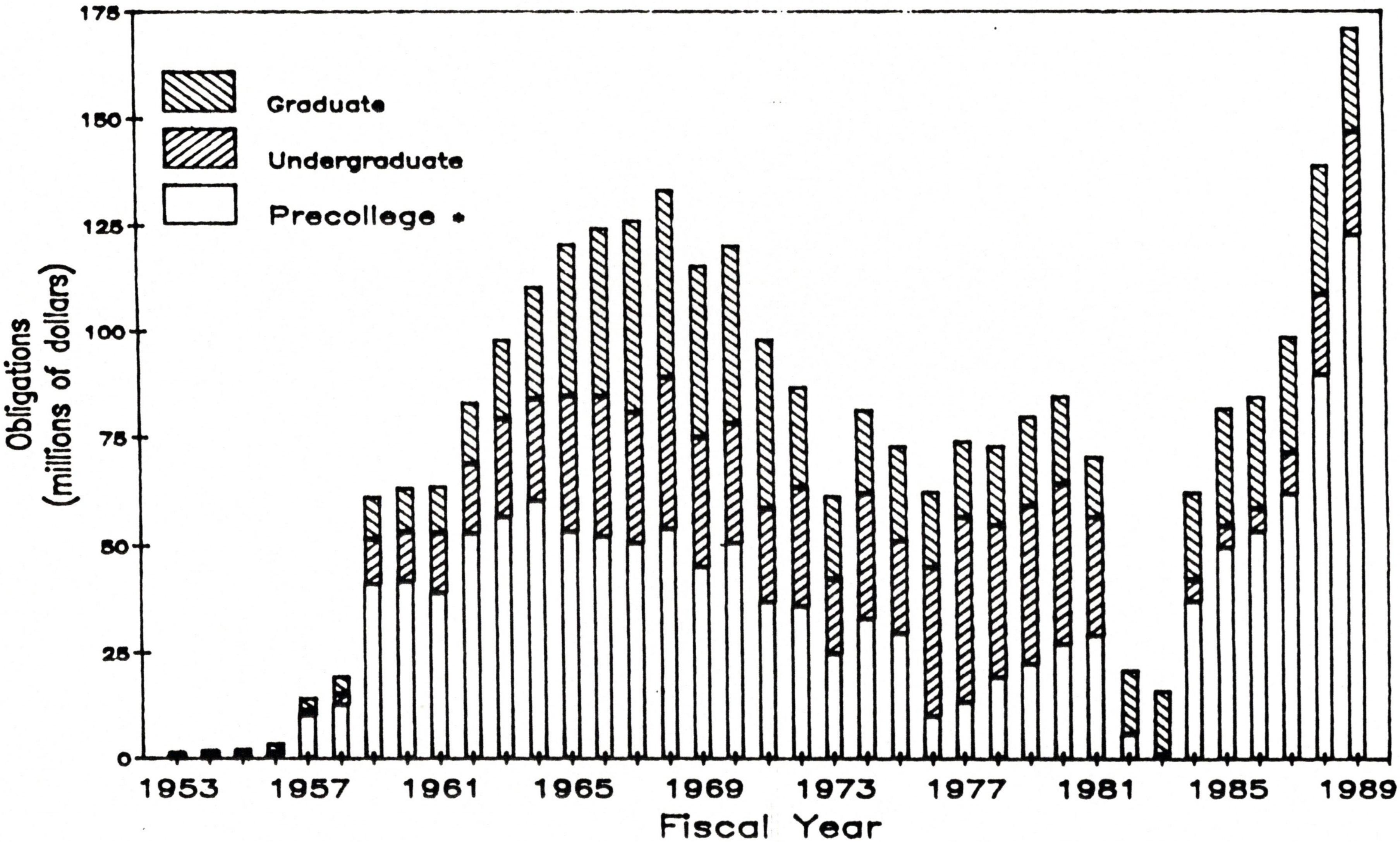

NSF OBLIGATIONS
Research
Antarctic
SEE
Obligations
(millions of dollars)
2000
1750
1500
1250
1000
750
500
250
0
1953
1957
1961
1965
1969
1973
1977
1981
1985
1989
Fiscal Year
in constant FY88 dollars

26

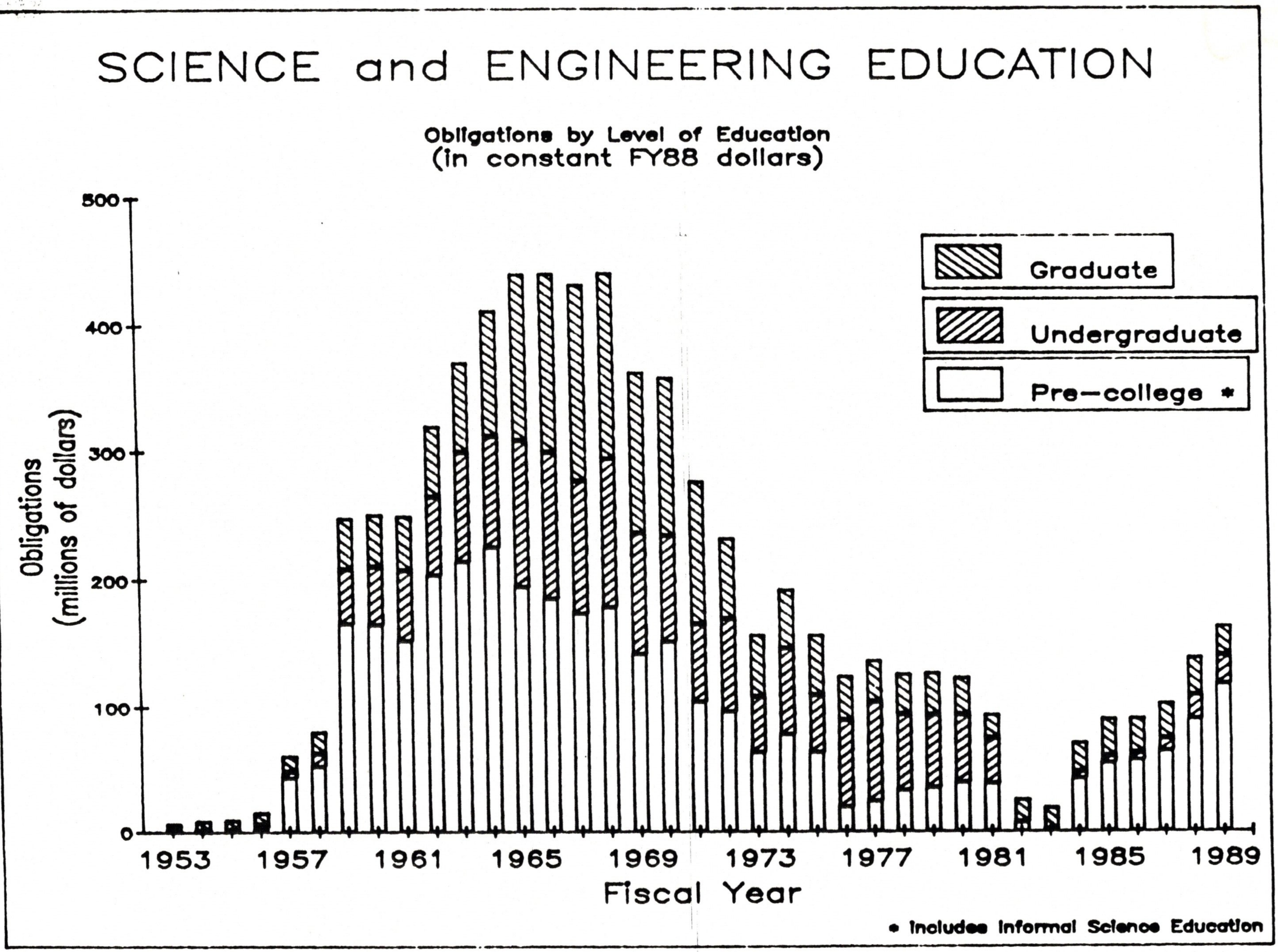
Obligations for Science & Engineering Education
as percent of NSF Budget



NSF Science and Engineering Education Obligations by Level of Education
(in current year dollars)



* Includes Informal Science Education


SCIENCE and ENGINEERING EDUCATION
Obligations by Level of Education
(in constant FY88 dollars)
Obligations
(millions of dollars)
500
400
300
200
100
0
Graduate
Undergraduate
Pre-college *
1953
1957
1961
1965
1969
1973
1977
1981
1985
1989
Fiscal Year
* Includes Informal Science Education