

If you believe academia and corporate management, there has been a "crisis level" engineering shortage for the last forty five years. The following quotes illustrates my point:

"Since 1947 the number of scientists and engineers employed has gone from 575,000 to 900,000, the Chase Manhattan Bank points out....Engineers now start at \$400 per month in contrast to less than \$250 nine years ago. It is estimated that there is a current need for 45,000 engineers a year. We graduate only 23,000. Four hundred men trained as nuclear scientists graduate each year. Twelve hundred are needed."

"The most challenging aspect of the problem lies in the fact that today only 16% of university students major in science and engineering, down from 25% since 1950, while in Russia over one-third of all students major in engineering." Does this sound familiar? This quote came from Forbes Magazine May 11, 1981 quoting from an article that appeared there in 1956. Nearly forty years and the story is the same.

For the entire decade that I have been involved in these issues, we have not produced enough engineers in our schools according to management and academia, yet the Bureau of Labor Statistics has indicated that some twenty percent of each years graduating class never enter the engineering workforce.

Supporting evidence is found in a report by OTA released in 1986 titled "Demographic Trends and the Scientific and Engineering Work Force". The report states "Less than two thirds of science and engineering baccalaureates produced in recent years have actually become a part of the science and engineering workforce."

The report concluded even though the college age population was expected to decline by 22 percent between 1982 and 1995, the market would draw from that third which had never entered the engineering workforce.

The NSF report which brought about these hearings "Future Scarcities of Scientists and Engineers: Problems and Solutions" as I understand it was never "officially" released and presumably was never an "official" position of NSF.

This report was quoted extensively in Rep. Morrisons immigration hearings and in fact was the basis for nearly tripling the number of foreign engineers and scientists who potentially are to be admitted to the United States. Every one was aware of the deep reductions in defense except perhaps Congress and the NSF.

The NSF report has been criticized and discredited by nearly every one who has read it. Someone, however, has forgotten to tell the press. Has NSF ever put out a press conference to withdraw a report? Have they ever said "we were wrong"?

What was NSF's answer to the criticism? They indicated they had never said there was a "shortage" of engineers, they defined it as a "shortfall". My dictionary (Webster's II, New Riverside University Dictionary) defines shortfall as follows: "1. A failure to attain a specified amount or level: SHORTAGE. 2. The amount by which a supply falls short of expectation, need or demand." To an unemployed engineer any difference seems inconsequential.

In late March of 1992 the CNN financial show "Money Line" quoted the latest version of this report suggesting we are facing a crisis level shortage of engineers by the 1020 or so. Less than a week later Money Line also ran a story about the difficult time this years crop of college graduates were having finding a job. One of the professions spotlighted as having the toughest time finding work was engineering.

To return to the systemic problems within NSF, perhaps the main one is the people who run NSF are from management and academia. Both groups have a vested interest in the outcome of the studies. NSF itself has a vested interest in having a shortage. With a projected shortage, NSF is in a better position for additional funding which keeps the bureaucracy expanding. The only loser is the working level engineer who has no representation in the process.

If you believe academia and corporate management, there has been a "crisis level" engineering shortage for the last forty years; yet no major project has been canceled because of a lack of technical expertise. No major project has been a technical failure due to a shortage of engineers. You can speak of the failures of management. (Ref. Divads, the A-12, etc., etc..)

To the best of my knowledge we have never had a "current" shortage of engineers, they have always been five or ten years or more in the future and seem to appear at about the same time as new immigration legislation.

Economics 101 teaches us if a commodity is in short supply the price increases. Engineering salaries have been virtually flat, in terms of common dollars, since at least the mid 1960's. Compare the salaries of engineers to doctors over the last thirty years. There is not now, nor has there ever been a shortage of engineers.

All predictions of engineering supply and demand have several things in common; they are never very accurate and invariably, they overstate the demand and understate the supply. Often they are based on the word of academics and management.

In my thirty plus years in the business, I HAVE NEVER HEARD OF A SURVEY OR STUDY WHICH INDICATED A POSSIBLE SURPLUS OF ENGINEERS. This includes the debacle of the early 1970's when between 60,000 and 100,000 engineers and scientists were unemployed.

What are the results of these surveys and all of the ensuing publicity? Congress holds hearings, panics at the horror stories emanating from management, academia and NSF, and throws hundreds of millions of dollars at NSF and the universities to make us competitive again.

Remember the early 1980's when the universities were lobbying for money to expand our engineering schools, turning away domestic students and at the same time were recruiting overseas for students? Remember the hundreds of millions of dollars NSF received to establish "manufacturing research centers"?

High school students were enticed to enroll in engineering only to find they were unable to get jobs upon graduation, older engineers were laid off and salaries failed to keep up with inflation.

Freshmen enrolling in college see these results and decide law, medicine or business was much more rewarding, stable, and probably less work academically. Many will point to demographics as the culprit in declining engineering enrollments. I believe freshmen witnessing the problems of previous graduating classes should bear at least as much responsibility as demographics.

What of the two million or so people who are to become unemployed due to previously announced defense cuts. Every fifth or sixth defense or high tech worker is an engineer. There will be thousands or perhaps hundreds of thousands of technically trained people in the military service who will be returning from overseas to a less than bright future after serving our country so well.

The people making the predictions are concerned only with "keeping the pipeline" full. A full pipeline lets management pick and choose without increasing salaries. A full pipeline lets academia keep the class rooms full and their position safe. A full pipeline "keeps the slaves between the decks."

#### SUMMARY

There is no bad time to engage in Engineering Shortage Propaganda (ESP). If we have a surplus of engineers, it merely insures "reasonable" salaries for the foreseeable future. If there is a (relatively) tight market, the studies will be useful in further loosening the immigration laws to "keep an adequate supply" of the worlds best and brightest. Of course the academics will stay busy (and employed) producing the next crop of young engineers.

ESP consistently overstates the demand and understates the supply. In spite of the forty years of constant shortage predictions, no projects have been canceled because of a lack of technical talent, no projects have been failures due to a lack of technical expertise.

In forty years one would reasonably expect to have a survey which indicated an oversupply of engineers. If we accept the premise of a shortage, we must then explain salaries which have not increased in real terms since at least the mid 1960's.

There is no shortage of engineers; there has never been a shortage of engineers. It's not possible to have a shortage of engineers if one accepts the law of supply and demand in a free market economy. As the demand and therefore prices increase, the supply will increase to fill the demand and create equilibrium. Our market is being grossly distorted by the shortage shouters.

#### RECOMMENDATIONS

1. - Require any study or survey to be reviewed by an independent, neutral body before being released or "leaked" to the public or press. This body should be representative of the engineering workforce.
2. - Require the effects of current market conditions to be considered as part of the overall study or survey as a leveling mechanism.
3. - Require NSF to spend as much in resources and effort "recalling" a faulted report as is spent to publicize the release of the report.
4. - Stop NSF from lobbying Congress on issues such as immigration, etc.. It's one thing to testify on credible, scientific evidence but quite another to spend taxpayer money to lobby for the NSF point of view.
5. - Place working level engineers in areas of responsibility within this process.
6. - Stop funding Engineering Shortage Propaganda. This money could be better spent to create jobs for engineers.

Engineers consider Engineering Shortage Propaganda an issue of the highest priority. Thank you for your consideration of this problem.

# THE PROFESSION

Section

4

Electronic Engineering Times

## NSF's Suh Says U.S. Engineers Are Overpaid Remark Stirs Debate

By Matthew J. Doherty  
WASHINGTON, D.C. — A high-ranking National Science Foundation official told engineering vice presidents here last week that American engineers are "overpaid" and less productive than their foreign counterparts.

Nam Suh, assistant director for engineering in the NSF, said that, in Japan, "two engineers are working on a problem when we [the United States] can barely afford to pay one." That statement came last Tuesday during a executive forum sponsored by the American Association of Engineering Societies.

When pressed later to clarify his remark, Suh said bluntly, "Yes, I think American engineers are overpaid." Several engineering vice presidents gathered around Suh agreed with his reply. But it's not likely to evoke the same favorable response from engineers and leaders in the profession.

The next day, Suh's boss, Erich Bloch, refuted his employee's contention. Bloch appeared before the same group to receive the National Engineering Award. Said Bloch, NSF director and former vice president for technical personnel development at IBM: "I don't think American engineers are overpaid. When I was an engineer, I always thought I was underpaid."

When informed about Suh's statement, IEEE president Bruno Weinschel, a member of the AAES Board of Governors and a participant in the two-day meeting, said engineers in the United States "are not overpaid; they are underutilized."

Weinschel, who has spent much of the last two years spreading his utilization gospel, blamed poor management for productivity problems and misplaced national priorities for a general lag in competitiveness.

And citing problems in engineering education, Weinschel said engineering-faculty salaries are low and should be raised in order to attract a larger, qualified pool of instructors.

### Much Debate

Engineering salaries have been the subject of much debate and concern in the profession. Electrical and electronics engineers, for example, get average starting salary offers that place them high on the wage-earning scale compared with other professions. The average salary offer to EEs as of July 1985 was more than \$27,000, according to the College Placement Council.

But salary surveys by this newspaper and the IEEE have indicated quite clearly that "salary compression" is a real factor in an engineer's career. The 1985 *EE Times* Annual Salary Survey found that, as engineers get older, their pay raises tend to diminish in size and their salaries level off after a period of steady annual growth.

The survey found that mean salaries for engineers peaked at age 49, when respondents earned an average of \$51,500. Respondents in the next two age categories, 50 to 54 and 55 to 59, actually reported earning less (\$49,800 and \$49,300, respectively).

Many engineers contend that engineers' pay lags well behind other professionals, such as doctors and lawyers, by design. As reported exclusively by *EE Times* several years ago, a large number of companies swap engineering salary data annually and use salary curves that appear to distribute larger raises to younger engineers.

Walter Nial, chairman of the IEEE Age Discrimination Committee, has argued for years that older engineers are granted smaller pay increases, even though they may still be as productive as their younger colleagues. And many other engineers say they can expect salary compression unless they are willing to move into management, consulting or leave the profession altogether.

Nam Suh's controversial remarks were not limited to salaries and productivity.

In his speech, which was warmly received by an audience of 40 corporate engineering executives, Suh said there is a shortage of engineers, a contention with which few engineering groups concur.

"We really don't have a sufficient number of engineers," he said. The United States is producing, he said, about 73,000 engineers per year, roughly equal to the number being turned out in Japan.

he told *EE Times* afterward. "We need to improve the quality of them and the number of them."

Suh's assertion that more

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**'A lot of people think we don't need more engineers, but I think we do. We need to improve the quality of them and the number of them.'**

—Nam Suh, NSF

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engineers are necessary is contrary to government and industry sources, and once again, his own boss, Erich Bloch.

A million-dollar National Research Council study last year found the engineering profession to be in good shape, and predicted some possible spot shortages in specialized areas of engineering.

That position was reinforced recently by the American Electronics Association, the industry trade group. It reversed its previous position by acknowledging that there is no chronic shortage of engineers.

### No Shortage

And Bloch, repeating a position he has taken previously, told *EE Times* there is no general shortage of engineers at this time. He did, however, express concern about spot shortages and a downturn in engineering enrollments.

Suh also said the doctorate degree has become the equivalent of a "union card" in hiring engineering faculty. And he said that NSF monies being used to support fundamental research are only the "bare minimum" needed.

# The shortage of scientists and engineers: crisis or hype?

by Dennis Chamot

**T**he number of U.S. scientists and engineers has doubled over the past decade, from 2.6 million in 1978 to 5.3 million in 1988, according to statistics gathered by the National Science Foundation in Washington. That's several times the rate of population growth. Even so, various leaders in the education and technical communities, including the NSF itself, have raised the specter of a looming shortage of technical professionals.

True, we live in an increasingly complex technological society. Both our economy and military security depend upon continued progress in science and engineering. A shortage of skilled technical people would be a serious flaw and indeed would justify the remedies called for by those raising the alarm — encouraging more young people to choose science and engineering as careers, and boosting public support of graduate students in these fields.

But what if they are wrong? Then increasing the supply of scientists and engineers would hold down salaries, reduce employment opportunities, and in the long run discourage even more young people from pursuing these areas of study.

Dennis Chamot is Executive Assistant to the President, Department for Professional Employees.

If a real shortage exists, one would expect to see an effect on salaries. The law of supply and demand would say that if the supply of a product, in this case people with particular training, were much less than the need, then the price of the product ought to rise. In other words, if employers were having difficulty filling positions, they would offer higher salaries to try to fill their needs. What has been happening to salaries?

This question has been looked at by the Office of Scientific and Engineering Personnel (OSEP) of the National Research Council (the NRC is the operating arm of the National Academies of Science and Engineering and the Institute of Medicine). OSEP obtained salary data gathered from employers by the Engineering Manpower Commission and corrected them for inflation. *Figure 1* shows that despite the enormous increase in demand for engineers (as reflected in the huge increase in numbers of engineers employed over the period examined), real salaries, corrected for inflation, did not increase at all from 1972 to 1990. If anything, there was a slight drop during the past four years. This is true at all experience levels, including new hires. One would expect starting salaries to be particularly sensitive if a real shortage existed, yet even new graduates ("0 years since BS") have followed the general pattern.

A similar situation obtains for industrial chemists. Using starting salary data collected by the American Chemical Society, I corrected for inflation and generated the graph shown in *Figure 2*. Over an 11-year period (1980 through 1990), starting salaries in real terms for B.S.-level chemists employed in industry were essentially unchanged. At the Ph.D. level, there was some gain since 1980, but the trend has been downward for the past four years.

Although demand for technical professionals has grown, employers seem to have been able to meet their needs without resorting to anything drastic. Will this situation continue?

*Figure 3* shows the number of degrees awarded in engineering over the past 15 years. There has been steady growth at the graduate level, both masters' and Ph.D., with nearly a doubling in degree production during this period.

There was also a doubling at the bachelors' level from the mid-seventies to the peak in 1986 (a higher growth rate than during the previous two decades). The steady decline over the past four years, from more than 78,000 B.S. degrees in 1986 to just under 66,000 in 1990, is fueling the concern. The decline is primarily a result of demographic factors; the college-age cohort is declining. This decline is tem-

Although demand for technical professionals has grown, employers seem to have been able to meet their needs without resorting to anything drastic. Will this situation continue?

porary, and is expected to reverse before the end of this decade.

**Foreign students**

Another area about which many have expressed concern is the composition of the student body. Although foreign nationals received about 8% of B.S. engineering degrees each year through the 1980s, the proportion of graduate degrees going to foreign citizens has been increasing. At the masters level, the growth has been modest, from 26% of degrees in 1981 to 29% in 1990, but the fraction is large.

The situation for Ph.D.s is of more concern. The total number of degrees is small. Even though there was a doubling over the past decade, to about 5400 engineering Ph.D.s awarded in 1990, much of the growth was accounted for by foreign citizens. The fraction of Ph.D. degrees in engineering awarded to foreign nationals increased from 37% in 1981 to 49% in 1990.

Some of the foreign students return to their home countries and are unavailable to satisfy U.S. needs directly. On the other hand, many do remain, some to teach in our universities and others to work in industry. (According to statistics compiled by the National Science Foundation from Immigration and Naturalization Service data, about 4800 scientists and engineers changed their status from non-immigrant to immigrant in 1988, including former students, and another 6100 were admitted directly from overseas.)

Recall that the NSF claims there were more than 5 million scientists and engineers in this country in 1988. The U.S. Bureau of Labor Statistics, using a more narrow definition of those actually employed in the field, counted 2.25 million scientists, engineers, and computer scientists. Even using the more conservative BLS figure, immigrants add only 1/2 of 1% to the pool each year, hardly an indication of excessive demand.

Perhaps we should compare the flow of immigrants only to the production of new degree holders. The NSF counted 193,000 bachelors degrees in engineering and the physical and biological sciences in 1988, 49,700 at the masters level, and 15,100 Ph.D.s, for a total of 258,000 new degrees. Even if immigrant professionals directly competed only with new graduates, they represent just one-twentieth of the available pool.

**No shortage seen**

None of the foregoing supports the view that there is a shortage of technical talent in this country, nor is there likely to be in the near future. We are currently in the midst of a serious recession, and technical professionals in a variety of industries are feeling the pinch. In fact, there has been a downward trend in R&D spending increases since the mid-1980s, both on the part of industry and the federal government. In real terms (corrected

*continued on next page*

**ENGINEER ANNUAL SALARY BY YEARS SINCE B.S. (constant \$)**

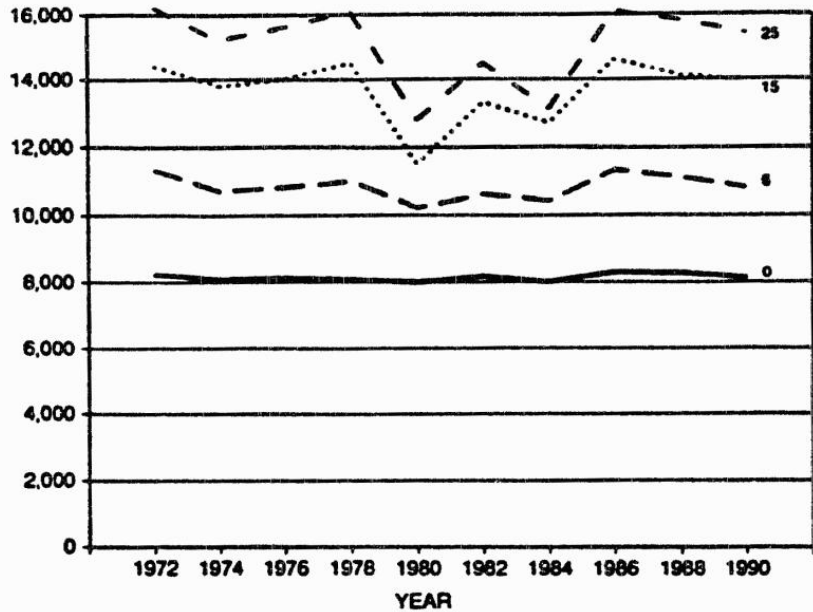


Figure 1. Annual salary for engineers by years since BS. Data deflated by Consumer Price Index 1967 = 100.

**CHEMIST STARTING SALARIES**

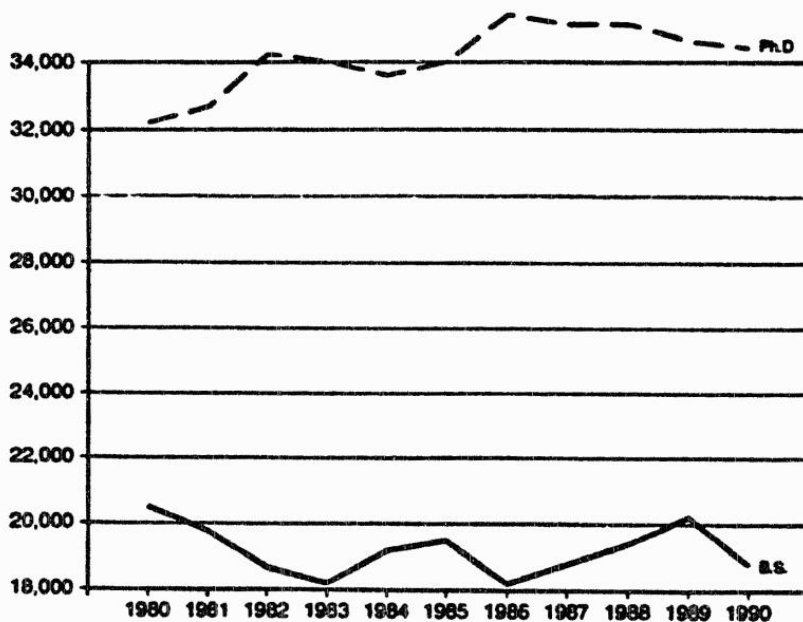


Figure 2. Median starting salaries for Inexperienced full-time chemists. Real dollars, CPI 1982-4 = 100.

## DEGREES IN ENGINEERING

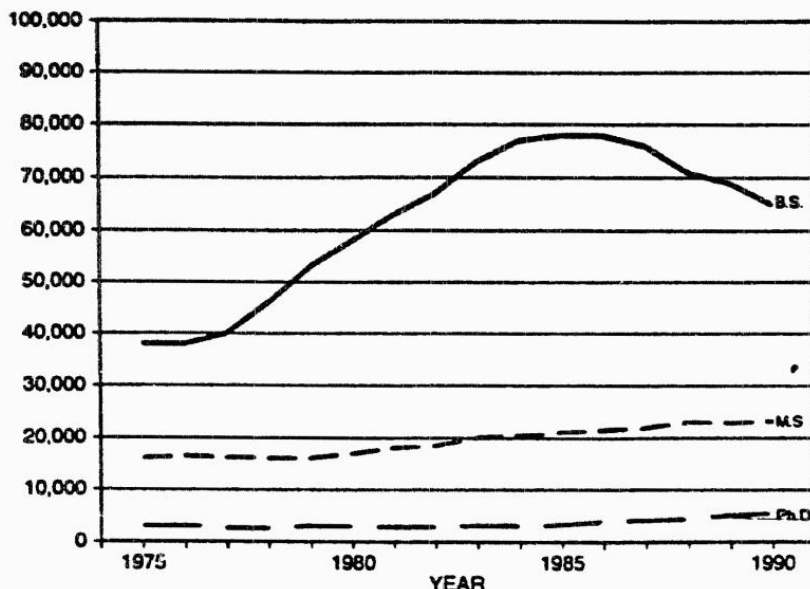


Figure 3. Degrees in engineering.

for inflation), there has been a decline in federal support for three years.

#### Employment outlook

Looking to the longer term, the BLS projects employment of about 2.9 million engineers, scientists, and computer scientists in the year 2000. That's about 700,000 (25%) more than they counted in 1988. If we assume that about one-fortieth of the work force will retire annually, we will then need an additional 800,000 professionals for a total of 1.5 million. Yet, some 2 million scientists and engineers at all levels will probably be awarded degrees during the period 1988-2000. Furthermore, we can also anticipate 100,000 or so immigrants to enter the work force as well. (This number could increase substantially under the newly revised immigration law.) The output would thus seem to be adequate to meet the demand.

Shortages or surpluses in specific fields do occur, and although the details change from year to year, this is nothing new. And it isn't something to get too excited about. Labor markets do equilibrate over time. In addition, advances in technology make substitutions easier to accomplish.

For example, much engineering design and a lot of theoretical science is now done on computers. Furthermore, with modern telecommunications, the world's engineers and scientists are available at a touch of a button, further contributing to the pool of talent that can be utilized by American companies.

Technical professionals in the workplace don't understand where the talk of shortages is coming from. This is especially true for employees of defense suppliers who are facing cutbacks, but it is not limited to them. A typical comment is one from a letter to the editor in a recent issue (May 13, 1991) of *Chemical and Engineering News*: "I observed several interesting advertisements for employment ... in *C&EN*: project leader, Ph.D., \$38,000 per year; research associate, Ph.D., \$30,000 per year; and research associate, Ph.D. plus postdoctoral experience, \$25,586 per year ... My guess is that the people who placed these ads did not get a lot of response, and therefore concluded that there must be a shortage of chemists."

Cries of shortage appear regularly. Several years ago, there was such an outcry of concern that the National Research Council set up a Committee on the Education and Utilization of Engineers, of which I was a member. In 1985, after a couple of years of detailed study, the committee issued a multivolume report. There was much useful information in it, but the one thing the committee could not do was confirm that there was any kind of crisis. At most, there was concern about the growth in foreign students in graduate programs, as an indication of possible diminishing interest in obtaining Ph.D.s on the part of American students, thus affecting the pool of potential faculty members. That specific concern still exists.

A good indication of the thinking of knowledgeable experts is a recent article by Alan Fechter (1), Executive Director of

the NRC's Office of Scientific and Engineering Personnel. He doesn't support the view that there are, or will be, serious shortages. He notes, "Most of the simulation models used to assess these labor markets assume that markets do not equilibrate; that if an imbalance occurs between supply and demand, nothing will occur to correct it. In fact, history demonstrates that these labor markets do tend to equilibrate ... Thus, projected imbalances derived from such models — both shortages and surpluses — are always overstatements of what actually will be experienced."

#### Sources of concern

So, where is the concern about shortages coming from? Perhaps another way to put the question would be to ask who benefits from a surplus. Clearly not working scientists and engineers — oversupply holds down salaries and makes it more difficult to find good jobs.

I suggest two sources. One is certain elements of the business community, a minority, who in fact want to pay relatively low salaries; some of these companies desire to employ foreign engineers at less than going rates of pay, and want to convince the Department of Labor that shortages exists.

The other source of complaint, and by far the most vocal, is the university establishment. In fact, one could make a convincing case that there is a real problem here, in that many universities are having trouble attracting American students, especially into their graduate programs, and are relying heavily on foreign talent for new faculty.

The problem for the rest of us is that the universities (and academically oriented organizations like NSF) have generalized their view of the crisis.

I'm convinced there is no general shortage today. I don't believe there will be one in the foreseeable future. Let's stop the rhetoric and act like scientists. Let's look at the evidence, and concentrate on the real problems.

#### References

- (1) Fechter, A. "Engineering Shortages and Shortfalls: Myths and Realities", *The Bridge*, Fall 1990, published by the National Academy of Engineering.

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March 11, 1992

Letters To The Editor  
New York Times  
229 W., 43rd. St.  
New York, NY 10036

To the Editor:

I take exception to your Tuesday, March 10, article "Amid 'Shortage,' Young Physicists See Few Jobs." Beside quoting known 'Engineer Shortage' shouters from the Universities, you cite as a reference the numbers from an erroneous paper by the National Science Foundation (NSF) to support your contentions that our nation suffers from a shortage of engineers. The NSF paper entitled "Future Scarcities of Scientists and Engineers: Problems and Solutions" contains such blatant errors that no one from the Foundation would put their name on it.

The NSF paper contains a few glaring errors: First, NSF collectively combines Natural Science and Engineering (NS&E) degree production for their Engineering Manpower projection. Using Natural Science and Engineering degrees is effectively mixing apples and oranges. Engineering degrees and Natural Science degrees are not the same.

Second, they refer to past "average" degree production and then use past "peak" degree production as their proxy for future needs. This further distorts the picture.

Third, NSF's disclaimer, on page 8 of their paper, basically states that they cannot predict future manpower needs without knowing both supply and demand parameters. Their paper neglects to consider the demand or lack of demand for engineers and they, of course, cannot predict the future.

Our nation has been suffering from layoffs and a reduced demand for engineers with an over supply from the colleges and thru immigration channels. Meanwhile, our young graduates are not getting the engineering jobs for which they studied so hard.



Letters To The Editor

Page 2

March 14,1992

NSF's paper only plots the unconstrained demand of our growing college empire without concerning themselves with the educational needs of our youth or utilization of our past engineering graduating classes.

There are too many other issues in your article to address in the limited space allocated to your "Letters Column", so I have enclosed some information to further enlighten you.

Sincerely yours,

Richard F. Tax  
Vice-President

enclosures  
cc: B. Reed

esprebut.let

1210

To: New York Times  
From: Richard F. Tax  
Subject: **Shortage Rebuttal** for New York Times.  
Date: March 11, 1992

ENCLOSURE OUTLINE

1. NEW Pollution From an Old Source - How National Engineers Week (NEW) and the Press are used by NSF to spread Engineer Shortage Propaganda. Includes part of NSF's paper "Future Scarcities of Scientists & Engineers: Problems & Solutions." Shows NSF disclaimer and their erroneous curves.
2. "Shortage-forecast methodology disputed." Also points out same NSF errors. "Burying the EE shortage myth" tells how NSF numbers are quoted to satisfy their needs and those of academia.
3. "IEEE booklet halted" - Professional society for EEs strives to keep "Pipeline" to engineering colleges full due to excessive control by academic membership, some of them have nothing to do with engineering.
4. "Precollege Education: Scheme or Scam?" - Another example of academic control of an engineering society to keep the "pipeline" full to the engineering colleges.
5. NEWSNET ONE attachment from Region I Executive Committee of the Institute of Electrical and Electronics Engineers (IEEE). Covers Employment issues for engineers.
6. "Enhancing U.S. Productivity Through Improved Utilization of Engineers." A manpower balance produces better engineers with more experience and enhances U.S. engineering capabilities.

nsfrebut.mem

# Professional Activities Committees for Engineers NEWS

By Richard F. Tax

## Rutgers University And Montclair State Cry Shortage

Like a cheap serial movie with the monster returning each year to wreak havoc on the community our engineering "Shortage Shouters" return once again to seduce our youth to the engineering colleges with cries of shortages and promises of golden opportunities. Each year National Engineers Week (NEW), assumed to honor our nation's engineering community, is misused to recruit our youth to the engineering colleges with fabrications of engineer shortages and unfulfilled promises. This year is no exception; however, New Jersey educators have a head start. Again, the false National Science Foundation paper is used by educators to sell college credits to the naive public.

In January, a TV program entitled "The Science Gap," sponsored by Rutgers University, shows Dr. Vaughn Vandergrift of Montclair State College quoting the false NSF report as the foundation for their shortage cries and college recruiting campaign. The program was aired many times on stations WNET (PBS) and WNJN (PBS) for millions of viewers to see. Surrounded by other shortage shouters, Vandergrift has gone to TV crying "wolf," to promise rewarding engineering careers to the viewers. Would it be indelicate of me to mention that the "shortage shouters" are usually employed in the public sector and should have some loyalty to their employer, the U.S. tax payer?

Let's set the record straight. In September, 1991, the Engineering Manpower Commission, of the American Association of Engineering Societies, sponsored a conference to consider the engineering manpower issue. The following "Conferees Say No Shortage Exists," from IEEE's "IMPACT" by Frank Lord, Editor, Career Activities Council, blows away the shortage argument and the NSF paper.

### Conferees Say No Shortage Exists

I was among a group of members of IEEE-USA's Manpower Committee who participated in a conference on September 11-12 in Washington, DC, sponsored by the Engineering Manpower Commission of the American Association of Engineering Societies. With the theme *Engineering in America's Future: Shortage or Surplus?* the conference addressed the question of the reliability of supply and demand projections and the likely impact of demographic and other trends on such forecasts. The answer was a judgement of no shortage, now or in the foreseeable future.

People of all persuasions explored the question, including industry leaders, practicing engineers, government statisticians, and engineering professors, most of whom were able to maintain objectivity. The program content flowed smoothly from the first day's sessions on *Statistical Background and Future Scenarios* to the *Employer Requirements* session on the morning of the second day. The keynote address was given by D. Allan Bromley, Director of the White House Office of Science and Technology Policy. The first day closed with the presentation of *Congressional Perspectives* by Congressman Don Ritter (R-Pennsylvania), the only Ph.D. engineer in Congress.

Most members of the conference's first panel seemed convinced that a manpower shortage exists, and they were there to speak about various aspects of it. Only the panel moderator put some caveats on what might be concluded from the present about the future. I was most astonished by a panelist from the National Science Foundation (NSF), who spoke about such deficiencies of the infrastructure as communications and transportation, attributing

those inadequacies to a shortage of engineers. This notion appears equivalent to concluding that street people in U.S. cities indicate a shortage of home builders. I thought it ironic that a person unable to distinguish between societal and economic needs would be speaking at a conference examining supply and demand.

Circumstances did not get any better when another panelist displayed some graphs, which showed engineering salaries increasing at an average rate of 4.4 percent, and declared that engineers were doing well. He neglected to point out that had the curves been normalized to constant dollars, the graphs would depict engineering salaries as barely keeping up with inflation.

Keynote speaker Bromley did not foresee an impending crisis. He did believe that students should concentrate on science and mathematics to keep the so-called "pipeline" full. Bromley said we need people who can function and contribute in a competitive industrial society. He did not say that the sole purpose of the pipeline was to direct young people into the study of science and engineering at the college level. He asserted that national policy as well as market forces should influence our industrial capability.

IEEE-USA Manpower Committee member Robert Rivers surprised the afternoon audience by declaring that there was no need to hold the conference. He explained that in a free market economy there is no such thing as a shortage or a surplus, only an equilibrium point between supply and demand that may shift position over time. Rivers cited elements of Economics 101 as applied to the engineering manpower arena. From that point on, I sensed a transition among the speakers to more caution in statements and more couching of answers to questions.

Congressman Ritter questioned the actual demand for engineers in the year 2000, seeing it as "less than certain, given the coming contraction in defense procurement and possible further declines in certain U.S. manufacturing industries and their continued growth offshore." He did not shy away from using such words as *laid-off*, *underutilized*, and *slump* in describing the current engineering employment situation. Ritter spoke of the need for national ability in production, quality, and competitiveness. In effect, he shifted the focus of the conference from academic views and bureaucratic concerns to the real world of engineering.

I saw no evidence of shortages in the second morning's sessions. A major computer manufacturer is spending a great deal on continuing education, but nevertheless, also laying off engineers. The U.S. Department of Defense does not have an employment goal. A utility company is successfully employing former full-time employees on a part-time contract basis.

In contrast to the mainstream, one participant apparently still quoted the discredited NSF shortfall figures as shortage numbers. He was experiencing an engineering shortage in his area of endeavor, because his particular business with its low salaries kept him out of the normal marketplace. The conference moved a giant step closer to what seemed to be its inevitable conclusion.

In the last session, *Conference Wrap-Up*, the bulk of the effort fell on Alan Fechter, Executive Director of the National Research Council's Office of Scientific and Engineering Personnel. He noted that three major issues had been addressed: shortage or surplus, technical competency, and reliable data.

On the first issue, Fechter expressed mild surprise at the ease with which a consensus of no shortage was reached, with an almost total lack of contention. He saw no indicators of crisis, only normal concern about the future amidst uncertainties.

In his closing remarks, Fechter distinguished between making judgments and drawing conclusions. He pointed out that judgments are based on evidence. Unfortunately, determinations are sometimes based on minimal evidence. In the case of this conference, a preponderance of evidence led to the judgment. While judgments can be modified over time, it is more awkward or embarrassing to change a conclusion.

This conference was a valuable forum. In aggregate, the whole carries more weight and is less confusing to the public than a collection of statements that might have been issued by the same presenters. The deduction was that there is no imbalance between supply and demand for engineers at the present time, nor is there likely to be one in the foreseeable future.

## Why Technical Leadership Matters

**Allan Bromley**  
Director  
Office of Science and Technology Policy  
Executive Office of the President  
Washington, DC



Bromley is assistant to the president for science and technology as well as director of OSTP. He is on leave from his former position as Henry Ford II Professor of Physics at Yale University, where he was founder and director of the A. W. Wright Nuclear Structure Laboratory. One of the world's leading nuclear physicists, Bromley has carried out pioneering studies on the structure and dynamics of nuclei. He is considered the father of modern heavy ion science. Bromley has served as president of the American Association for the Advancement of Science and the International Union of Pure and Applied Physics. He holds a Ph.D. in nuclear physics from the University of Rochester. Bromley received both a B.Sc. in the Faculty of Engineering and an M.Sc. degree in nuclear physics at Queen's University, Ontario, Canada.

The federal government must play a role, says Allan Bromley, if America's science and technology are to remain world-class.

**Design News:** At a time of tight budgets for all science and engineering projects, why should we as a nation put money into science megaprojects like NASA's Space Station?

**Bromley:** The space station really is the first step in a glorious adventure that will take humankind off the home planet on the first step to the cosmos. And it seems to me that we, as the last superpower on the planet, have an obligation to provide leadership in this area. It's going to cost us something like 0.25% of our GNP. We were talking about substantially more than that all through the Apollo program period. And I remind you that the Apollo program was the first time in the history of our race that we were able to get a quantum leap forward in both science and technology without having to involve most of the then-civilized world in a major war.

**Q:** Once again we hear predictions of a shortage of engineers. Should such predictions be taken seriously?

**A:** The one thing we can say with absolute certainty is that we have a very real shortage of American engineers. In recent years we have been granting more than 50% of degrees in engineer-

ing at the Ph.D. and the M.S. levels to people born outside of the United States. And we're getting to the point where the B.S. situation is really close to that level. Now that does not mean that we've got too many foreigners, it means that we've got too few Americans. It's clear that we have a major shortage of American engineers, and we have to do something about that. We are doing something about it.

**Q:** How can companies cooperate in doing R&D without being placed at a disadvantage in the marketplace?

**A:** In the countries with whom we compete most aggressively, there clearly is cooperation not only among companies, but also among companies with assistance from their federal governments. If we insist that each of our companies essentially reinvent the technological wheel, independently, then clearly they're not going to be competitive. That's why the Bush administration has focused on the federal responsibility not only to support basic research, but also to support the development of generic technologies. An example of this sort of thing is the consortium with the automobile companies that seeks to use composites more effectively. Another is the battery consortium, where we're working with the Electric Power Research Institute, the big three auto manufacturers, and a number of battery manufacturers.

**Q:** How important are intellectual property rights to innovation in this country?

**A:** Extraordinarily important, not just in this country but worldwide. Because if in the highly competitive world marketplace a company can't get some appropriate return for its investment in developing a new product, then there can be no long-term research program that will pay off. It's very important for me to emphasize that we still have the strongest science and technology enterprise that the world has ever seen. The fact that some countries by focusing their resources into narrow salient areas have been able to equal us, and in some cases to surpass us, is not surprising.

**Q:** What are the objectives of the High Performance Computing Program?

**A:** The goals of the High Performance Computing Program are quite broad. First of all, we want to make sure that we retain the leadership in computer hardware. Second point: That high-performance hardware will be of very

*‘We still have the strongest science and technology enterprise that the world has ever seen.’*

little use to us unless we have software that is user-friendly and readily available. We have to make a major effort to bring our software up to an appropriate level. The third goal is to have a private-sector network initiative by the end of this century that will make high-performance computing as accessible and acceptable as the telephone. And, fourth, we're going to need a lot of people, including a whole new level of trained technicians.

**Q:** You asked a Japanese science adviser why he thought our countries had enjoyed different rates of success in recent years. What was his answer?

**A:** I asked him—after two days of meetings, when I thought I could really ask a more pointed question—why he felt that the Japanese economy was more vigorous than ours. His answer was: It may not be unrelated to the fact that per capita we produce five times more engineers than you do, one-twenty-sevenths the number of lawyers, and no M.B.A.s at all. □

# METSAC

## PACE News

by Richard F. Tax, METSAC PACE  
Chairman

### New Pollution From an Old Source

According to some, National Engineers Week, 1990, (NEW) was a resounding success - at least, to the Shortage Shouters it was. Well, NEW is over but, not the effects. Newspaper headlines across the country spread more ~~distortions~~ ~~propaganda~~ to satisfy the needs of the colleges at the expense of the public. The distortions are real, very bold, and laundered several times by pseudo engineering societies and the new media. Many "engineering" societies were involved but, lets just review one classic case in New Jersey.

The February 14, 1990, "Star Ledger" ran an interesting column by Gordon Bishop entitled "The Environment." Upon reading the piece I thought a more appropriate title would have been "Engineering Society Shoots Itself in the Foot".

#### Let me explain.

Picture the owner of the local pharmacy stating that business is so good he would like someone to open a competing pharmacy across the street. This is not a very realistic scenario. Consider the same scenario for the butcher, baker or engineering society. I can't picture anyone throwing away profits and encouraging competition. That's called "shooting yourself in the foot."

Gordon Bishop wrote "Without engineers there can be no environmental revolution." That was his token relationship to his title - "The Environment". I would respond, "without engineering clout there can be no environmental revolution". When engineers lose their jobs for doing their jobs they, obviously, do not have any clout. Engineers will not have any clout while the engineering manpower balance is stretched beyond normal economic limits by engineer shortage propaganda. Milton Alpern wrote, in 1976, "...it is that extra engineer,

waiting to take one's job or client, that prevents the engineer from doing his or her professional best". Mr. Alpern refers to the engineers creed to protect the public and the environment.

Mr. Bishop dedicated the rest of his column to how we shall all suffer from the shortage of engineers - and extensively quotes the Consulting Engineers Council (CEC) of New Jersey to support the premise.

In his article he made the following statement which I assume he received from the CEC. "The number of undergraduate engineering degrees in 1996, for example, will fall short of demand. In only 20 years, the shortfall will be 700,000." He continued to elaborate about shortages with "Some other sobering facts from the CEC".

The realities are:

1. The distortions quoted from Bishop's column came from a National Science Foundation (NSF) report entitled, "Future Scarcities of Scientists and Engineers: Problems and Solutions".

2. The NSF report did not study the scarcity of Scientists and Engineers as falsely implied by the title.

3. NSF's projected shortfall covers the production of Natural Science degrees, Computer Science degrees and Engineering degrees (referred to as NS&E degrees) with only 40 percent being degrees in engineering.

4. Buried on page 8 of NSF's paper lies the caveat, the disclaimer, that their shortfall does not mean a shortage and that demand was not considered in their study.

5. Engineering Manpower requirements cannot be determined without considering both supply and demand.

6. The NSF concern is directed at the "cumulative reduction in the production of NS&E bachelor degrees" below the peak years of 1984-1986 because our birth rate has not kept up with the "uncon-

strained demand" of our growing college empire.

The NSF paper is so blatant that no one at NSF had the courage to put their name on it.

I believe Gordon Bishop did his professional best. I also believe he just published without question, the distortions presented to him by the Consulting Engineers Council. However, why would CEC want to increase the competition for their "engineering" members? Is CEC, in fact shooting itself in the foot or is CEC something other than what they appear to be? Should a reporter question: "why are you pointing a gun at your foot?" before lending it credibility and presenting the information to his readers? The Star Ledger and its readers are only one sample of those taken in by the distortions of the NSF report.

Don't expect to see CEC members, foot bandaged, hobbling about on crutches. You will probably find them in the supply line worrying about the production of next years bachelor degrees and getting more tax dollars from Congress.

As engineers, we are suppose to protect the public and the environment. Shouldn't we consider false manpower reports to be a form of pollution and strive to serve the public and protect our environment from this contaminant? Who also will serve the public? I haven't heard of NSF expressing their concern about their report being misquoted.

More difficulties arise from the vantage point. People get paid to generate this type of pollution while engineers must volunteer their personal time to protect the public from its effects.

#### Engineering Layoffs

Please make copies of all articles on engineering layoffs and send to: Mike Altman, 509 Green Pond Road, Rockway, N.J. 07866.

Call the local Talk Shows:  
WOR 1-212-398-9404.

Let's see how many engineering students are not getting jobs.

# Role of engineer is crucial to the quality of life

Without engineers, there can be no environmental revolution.

Engineers shape our external world, from the vehicles we ride around in, the roads we drive on and the bridges we cross, to the buildings we work in, the clothes we wear and the food we eat.

Each step along the way, an engineer is involved in the development, as well as the quality, of our structured environment.

Civil, electrical, mechanical, chemical, automotive, aeronautical, construction and environmental engineers collectively, they are responsible for the lifestyle we lead and, to a great extent, even for how long we live.

But engineering—the foundation of America's economic system—has been on a bumpy, pot-holed road in recent years as students' skills in the sciences



**Gordon Bishop**

## The Environment

and mathematics have declined in public school systems from coast to coast.

Unless these basic skills improve, not just our high-tech society, but also our beleaguered environment, will be seriously undermined from within.

A lack of engineering know-how stands as our greatest obstacle in improving the environment and the quality of life in the 1990s.

The number of undergraduate engineering degrees in 1996, for example, will fall far short of demand. In only 20 years, the shortfall will be 700,000.

Over the next five years, the college-age population will decline and the supply of engineers graduating from college will also plummet, quite markedly, according to the Consulting Engineers Council of New Jersey (CEC).

Some other sobering facts from the CEC:

- The United States trains 1,000 lawyers for every 100 engineers. Japan, by comparison, trains 1,000 engineers for every 100 lawyers. Two-thirds of the world's lawyers practice in the U.S.
- The average starting salary for graduate engineers exceeds that of graduate attorneys.
- Between 1,300 and 1,800 engineering faculty positions at U.S. colleges and universities are currently vacant.
- America invests 2 percent of its Gross National Product (GNP) in public infrastructure (roads, sewers, water, etc.). Japan invests 8 percent, or quadruple the amount for improving vital necessities.
- On a world-wide basis, the U.S. interest in engineering and science is declining to about 18 percent of the world's total engineers and scientists, while the Soviet Union has about 38 percent of the world's engineers and scientists.

These numbers curiously reflect the level of engineering commitment at the New Jersey Department of Environmental Protection (DEP).

Of the nine DEP commissioners since 1970, only two had training in the engineering field—Richard Dewling and Rocco Ricci.

Four commissioners, however, were lawyers. The others had backgrounds in education, public health and, of course, politics.

The lawyers have taken over the environmental movement, leaving the engineers to deal with the

*'Engineering is precise down to the last decimal point.'*

litigious problem-solving process not by the numbers or technology, but by vague, ambiguous legalese that often compounds the confusion.

Engineering is precise down to the last decimal point.

The law is a matter of interpretation.

Focusing on the crucial role of engineering in the 1990s, Princeton and Rutgers universities will be participating in National Engineers Week (Feb. 18).

Science teachers will be sending students from the sixth through 12th grades to either of two "Engineer Your Career Days" at Princeton (Feb. 22) and Rutgers (Feb. 28).

Among the speakers at the two career days will be Professor Steve Slaby of Princeton's civil engineering department, and Professor Fred Bernath, associate dean for academic affairs at Rutgers' College of Engineering.

The future of the environment depends not on more laws and rules and regulations, but better engineering practices and methods of cleaning up the air, water and land.

As Congress debates the Clean Air Act this year, it will be the engineers and scientists who will determine how to combat acid rain, the greenhouse warming of the planet and toxic air emissions.

In the real world of getting the job done, physically, it's the engineers who must do it, from the ditches to the drawing boards.

Beyond the rhetoric and posturing are the hands-on applicators who must decide how to do it and how much it will cost.

National Engineers Week will put the pragmatic problem-solvers in the spotlight.

For the 1990s, every week should be *Engineers Week* as a constant reminder of the economic-environmental challenge confronting America.

Engineers make our system work.

Let's not forget them after their one week under the sun.

rudeau

THE STAR LEDGER 2/14/90



## About Letters

The Star-Ledger attempts to offer representative viewpoints in the Readers' Forum. Because of limited space, only a small number of the many letters received can be used. Each letter must include the writer's name, address and phone number. Unsigned letters are not considered for publication and unused letters will not be returned.

# THE PROFESSION 2

NAE OFFICIAL QUESTIONS NSF PREDICTION OF 275,000-PERSON SHORTFALL IN SCIENCE, ENGINEERING

## Shortage-forecast methodology disputed

By Robert Bellinger

An article published in a National Academy of Engineering magazine questions the method by which the National Science Foundation arrived at its prediction of a shortfall of 275,000 engineers and scientists in the United States by the year 2011.

The article, published in *The Bridge* this week, appears to vindicate IEEE activists who have slammed predictions of shortfalls for overemphasizing supply and ignoring demand.

Referring to the NSF's Division of Policy Research and Analysis (PRA), writer Alan Fechter concludes: "The PRA model is not very useful for policy formation."

In fact, Fechter, who is executive director of the National Research Council (NRC) Office of Scientific and Engineering Personnel, writes of the PRA's "fanciful shortfalls."

The NSF, however, defends its findings. Myles Boylan, a PRA analyst, told *EE Times* that the article "is a little off base. It's criticizing us for something we were not trying to do."

In a letter to *The Bridge*, PRA director Peter House maintains that "Fechter stretches our projection of a declining number of [natural science and engineering] BS degrees into a job market shortage, which we never intended."

But that admission, said IEEE activist Robert Rivers, should make "any predictors of shortages very careful in the future."

### The arguments

Fechter's report, which does not necessarily reflect the views of the NAE or the NRC, acknowledges that the pool of 22-year-olds is shrinking. "Boiled down to its essence," Fechter wrote, "the [NSF] model simply reinforces the common-sense notion that adverse demographic trends will make it more difficult in the future to produce a given number of engineering graduates. But the model does not provide meaningful information on whether we will need to recruit this number."

The NSF's PRA division, meanwhile, appears to be downplaying its own predictions. "Fechter," replies PRA's House, "is one of the few people who glorify [our] simple process with the term 'model.' PRA prefers the terms 'projection' or 'extrapolation.' And the numbers that PRA comes up with in extrapolating are for 'natural sciences and engineering fields,' not just engineering. In fact, House adds in his letter, PRA's numbers become "much less stable" if only engineering is considered.

"A more fruitful strategy would be to deepen our understanding of demand," says Fechter in his article.

"Treatment of demand is . . . ambiguous. Demand is not explicitly defined; instead, the [PRA] model considers a 'proxy' for demand, defined as the annual production of bachelor's degrees in a given year."

Fechter explains that the NSF's PRA division has to fudge the demand data, in part because "a difficulty arises from the mismatch between labor market data, which are occupationally oriented, and education data, which are organized by academic discipline." Many BSEE grads go into occupations other than engineering, and some engineers do not have a degree. "These mismatches make quantitative projection of demand highly uncertain."

Boylan agreed that getting a handle on demand is "extraordinarily difficult to deal with. It's highly dependent on things we don't know about."

The PRA analyst cited three factors that affect demand:

- Growth in real R&D spending. EEs are especially affected by growth in defense spending, which is on its way down.

baccalaureate degrees has gone down. We're not saying that there are not enough graduates," he said.

"What are they saying, then?" asked the IEEE's Rivers, who protested references to shortages at the IEEE's PACE conference this year.

The NSF/PRA figures have been widely quoted in the press, including the IEEE's own publications, usually in a context that foresees a shortage of engineers. But with defense layoffs, an apparent recession in place and a wave of early retirements sweeping the electronics industry, engineers see red at suggestions that employers face hiring problems.

Boylan said PRA recognizes the sensitivity of the issue. "It's not our intention to encourage a policy of flooding the labor market," he said.

growth rate "and chose instead to present demand with one particular proxy"—degree production.

Fechter questions the assumption that "if an imbalance occurs between supply and demand, nothing will occur to correct it." Previous studies have shown that project imbalances "are always overstatements of what actually will be experienced."

For example, the PRA model fails to factor in immigrant engineers and personnel from other disciplines who can be tapped for engineering work. Both groups affect the size of the available engineering pool in the United States.

One reason engineers get so upset when agencies make forecasts is that the government sometimes uses them as a basis for formulating policy—regarding, for example, whether to allow immigrant engineers into the country or how much support to give engineering universities.

Engineers have long argued that an overcrowded pool of engineers keeps salaries down, benefiting industry and hurting EEs. In the latest *EE Times Salary & Opinion Survey* (see Oct. 15, page S1), almost 78 percent of the engineers responding said no engineering shortage exists.

PRA analyst Boylan said that looking "five, 10, 15 years down the road, we see a tightening of the labor market. It does not look good at all."

But Rivers, an engineer who tracks engineering manpower trends in a newsletter, said a tighter labor market may not be such a bad thing for engineers. He asserted there is no such thing as a "shortage of engineers." Instead, there are "high demand periods" for engineers, in which salaries climb above the Consumer Price Index. Such a demand occurred in 1966, he said. During such periods, employers "have to pay the price" to get engineers.

But that attitude disturbs some human resource managers. At a meeting of HR professionals last year, one personnel manager for a government contractor said, "Don't you think engineers are being self-serving here? They want higher pay."

Indeed, at IEEE discussions, engineers have asked why they cannot control how many people come into the profession, much like the American Medical Association controls the number of doctors by limiting certification at medical schools.

At the same time, EEs have noted that it serves industry to have a constant flow of new engineering graduates coming into the market, attracted by claims of a shortage of engineering professionals. Employers are thus able to replace \$60,000 veterans with \$32,000 recruits, critics assert.

A conference has been organized to address the shortage issue. Sponsored by the Engineering Manpower Commission of the American Association of Engineering Societies, "Engineers in America's Future: Supply and Demand" will draw statisticians, politicians, engineers and employers to Loews L'Enfant Plaza Hotel, in Washington, Nov. 28-29. For information, call (800) 658-8897.

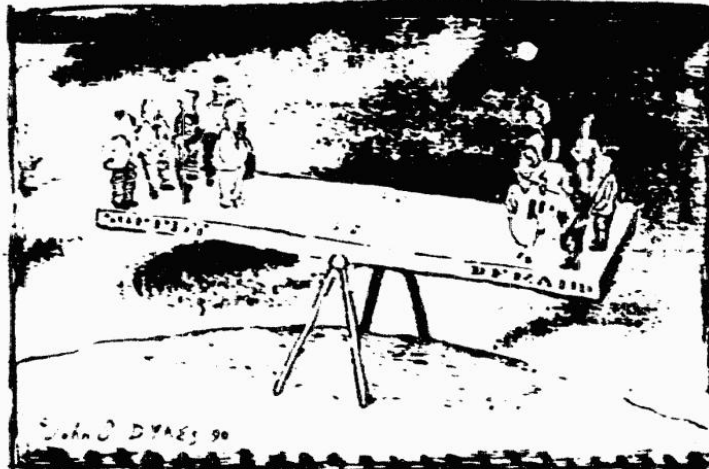


Illustration: Alan S. Davis

- The rate of growth in the nation's GNP. Boylan foresees a recession "for the next one to three years."

- The attractiveness of U.S. exports. Boylan noted that if U.S. salaries go too high, work will move offshore and exports will become too expensive to compete. The balance among the supply of people, salaries and demand is a delicate one. The NSF predictions are simply attempting "to stimulate discussion" about what this nation must do to compete, said Boylan.

### A matter of definition

The PRA model, according to Fechter, defines "shortfall" as the amount by which annual engineering degree production falls below the average experienced in 1984-86, cumulated over the years 1988-2011. "But those years saw historic highs for engineering degrees; they were peak—not average—years. Thus, the flipping of fewer degrees than in 1984-86 does not necessarily translate into a 'shortage' of new graduates."

PRA analyst Boylan more or less agrees. "In the last four years, the number of

In his article, Fechter criticizes the NSF's "failure to acknowledge uncertainty" in its estimates.

PRA's House disputes that. "We stated clearly that this was an 'if-then' analysis," House wrote. "The analyses should be interpreted as conditional."

But Rivers said that not all NSF reports have offered sufficient warnings about the shakiness of extrapolating too far.

Fechter also chastises the NSF/PRA for considering "only degree production, excluding other sources of supply from its analysis." It doesn't consider mobility from "closely related fields," Fechter wrote.

Counters PRA director House: "We should not be criticized for not acknowledging sources of supply other than new bachelor's degree earners, since we did not undertake to analyze the 'supply' of NS&E personnel."

Fechter further states in his article that the PRA's reliance on average degree production implies there is some growth rate in the work force with engineering skills. But the PRA model failed to address that

5/89 to 5/90 1 YEAR

(PACE NEWS—Continued)

**THE AX IS FALLING**

by M. Alterman

For the past year this section has been collecting data on job losses in technology companies—companies that employ engineers, programmers and/or scientists. Thank you to everyone who sent in contributions to this database. Listed below is the result of our efforts—75 instances of a company or government agency cutting employment with a loss of approximately 200,000 jobs. These cuts have happened or are scheduled to happen over the next several months. This list should not be considered complete.

DATE	COMPANY	LAYOFF #	COMMENTS
	Chrysler	4000	
	Cipher Data	525	
	Drexel	300	
	H-P Apollo Div	330	
5/17/89	Hartman Systems	115	Closed
5/22/89	Control Data Eta Sys	1500	Closed
6/5/89	Conner Peripherals	200	
6/5/89	Hughes Aircraft	6000	
6/5/89	Prime Computer	240	NH Close
6/5/89	UTC Norden Div	400	
6/14/89	Sikorsky Aircraft	1300	
6/16/89	Grumman Sys Div	90	
7/3/89	BBN Comm AS (DEN)	200	Closed
7/3/89	Honeywell	300	
7/3/89	H-P Apollo	100	
7/3/89	Wang	1700	
7/31/89	Honeywell	4000	
7/31/89	Lockheed Electronics	300	
8/4/89	Olin Hunt chemical	120	Closing
8/8/89	Brooks Bros clothes	290	NJ Closing
8/21/89	Ashton-Tate	350	
8/22/89	PAR Pharmaceutical	150	
8/24/89	Campbell Soup	2800	
8/24/89	Kodak	4500	
8/28/89	Tachonics (Grumman)	47	Closed
9/11/89	Comport Corp		Chap 11
9/11/89	Sprague Technologies	10%	
9/18/89	PRIAM	230	
10/16/89	Data General	2200	
10/23/89	Motorola/Codex	3000	
10/23/89	UNISYS	8000	
10/24/89	Prime Computer	2500	
10/30/89	AT&T	34000	Early Ret
10/30/89	CODEX		Attrition
10/30/89	CODEX	300	7/89
10/30/89	Von Neumann Computer		No Fed \$
11/8/89	Shearson Lehman	800	
11/13/89	Cray Research	400	
11/13/89	Data I/O	50	
11/13/89	DAZIX	170	
11/13/89	IBM	1000	
11/13/89	Wang Labs	2500	
11/20/89	Evans & Sutherland		Closed
11/20/89	Sci Comp Sys		Closed
11/27/89	AMDAHL	400	
12/1/89	Lockheed Electronics	1160	Closing
12/11/89	IBM	10000	Attrition
1/14/90	US DOD	30000	Civilian
1/14/90	US DOD	20000	Military
1/16/90	Auto Companies		Large #
1/16/90	Merrill Lynch	3000	
2/1/90	Fairchild Weston		
2/1/90	Grumman	2000	
2/1/90	Gull Aviation		
2/5/90	ATT Microelectronics	1000	
2/5/90	GE Aerospace	5600	By 91
2/5/90	H-P	1000	Early Ret

2/8/90	ITT Avionics	300	Since 87 +
2/15/90	Drexel	7000	Chap 11
2/22/90	Apple Computer	400	
2/26/90	DEC	260	10/89
2/26/90	DEC		Severance
2/26/90	Tektronix	1400	
2/28/90	Shearson	2000	
3/15/90	Harris, Intersil Fab	350	Close
3/25/90	ITT Federal Electric		NJ Close
4/2/90	Multiflow Computer		Closed
4/2/90	Supertek Computers		Cray purch
4/8/90	Von Neumann Comp Ctr		Closing
4/15/90	ATOCEM		NJ Close
4/22/90	F L Smidth		NJ Close
4/28/90	General Electric	4200	next 2 years
4/28/90	Lockheed	2750	
4/28/90	McDonnell Douglas	3000	
5/1/90	ATT Network Svc Div	6000	
5/6/90	Slater Electric		NJ Close

**ENGINEERING LAYOFFS**

Please make copies of all articles on engineering layoffs and send to: Mike Alterman, 509 Green Pond Road, Rockaway, NJ 07866.

**PACE Committee Meets Monthly**

The PACE Committee meets on the second Thursday of every month at the ITT Auditorium, 500 Washington Avenue, Nutley, N.J. (near the the ITT Tower) at 7:30 PM. Our Section Executive Committee meets there on the first Wednesday of every month (except in December) at 7:00 PM. Any questions or comments will be well received. Contact Richard Tax at (201) 664-0803 (after 7:00 PM) or write to R. Tax, 630 Montview Place, River Vale, N.J. 07675.



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October 1, 1990 *Electronic Engineering Times*

## THE PROFESSION

AD HOC PANEL LOOKS AT REFERENCE TO SHORTAGES

# IEEE booklet halted

By ROBERT BELLINGER

A three-man ad hoc committee has been formed to review an IEEE pamphlet that set off a storm of protest over a section that refers to an impending shortage of engineers and scientists.

Named to the panel by Michael Whitelaw, IEEE vice president of professional activities, were: Robert Rivers, one of the protestors objecting to the pamphlet; Jack Doyle, chairman of the U.S. Competitive-ness Committee; and Gerald Gordon, chairman of the Member Activities Council.

Whitelaw has ordered a temporary halt to the distribution of the pamphlet, "A Passport to Opportunity: Strategies for Improving Precollege Education," until the United States Activities Board reviews the ad hoc committee's recommendations.

Whitelaw said he has asked Doyle to submit a report to him before the Nov. 14 USAB meeting.

The passage that has stirred so much controversy reads as follows: "Based on recent declines in engineering college enrollments, the Task Force on Women, Minorities and the Handicapped in Science and Technology, established by the U.S. Congress, predicts that by the year 2010, the United States could experience a shortage of as many as half a million engineers and scientists."

At this month's Professional Activities Council for Engineers meeting, in Phoenix, Ariz., IEEE members Rivers and

Richard Tax, North Jersey Section PACE chairman, were among several attendees who raised repeated objections to the shortage reference.

The three men serving on the panel represent a cross section of views. Rivers is a vocal critic of the pamphlet. Gordon defended it at the PACE meeting, and maintained that the controversial paragraph was being taken out of context. Doyle, according to Whitelaw, "has had a lot of experience in manpower issues."

The shortage issue is a volatile one. In the upcoming "1990 *EE Times* Salary & Opinion Survey," to be published Oct. 15,

**T**he controversial passage: "The United States could experience a shortage of as many as half a million engineers and scientists."

FROM IEEE'S  
PRECOLLEGE  
EDUCATION  
COMMITTEE  
CHAIRMAN  
LAWRENCE P. GRAYSON  
US DEPT OF  
EDUCATION.

78 percent of the respondents said there is no shortage of engineers. Engineers have protested that, for years, forecasts have served the interests of academia and industry—engineering schools benefit from attracting more students, and industry can hire more "freshouts" instead of using experienced EEs.

L. P. GRAYSON

The Engineering Manpower Commission of the American Association of Engineering Societies is holding a conference Nov. 28 and 29 in Washington, which will be devoted solely to the supply-and-demand question. Titled "Engineers in America's Future: Supply and Demand—New Problems and New Opportunities," the conference will attract those who believe the U.S. won't have enough technical people and those who dispute such forecasts.

Editorial ✓

# Burying the EE shortage myth

**I**T'S THE PREDICTION that will not die. Like Dracula and "Rocky" movie sequels, the National Science Foundation prediction that we're heading for a massive shortage of engineers and scientists keeps coming back.

Only the numbers and the people being quoted change.

A Maryland newspaper: "The United States could experience a shortage of 750,000 scientists and engineers by the year 2000."

A General Motors vice president: "The National Science Foundation predicts a shortfall of 450,000 engineers and scientists by 2010."

An IEEE pamphlet: "By the year 2010, the United States could experience a shortage of as many as a half-million engineers and scientists."

It's bad enough that they're all harping on the engineering shortage myth. But what is this: fill in the blanks? ~~They can't~~



~~the National Science Foundation's~~

The NSF whines that its work has been misinterpreted. First of all, the number covers both engineering and science—an extremely broad category, to be sure. Second, the projection is based on natural-science and engineering (NS&E) degrees, which is *not* the same as scientists and engineers.

~~our projection of a declining number of NS&E B.S. degrees into a job market shortage, which we never intended . . . We did not undertake to analyze the supply of NS&E personnel."~~

Third, the NSF maintains that it warned everyone that its analysis "should be interpreted as conditional." Break out the violins and hankies. We don't have much sympathy for the National Science Foundation, now that its analysis is under sharp attack.

2

The National Academy of Engineering, a cross-town sometime-rival of the NSF, published an article recently that thoroughly debunked the NSF's methodology of shortage predictions. The American Association of Engineering Societies has just come out with a bulletin that says engineering manpower shortages are "exaggerated." And the IEEE, to its credit, last month yanked its "Passport to Opportunity" pamphlet that referred to shortages, and it promises to rewrite the offending paragraph. It did that, however, only after IEEE members raised a holy stink about it.

In this time of layoffs, underutilization and wide-open immigration policies, it seems patently ridiculous to perpetuate this myth. Let's drive a silver stake into its heart.

*Robert Beeing*

28 December 3, 1990 *Electronic Engineering Times*

## On IEEE and shortages ✓

Thank you for printing the article "IEEE booklet halted" (see Oct. 1, page 95). Your article serves the members of the IEEE by bringing to their attention a continuing problem of the insensitivity of the organization to individual member needs.

For the three decades of my IEEE membership, I have continued to see the IEEE initiate and parrot forecasts of impending engineering shortages—none of which have ever materialized. All of them ensured a continuing supply of technical personnel that could be used at less-than-optimum productivity.

The members of the IEEE panel should meet with a cross section of the many thousands of currently unemployed engineers.

Your reporting in the Profession section has been excellent. Thank you.

Donald J. Heller  
Stow, Mass.

*Editor's Note: The IEEE-USA board has just voted to pull the pamphlet from distribution and revise the offending passage on shortages (see accompanying editorial).*

# PACE NEWS

By R. Tax

*One student  
outcry!!*

This month I am dedicating our column to our engineers. In celebration of National Engineers Week (NEW) and our steady fight against "Engineer Shortage" Propaganda (ESP), we have printed a letter from a young engineer from North Jersey and NJIT, Class of '88, dated September 13, 1989. Please note that the letter was written more than a year after graduation.

We have also included two responses, from members of the Long Island Section, to a question from the Region 1 PACE Coordinator, Bill Wilks.

First, I would like to invite you to attend two PACE meetings this month. The first on February 8th will give you the opportunity to suggest and select subjects and meetings of interest for 1990. The second is a joint PACE/Engineering Management Society meeting about "How To Reduce Your Taxes." See Newsletter for further information. If you can, please post our Calendar.

Dear Mr. Tax:

I recently had the opportunity to read your articles in the IEEE Newsletter regarding unemployment among engineers in the local area, particularly unemployment among recent graduates. I also find myself in that situation, as I graduated in May of 1988 from NJIT with a 3.15 GPA and I am currently working as a book-keeper, a job which is totally unrelated to engineering. In fact, as if to add insult to injury, I was rejected for an electrical engineering officer position in the U.S. Air Force, as the military is apparently cutting back on its manpower.

One of the problems I have encountered in my job search is that many prospective employers scorn applicants who have been unemployed for long periods of time, and the longer one is out of work, the worse the situation gets. There is still a belief among the general public that an EE degree is a guaranteed ticket to a good job.

Also, there is a tendency for employers to categorize engineers according to specialty, even at the entry level. For instance, my senior year at NJIT I had to choose a two-semester "systems" sequence; I chose communications systems (which I now regret, as this field seems to be very dependent on defense spending). During my job search I found that some employers classified me as a communications engineer and would not consider me for positions in other areas. I personally don't think it is fair to classify an individual into a particular specialty at that point in his or her career.

However, I would like to thank you for your articles, as I have gained a degree of moral strength in knowing that I am not alone in my predicament. I would also certainly welcome any useful information or advice that you may offer me. In closing I would like to say that we engineers in the North Jersey area are very fortunate to have a PACE committee chairman who is taking such a personal interest in the employment situation.  
*Name withheld by request*

*Editor's Note: The word "employers" is often misused and in some cases it represents other employees involved in the hiring practice. Most of these people are from the personnel departments and they do not have an engineering education or background. They do not understand that a 3 or 6 credit specialty is a very small part of an engineering education and that good engineers are flexible. They also play it safe and disqualify candidates wherever they can. When they can't find their 5 pound butterfly they claim there's a shortage of butterflies.*

*Let's face it; when competition is as tough as it is today, people just don't want another itch to scratch.*

Page 7 - February, 1990 - North Jersey Section "IEEE NEWSLETTER"

The following are reprinted from the Long Island Section's newsletter called "The Pulse."

## READERS RESPOND

(In the November issue, we posed two questions from the PACE Coordinator. Here is one of the responses.)

Would you encourage your child to pursue a career in engineering? Why?

Engineering; No, No, No

No profession, no trade, no career

No patent rights, no design rights, no copyrights

No honors, no prizes, no recognition

No big paychecks, no bonuses, no overtime pay

No equity, no security, no future

No office, no laboratory, no library

No authority, no lack of responsibility, no end of educating others

No leisure, no end of learning, no end of books and journals

No community ties, no company ties, no work ties

No skill portability, no pension portability, no career continuity

No organization, no political representation, no public adulation.

NO! NO! NO!

## A SECOND RESPONSE

I'm writing in response to the inquiry of the PACE Coordinator in the November 1989 issue of *Pulse*. He poses the question, "Would you encourage your child to pursue a career in engineering? Why?"

I have two daughters, now college graduates, who showed talent in math and science when they were in high school. I told them I'd pay for their college educations, except if they studied engineering. If they'd been particularly keen on becoming engineers, they might have argued with my decision. However they only had to consider what they'd learned of my career, from my dinner-table conversations.

They observed how I'd been laid off several times during project cancellations and federal budget cuts. They saw how I sometimes came home from work too angry to talk to them. They heard how some boss demanded that I meet preposterous deadlines, even though the parts of the project that preceded my part had slipped schedule. If I objected to the schedule compression, the boss would ask if I was a competent engineer. How come I couldn't accomplish such an easy task in a short time?

They heard me tell how I tried to make my designs meet the specification and was questioned in light of budget and schedule constraints. They heard how some of my employers made managerial decisions that overruled engineering decisions. They heard me tell how certain "accidents" resulted from overruling engineering decisions, like the collapse of the sky walk in a Denver hotel or the BART train overrunning the station.

In the face of my experience, which I sometimes brought home from the office, my daughters decided to pursue careers other than engineering. They're happy and fulfilled professionally.

*Name withheld by request*

## ENGINEERING LAYOFFS

Please make copies of all articles on engineering layoffs and send to: Mike Alterman, 509 Green Pond Road, Rockaway, NJ 07866.

## PACE Committee Meets Monthly

The PACE Committee meets on the second Thursday of every month at the ITT Auditorium, 500 Washington Avenue, Nutley, N.J. (near the ITT Tower) at 7:30 PM. Our Section Executive Committee meets there on the first Wednesday of every month (except in December) at 7:00 PM. Any questions or comments will be well received. Contact Richard Tax at (201) 664-0803 (after 7:00 PM) or write to R. Tax, 630 Montview Place, River Vale, N.J. 07675.

# PACE NEWS

By Richard F. Tax

## PRECOLLEGE EDUCATION: Scheme or Scam? ✓

The latest headline in *Electronic Engineering Times* addresses the efforts of the American Association of Engineering Societies (AAES), led by its chairman Lawrence P. Grayson, to improve the quality of precollege mathematics and science education in the U.S. The AAES wants to enlist 100,000 members to work with the secondary and elementary schools in this endeavor.

The *E.E. Times* article indicates that some IEEE members feel that the program is a smokescreen to recruit more students to the engineering colleges. In the article Grayson denied the allegation that the objective was to increase the number of engineers. *E.E. Times* quoted an AAES press release that said: "In accepting the challenge to enlist an engineer to work as a volunteer in each school in the nation for the improvement of math and science education the Task Force began a major program to insure the future supply of engineers and scientists." The article also quoted Grayson as saying "That was a poor release. That went out before I had a chance to see it." He promised that this would not happen again.

In July 1990 I had the opportunity to serve on an Ad Hoc committee to review the activities of the IEEE, USAB, Precollege Education Committee (PEC). My observations relating to the Precollege Education Committee's activities were so strong I wrote a minority viewpoint and sent it to other officials of IEEE. The following were some of my observations.

"The PEC published a pamphlet entitled "A Passport to Opportunity - Strategies for Improving Precollege Education." This paper does not mention even one way to improve precollege (K-12) math and science education. The primary thrust is to recruit the very young to the engineering colleges. It promises increased engineering jobs and a concern to yield a large group of scientists and engineers to keep the "Pipeline" full. This is nothing more than another form of college recruiting directed at the very young. College recruiting is not a USAB function and our members funds should not be spent on this effort.

The "Discover 'E'" (E is for Engineering not Education) is a nationwide recruiting program directed at all precollege students and is supported by the PEC. The program is intended to introduce students to the field of engineering and guide them towards the engineering colleges. This program also satisfies the recruiting needs of our colleges and not our membership's need. They promise the children careers in engineering that they cannot guarantee. I don't believe this activity improves precollege education.

The committee's original and continuously stressed goal is to "effect improvements in the quality of precollege education in the United States." With every following objective, word and deed this committee deviates from their original goal. Their main activities appear to concentrate on efforts to utilize the membership's funds to attract a steady supply of future students into the engineering college pipeline.

In reviewing the PEC data package I found little evidence to indicate a sincere effort to directly evaluate and improve precollege math and science education. We should note that the membership of the Precollege Education Committee is not a homogeneous representation of IEEE's membership. The committee suffers from a preponderance of academics, 50%, while academics consists of less than 5% of IEEE's general membership.

Members of the Precollege Education Committee constitute a large percentage of members that earn their income from the field of college engineering and science education." These were just some of my most obvious comments about the committee's activities. Upon receiving my critique, Michael Whitelaw, VP of

Professional Activities, responded in a letter that stated my "...minority positions are so accurately stated in the Committee's report."

What does the Precollege Education Committee have to do with this latest AAES issue? The same Dr. Lawrence P. Grayson, of the AAES, was the past chairman of IEEE's PEC and is also responsible for the "engineer shortage shouting" pamphlet being distributed to our young elementary and high school students. He also happens to be employed by the U.S. Department of Education. He also earns his income from promoting education and not from engineering.

Why is Grayson chairman of AAES, an engineering society? Why was Grayson chairman of IEEE's, Precollege Education Committee? I cannot see his relationship to any engineering function. We also support AAES and his activities with our USAB assessment. I believe we should improve education on all levels. I don't believe Grayson and AAES are doing this.

The latest USAB news is that Michael Whitelaw, USAB VP has put a stop order on the distribution of the IEEE pamphlet "A Passport to Opportunity" and appointed a committee to review the material.

## Upgrade—Don't Procrastinate

Advance to the highest grade that matches your qualifications. Dues are the same for all three membership grades.

As an Associate Member, you may be able to advance to Member or Senior Member grade. Members may be qualified for Senior Member grade.

For information and an application, contact Don Weinstein, Kulite Semiconductor, One Willow Tree Road, Leonia, NJ 07605 (201) 461-0900.

## NY Section-COMSOC:

### 80th Semiannual Seminar

On November 15, 1990, the New York Chapter IEEE Communications Society will hold their 80th Semiannual Seminar. The seminar on "Emerging Technologies for High Speed Digital Communications, New Architectures & Applications" will take place from 8:30 AM to 5:00 PM at the United Engineering Center 345 E. 47th St., NYC. in New York City.

Topics to be covered are as follows:  
Switched Multi-Megabit Data Services (SMDS); SMDS Trials; SMDS Applications; Metrocore-140HB; Fast Packet Switching; Multimedia Workstation; ACCUNET Switched 384; Standards Update.

The seminar will end with a panel discussion.  
Fee: \$140 for non-Members; \$110 for Members (includes lunch, and coffee breaks. Special student and group fees available.

---

#### Registration for "Emerging Technologies For High Speed Digital Communications, New Architectures & Applications"

To: Robert Puttre, 500 Westchester Ave., White Plains, NY 10604. Make checks payable to "NY IEEE COMSOC"

Name \_\_\_\_\_ IEEE # \_\_\_\_\_

Company \_\_\_\_\_ Phone# \_\_\_\_\_

Address \_\_\_\_\_

### **IEEE-USA Publishes New Employment Guidelines**

IEEE-USA's new printing of *Guidelines to Professional Employment for Engineers and Scientists* is now available. The third edition has been updated and approved by 33 engineering and scientific societies, including the Institute.

The guidelines were developed for use by employers in evaluating their own responsibilities and those of their employers, and by new graduates and other employment seekers in evaluating their potential new employers.

A sample copy of the document and information about receiving bulk copies for distribution are available from the IEEE-USA Office in Washington, D.C.

#### **If You Become Unemployed...**

IEEE-USA makes several forms of employment assistance available to help you in finding a job.

#### **Free Employment Guide Includes Directory of Employers**

A free copy of the book, *Employment Guide for Engineers and Scientists*, published by IEEE-USA, is available to unemployed members simply by writing to IEEE-USA Office in Washington, D.C. The 236-page revised, expanded second edition of this popular guide contains chapters on employment agencies, resume preparation, employment contracts, and interviewing. The guide includes a recently updated directory listing employers of IEEE members by state with addresses and contact names. When requesting the book, please mention that you are currently unemployed and include your IEEE membership number. You can also purchase the book through the IEEE Service Center by calling (800) 678-IEEE.

#### **Computerized Employment Registries Are A Member Benefit**

IEEE-USA also maintains a computerized resume database called PEER, the Professional Engineering Employment Registry, which is free for members. A segment of the registry is the Nonemployed Engineers

Employment Registry, or NEER. The difference between the two registries is that PEER is confidential (members' names and current employers are shielded), while NEER is nonconfidential and free of charge for employers. Two other employment registries are also available: SEER, the Self-Employed Engineers Registry for consultants, contractors, and subcontractors; and GEER, the Graduating Engineers Employment Registry for graduating students members.

The PEER registries include an on-line job posting system accessible to members with a personal computer (or terminal) and a modem. You can call the on-line Career Network at (508) 263-3857. Simply press your RETURN key twice and enter the password "PEER" to log on. Additional information about the PEER services is available by talking computer. Call, using a touch tone phone only, (508) 263-6823. When requested, slowly enter User ID 200# 225# and the Password PEER#. For more information about the PEER services, call or write PEER Service Center, CTC, 6 Londonberry Commons, 44 Nashua Road, Londonberry, NH 03053; (603) 437-PEER.

#### **Employment Assistance Seminar Is Available to Your Section**

If your employer has initiated a large layoff, you might want to contact your IEEE Section Chairman or PACE Chairman. IEEE-USA presents a one-day seminar entitled *Career Planning & Employment Assistance*, which Sections can sponsor. IEEE-USA will provide planning materials and handouts and even partially subsidize a speaker for the seminar from its Employment Assistance Committee. For more information about this service, contact IEEE-USA Employment Assistance Committee Chairman John Miller at (703) 475-3420.

#### **Get In Touch With other IEEE Members**

Remember that local IEEE meetings are a great place for networking. You can find more jobs through per-

sonal contacts than by answering advertisements. Simply introduce yourself, and don't be embarrassed about being unemployed. It happens to most people at least once in their careers. If you are still unemployed at IEEE dues renewal time, there is a dues reduction available.

Good luck on your job search! For more information about any of these services, contact IEEE-USA, 1828 L Street, N.W., Suite 1202, Washington, DC 20036; (202) 785-0017.

#### **IEEE-USA Selects WISE Interns**

IEEE-USA selected two college seniors to participate in the Washington Internships for Students of Engineering (WISE) program at a recent WISE Board meeting. Brian J. Congelco is an electrical engineering major at the United States Military Academy in West Point, New York. Bruce Maxwell is a political science major at Swarthmore College in Swarthmore, Pennsylvania.

The WISE program's concept is to bring engineering students to Washington to learn about the relationship between engineering and public policy. Its long-term goal is to enhance the engineering profession's ability to contribute to public policy decision-making on technology issues.

According to his application, Bruce Maxwell is particularly interested in information management and storage--specifically in data from satellites that NASA currently stores. Brian Congelco's interest lies in electronic communications. He would like to research government policy in satellite communications regulations.

<b>Editor, Region:</b>	<b>John Kozarowski</b>
<b>Site Chairman:</b>	<b>Harold Samowitz</b>
<b>Secretary/Treasurer:</b>	<b>Michael S. Chester</b>
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<b>Copy Editor:</b>	<b>Uinda DeGrosario</b>
<b>Graphic Designer:</b>	<b>Richard P. Wilson</b>

**NEWSLETTER** was prepared by the Regional Publications Committee.

Any news items, comments, suggestions or criticisms should be welcome. Just write to the Editor: Edward S. Ferkas, Post Authority of NY & NJ, Aviation Department, La Guardia Airport (LGA), Flushing, NY 11371

**Report from the Region's  
Federal Government  
Activities Committee:  
Professionals and  
Skilled Workers  
Encouraged to  
Immigrate by  
New Law**

After arguments, delays, policy disagreements, consultations, delays, compromises, delays and other digressions, Congress has enacted a major reform of immigration law. Agreement came at the end of the 101st Congress (Oct. 26-27) when Senate and House approved a compromise measure. Although both houses adopted the conference report by large majorities, they agree that the measure is far from perfect. Sen. Alan Simpson (R., Wyo.), a "grandfather" of legislation in this field, characterized immigration as "the greatest political no-win turkey" he has ever encountered. It has "no good results except the national interest." One fact of political life is that he can be effective in changing immigration policy because he represents a small state and is able to steer the law back into "the classic immigrant stream, which is more special skills, special abilities, employer-based immigration." Simpson said that during debate.

Congress last addressed immigration in 1986 when it enacted a law that granted amnesty to about 1.7 million illegal immigrants. The new bill represents the first major expansion of our immigration system in a quarter century (since 1965). Under its terms, legal immigration will increase from current levels of about 490,000 to 700,000 in the first three years. Beginning in 1995, a permanent level of 675,000 will be set, a 38% increase in legal immigration. Of the total, 520,000 visas will be reserved in the first three years for people with relatives in the U.S.

In 1995 that total will be scaled back to a permanent 480,000. All immediate relatives of U.S. citizens



will be admitted without regard to visa-allocation limits.

The new law also increases the number of permanent admissions will include: (1) 40,000 priority workers (aliens with extraordinary abilities in the sciences, arts, education, business, and athletics; outstanding professors and researchers; and multinational executives), (2) 40,000 professionals with advanced degrees or exceptional abilities, (3) 40,000 professionals with baccalaureate degrees, skilled and unskilled workers, (4) 10,000 special immigrants such as religious workers and government employees, and (5) 10,000 employment creating investors. The latter category is for persons willing to invest \$1 million in new businesses, preferably in depressed areas, that will create at least ten new jobs.

Categories 2 and 3 will be subject to foreign labor certification procedures to ensure that the admis-

sion of foreign workers will not adversely affect employment opportunities, wages or working conditions for U.S. citizens.

In addition, the new law creates a new category of H-1 (b) temporary visas for specialty occupations that require highly specialized knowledge and the attainment of a bachelor's or higher degree. Admissions under this visa category will also be subject to labor certification requirements.

A new independent commission is established that requires Congress to review immigration law and policy every three years. Thus, no number, no level, and no category of immigration will become frozen into law.

Some provisions will serve to discourage indiscriminate "importation" of foreign workers. Employers who wish to bring in foreign workers will be taxed for each one hired and the funds thus generated will be used for educating and training U.S. workers. Before bringing in a worker(s), each employer must attest to the Labor Department that it is unable to hire U.S. workers. In the ensuing 30-day period, unions and/or individuals may challenge the application.

**Federal Government  
Activities IEEE Committee  
Meets With Local Officials  
to Expedite Labor  
Certification Process**

Members of IEEE Committee are meeting with Labor Department Regional Alien Certification Officers, as well as with the certification officers at the state level, to ensure that employment opportunities for United States citizens are not adversely affected by the admission of foreign workers. According to Edward B. Farkas, who heads the organization's committee, IEEE volunteers have recently visited Labor Department Regional Offices in New York, IEEE-USA has also met in Chicago, Dallas, Seattle, San Francisco, New York, and Boston; as well as state offices in Washington, California, Michigan, and Illinois.

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## Manpower Fluctuations Give Engineers Grief

by Richard F. Tax

The instability of the engineering profession is graphically represented in the Deutsch, Shea and Evans, (D,S&E) High Technology Recruitment Index (HTRI) shown. Every engineer or person considering engineering as a career should be familiar with this index and the dramatic fluctuations in the demand for engineers.

The HTRI is a national indicator of technical manpower demand and based on a monthly count of recruitment ads directed to four year or more degreed engineers and scientists. D,S&E is a national recruitment advertising agency that has been conducting research on employment, recruiting and other aspects of human resources since 1950. They have maintained the Index for 30 years.

We modified the Index to include the two additional reference lines at the 90 and 130 levels and the associated observations from studies by Robert Rivers. Rivers is a Fellow of the IEEE, a past member of IEEE's Manpower committee.

The comments by Robert Rivers highlight the periods of economic insecurity (unemployment) whenever the Index is below the 130 reference line. The curve also shows periods where our young engineering graduates are unable to find engineering employment because the demand is depressed. They may never be able to enter the profession for which they studied so hard.

However, since more engineering graduates are not getting engineering jobs and more engineers are being underutilized the original lines projected by Rivers may now be shifted by the influence of a greater supply of engineers. Rivers said, "The current recession may be worse than the recession from 1969 to 1973". See curve. The increased supply is derived from the recruitment of foreign students by the U.S. engineering schools and the importation of foreign engineers. Both sources have been promoted by Engineer Shortage Propaganda (ESP) and erroneous mathematical models that only predict engineering manpower shortages. Drastic cutbacks in defense spending and the completion of engineering intensive programs such as the Space Telescope further

inflates the surplus.

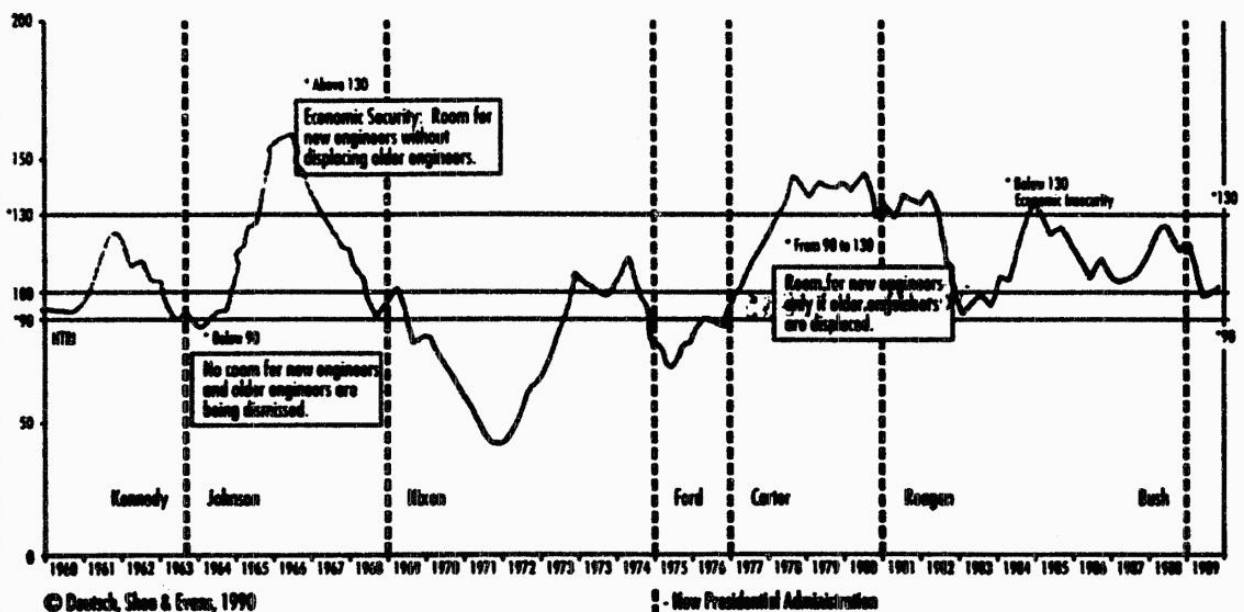
There are very good reasons for addressing the issue of fluctuating engineering manpower demand. First, this effects the lives and careers of all engineers, recent graduates and students who may choose engineering as their field of study. Second, this indicates that the engineer shortage reports were false and the shortage shouters were wrong. Third, this indicates priorities and budgets can be shifted from producing a surplus of engineers to investing in research and development to maintain a fully utilized engineering community. Indeed, government R&D might be increased if it were known how many engineers are available.

The D,S&E High Technology Recruitment Index sheds light on the employment situation. Unemployed engineers and engineering graduates who cannot find engineering jobs may find some comfort in the assurance that they are unemployed for reasons beyond their control. They are facing these difficulties, not because they are poor engineers or students, but because there is a drastic manpower unbalance between the supply and demand of engineers.

### Deutsch, Shea & Evans High Technology Recruitment Index

(Seasonally Adjusted; Base: 1961 = 100)

\* Notes from analysis by Robert Rivers, 1975.



### Engineering Unemployment Increasing

Engineering unemployment including Electrical engineering unemployment is increasing and is forecast to increase at least until the first quarter of 1991. Engineering unemployment that averaged 26,000 during 1989 has grown to 37,000 in the first quarter of 1990 and to 39,000 during the second quarter just completed. It is forecast to 42,000 in the first quarter of 1991 and then to decline. The forecast is based solely on slowdown in the general economy and does not include the effects of additional cuts in Defense spending.

The forecast of engineering unemployment is based upon a regression of the Bureau of Labor Statistics Current Population Survey Quarterly Data with the Federal Reserve Board controlled Quarterly average of the Federal Funds Interest Rate. The correlation has been found to be 0.719 during the 1980's on a simple linear regression basis. Actual forecasts are made using a regression techniques covering a period of almost 20 years. The forecasting technique was found to be reliable by the prior year limit tests.

Figure 1 shows engineering unemployment and forecast engineering unemployment percentages from 1970 to 1992. The solid line is the real data curve and dashed line is the forecast equation plotted with the real data for comparison and plotted by itself for the period from 1990 second quarter to 1992 first quarter. Noting the unemployment curve, it is obvious that the data is rather noisy. It has a standard deviation of 0.6 to 0.7% and is due to the fact that the number of engineers in the BLS CPS is small in the range of 1.5% of the approximately 55,000 sample size.

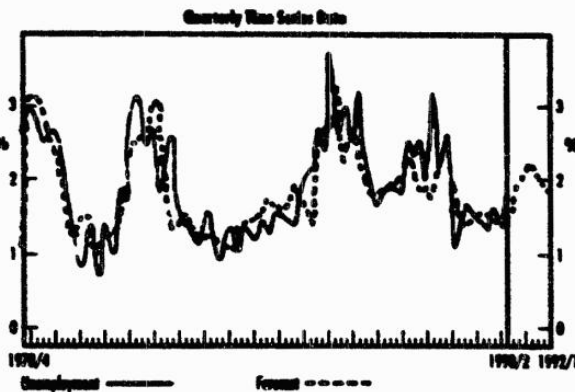


Figure 1. Percentage Engineering Unemployment & Forecast

Engineers have experienced unemployment ranges from 0.3% to 3.8%. The 0.3% level occurred in 1966 due to the space program and the Viet Nam buildup and can be considered the full employment level compared to the average national full employment level in the 3% range. Engineers like to work. The 1971 level of 3.2% was a major crisis for engineers while it takes double digit unemployment levels in the general population to create a crisis atmosphere.

Figure 2 shows engineering employment from 1973 to the present second quarter of 1990. In addition a linear least squares approximation of the trend is shown as the dashed line and extended to 1993. The trend line tends to accent the periods when growth is above and below the trend. While growth was significantly above the trend line during the early eighties, from 1987 on, there is evidence of a flattening of the demand growth. On a yearly average basis, growth in employment from 1968 to 1989 was only 16,000 contrasted with an average for the decade of 46,000 per year.

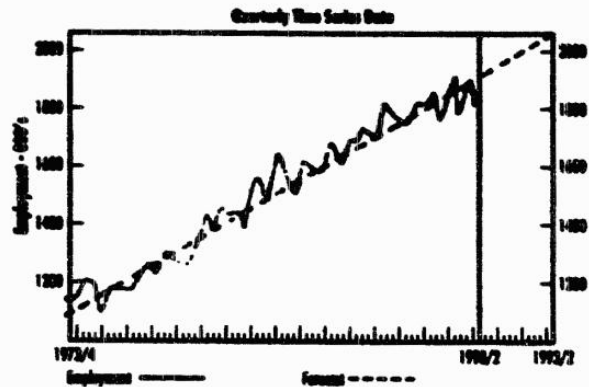


Figure 2. Engineering Employment & Trend

Electrical engineering employment from 1972 to the present is shown in Figure 3 along with a least squares fitted quadratic curve and projection. Again it shows that there are periods of above average growth and periods below average. The period from 1983 to 1986 showed above average growth due to heavy growth of Defense expenditures. A leveling off has occurred since 1987 corresponding to the topping out and real decline of Defense expenditures. Defense has more impact on Electrical and Electronics engineers because a higher percentage are engaged in Defense related activities than engineers in general.

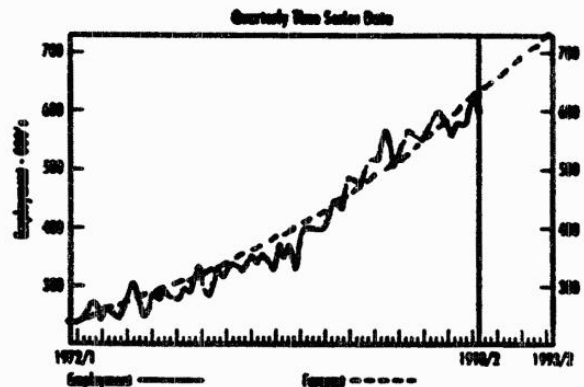


Figure 3. Electrical Engineering Employment & Trend  
by Robert A. Rivers For IEEE-USA 7/12/90



APR 07 1992



**Department for Professional Employees, AFL-CIO**

815 16th Street, N.W., Washington, D.C. 20006 Phone 202/638-0320

April 7, 1992

The Honorable Howard Wolpe  
Chairman  
Investigations and Oversight Subcommittee  
House Committee for Science, Space and Technology  
A-822 O'Neill House Office Building  
Washington, D.C. 20515

Dear Chairman Wolpe:

We are extremely pleased that the Investigations and Oversight Subcommittee is conducting a hearing on National Science Foundation projections of supply and demand for engineers and scientists. While the Foundation engages in an enormous amount of very valuable activity, for some time we have been concerned that the prestige of the agency has been linked to what we consider to be overly pessimistic views of future shortages of technical professionals. Such pronouncements cause great distress to working scientists and engineers, who see a far different reality.

Dr. Dennis Chamot, of this Department, recently wrote a commentary on this issue for **CHEMTECH**, published by the American Chemical Society, which we reprinted in our own newsletter, **INTERFACE**. A copy of the latter is enclosed, and along with this letter, I hope it can be included in the record of the April 8 hearing. In addition, I bring to the attention of your committee a **Washington Post** article by Daniel Greenberg, editor and publisher of **Science and Government Report**, which more pointedly addresses the NSF research which is the subject of your hearing.

The Department for Professional Employees, AFL-CIO comprises 27 national and international unions (see enclosed list). Within their membership are many thousands of scientists, engineers, and technicians employed by private industry as well as government at all levels.

Should you or your staff believe we can be of assistance to the committee in its work, we trust you will not hesitate to call on us.

Sincerely,

  
Jack Golodner  
President

enclosures

# The shortage of scientists and engineers: crisis or hype?

by Dennis Chamot

**T**he number of U.S. scientists and engineers has doubled over the past decade, from 2.6 million in 1978 to 5.3 million in 1988, according to statistics gathered by the National Science Foundation in Washington. That's several times the rate of population growth. Even so, various leaders in the education and technical communities, including the NSF itself, have raised the specter of a looming shortage of technical professionals.

True, we live in an increasingly complex technological society. Both our economy and military security depend upon continued progress in science and engineering. A shortage of skilled technical people would be a serious flaw and indeed would justify the remedies called for by those raising the alarm — encouraging more young people to choose science and engineering as careers, and boosting public support of graduate students in these fields.

But what if they are wrong? Then increasing the supply of scientists and engineers would hold down salaries, reduce employment opportunities, and in the long run discourage even more young people from pursuing these areas of study.

Dennis Chamot is Executive Assistant to the President, Department for Professional Employees.

If a real shortage exists, one would expect to see an effect on salaries. The law of supply and demand would say that if the supply of a product, in this case people with particular training, were much less than the need, then the price of the product ought to rise. In other words, if employers were having difficulty filling positions, they would offer higher salaries to try to fill their needs. What has been happening to salaries?

This question has been looked at by the Office of Scientific and Engineering Personnel (OSEP) of the National Research Council (the NRC is the operating arm of the National Academies of Science and Engineering and the Institute of Medicine). OSEP obtained salary data gathered from employers by the Engineering Manpower Commission and corrected them for inflation. *Figure 1* shows that despite the enormous increase in demand for engineers (as reflected in the huge increase in numbers of engineers employed over the period examined), real salaries, corrected for inflation, did not increase at all from 1972 to 1990. If anything, there was a slight drop during the past four years. This is true at all experience levels, including new hires. One would expect starting salaries to be particularly sensitive if a real shortage existed, yet even new graduates ("0 years since BS") have followed the general pattern.

A similar situation obtains for industrial chemists. Using starting salary data collected by the American Chemical Society, I corrected for inflation and generated the graph shown in *Figure 2*. Over an 11-year period (1980 through 1990), starting salaries in real terms for B.S.-level chemists employed in industry were essentially unchanged. At the Ph.D. level, there was some gain since 1980, but the trend has been downward for the past four years.

Although demand for technical professionals has grown, employers seem to have been able to meet their needs without resorting to anything drastic. Will this situation continue?

*Figure 3* shows the number of degrees awarded in engineering over the past 15 years. There has been steady growth at the graduate level, both masters' and Ph.D., with nearly a doubling in degree production during this period.

There was also a doubling at the bachelors' level from the mid-seventies to the peak in 1986 (a higher growth rate than during the previous two decades). The steady decline over the past four years, from more than 78,000 B.S. degrees in 1986 to just under 66,000 in 1990, is fueling the concern. The decline is primarily a result of demographic factors; the college-age cohort is declining. This decline is tem-

Although demand for technical professionals has grown, employers seem to have been able to meet their needs without resorting to anything drastic. Will this situation continue?

porary, and is expected to reverse before the end of this decade.

**Foreign students**

Another area about which many have expressed concern is the composition of the student body. Although foreign nationals received about 8% of B.S. engineering degrees each year through the 1980s, the proportion of graduate degrees going to foreign citizens has been increasing. At the masters level, the growth has been modest, from 26% of degrees in 1981 to 29% in 1990, but the fraction is large.

The situation for Ph.D.s is of more concern. The total number of degrees is small. Even though there was a doubling over the past decade, to about 5400 engineering Ph.D.s awarded in 1990, much of the growth was accounted for by foreign citizens. The fraction of Ph.D. degrees in engineering awarded to foreign nationals increased from 37% in 1981 to 49% in 1990.

Some of the foreign students return to their home countries and are unavailable to satisfy U.S. needs directly. On the other hand, many do remain, some to teach in our universities and others to work in industry. (According to statistics compiled by the National Science Foundation from Immigration and Naturalization Service data, about 4800 scientists and engineers changed their status from non-immigrant to immigrant in 1988, including former students, and another 6100 were admitted directly from overseas.)

**No shortage seen**

None of the foregoing supports the view that there is a shortage of technical talent in this country, nor is there likely to be in the near future. We are currently in the midst of a serious recession, and technical professionals in a variety of industries are feeling the pinch. In fact, there has been a downward trend in R&D spending increases since the mid-1980s, both on the part of industry and the federal government. In real terms (corrected

*continued on next page*

**ENGINEER ANNUAL SALARY BY YEARS SINCE B.S. (constant \$)**

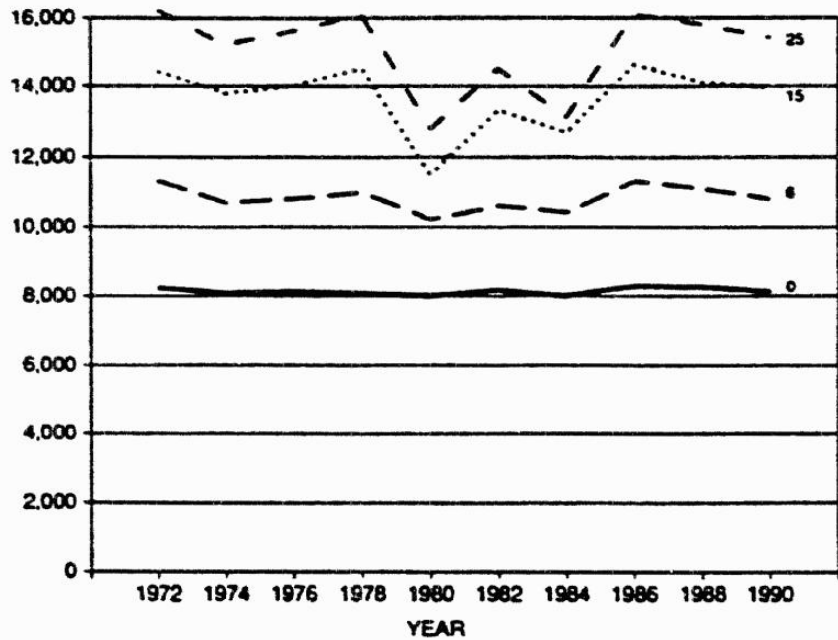


Figure 1. Annual salary for engineers by years since BS. Data deflated by Consumer Price Index 1967 = 100.

**CHEMIST STARTING SALARIES**

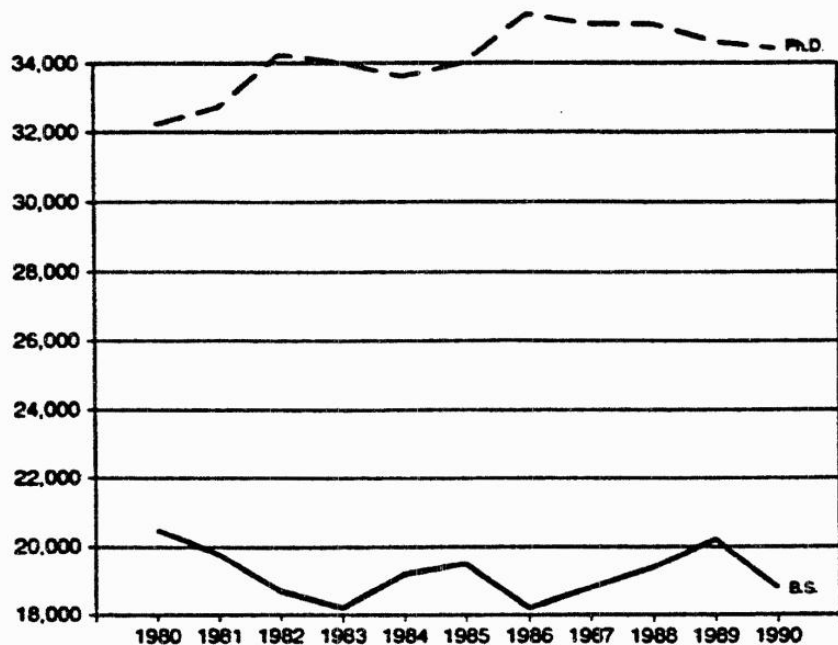


Figure 2. Median starting salaries for inexperienced full-time chemists. Real dollars, CPI 1982-4 = 100.

## DEGREES IN ENGINEERING

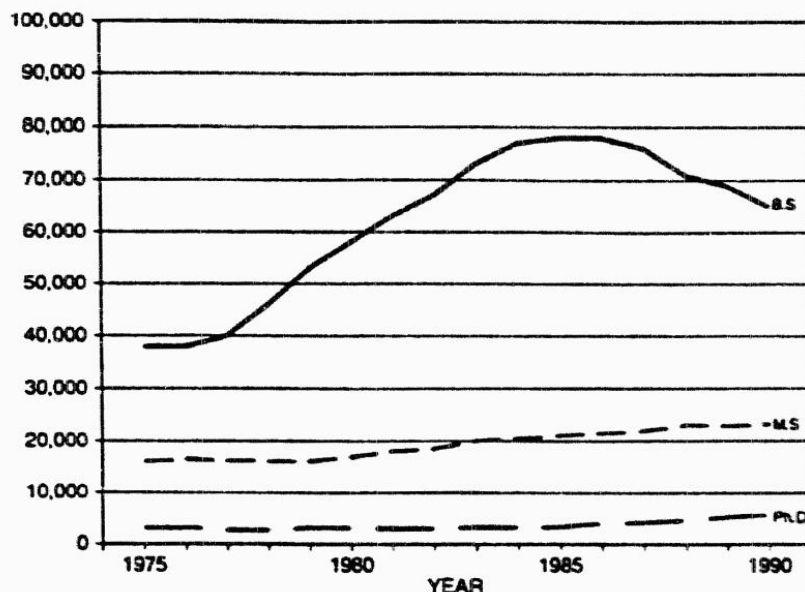


Figure 3. Degrees in engineering.

for inflation), there has been a decline in federal support for three years.

#### Employment outlook

Looking to the longer term, the BLS projects employment of about 2.9 million engineers, scientists, and computer scientists in the year 2000. That's about 700,000 (25%) more than they counted in 1988. If we assume that about one-fortieth of the work force will retire annually, we will then need an additional 800,000 professionals for a total of 1.5 million. Yet, some 2 million scientists and engineers at all levels will probably be awarded degrees during the period 1988-2000. Furthermore, we can also anticipate 100,000 or so immigrants to enter the work force as well. (This number could increase substantially under the newly revised immigration law.) The output would thus seem to be adequate to meet the demand.

Shortages or surpluses in specific fields do occur, and although the details change from year to year, this is nothing new. And it isn't something to get too excited about. Labor markets do equilibrate over time. In addition, advances in technology make substitutions easier to accomplish.

For example, much engineering design and a lot of theoretical science is now done on computers. Furthermore, with modern telecommunications, the world's engineers and scientists are available at a touch of a button, further contributing to the pool of talent that can be utilized by American companies.

Technical professionals in the workplace don't understand where the talk of shortages is coming from. This is especially true for employees of defense suppliers who are facing cutbacks, but it is not limited to them. A typical comment is one from a letter to the editor in a recent issue (May 13, 1991) of *Chemical and Engineering News*: "I observed several interesting advertisements for employment ... in *C&EN*: project leader, Ph.D., \$38,000 per year; research associate, Ph.D., \$30,000 per year; and research associate, Ph.D. plus postdoctoral experience, \$25,586 per year ... My guess is that the people who placed these ads did not get a lot of response, and therefore concluded that there must be a shortage of chemists."

Cries of shortage appear regularly. Several years ago, there was such an outcry of concern that the National Research Council set up a Committee on the Education and Utilization of Engineers, of which I was a member. In 1985, after a couple of years of detailed study, the committee issued a multivolume report. There was much useful information in it, but the one thing the committee could not do was confirm that there was any kind of crisis. At most, there was concern about the growth in foreign students in graduate programs, as an indication of possible diminishing interest in obtaining Ph.D.s on the part of American students, thus affecting the pool of potential faculty members. That specific concern still exists.

A good indication of the thinking of knowledgeable experts is a recent article by Alan Fechter (1), Executive Director of

the NRC's Office of Scientific and Engineering Personnel. He doesn't support the view that there are, or will be, serious shortages. He notes, "Most of the simulation models used to assess these labor markets assume that markets do not equilibrate; that if an imbalance occurs between supply and demand, nothing will occur to correct it. In fact, history demonstrates that these labor markets do tend to equilibrate ... Thus, projected imbalances derived from such models — both shortages and surpluses — are always overstatements of what actually will be experienced."

#### Sources of concern

So, where is the concern about shortages coming from? Perhaps another way to put the question would be to ask who benefits from a surplus. Clearly not working scientists and engineers — oversupply holds down salaries and makes it more difficult to find good jobs.

I suggest two sources. One is certain elements of the business community, a minority, who in fact want to pay relatively low salaries; some of these companies desire to employ foreign engineers at less than going rates of pay, and want to convince the Department of Labor that shortages exist.

The other source of complaint, and by far the most vocal, is the university establishment. In fact, one could make a convincing case that there is a real problem here, in that many universities are having trouble attracting American students, especially into their graduate programs, and are relying heavily on foreign talent for new faculty.

The problem for the rest of us is that the universities (and academically oriented organizations like NSF) have generalized their view of the crisis.

I'm convinced there is no general shortage today. I don't believe there will be one in the foreseeable future. Let's stop the rhetoric and act like scientists. Let's look at the evidence, and concentrate on the real problems.

#### References

- (1) Fechter, A. "Engineering Shortages and Shortfalls: Myths and Realities", *The Bridge*, Fall 1990, published by the National Academy of Engineering.

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THE WASHINGTON POST, Sunday, August 18, 1991

*Daniel S. Greenberg*

# A Shortage Of Scientists And Engineers?

From the White House to local school boards, the drums are beating to encourage more youngsters to pursue careers in science and engineering, the assumption being that otherwise a massive shortage of trained technical specialists could cripple the nation.

But if the call is heeded, will suitable jobs await an avalanche of newly minted scientists, engineers and technicians? The reality is that the recognized experts strongly disagree about future supply and demand in these fields. Furthermore, the basic statistics on technical manpower are in such a derelict condition that disputes even rage about the number of specialists now in the work force, let alone manpower needs in the next century.

There's no disagreement about the importance of strengthening science and math education throughout all school levels as a means of promoting general scientific literacy. But the experts diverge on whether mammoth shortages are inexorably building up in professional specialties crucial for industry, defense, education and many other sectors of modern society.

Throughout the postwar era, many factors have conspired to encourage gloomy manpower assessments, including a natural tendency of scientists and engineers to revere their professions and campaign for more recruits. In periods of expanding defense and space spending and the Silicon Valley computer boom, spot shortages seemed to support the alarms and negate the sad tales of PhDs reduced to waiting tables or driving taxis.

But panic about coming shortages soared in 1989, when Peter House, the chief of policy analysis at the National Science Foundation, circulated a paper—never published—that calculated a "shortfall" of nearly 700,000 bachelor degrees in science and engineering between 1986 and 2011. The figure

reflected declines in the college-age population and the generally stable proportion of students who major in science and engineering.

House diligently insisted that "shortfall" means a decline from current levels and should not be equated

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*"Experts strongly disagree about future supply and demand."*

with "shortage." But the distinction was lost in the ensuing excitement. And then the shortage alarms were strongly reinforced when a widely publicized study by Richard Atkinson, then-president of the American Association for the Advancement of Science, warned that a shortage of several thousand new PhDs in science and engineering would hit the United States later in the decade.

Events alone can test those dour prophecies, but the doubters raise points that invite attention. For example, Alan Fechter, head of manpower studies at the National Academy of Sciences, observes that science and engineering manpower tends to be mobile and adaptable. Thousands work at science and engineering tasks for which they were not specifically trained, he points out, while many trained in these fields hold non-technical jobs. When demand and pay rise, he recently told a congressional hearing, the trained specialists respond: "Studies that do not account for such feedback generate worst-case scenarios," he said.

Chaos reigns in the government's tallying of scientists and engineers. For example, the National Science Foundation puts the count of aerospace engineers at 56,000, whereas the figure from Bureau of Labor Statistics is 93,000. R. A. Ellis, director of manpower studies for the American Association of Engineering Societies, notes that the National Science Foundation reports that the ranks of engineers grew by 441,000 between 1986 and 1988—three times the number of new graduates during that period. Even allowing for immigration and other sources of supply, he said, "discrepancies of this magnitude are not credible."

The main responsibility for collecting and analyzing science and engi-

neering manpower statistics is assigned to the National Science Foundation's Division of Science Resources Studies. Two years ago, a review concluded that its performance was "ambiguous, subject to misinterpretation by users and very difficult to relate to estimates produced by other data systems." In layman's language that translates to a big mess. Since then, the division has gone through four directors and is currently under review by the foundation's inspector general.

There can be no quarrel with the need to improve science and math education or with the importance of a suitable supply of well-trained scientists and engineers. However, training in these fields is long, arduous and expensive. It would be sad indeed if the drumbeats of shortage lead to bitter disappointment in a miscalculated job market.

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*The writer is editor and publisher of Science & Government Report, a Washington-based newsletter.*

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Agricultural Implement Workers of America  
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United Association of Journeymen and Apprentices of the Plumbing and  
Pipe Fitting Industry of the United States and Canada  
United Food & Commercial Workers International Union  
United Steelworkers of America  
Writers Guild of America - East

42 Maple Street  
Auburndale, MA 02166  
March 31, 1992

Congressman Howard Wolpe  
Investigations and Oversight  
House Science, Space, and  
Technology Committee  
B374  
Rayburn House Office Building  
Washington, DC 20515

Dear Congressman Wolpe:

I understand that you are sponsoring an investigation of the NSF scientist and engineering forecasts. On Labor Day 1980, I presented a paper showing that the NSF study as well as two others used in the past were defective. In the case of the two other studies, historical data was available. In the case of the NSF study, a analysis of the methodology used indicated that no estimate was made of actual demand! The NSF assumed that college enrollments were dropping. The estimates from the US Department of Education showed just the reverse to be true. The decrease in 18 year olds was more than made up for by the older students returning to the campus at a non traditional age.

Numerous studies have shown that the most critical factor is the percentage of students that choose to study engineering. Many students do not see engineering as a fruitful career. They see manufacturing especially as a low paying route for a professional. Law, accounting, and business are seen as fields with better opportunities.

Employers are part of the problem, too. There is widespread sharing of wage and salary data, limiting salary increases. The statistics show that adjusted for inflation, engineering salaries have not risen during the 80's. With cuts in defense spending there is currently a surplus of engineers, especially here in Massachusetts. I have spoken with more than 100 through IEEE advertisements, Job Fairs, and personal contacts. The stories told would break your heart!

As a result of the "bad" NSF research several incorrect policy decisions have been made. The most serious one is to increase the number of technical professionals allowed into the country under the Immigration act of 1990. Some say that Labor Certification will solve any problems. In 1986 and recently I proved that in some cases that Labor Certification is not working. The easiest way to show this is to take the degree required and compare the salary offered to the average shown in national surveys. Isabel Kaldenbach from Congressman Barney Frank's Office (225-5931) can show you some of the problems we have found. Note that these are only the tip of the iceberg. With sufficient funding many more could be found.

I find it distressing to be told there is or will be a shortage of engineers when many layed off at the 40-50+ age range with little chance for professional employment. Equally unethical is when academics continue to use the NSF numbers to recruit women and minorities to the field, without indicating realistic career opportunities.

Congressman Wolpe March 31, 1992

-2-

In the past the press has carried headlines about engineering shortages, yet when we supply them with facts, it seems not possible to get publicity in the local and national news media. As recently as February 1992 the shortage words were used by Donald Beall, the President of Rockwell International. Except by the use of letters to the editor we have been unable to get major media coverage.

Enclosed is a copy of my September 1990 paper. Could you enter it into the record?

If it is possible to get a copy of the proceedings of your hearing please send me one.

Sincerely,



John P. Densler 617-244-4417



# FILE COPY

## ENGINEERING MANPOWER FORECASTS

### REALITY VS PUBLICITY

John P. Densler  
BOSTON PACE Co-Chairman

With the proposed 25%-50% decrease in defense spending, are we to repeat the disaster engineers experienced in the 70's when defense and space spending dropped? Professionals out of Work, by Paula Leventman describes the tragic plight of the unemployed engineer during the early 70's in the Boston area. Unemployment among engineers in Boston reached 20%!! If widespread layoffs occur a generation later, many young people will avoid engineering careers.

From time to time one group or another is widely quoted by the press as forecasting a shortage of engineers. Most of us see the headlines, but few have the opportunity to examine the methodology and assumptions used in the study. In this paper, I will analyze three widely quoted forecasts, the Engineering Manpower Commission forecast from 1967, the American Electronics Association forecast from 1981, and the National Science Foundation forecast from November 1989.

#### Supply-Demand Considerations

Economists explain the actions of markets in terms of supply and demand. The price of any product determines the supply and demand both over the short and long term. Surplus or shortage implies some control of the market where normal supply or demand is not functioning. In a free market, supply equals demand at all times. Buyers bid up the price of any good or service until the increased supply meets the demand or some buyers drop out of the market to decrease demand. Buyers may also compromise with an inferior good at the same price.

The market for engineering talent is far more complex than a simple supply demand model at one point in time. A delay in the number of graduates as a function of starting salaries can result in unstable market conditions with long term overshoots and undershoots. This response to changing demand is known as the cobweb effect.<sup>1</sup> The supply side is constrained by the rate at which academic institutions and industry can train people, as well as the availability and ability of trained people in similar fields to adapt to the market opportunity. Student choices determine the utilization rates of academic facilities. It is not easy or inexpensive to change the capacity of educational institutions. The demand for engineering skills however, changes with economic conditions much more rapidly than the supply can

1. Freeman, Richard B., "A Cobweb Model of the Supply and Starting Salaries of New Engineers", Industrial and Labor Relations Review, Vol 29, January 1976, pp 236-248

change. Not all engineering work is done by classic BS degreed engineers. The more practical work is done by BSET 4 year graduates; other work is done by those with 2 year associate degrees. Engineering work has also been done by graduates trained in similar fields, such as physics and mathematics. Most manpower forecasts do not consider these other sources of engineering resources.

In the industrial marketplace, who performs engineering work is determined by engineering management. Except in areas as civil engineering and electrical power, the PE license is not a common requirement limiting who can perform engineering work. Manpower forecasts do not differentiate between these markets.

Forecasting any good or service is never easy! The only measure of a forecast is historical performance. Looking back in time allows one see how well a forecast predicted the events that happened. Forecasts are rarely correct, meaning 100% achievement of the numbers forecast. A good forecast is reasonably close to the actual outcome; a bad one is not very close to the outcome.

A fundamental consideration in forecasting is that the variables driving a forecast must be predictable in the future. Who could anticipate the drop in defense spending as a result of the changes in Eastern Europe two years ago? Since a significant percentage of engineering workforce is directly or indirectly involved in defense related work, how can reliable forecasts be made?

### Historical Forecasts

In 1967 the Engineering Manpower Commission<sup>2</sup> forecast the need for engineers to 1976. Their conclusion was that by 1976 there would be a cumulative shortage of 300,000 engineers. This number was the result of an increase in demand projected to be 69,000 per year based on a survey of several hundred industrial firms. Growth rates for the years 1965 to 1976 were projected to be 33% for all engineers and 40% for electronics and electrical engineers. This growth was projected to be conservative based on the growth in employment of 7% per year from 1964 to 1966. NSF at that time projected an annual need for 71,700 graduates. The supply of new graduates was forecast to be 41,000 per year through 1976, including some physicists and graduates of other curricula who could do the desired engineering work. Since both demand numbers were close, the authors concluded that their forecasts were "reasonable".

Figure 1 shows EMC forecast of job growth and the historical record. During the early 70's engineering unemployment nationally reached 3.2% in 1972 as a result of cuts in defense spending and the termination of space exploration. The 3.2 % figure does not include those engineers employed in other fields or no longer

2. The Demand for Engineers and Technicians - 1966, Engineering Manpower Commission of the Engineers Joint Council

seeking work. The level of those seeking unemployment benefits alone indicated a surplus of engineering manpower of at least 35,200 people!!

In 1981 the American Electronics Association conducted a survey<sup>3</sup> of member manpower needs through 1985. This survey was analyzed and published by an AEA "Blue Ribbon Committee" on Engineering Education. The conclusion of this survey was that total technical professional manpower was predicted to grow by 12% per year during the period 1980-1985.

This growth rate was substantially above the growth rates experienced in the past and forecast by the Bureau of Labor Statistics or other organizations. The results compared to historical experience are shown in figure 2. By 1982 IEEE President Robert Larson<sup>4</sup> criticized the survey by stating "The AEA'S shortage figures may be grossly overstated." Despite widespread criticism, the study was used in industry and on Capital Hill to justify the need for a major effort in industry and academia to produce more people trained in high technology. By January 1986, Pat Hill Hubbard, the AEA vice president indicated<sup>5</sup> that "The Electrical Engineering shortage no longer exists" At that time, Hubbard said the AEA was no longer in the numbers game.

Douglas Braddock explained the fundamental flaw in the AEA (and EMC) methodology in an article in the Monthly Labor Review.

"This report probably overstated future requirements because of the biases inherent in the methodology. Projections based on company plans are generally upwardly biased because companies plan and expect growth in sales and therefore employment. Not only may companies overstate industry growth, but many companies plan to increase their market share, even though one company can only increase its share at the another's expense. Such overly optimistic estimates of future needs are particularly striking in the defense related fields because, only one firm can be awarded each major-defense contract, each firm is likely to assume that it will get the contract when responding to the survey. Another drawback of this survey is that most people tend to see the future as very much like the present. These projections of rapid growth may therefore, be extrapolations of the rapid growth of the past few years,<sup>6</sup> rather than a realistic assessment of the long term trends."

3. American Electronics Association Blue Ribbon Committee Report, Pat Hill Hubbard, dated May 31, 1981

4. Electronic Engineering Times, March 15, 1982, Page 1

5. E E Times January 27, 1986

6. "The Job Market for Engineers: Recent Conditions and Future Prospects", by Douglas Braddock, Occupational Outlook Quarterly, Summer 1983. pp2-8

Recent Forecast

Recently, the National Science Foundation published a study indicating a growing shortage of scientists and engineers. Again this study was widely quoted in the newspapers and three articles based on the data in this study were published in Science. The support of this report by the NSF and American Association for the Advancement of Science provided important prestige to the results. As a consequence of this study, there is wide public acceptance of an impending future shortage of scientists and engineers. Two bills now in Congress are designed to help alleviate this critical "shortage" of engineers. The first bill sponsored by Senators Edward Kennedy and Alan Simpson greatly improves the ease with which US corporations are permitted to hire foreign nationals as engineers (HR 4300 & S 358). The other bill, Excellence in Mathematics, Science, and Engineering, proposes to increase the number of potential engineering students.

The NSF report was titled, Future Scarcities of Scientists and Engineers: Problems and Solutions. It was developed by the Division of Policy Research and Analysis, and listed as a working draft dated November 13, 1989. No authors were listed for the report. This study appears to be an update of the data provided in The Science and Engineering Pipeline, PRA-87-2 dated April 1987. The logic presented is that the population of 22 year olds will drop by 25%, therefore it is reasonable to anticipate a 25% decline in NS&E (Natural Science and Engineering) bachelors degree graduates. The cumulative difference between the production of the average number of NS&E graduates in 1984-86 is listed as a "shortfall". The following is from the report, page 8.

"This "shortfall" does not necessarily translate directly into a "shortage" unless the demand for such skills exceeds the declining supply. Because of the complexities in utilization of NS&E training (e.g., many NS&E graduates use their skills productively in occupations not officially counted as scientists or engineers) and the limitations of occupational census data (counting those individuals officially categorized as scientists or engineers), quantitative projection of demand for individuals with NS&E training was highly uncertain, and was not attempted in this work. Instead, the average production during 1984-1984 was taken as a proxy for future demand."

It is interesting that none of the newspaper articles quoting the report included this assumption of demand! The articles merely indicated a shortage was to occur.

This highly publicized NSF report is based upon the following presuppositions which have inherent biases and which effectively prevent it from being able to realistically project the engineering market.

- 1) The 1984-1986 base period was during the boom in defense spending. Industry had recovered from the mini recession of the early 80's and increased hiring of engineers. Projections of the economy in the 90's are different from the mid 80's. Slower economic growth and a reduction in defense spending will sharply contrast with the mid 80's. The study does not attempt to predict BS degree demand, but uses this 3 year boom period as an example of typical demand.
- 2) The use of NS&E as a pool does not allow the separation of engineering demand from scientific demand. The markets are very different. The number of BS engineering graduates has not remained constant as a percentage of the number of 22 year olds, but varied from about 1% to 2% of this population (figure 3).
- 3) This study chooses to ignore the projections of the US Department of Education which indicate that the decrease in total bachelor's production will be considerably less severe than the NSF's projections. Figure 4 shows the USDE data and the demographic data. The number of 22 year olds will drop by 25%, but the total number of BS degrees will increase to the peak year of 1993 then decrease by only 5.5%!
- 4) Ignored is the increase in four year BSET graduates that fill many of the more practical oriented engineering openings. Some computer science graduates can be considered to be part of this pool. Neither group is included as part of the NSF projection of supply. Figure 5 shows this trend. Note the increase in BSET to BS ENG ratio.
- 5) The issue of engineering productivity is also ignored. Without considering the productivity increases resulting from computer usage in design, how can demand be realistically estimated?
- 6) Another branch of the NSF has an Occupations Modeling System based on the DRI US Quarterly Macro Model. It is informative to compare the output from this model to the demand listed in the widely quoted NSF report. Figure 6 and figure 7 show a comparison of the growth rates experienced in the 1984-1986 period and the NSF model in early 1990. Why was other data within the agency ignored? The most recent BLS model predicts a 2 1/2% engineering growth rate, before considering the effects of a decrease in defense spending. Why should the NSF consider a 3.5% growth rate typical of the future?

#### Future Outlook

"Despite substantial growth, (in the 80's) the projected gains in S/E requirements should not match past increases, due to the overall slowdown expected in the 1990s of growth in the labor force, total employment, and GNP." Would it not be logical to project a lower demand for technical manpower? A major factor is

7. National Science Board, Science and Engineering Indicators-1990, Washington, DC:U.S. Government Printing Office, 1989.(NBS89-1)

the decreases in defense spending. 1991 budget for defense spending will be cut by at least 18 billion dollars.<sup>8</sup>

In my professional career of more than 30 years, I have never seen the general press use the term engineering surplus, yet during significant periods the market for engineering skills was depressed. The Deutsch Shea High Technology Index is one measure of the engineering job marketplace. This index measures the volume of high technology job advertisements (figure 8). During the last 15 years, the index has been above 130 for only 28.3% of the quarters reported! Why the cries of a shortage? My explanation is that the surplus we are now experiencing will affect the enrollment and cause smaller graduation classes some years in the future. If we want to increase defense spending at some time in the future, where will we find the engineers to do the work? Perhaps this is the real reason for the NSF report.

The effects of the 70's were long lasting. The total number of engineers reported by the BLS dropped and did not regain the same level for 7 years. Figure 9 shows the long term trend in engineering employment where this effect may be seen.

A much better way to prevent shortages might be to deal with the problems experienced by engineers in industry. Even the NSF recognizes that there is a problem in engineering careers.

"Since more than three fourths of the US engineers are employed by industry, both the image and the reality of engineering careers are largely determined by industrial practices. If industrial companies follow the boom and bust hiring practices for engineers, mathematically and scientifically capable students will seek nonengineering careers. "

Even worse are some of the working conditions many engineers experience. The conditions described in Tracy Kidder's book, The Soul of a New Machine are perhaps one reason why young people are choosing other careers. Some of the "best and brightest" of our graduates were treated in a most nonprofessional way by Data General.

Electronic Business conducted a survey of top graduates in engineering and business last year.<sup>10</sup> Some of the comments are especially revealing as reasons why students make career choices. Examples include: "I intend to avoid the semiconductor equipment industry. It's a bad industry. It's tough to make money in it. There is a lot of risk involved." "The people who come up with the ideas aren't rewarded." From the student's view, "the

8. Boston Globe, July 21, 1990, page 5

9. Education and Employment of Engineers, National Academy Press 1989, page 19

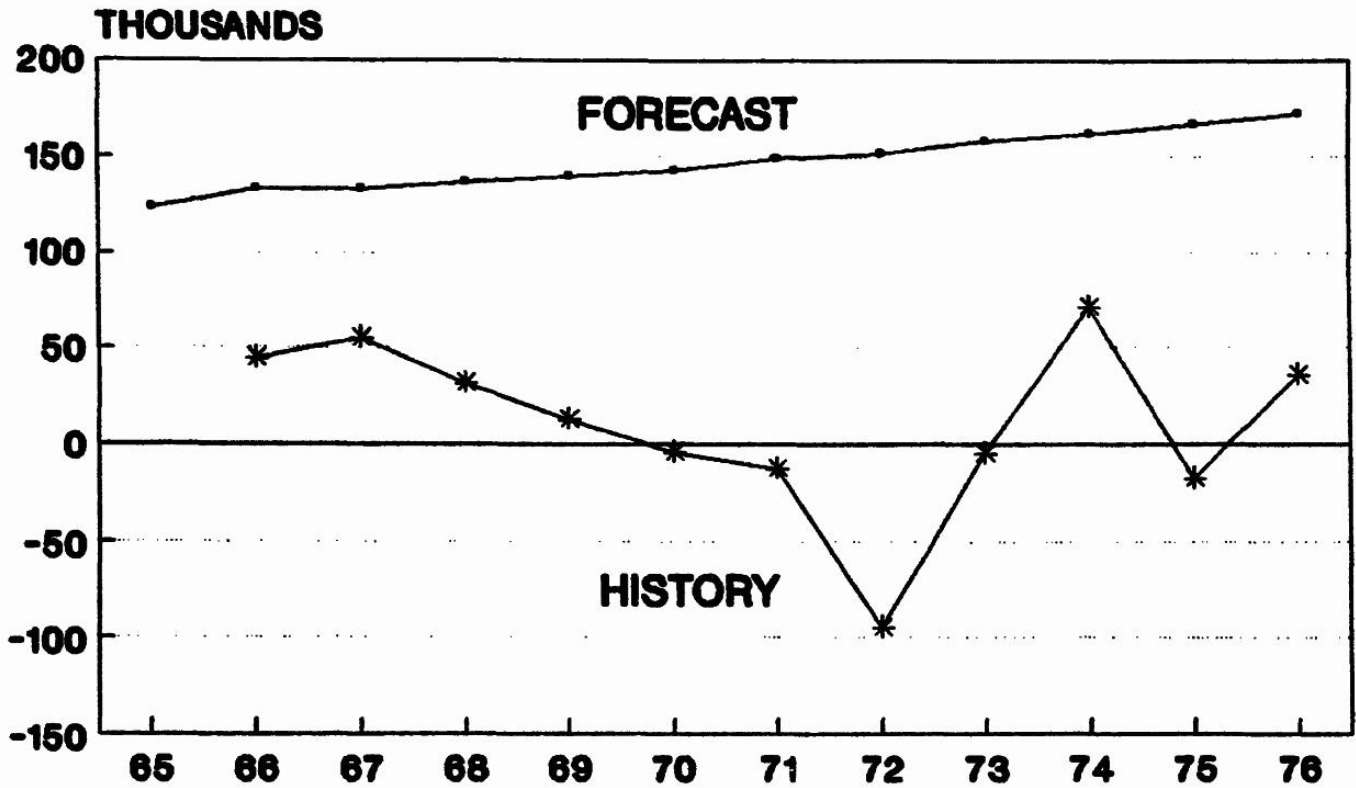
10. "The Best and Brightest Speak Out", Electronic Business, June 12, 1989, pp 29-37

corporation of today is for the most part marked by instability, not opportunity".

Will we have shortages or surpluses of engineers? I frankly don't know. This may not be the important issue to address. As we attempt to recruit minorities and women to the profession and depend upon them to make up for a projected "shortfall", they will perceive the same problems as do white males. Will the "shortage" problem be solved? These newly recruited engineers will leave as do about half the working graduates in NS&E fields. The greater part of the demand for engineers comes from those leaving the field, not from an increase in the demand for engineers. The more important issue is why graduates leave the field. If the rewards are perceived to be better in other areas, people will switch fields. Changing the reward structure and better working conditions will have a much more positive influence on young people than advertising or public relations approaches.

August 20, 1990  
TLKPHX1

# EMC 1965 FORECAST FORECAST VS. RESULTS

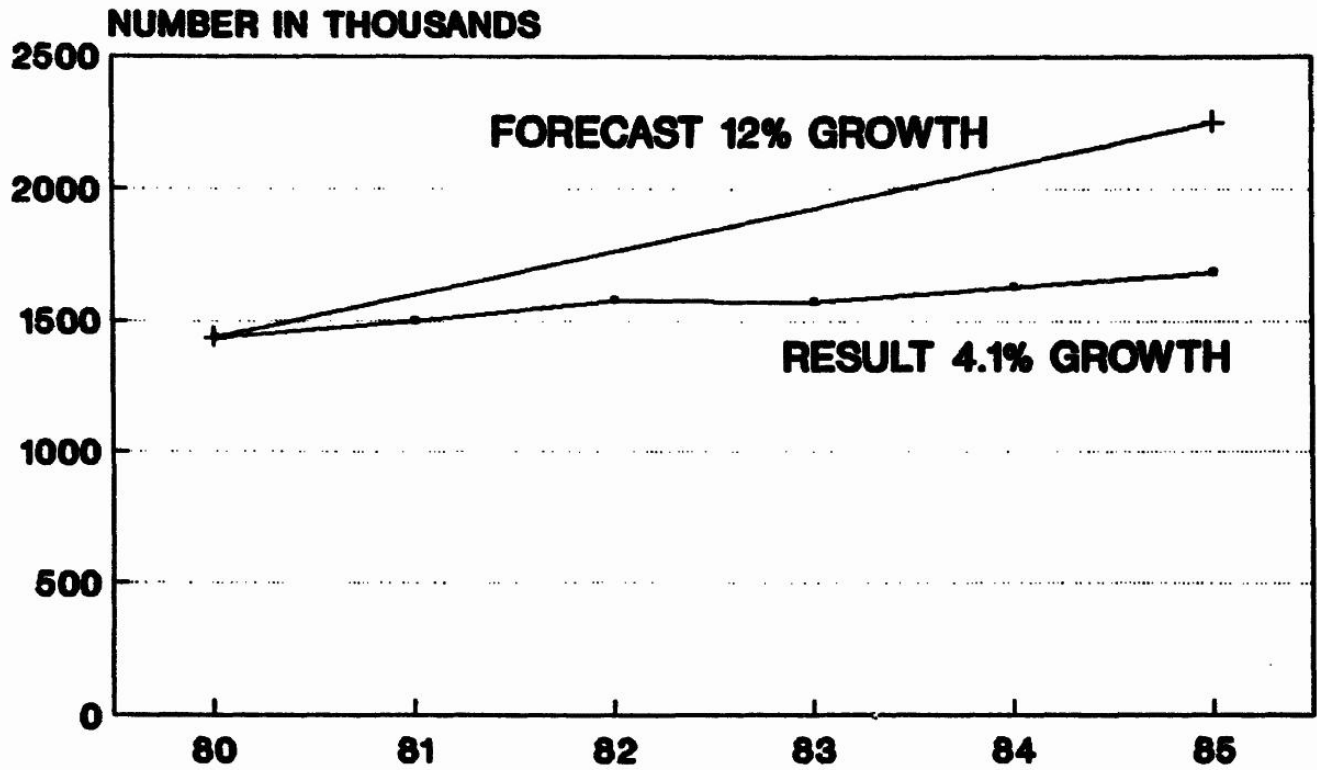


SOURCE: BLS DATA QUARTERLY SERIES AVG

FIGURE 1



# AMERICAN ELECTRONICS ASSOCIATION MANPOWER FORECAST MAY 1981



DATA FROM BLS QTR SERIES A/G

FIGURE 2

## Engineering Graduates as Percentage of 18 Year Olds 4 Years Earlier, 1950 - 1989

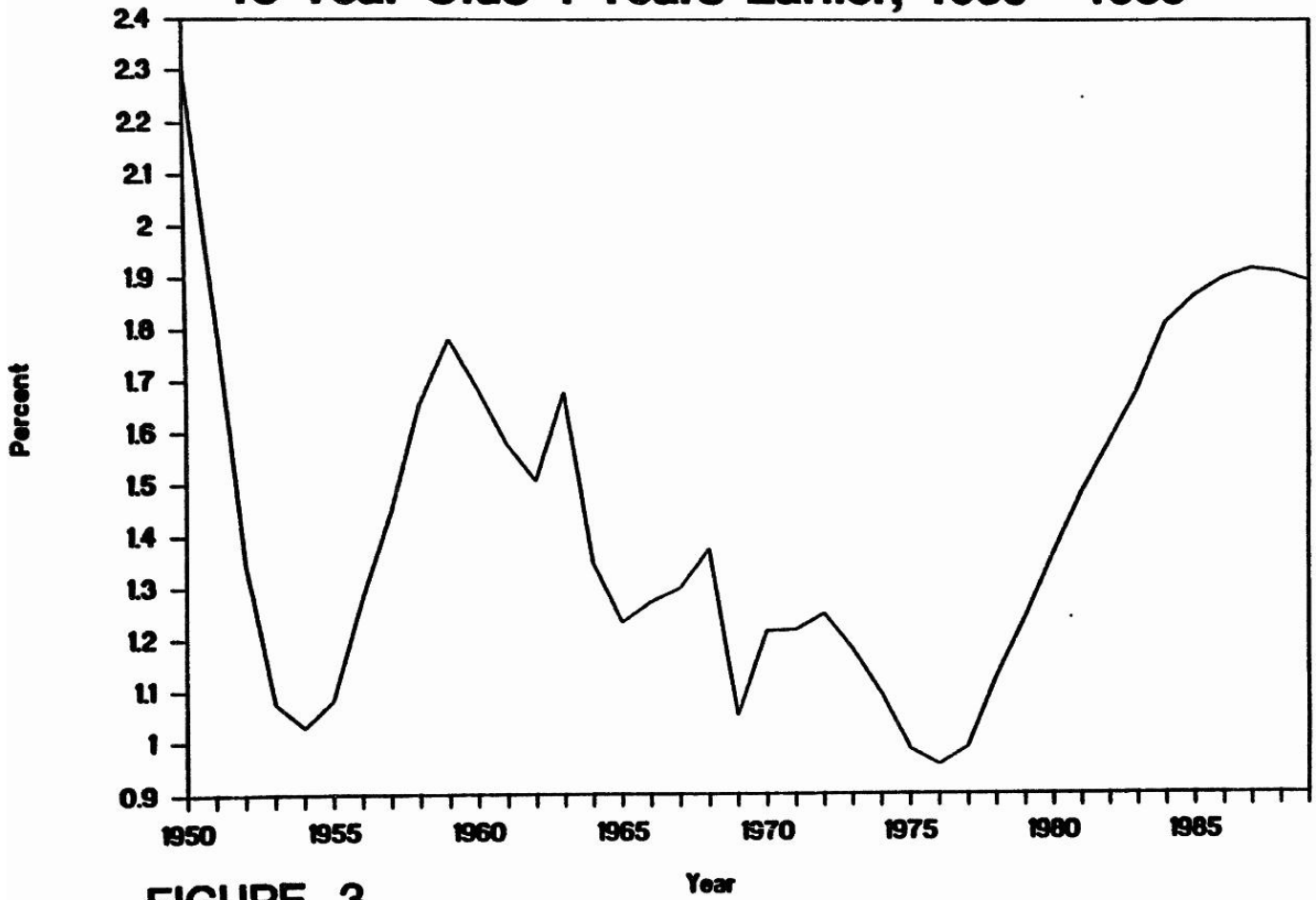
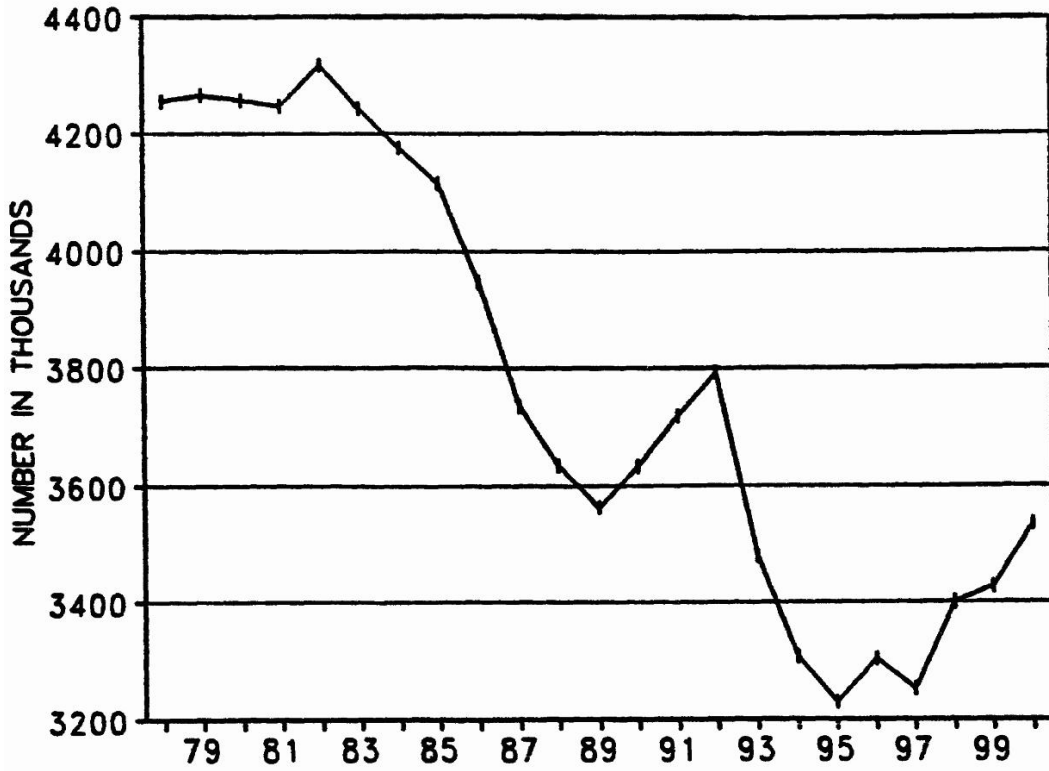


FIGURE 3

# NUMBER OF 22 YEAR OLDS



# BS DEGREE GRADUATES

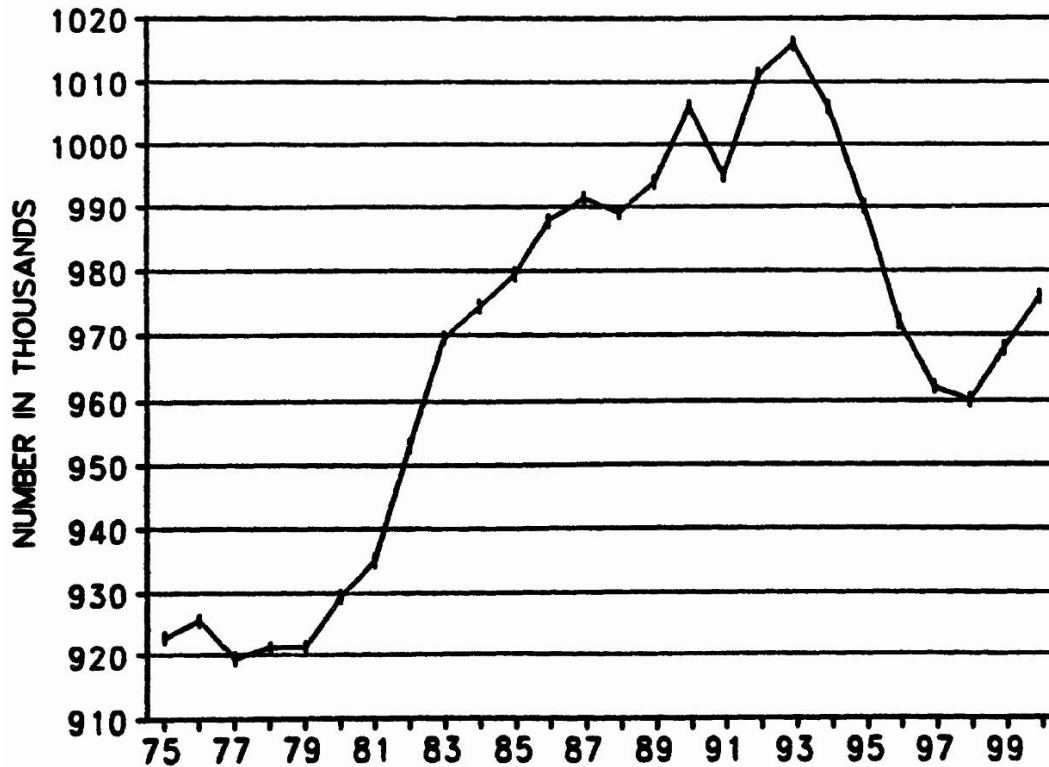
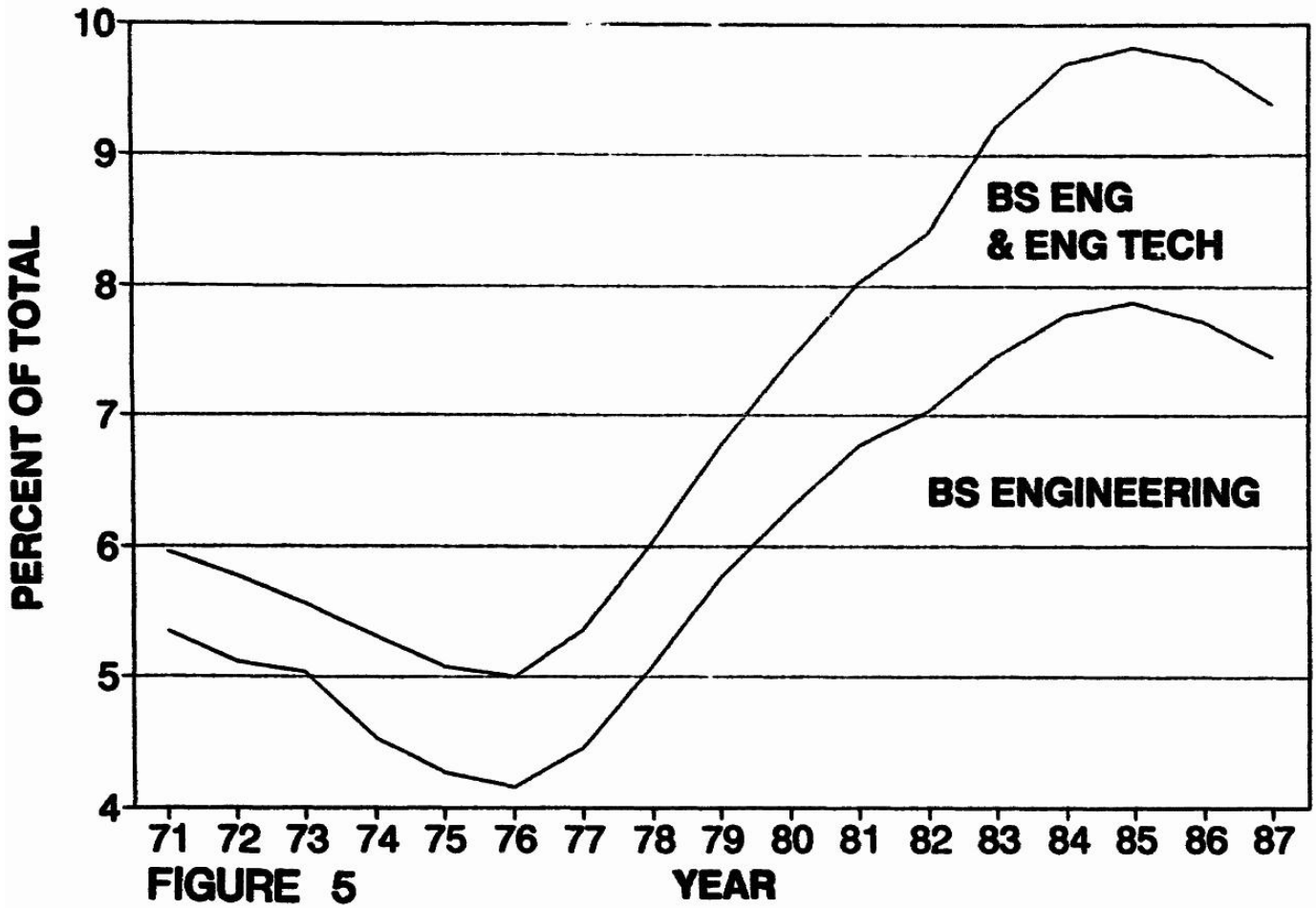
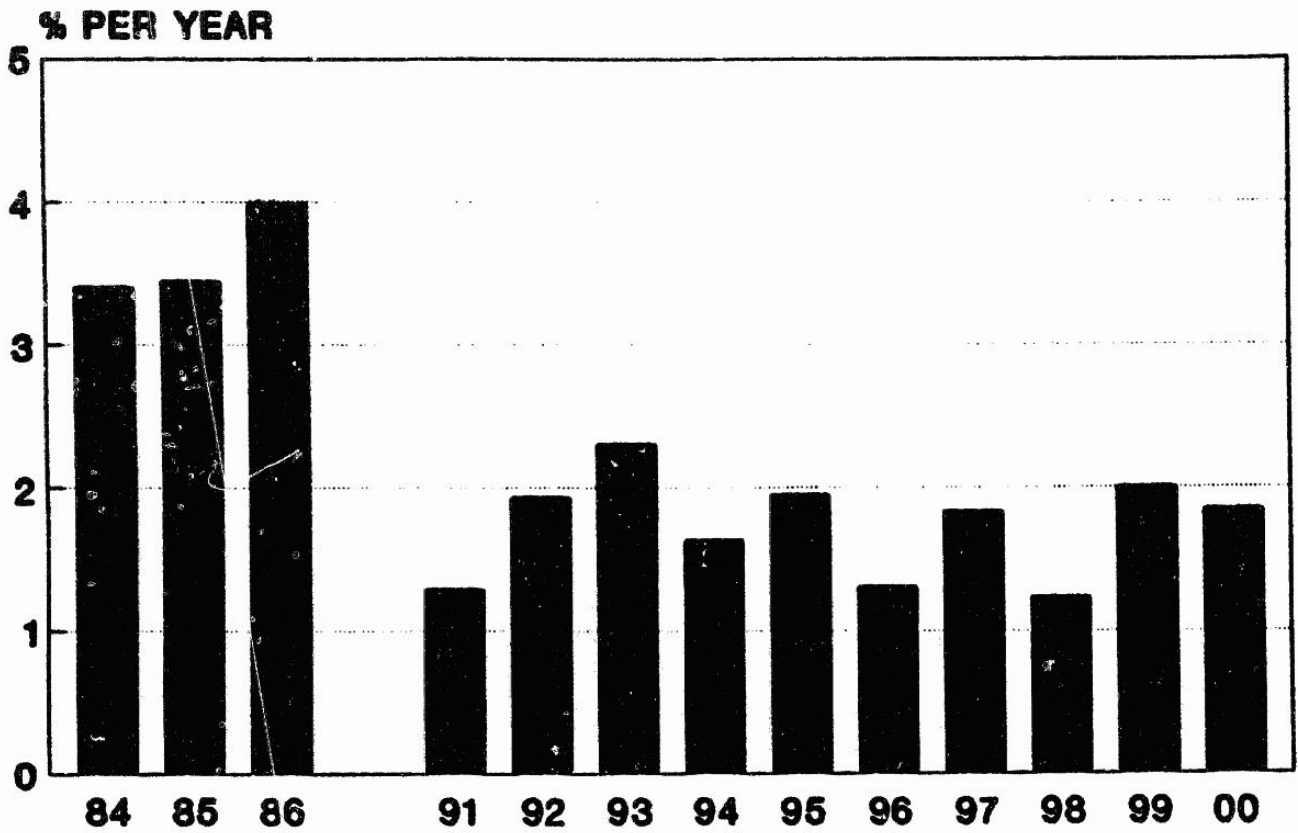


FIGURE 4

# BS DEGREES

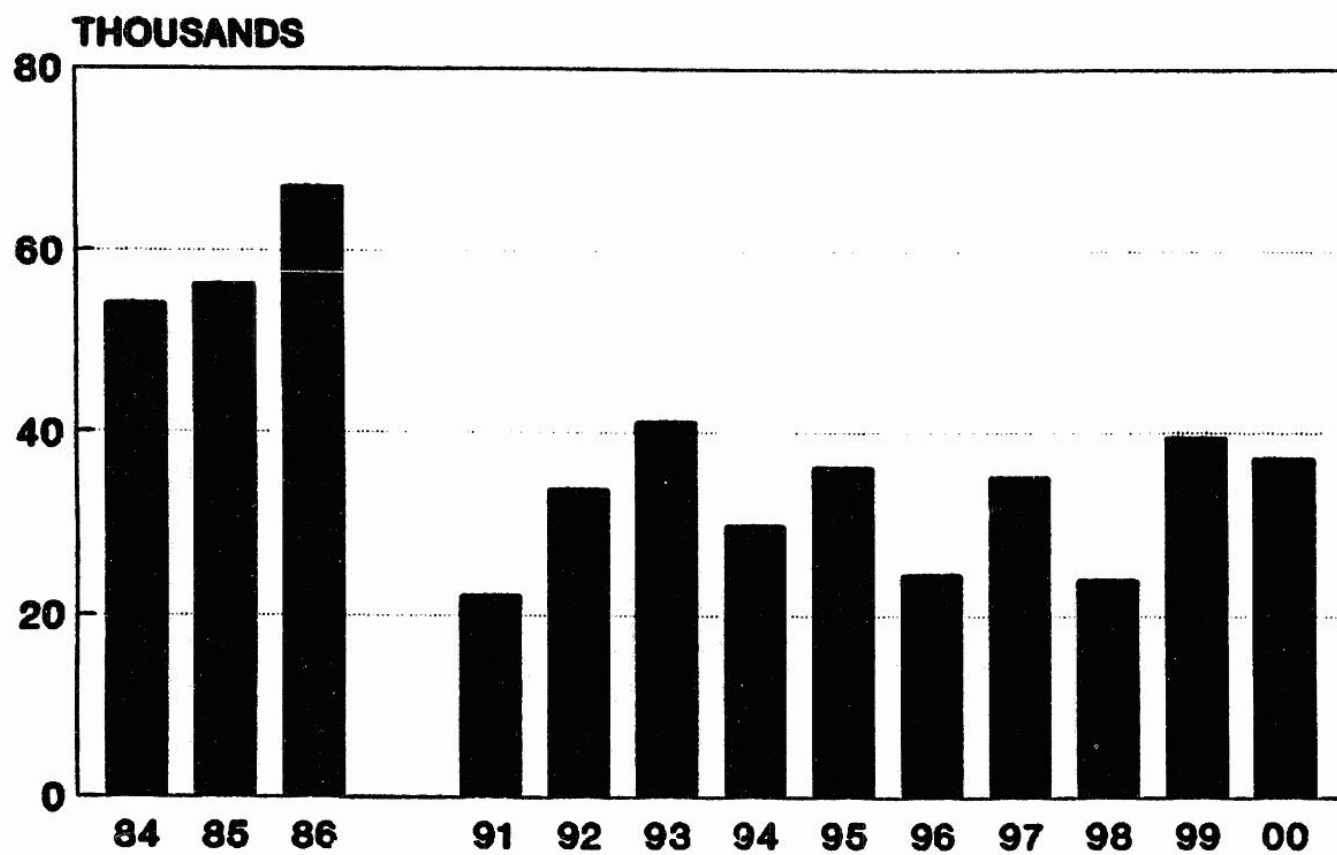


# ENGINEERING GROWTH



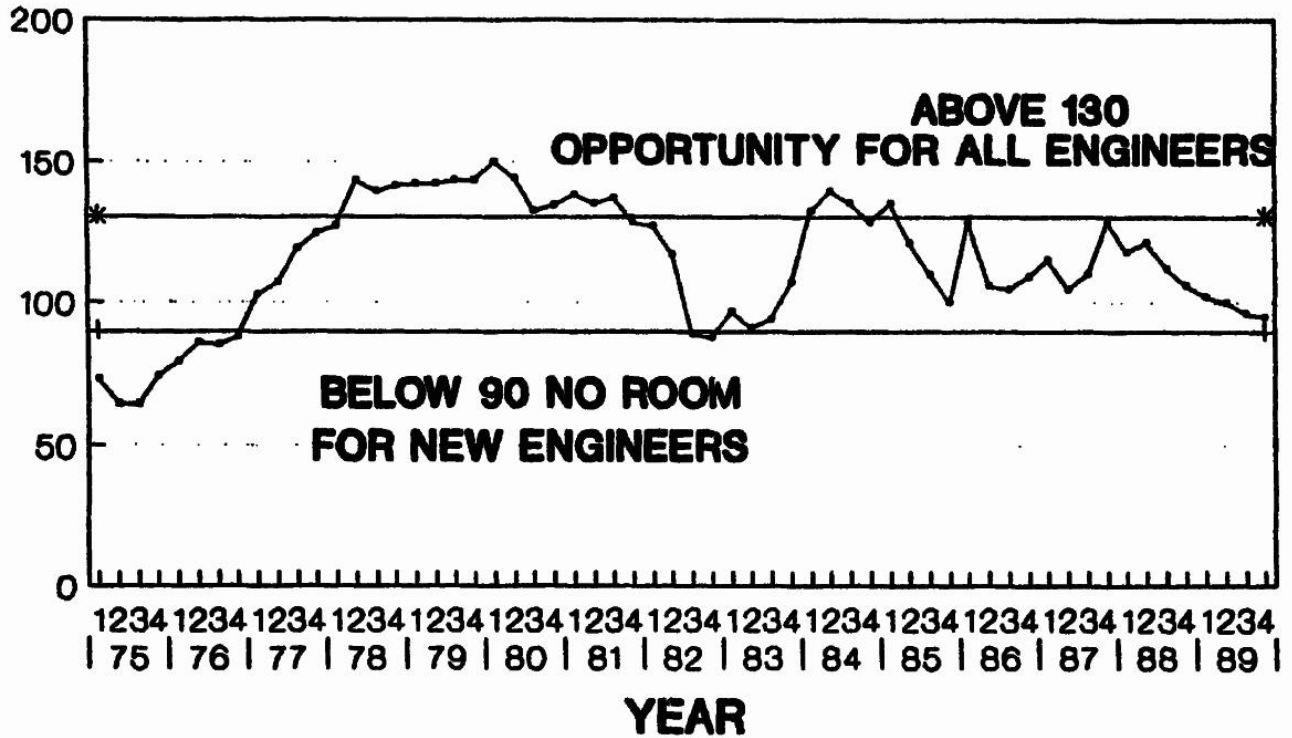
DATA FROM NSF  
**FIGURE 6**

# ENGINEERING GROWTH



ALL DATA FROM NSF  
FIGURE 7

# DEUTSCH, SHEA & EVANS HIGH TECHNOLOGY RECRUITING INDEX



1961- 100 BASE  
FIGURE 8

# NUMBER OF ENGINEERS BLS SURVEY DATA

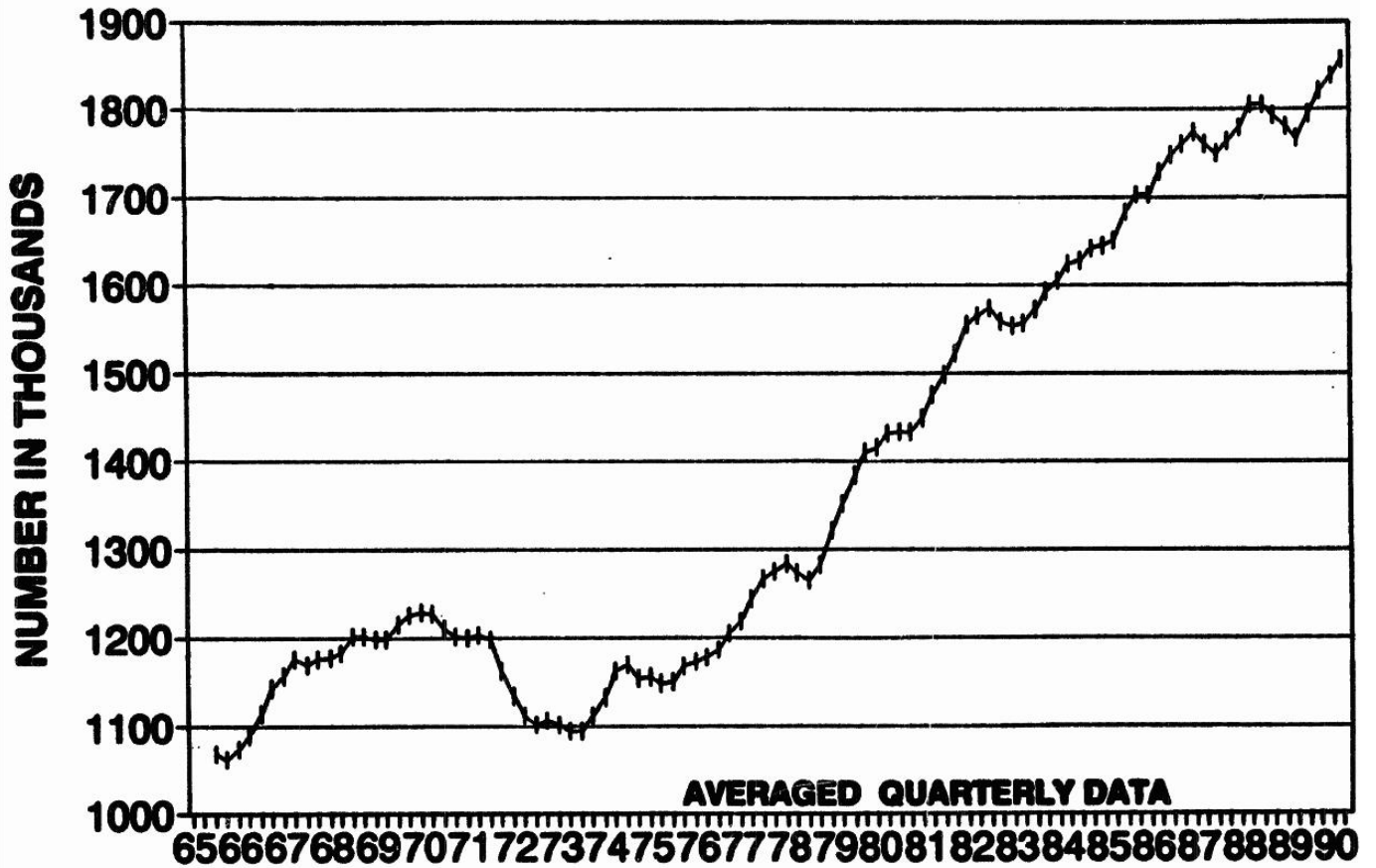


FIGURE 9



## EE Division Chair's Message

### Too Few or Too Many?

Until the last year or so most would have agreed that America has been producing too few engineers, EE included. Even in 1985 when we produced the largest number of engineers ever, the unemployment among engineers was running right at two percent. Now with America producing only 70% of that number many today are shouting that we have too many engineers. These individuals are forcefully demanding that there should be no recruiting of precollege students; some even say that there should be caps placed on the number of students admitted to engineering schools. They base their concerns on the premise that the peace dividend will force large layoffs in the government sector and that a weakened US economy will not be able to absorb these laid-off individuals, as well as, a large number of new graduates. The National Science Foundation in a recently completed study cites quite the opposite concern. In their study they predict that the US will face a growing shortage of scientists and engineers - over 500,000 by 2005. They go on to say that such a shortage if even only half correct will force America to fall even further behind in its ability to compete. So who is right?

Since no one can guarantee the future no one can be said to be right or wrong until the future becomes the present. However, what we do today can affect the outcome of our future. What we choose to do as a nation, then, should be chosen so that even if we err it will have the least consequence to our future. It is useful to examine the consequences of increasing the production of engineers and compare it to decreasing the production. We will examine the worst-case scenarios of either consequence. First we'll examine decreasing production.

Let's assume that we can by placing restrictive caps on admission limit the production of entry level engineers so that the number of new engineers matches the number of engineers that are retiring or otherwise leaving the occupation. This cutback should guarantee that displaced engineers due to government cutbacks and loss of jobs in the civilian sector will have a good chance of finding employment. In the ideal every displaced engineer gets rehired within a few weeks and engineers enjoy full employment. This scenario is not too different than what is actually happening today since unemployment is running at about 2%, nearly full. The negative side to this scenario is that should there be opportunities for expansion there will not be sufficient engineers to hire. Further, full employment presumes that there is an available engineer with the right background and skills to match every available open-



Albert Rosa

ing that becomes available. Trying to find that engineer, should he or she even exist, will be difficult to say the least. With a limited number of available engineers there will be a lot of "round pegs" in "square holes." The best that this scenario seems to promise is a status quo with little chance of recapturing American technological superiority. The worst is increasing lack of competitiveness and more layoffs resulting in fewer engineers needed until America ceases to be a technological power as the spiral collapses.

Let's see what the best and worst of producing too many engineers produces. Let's assume that pre-college students see engineering as a key piece in the puzzle in helping America regain its competitive spirit and flock to the major in large numbers. The best that can happen is that these young engineers will fill all positions available, the companies choosing the right peg for the right hole. These companies become very competitive, as new ideas flow into the firms. Older engineers return to school, short courses and conferences to stay competitive. As companies grow, more engineers are needed to meet the growing demand. America regains its competitive edge in the world marketplace. The worst that can happen is that too many engineers are produced. Many of the weaker graduates that can't find engineering jobs must seek employment in other fields. Some older engineers displaced by younger engineers find that they are unwilling or cannot compete and are laid off. These too are forced into other fields of employment. In general, many engineers voluntarily leave the profession after twenty or so years, some even sooner. They take superior problem-solving skills and generally, a superior work ethic with them. While for many this change in careers will cost them some income, most will find challenging employment. These individuals will usually succeed over others without the engineering training. Hence,

other segments of our service or manufacturing industries will be strengthened.

It seems clear to me that to err in the direction of too many engineers is a win-win situation for America. Japan, for example, produces about twice as many engineers per capita as America and it doesn't suffer from oversupply.

Shortages of engineers exist in Germany, France and even India - where until now, a large number of America's engineering talent came from. While too many engineers may keep salaries down and force some engineers to do something other than engineering, the consequence of too few engineers is far more nefarious.

### ***NEEDHA Chairman's Message***

The NEEDHA Board of Directors met in Chicago in September of 1990 and one of the issues brought to our attention was a Draft Report authored by Russel C. Jones as Chairman of the Ad Hoc Committee to Review Engineering/Engineering Technology Interrelationships. Our concern was that this report drifted far afield of the topic of the committee title and also with the content of the report.

The subject of their Scenario Four sounds like a good idea until you read about what it includes. It included 10 proposed elements. I cannot include the entire response letter since it was three pages long. The following are excerpts from the letter where quotations "" are from my response letter and comments in single "" are quotes taken from their draft which were used in my letter.

"Universal licensure is fine as a goal, but not as a demand. Not all engineering positions have a real need for registration." We also felt that degreed, practicing engineers without a P.E. are professionals, although the draft claimed otherwise.

"Creating a true generic 'pre-engineering' baccalaureate, as you call it, would not attract more people to study engineering. In fact, it would do quite the opposite. Enrollments are low now and adding a year or two to get the 'true, accreditable, licensable degree' would make engineering even less attractive than it is now to high school students."

"We do not feel that the 'first professional degree', the name you give the advanced engineering degree, should be a requirement for licensure. In fact, we question whether the degree we now offer should be a prerequisite for registration. We also feel that it should not be up to ABET to decide this issue."



**Roney J. Soukup**

"Your first paragraph says that you want to create a 'comprehensive engineering professional model.' We feel that this would be a serious mistake. Engineering is a broad, diverse profession and there is now and should always be more than one model for engineering professionals."

"The adoption of ABET advanced level accredited engineering program has been opposed by NEEDHA since NEEDHA came into existence. This opposition comes from the entire membership, not just the BOD and is emphasized at every meeting we have."

There is much more in my three page letter in response to Dr. Jones' 12 page draft. If you would like a complete copy, you can write to me. I hope to report on the annual NEEDHA March meeting in my next message."