

**IEEE
Education
Society**



Newsletter

Winter 1991

**ASEE
Electrical
Engineering
Division**



Engineering Education: the Next Century

Introduction

Study and scrutiny of what we do, what we should do and what the future should bring are not new for engineering education. Rather, it almost seems to be the norm. During the 1980s alone there were at least nine major studies and reports (1-9), each of which analyzed and diagnosed the ills of the engineering education enterprise and prescribed remedies. Increasingly, individual faculty and institutions are seeking and implementing innovation in the educational experience offered to engineering students.

When we step back and review the reports, the proposals, the discussions, along with what engineering faculty and their administrators are doing, a picture emerges that suggests engineering education is on the verge of a period of change that promises to be both broader and deeper than any we have seen in the past several decades. The answers to four questions should help us to understand better what this change may be.

1. What is the nature, scope and direction of the change that seems to be evolving?
2. What parts of engineering education do we do best?
3. What parts of engineering education appear to have been neglected?
4. What parts of engineering education appear to be prime candidates for significant change?

Nature, Scope and Direction of Change

Several indicators suggest that significant change is part of the future for engineering education.

1. Society appears to be recognizing that engineers are the ones to solve many of the most pressing societal problems.
2. The demand for increased breadth of engineering education--for both technical and contextual aspects--seems to be accelerating.
3. The baccalaureate in engineering is seen as a four-year program followed, with increasing frequency, by full-time study at the masters level.



Edward W. Ernst

4. A broader range of career opportunities for graduates of engineering programs is developing, at both the undergraduate and graduate levels. Career opportunities will include not only the ones we regard as central to engineering: research, design and development; and those a majority of our graduates now pursue: marketing and management; but an even broader array: systems analysis, politics, entrepreneurship, and others. This emphasizes one of the trends for the future of engineering education: the increased diversity of the career opportunities and the corresponding need for increased diversity of the engineering education programs.

Best Aspects of Engineering Education

The present programs in engineering education, particularly at the undergraduate level, are especially strong in a number of aspects--including our ability to teach

1. Technical content.
2. Techniques for analysis, modeling and simulation.
3. Design.
4. Problem solving.

Neglected Aspects of Engineering Education

By comparison the present programs in engineering education, seem to have neglected several aspects, including the following:

1. The capability for teaching:
 - a) Problem statement and problem formulation.
 - b) Contextual issues (economic, political, societal, environmental).
 - c) Communication skills.
 - d) Business related topics.
2. The use of innovative methods for the delivery of education.
3. Faculty/student interaction for the development of students as creative professionals.

Candidates for Significant Change

Six aspects of undergraduate engineering education seem to be the most likely areas for change in the next decade. For each of these, pilot projects are either underway or in the planning process in one or more institutions.

1. The focus for the undergraduate program will shift from the content of the courses to the development of young people as emerging professionals. Course content will continue to be important but the attitudes and capabilities students develop during their educational experience will be recognized to be as important as the content that is presented.

2. The four-year baccalaureate engineering education will be designed "... to provide the knowledge base and the capability for life long learning." (8)

3. Engineering as a topic for study, including problem definition and problem formulation as well as problem solution, will be introduced early in the undergraduate program, perhaps the freshman year. The motivation this furnishes will "drive" other aspects of the educational experience.

4. The emphasis in the undergraduate program will shift from almost exclusive attention to the technical or the technical/economic axes to technical/economic/societal/political/environmental axes.

5. The educational delivery system has had relatively little change and seems ripe to benefit from recent advances in computers, communications and information processing. Computers, along with video and audio storage and retrieval will be combined with telecommunications in ways that will allow new, enhanced educational delivery that is more responsive to the needs of the individual student than we have been able to offer.

6. Future uses of computers will recognize that computers have changed the way engineering is done, the way engineers understand engineering, and should change the way engineering is learned.

Impact of These Changes

At present the lecture drives the education of the student. The future will see the education of the student driven by faculty/student interaction. The role of the lecture as **dispenser of information** will continue and will be supplemented by video,

communications and computers. Students will **learn to learn**, will learn to use multiple learning resources. **Students-learning-from-students** will be recognized as a significant factor in the learning experience and will be used as a critical part of the education of students.

The learning experience of students will use as a paradigm a **student/faculty partnership** in learning in which the faculty role is that of helping the student design and manage the learning.

The traditional format for engineering education includes little engineering content in the freshman or even the sophomore year. That which is included is focused on the development of methods of analysis or the development of skills and, thus, fails to convey the excitement of engineering. Future students will be involved in the definition of problems and will understand that defining as well as solving the problem is what engineering is about. Students will be put in a position where they are forced to seek additional information beyond what is covered in the class or what is "in the book." They will become active, aggressive learners. Freshman, sophomore courses in the engineering program have become "compartmentalized" encouraging the students to learn only that needed to pass the test and then forget that as the relationship to other courses in the curriculum is neither understood nor believed to be important. The studies in the first two years of the engineering curriculum will be integrated or, at the very least, be presented in such a way that the student is helped to integrate the material presented. This is particularly true of the math, science and engineering taught at this level. One can use the engineering taught as the basis for integrating the mathematics and science into the engineering curriculum. The common core of technical studies in the first two years is to be a functional core. It is imperative that the material for the first two years of the engineering program be presented in a manner that helps the student to integrate the material and to relate each part to the other parts.

Computers are presently focused on roles as giant calculators and as large, accessible file cabinets. Now the capability of computing systems, communication systems, and other elements of our information age allows us to plan innovation that will expand the intellectual efforts of an individual just as the development of mechanical and electrical machines has expanded the muscular efforts of an individual.

The preceding changes in the undergraduate program will **make the study of engineering more attractive** for undergraduate students. Other steps that strengthen and enhance faculty-student relationships as well as those that strengthen and enhance student-student interactions will also serve to make engineering a more attractive area for study. This, in turn, will increase the retention of students in engineering. (Retention of engineering students is the fraction of those students who start the study of engineering at a given campus [as freshmen] and also graduate with a baccalaureate in engineering.) The increased retention will increase the number of engineering graduates with no increase in the number of students that are attracted to the study of engineering. The potential for increasing the number of engineering graduates from under represented groups may be even higher as the retention for these groups is usually below the average for all students in engineering. Improved retention is a significant key to the engineering pipeline problem as this will:

1. Increase the number of graduates with no increase in the number who start the study of engineering;
2. Attract more students when those studying engineering are seen by others to be successful in this endeavor;
3. Increase the number of students from under represented groups graduating and attract more students from these groups to the study of engineering.

Faculty

In any plan for changing engineering education, it must be recognized that the faculty is central to the quality of engineering education and changes will occur only through the participation of faculty members who bring their experience, capability and enthusiasm to the task. Unfortunately, there is considerable anecdotal evidence that a significant fraction of engineering faculty are either avoiding participation in undergraduate engineering education efforts or are giving this part of their responsibility a very low priority. Most of the discussions suggest that the relatively low priority given to undergraduate teaching by the faculty reward system is the reason faculty give undergraduate teaching such a low priority. Although this may be true, the unattractiveness of undergraduate teaching may be even more responsible for the widespread apathy toward undergraduate teaching by faculty. Thus, the changes made to the undergraduate program should be done in such a way as to make participation in the teaching effort more attractive and more meaningful for faculty. Undergraduate teaching should be regarded as a teaching opportunity rather than a teaching load.

One of the neglected areas for which new approaches are needed is that of improved and strengthened student-faculty relations to give greater emphasis to the development of students as emerging professionals. Increased student-faculty interaction is usually seen as requiring more time for faculty than present approaches to undergraduate education. Fortunately, this need not be so. The focus for student-faculty relationships should be on management of the student learning experience. The faculty role should be that of helping the student manage the learning experience, to use the student's time and effort effectively in meeting the goals that have been set. In this model—with the student as an active, aggressive learner—the availability of the individual methods for educational delivery (computers, video, telecommunications) become significant and are part of the resources for learning to be managed.

A Look to the Future

In December, 1989, under the sponsorship of the National Science Foundation, the National Academy of Engineering conducted a workshop entitled, *Engineering, Engineers, and Engineering Education in the Twenty-First Century*. The participants were challenged by questions in three main categories:

1. The future work environment for engineers
2. Necessary future engineering skills and competencies
3. The future form and content of engineering education

Five dominant themes emerged from the discussions:

1. The scope, diversity, and depth of engineering have grown immensely and will continue to do so in the twenty-first century.
2. To meet future opportunities and needs in engineering, vastly greater numbers of people must be attracted to the profession than at present.

3. No single, four-year college curriculum can give the full array of technical and contextual knowledge needed for the diverse span of engineering careers.

4. No single institution can encompass the full range of engineering courses, contextual courses, and auxiliary courses needed to educate all types of engineers needed by our society

5. A diversity of institutions with consortia, coalitions and networks among these institutions will be needed to meet these challenges.

The primary impression from the workshop is that of **diversity** for all categories of challenges given to the participants. **Diversity** in the engineering workplace, **diversity** in the skills and competencies needed, **diversity** in the form and content of engineering education.

The demands this creates for engineering education are particularly piquant and the engineering education enterprise will be particularly hard pressed to make an adequate response. This will require: **More innovation** in the learning environment, methods of delivery, the curriculum the way the student learns, the way engineering education is done; **More diversity** in programs, in kinds of institutions, in faculty interest, in students; **More sharing** of resources, both human and curricular. This picture is in sharp contrast to much of what we do now.

Major Reports On Engineering Education During The 1980s

1. 1981- "Engineering Education: Aims and goals for the '80s." Proceedings of an Engineering Foundation Conference
2. 1983- "The Undergraduate Engineering Laboratory." Proceedings of an Engineering Foundation Conference
3. 1984- "Mid-Course Corrections in Engineering Education." IEEE Centennial Education Forum
4. 1985- "Engineering Education and Practice in the United States." National Academy Press
5. 1986- "Undergraduate Science, Mathematics and Engineering Education." National Science Board, NSB 86-100
6. 1986- "Quality of Engineering Education." *Report of the Quality of Engineering Education Project*, ASEE
7. 1986- "Engineering Education Answers the Challenge of the of the Future." *Proceedings of the National Congress on Engineering Education*, ABET
8. 1987- "A National Action Agenda for Engineering Education." A Report of the Task Force, ASEE
9. 1988- "Report of the 1988 NSF Workshop on Undergraduate Engineering Education," pp. 51-55, NSF 89-3, *Report on the National Science Foundation Disciplinary Workshops on Undergraduate Education*

42 Maple Street
Auburndale, MA 02166
April 2, 1992

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

Dear Congressman Wolpe:

Further discussions with Ms. Edith Holeman and my observations convince me that there is a serious problem with the NSF than just the discredited engineering forecast numbers. First, the discredited numbers that have been quoted by nearly every engineering academic to recruit young women and minorities into science and engineering. Samples are attached.

The net effect of what has been done is to cause the "best and brightest" to choose other careers. Even NSF work has documented this effect. Clearly this is not in the national interest.

The more serious question is what is to be done to prevent this action in the future? First, the initial releases received wide publicity in the press. That same level of publicity has not been provided by those who have proved the data to be incorrect. Senator Kennedy from Massachusetts has used the data for the basis of the new immigration bill.

In the past, the NSF has been criticized for a counting of engineers that differs with the US Department of Labor. The April 17th, 1989 article in the Electronic Engineering Times describes a University of Michigan study on the deficiencies in the NSF counting of engineers.

Let me suggest a remedy that may help to overcome the damage done to many young people provided inappropriate advice based on NSF publicity.

- 1) A press release be issued clearly discrediting the previous work in projecting shortages. This action should be taken by no later than May 1st 1992.
- 2) The NSF, subject to oversight, be required to determine where their projections were used to establish public policy and publically recommend reversal of the policies or laws based on research.
- 3) All programs financed to increase the supply of engineers by the NSF be immediately terminated at the end of the current academic year (May 1992).
- 4) All academic institutions using the discredited numbers to recruit young people after the press release be declared ineligible to receive federal funding for engineering programs two or more years after they have made these statements.

Congressman Howard Wolpe

April 2, 1992

-2-

Second there is an even more serious problem in the NSF funding of many science and engineering programs in academia. Approval is done by "Peer Review." This inbreeding of research does not lead to the innovation we need to compete in the 20th century. Professors use the research funds to get the lowest paid, hardest working graduate students. American students find this environment unsatisfactory and tend not to get advanced degrees in science and engineering, except at the best institutions, where this is less of a problem. This situation is somewhat more complicated, but is like Gresham's law of coins. The cheap coins drive out the good ones, so it is with students. The solution is to limit funding for research to US citizens. A foreign graduate student could not be funded from US taxpayer funds.

The NSF has been known as an organization primary funding academic research. Many times, faculty members will take a period of time to work at the NSF and later return to their institutions. They may even make judgments on programs to be financed by some of their colleagues during the time they are at NSF. The Publish or Perish environment is funded by the US taxpayer. The fundamental issue is, are we getting our money's worth from the activities of the NSF?

Sincerely,



John P. Densler
617-244-4417

FILE COPY

42 Maple Street
Auburndale, MA 02166
March 11, 1992

Dr. Saul K. Fenster
President
New Jersey Institute
of Technology
323 King Blvd
Newark, NJ 07102-9938

Dear Dr. Fenster:

In the Summer 1991 issue of Planning for Higher Education, you coauthored an article titled, "Attracting Blacks into Engineering." In that article you included a statement, "By the year 2010, the United States could face a shortage of a half million technically trained professionals."

Your source of data can be indirectly traced back to the National Science Foundation. The study has been widely discredited, by no less than the National Academy of Engineers. A copy of Alan Fechter's paper has been enclosed for your information.

You and others that quote a study that is technically deficient in methodology and widely discredited are doing a disservice to young people that may choose to study engineering. What will you tell them when they have trouble finding jobs when they graduate or are terminated after 40 years of age and no longer can find professional employment?

I find serious ethical considerations in what you are doing to young people. You either knew or should have known that the NSF study had serious defects in its methodology.

Minorities and women have been able to determine where the rewards are in our society. They have been choosing careers in accounting, business, and law. These areas do not need to use exaggerated forecasts of future needs to recruit young people. Why do you and others use these unethical methods?

Sincerely,



John P. Densler
617-244-4417
att.

cc
Bob Bruce, American Engineer
Dick Lowrie, ACE News
Bob Bellinger, EE Times

FILE COPY

42 Maple Street
Auburndale, MA 02166
March 11, 1992

Letters to the Editor
Fortune
Time & Life Building
Rockefeller Center
New York, NY 10020

In Fortune People (March 23, 1992) you tell about Jack Kuehler, President of IBM visiting schools during Engineers Week to encourage students to study engineering. The article quotes Donald Beall of Rockwell saying, "Every long-term projection that I've seen suggests that we're going to have a continuing significant shortage of engineers and scientists in the decades to come, unless we get at it."

The widely quoted NSF engineering and scientist shortage projection has been shown to be defective research, by no less of an authority than Fechter from the National Academy of Engineering. Many business leaders have used this bad research to recruit young people, especially women and minorities into engineering and science. This is unfortunately not in their best interest as the career long rewards are much better in law, accounting or business.

The layoffs and age discrimination in engineering are heard by young people in their neighborhoods and have resulted in decreased enrollments in engineering programs. Rather than correcting inherent problems in the employment of engineers, these industry leaders choose to simply recruit another group of students. They avoid the issues of retraining experienced technical professionals in favor of layoffs and early retirements.

John P. Densler
617-244-4417

Annual surplus of 10-15k EEs predicted

By MARGARET RYAN

A recent issue of *Engineering Manpower Newsletter* disputed the prediction that there will be a shortage of engineers by the year 2000, concluding instead that "the decade of the '90s will produce an annual surplus of 10,000 to 15,000 electrical engineers per year." In addition, the newsletter reports that unemployment among electrical engineers is on the rise and will continue to increase until the first quarter of 1991.

According to Robert A. Rivers, the editor of the newsletter, the pool of working engineers will grow faster than the demand in the next decade.

With existing working engineers, BSEE and BSET graduates, immigrant engineers and the untapped supply of mi-

norities who could become engineers in the 1990s, Rivers argues there will be 10,000 to 15,000 more engineers than will be needed to meet industry demand. The figures do not take into account any possible effects of Pentagon budget cuts.

Paired with an engineering work force that expands at the rate of 35,000 per year, according to trends from the Bureau of Labor Statistics Current Population Survey, "the excess supply will result in early retirements, inability for some engineering graduates to obtain engineering employment and disaffection of engineers to other occupations during their careers," Rivers contends.

Rivers isn't concerned that his projections are at odds with those released by the National Science Foundation in Novem-

ber 1989, which project a shortage of 560,000 scientists and engineers in the United States by 2000.

"The NSF's numbers are based on Erich Bloch's preconceived notion of a shortage and a projection from the early to mid-'80s when engineering demand was higher because of the Reagan administration's defense buildup," Rivers explained.

Rivers, a retired engineer and member of the IEEE Engineering Manpower Committee who has reported supply and demand of engineers for many years, based his predictions on information on the work force and the economy from the Federal Reserve Board controlled quarterly average of the federal funds interest rate,

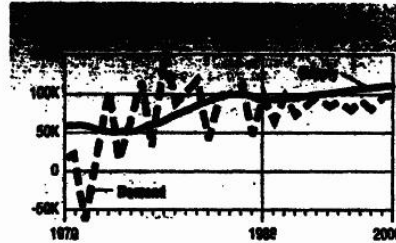
the Bureau of Labor Statistics Current Population Survey and forecasts from DRI/McGraw Hill, a Washington research think tank.

He suggests NSF is using en-

on economics, not NSF projections. He cited a book by Harvard University professor Richard B. Freeman, entitled *The Market For College-Aged Manpower*, in which Freeman found a correlation between the changes in engineering college freshman enrollment and changes in engineering starting salaries.

The current economy could steer next year's college freshmen away from engineering. According to Rivers, engineering unemployment averaged 26,000 during 1989 and grew

to 37,000 in the first quarter of 1990 and to 39,000 in the second quarter just completed. It is forecast to grow to 42,000 in the first quarter of 1991 and then to decline.



gineering shortage publicity as a "scare tactic," to increase engineering school enrollment.

Rivers pointed out that such tactics are useless, since college freshmen choose careers based

Bromley Scoffs At Warnings Of R&D Manpower Shortage

Warnings of impending shortages of scientists and engineers have been a standard theme for decades in the science establishment's appeals for increased federal support for research and training. Having been repeatedly proclaimed, the shortage thesis has come to be accepted as reality in public discourse.

Lately, however, as skeptics raise doubts about the reliability of alarmist manpower projections, the Bush Administration has been discreetly distancing itself from the shortage camp. The strongest sign of repositioning is evident in a talk on September 11 by D. Allan Bromley, the President's Science Advisor, at a conference on "Engineers in America's Future. Shortage or Surplus," held in Washington by the Engineering Manpower Commission and the American Association of Engineering Societies.

Citing declines in the college-age pool and a shift away from science and math studies, Bromley acknowledged that "these trends would seem to indicate that this country faces rather severe shortages of scientists and engineers in the near future.

"But," he continued, "I have learned to approach these projections with some caution. Labor markets in this country are remarkably flexible. Particularly in engineering, where many baccalaureate-level engineers can be trained in just a few years, fluctuations in supply or demand generate quick responses."

The position stated by Bromley represents a remarkable turn-about in a relatively short time. In July 1989, at his confirmation hearing before the Senate Committee on Commerce, Science, and Transportation, Bromley matter-of-factly repeated the warnings of shortages that have long emanated from the National Science Foundation.

"NSF surveys," he told the Committee, "have already identified major shortages amounting to more than 100,000 computer scientists per year in the early 1990s and to corresponding shortages in the 35,000-50,000 range in many fields of engineering." He added that "There are corresponding shortages in biomedical science, in biotechnology and in the number of physicians committed to careers in research."

In his recent address, Bromley linked his conversion to an examination of the prophetic powers of the alarm criers. Referring to a retrospective study of manpower modeling and forecasts conducted for the National Science Foundation by Ronald L. Oaxaca and Larry Leslie, economists at the University of Arizona, Bromley said: "None of the models of interest to policymakers had much validity beyond one year. By the end of two years, the model predictions were almost invariably worthless. In these cases, it is the demand numbers that turn out to be wrong; supply numbers are relatively easy to obtain from the educational pipeline and are relatively reliable."

Bromley then turned to history to support his skepticism. In 1962, he recalled, a panel of the President's Science Advisory Committee, responding to a widespread perception of impending shortages of personnel for the nation's space and military programs, recommended a crash program of support for students and universities.

"Universities responded enthusiastically—in retrospect, much too enthusiastically—so that the 1970 manpower goals were achieved in 1967, and, not surprisingly, the crash program was terminated," Bromley said. He added, "The large number of students, particularly doctoral students, educated in the 1960s in the

crash program had difficulties finding employment in the 1970s. Media reports of these difficulties—frequently exaggerated—inspired a new generation of students to shy away from graduate training in science and engineering."

Bromley assured his audience that he wasn't pointing to a reduced federal role in science and engineering training. But, he continued, "the fundamental uncertainty surrounding manpower projections... emphasizes that in training scientists and engineers, we must focus on flexibility and versatility," so that engineers can shift employment as market needs change.

Bromley's reversal on the shortage issue did not affect his standing plea for efforts to encourage more American students to pursue science and engineering careers. He tied that goal to the possibility that many of the foreign students who now fill engineering classes and remain to work here may eventually be lured back to their homelands. And he reiterated the Administration's call for upgrading science in the schools.

This campaign, a centerpiece of Mr. Bush's anemic domestic program, has been aimed at the dual goals of raising scientific literacy in the workforce and putting more students into the educational pipeline that leads to PhDs. Bromley left the impression that the Administration's thinking on advanced training and US manpower needs is in an inchoate state.

Bromley told the meeting of engineers that he endorsed a proposal by Roland Schmitt, President of Rensselaer Polytechnic Institute, for "engineering-based liberal education." The aim would be, Bromley said, to prepare engineers to go on to "broader managerial roles," and to enrich the education of non-engineers.

In support of this proposal, Bromley cited an odd couple: "People trained as engineers are now making many important contributions to society—Boris Yeltsin and John Sununu are only the two examples that come most immediately to mind."

Meanwhile, the belief that the nation is short of scientists and engineers persists as a popular article of faith, though in many fields, jobs are scarce. An editorial in the *Washington Post* on September 21, "Math, Science, and Uncle Sam," argues for improving the quality and extent of science in the schools. Tests show American students perform poorly in math and science, the editorial states, adding, without explanation: "The evidence also lies in the debilitating shortage of American scientists."

On Capitol Hill, the manpower alarms have drawn the skeptical interest of the Subcommittee on Oversight and Investigations of the House Science, Space and Technology Committee (*SGR* September 15: "Scientist Shortage? House Committee Requests Data"). Heaps of data requested from NSF were delivered to the Subcommittee last week and are now being examined by the staff. No decision has been made at the Subcommittee on the next step, if any.

In political terms the skepticism works against calls for a major new federal fellowship program to counter warned-of shortages. The leading proponent of the fellowship drive is Richard Atkinson, Chancellor of UC San Diego. Two years ago, Atkinson calculated, in a widely publicized paper, that a major shortage of PhDs in science and engineering would peak in about 15 years, with demand at about 18,000 new degree holders and a supply of only 10,500. At present, foreign students account for 30 percent of the PhDs in the physical sciences, 50 percent in math and 60 percent in engineering.

By Atkinson's account, the future is bleak and no time should be lost in providing incentives for Americans to proceed through advanced training.

The evidence in these matters is murky, neither fully supportive of the shortage school, nor conclusive in behalf of the new skeptics. It should be noted the Bromley is merely arguing that the warnings of shortage have proven wrong in the past. He has not dismembered the latest round of warnings.—*ESB*

(This article reprinted from the Oct. 1, 1991 issue of "Science & Government Report", with permission of Daniel S. Greenberg, Editor & Publisher.)

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THE POST OFFICE WILL NOT DELIVER THESE ENVELOPES! To continue to use these envelopes will only cause all of us problems. We have not printed or distributed these envelopes in over a year. Thanks for your cooperation.

Robert A. Rivers, Ed.
 Engineering Manpower Newsletter
 PO Box 129
 Union NH 03887

Rep. Howard Wolpe, Chairman
 Investigation and Oversight Committee
 House Science and Technology Committee
 House Annex #1, Rm. 824
 Washington DC 20515

I wish to thank the committee for this opportunity to provide input for its investigations and oversight activity.

Enclosed are copies of a letter to Dr. Erich Bloch, a three page response from Peter W. House, and my subsequent letter to Dr. Block rebutting Peter House's comments. No response was ever received to my second letter. My comments refer to an April 13, 1990 Working Draft of "FUTURE SCARCITIES OF SCIENTISTS AND ENGINEERS: PROBLEMS AND SOLUTIONS". The report was misleading in stating that demand would exceed supply. It used a proxy for demand extrapolated from an abnormally high demand period in the mid-eighties.

The report introduces and defines the term "Shortfalls" saying first that "Shortfalls" do not mean Shortages yet, in a number of places in the report, the terms are used interchangeably including in the very last paragraph of the report, first and third sentences. The press and others interpreted it as a "Shortage" forecast and so used it even as late as last month.

The report and its originators should have been and still should be repudiated by the NSF because it discusses the supply-demand system in the U. S. on the basis of "Shortfalls", a characteristic of a COMMAND economy such as in the old Soviet Union or in the U. S. in WWII. For most of the last 47 years, we have had a MARKET economy in which prices adjust to efficiently distribute the supply of people as well as things. To even use the word "Shortage" or its euphamism is to confess to lack of even rudimentary knowledge of Economics 101. In a market economy, the inability of an employer to hire individuals below the market price does not prove a shortage but demonstrates an unrealistic attempt to buy cheap.

In summary, the NSF should not have used and should not in the future use the word "Shortage" or its euphamisms to describe the U. S. Engineering and Scientific labor markets. The NSF should be constrained from using "Shortage" projections to enhance the supply of engineers and scientists beyond the ability of a free market economy to provide career utilization of the societal and individual educational investment. To do otherwise is an irresponsible waste of scarce resources.

Robert A. Rivers
 Robert A. Rivers
 4/2/92

1261

Robert A. Rivers
P. O. Box 179
Union Nh 03887
603-473-2323

Dr. Erich Bloch, Director
National Science Foundation
Washington D. C. 20550

You do a disservice to the NSF and to Scientists and Engineers by allowing NSF to contribute ammunition to the "Engineering Shortage Industry" by the enclosed and similar articles. That "Industry" attempts to promote enrollments and supply for the benefit of the educational establishment and industry and to the detriment of the professionals. Such "Shortage" promotion diminishes the reputation of the NSF as a responsible organization. In addition, it does not accomplish its aim of influencing the college bound youths who respond to the real world of real money and career opportunities.

Where is the specific article misleading? In the title, "Demand to exceed supply for engineers", it is presumed the author knows something about demand while in the actual publication, page 8, "quantitative projection of the demand for individuals with NS&E knowledge and training is highly uncertain, and was not attempted in this work." That caveat destroys the demand side of the equation. Further "Even market forces may not help because similar shortages are expected in all academic fields and little correlation exists between the higher starting salaries in engineering and natural sciences and the number of bachelor of science degrees produced in these fields." In the report page 8 however "the subfields of engineering and computer science do show some response to relative salary changes," In addition, over 19 years ago a respected researcher, Richard B. Freeman, found "an extremely close connection between changes in enrollment and changes in engineering starting salaries ($r=0.71$, where the 1% significance level is 0.55)."

I suggest that the NSF refrain from supporting the "Shortage Industry" with support of slanted reporting.

Sincerely

Robert A. Rivers 5/15/90

NATIONAL SCIENCE FOUNDATION
1800 G STREET, N.W.
WASHINGTON, D.C. 20550

June 5, 1960

DIVISION OF POLICY
RESEARCH AND ANALYSIS

Mr. Robert A. Rivers
P. O. Box 129
Union, N.H. 03887

Dear Mr. Rivers:

Thank you for your comments on the engineering employment market. Mr. Bloch asked us to reply to your letter, since our analysis played an important role in developing his policies to encourage the production of more scientists and engineers. A copy of our discussion paper, "Future Scarcities of Scientists and Engineers: Problems and Solutions," is enclosed.

It is probably true that if the government were to subsidize or otherwise augment the production of engineers, engineering salaries would not rise as fast as without intervention, and that employers who need such talent would benefit in terms of reduced labor costs. It could be argued, on the other hand, that since engineering starting salaries are already among the highest for bachelors degree recipients, intervention to constrain the rapid escalation of starting salaries is socially beneficial.

Nonetheless, if the National Science Foundation were only concerned with the engineering professions, we might agree with your philosophy. As explained in the enclosed report, however, our concern is with the supply of both engineers and natural scientists. The analysis provides justification for treating these professions as a single pool of highly trained technical personnel.

It is the NSF position that for American industrial, governmental, and educational institutions to remain on the forefront of technical knowledge, they need a continuous supply of new scientists as well as engineers. In particularly short supply are the natural scientists (physical, life, and environmental science). In studying the production of natural scientists and engineers over the past three decades, we have found a remarkable complementarity between engineering and natural science bachelors degree production. Whereas participation in the engineering curriculum has varied by $\pm 50\%$, participation in the combined fields of natural sciences and engineering has varied only by about $\pm 10\%$. In other words, it appears that when the market doesn't demand engineers, persons who might have elected engineering pursue natural science

Mr. Robert A. Rivers

2.

careers instead. The new computer science profession is the only discipline which appears to have recruited additional individuals into the quantitative fields.

This stability in participation rate for the combined engineering and natural science fields suggests that there may be a relatively fixed fraction of the population with specialized interests and talent whose career choice is constrained to such fields. That is why we think it highly probable that the future annual production of U.S. bachelors degrees in these fields will closely follow the population of our 22-year-old citizens (Figure 1 in the paper) unless some effort is made to encourage a larger fraction of qualified individuals to choose those careers. With no change in participation, the annual production rate in the mid-1990s could be as much as 25% below the peak rate of 1986. This decline in production has already started, and could lead to a large cumulative shortfall over the next two decades (Figure 4).

How can we have a shortfall when we don't know what the demand will be? In fact, we used a simple constant demand projection for the future, equal to the average number of bachelors degrees granted from 1984 to 1986. So the "shortfall" is simply the cumulative deficiency from a constant production rate. There is an upward pressure on demand because of the increasing penetration of technology into all of our social functions. Downward pressure on demand might be caused by automation of simpler science and engineering tasks, increasing salaries, reduction in defense procurement, and loss of product markets to foreign corporations. However, we don't have enough data to determine even if the demand trend will be positive or negative. Many people consider the flat demand assumption a conservative estimate.

Of course, simply by making the concerned communities aware of this potential problem, we are inducing actions which will lessen its severity--that is Mr. Bloch's objective. Finally, even if not employed in occupations formally titled "scientist" or "engineer," many science and engineering graduates find their training to be beneficial in other occupations such as management, education, medicine, law, and business. We are well aware of surpluses of technically trained individuals created in the past due, in part, to Federal programs and have therefore cautioned that any programs started now may require termination in the future.

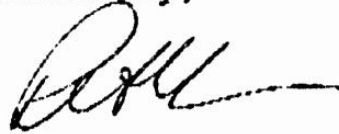
Mr. Robert A. Rivers

J.

Although the outcome of our efforts to stimulate the pursuit of science and engineering careers is difficult to predict precisely, the Foundation is convinced that the chance of beneficial results is far higher than negative results.

We appreciate your interest in these important issues.

Sincerely,

A handwritten signature in black ink, appearing to read "P. W. House", with a long horizontal flourish extending to the right.

Peter W. House
Director

Enclosure

1265

ROBERT A. RIVERS
P. O. Box 129
Union NH 03887
603-473-2323

Dr. Erich Bloch, Director
National Science Foundation
1300 G St. NW
Washington DC 20550

Reference: Reply to our 5/15/90 letter by Peter House

The arguments to support a policy to encourage the production of more scientists and engineers may apply to scientists but do not apply to engineers. I encourage any efforts to provide a scientifically educated population based on its necessity for a well rounded education in our times. Promotion based upon supposed shortages without foundation is intellectually dishonest and irresponsible in that it induces people to follow courses of study for careers that do not exist.

In paragraph 2, the facts are that over a 40 year period there has been no significant change in the real wages of engineers.

In paragraph 3, no justification for grouping engineers and scientists can hold water when we know that engineers are highly career oriented with more engineers employed than the last 40 years of BS engineering graduates living. The rest come from immigration and upgrading.

In paragraph 4, I have no argument with the facts, but suggest that any so called short supply can be traced to an unwillingness for employers to adequately compensate those scientifically literate individuals.

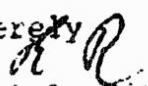
In paragraph 5, scare tactics are used to make the numbers big by accumulation over a period of time for which no-one can predict.

In paragraph 6, any shortfall argument is destroyed by the statement " we don't have enough data to determine even if the demand trend will be positive or negative."

In paragraph 7, " many science and engineering graduates find their training to be beneficial " would be more accurate if stated only for science graduates leaving engineering graduates only referring to engineering management.

In paragraph 8, " beneficial results " can only refer to employers of engineers and scientists, not engineers and scientists as individuals whose investment in career education may be destroyed by oversupply.

Sincerely,


Robert A. Rivers 6/11/90 ✓

Engineering and Electrical Engineering— Supply and Demand

ROBERT A. RIVERS
Main Street
Union, N.H. 03307

Abstract

Change in employment of engineers is shown to be related to the Deutsch and Shea Index of Engineering Demand. A relationship is given that shows the changes in engineering employment on a quarterly and annual basis. Engineering employment has turned upward for the first time since the last quarter of 1969. We have displaced and stored over 90 000 qualified engineers since 1969, in addition to displacing over 40 000 not qualified by an engineering education. Estimates by some of the need for 48 000 engineers per year is shown to be highly questionable. Current demand is still insufficient to absorb the current output without displacing some currently employed. It is suggested that demand in specialties can be determined by advertising lineage devoted to specialties in the same manner that the engineering demand is determined by the Deutsch and Shea Index. The years 1970, 1971, and 1972 were characterized by a decrease in employment of 62 000 engineers, 150 000 new graduates, 25 000 immigrants, and only 55 000 normal retirements and deaths.

Introduction

Many people are interested in the relationship between the Deutsch and Shea Index of Engineering Demand with the U.S. Bureau of Labor Statistics Current Population Survey engineering employment data. Changes in employment from this approximation are much smoother than the Current Population Survey sample and permit the development of an input-output table. The cumulative surplus or deficiency of engineers appears to correspond with reality in the period from 1962 to 1971. Continuation of the calculations through 1972 indicates a continuing buildup of displaced engineers. Engineering supply as characterized by the Bureau of Labor Statistics, or the Census Bureau, is a rather flexible quantity. A large percentage of engineers are non-degree holders. Another significant percentage of engineers are other than engineering degree holders. Again, not all engineering graduates stay in engineering occupations. The calculations shown tend to substantiate the fact that there is a large displaced pool of engineers that could be available if the society decides that it wants to support more engineering work with public or private funds.

The supply of engineers is determined by the output of the educational institutions, and the upgrading of experienced non-degree people. The demand for engineers is determined by the level of the economy and expenditures for future growth. While it would be desirable to be able to tell an individual just what the demand is for his services, we are far from the point of being able to address ourselves to any of the specialties of electrical and electronic engineering. We do have a statistical base available to address the problem of engineering in general, and, by inference, the problems of electrical engineering supply and demand. It is hoped that dedication to the collection of detailed electrical engineering statistics will produce results in the future.

Discussion

Table I is an input-output table for engineering supply and demand. It summarizes the supply-demand flows and shows the cumulative surpluses and shortages. It shows a cumulative surplus of 29 531 engineers in 1964, a year of engineering recession. It shows a cumulative shortage of engineers amounting to 5198 in 1967, at the peak of the Vietnam escalation. It also shows a cumulative surplus of 96 002 at the end of 1972.

The "degree" column of Table I is the number of engineering degrees awarded and projected to be awarded in the United States. The numbers are good out through 1976, because the class of 1976 is in the educational system, and these people are fairly well committed. Beyond 1976, the projections are based on a return to normalcy for which there is no supporting evidence. Engineering graduate starting salary data for 1973 does show a 4.8 percent increase for B.S. graduates over the 1972 figure. This number is in the middle of the range of increases over the previous years, and will probably result in a slight increase

Manuscript received September 1, 1973; rev. sec. September 20, 1973

growth of non-degree people in engineering started at 406 000 in 1960 and increased to 476 504 in 1970. Fig. 1(A) shows the cumulative growth of the total. The 39 percent due to non-degree people would amount to 18 000 in 10 years. The U.S. Census figures show about a 10 000 increase in that period. It is my conclusion that the above agreement within 11 percent over a 10-year period is sufficient evidence to give some credibility to the hypothesis.

While the 56 percent expansion figure has been crudely verified by the U.S. Census figures, the base to which the 56 percent has been applied has not been verified. The base for the expansion calculation is column 9 of Table I, entitled "Rivers delta". Fig. 2 shows a number of curves, including one entitled ΔDQ . In addition, an erratic curve of U.S. Bureau of Labor Statistics data on quarterly employment of engineers is included. At the present time, it is sufficient to say that our ΔDQ curve is a smoothed approximation to the Bureau of Labor Statistics employment data. It is to this approximation to employment that we have applied the 56 percent to get the inflow and outflow of non-degree and other-degree people.

Deaths are calculated on a basis of a weighting of mortality rates with the population of engineers in different age brackets. Fig. 3 shows the IEEE 1972 population distribution. We have used the 1969 Mortality Tables in Statistical Abstracts 1970. Fig. 3 also shows that the IEEE population distribution is roughly consistent with the 1972 U.S. Census Study of engineering population. Some corrections and redistributions have been made because of inconsistent age brackets. We have used the IEEE figure of 9.52 percent in the 55-65 age bracket and assumed a percentage of 0.952 percent of the population to determine the "retirements" column in Table I.

The "engineers" column is the total population of working engineers. Comparison of the various statistical series is made in Fig. 4. Verification is obtained with the U.S. Census data. The Bureau of Labor Statistics Current Population Quarterly Surveys appear to be consistent with the 1970 U.S. Census figures. It is hoped that this series of unpublished data can continue to be obtained to further confirm the value of the Deutsch and Shea Index in showing current changes in engineering employment.

The "Rivers delta" column is an annualized change in employment computed from the Deutsch and Shea Index. The Deutsch and Shea Index varies from about 40 to about 200. We have assumed that this demand index shows the pressures to increase or decrease engineering employment. Fig. 4 shows the actual quarterly increments of employment computed. A comparison with the raw Bureau of Labor Statistics curve and, especially, the smoother one in Fig. 2 shows excellent agreement. The curve match points were the last quarter of 1965, and the last quarter of 1969. The match data point from the Bureau of Labor Statistics data was with their 12-month moving average.

The "surplus or deficit" column of Table I is the sum of current inputs and outputs. It is equal to 58 percent degree + 56 percent expansion + immigration-deaths-retirements-Rivers delta. This column shows a surplus production of

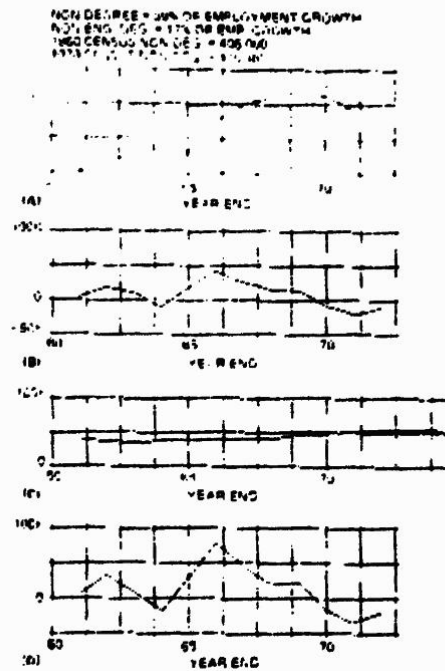


Fig. 1. (A) Cumulative additions of non-degree and non-engineering degree engineers. (B) Current inflow or outflow of non-degree and other degree engineers. (C) Engineering BS graduates including technology degrees. (D) Annual increase or decrease in engineering employment using author's approximation involving D&SI.

over 17 000 in 1964. It shows a deficiency in output of over 25 000 in 1966. There was a nominal excess supply in 1968 and 1969. The period from 1970 through 1972 showed annual excess outputs of over 27 000 each year. While it is not generally accepted that the recession continued through 1972, the employment statistics of Fig. 4 for that period show continued problems. The educational output and the immigration did not adapt to the demand during that period.

Fig. 5 shows graphically the cumulative surplus and shortage of engineers, as shown in the next to the last column of Table I. The cumulative surplus shows a peak of 29 531 in 1964, which we know qualitatively to have occurred. It shows a cumulative deficit of 5198 in 1967, which we also know qualitatively to have occurred. The same data shows a cumulative surplus of 96 002 at the end of 1972. I believe that this figure represents a combination of 2.5 percent actual unemployed and 5.1 percent displaced and qualified persons. It can not be said that this amount represents the non-degree and other degree engineers, because we have previously excluded them in the 56 percent expansion figure (11 430 were displaced in 1972).

Conclusion

There is a large stored supply of qualified engineers and electrical engineers available. The 1964 surplus was not used up until the rapid expansion of 1966. Similarly, the present available supply will not be used up unless we have

TABLE I

Year	Degree	58% Degree	56% Expansion	Immigration	Deaths	Retirements	Engineers	Rivers Delta	Surplus or Deficit	Accum Surplus or Deficit	Accum F.E. Surplus or Deficit
1960	37 679			3354	5040	7 591	796 700				
1961	37 528	21 750	+ 1 675	2896	5230	7 890	828 500	2 989	10 206	10 206	2 245
1962	36 070	20 900	17 500	2940	5490	8 260	869 400	31 377	- 3 787	6 419	1 412
1963	34 972	20 250	+ 5 450	4014	5800	8 740	918 300	9 720	5 450	11 873	2 612
1964	37 014	21 550	- 9 320	3725	5950	8 960	941 300	-16 613	17 658	29 531	6 497
1965	38 514	22 300	+14 800	3446	6670	10 060	1 057 000*	26 389	- 2 573	26 958	5 931
1966	37 972	22 000	44 200	4915	6980	10 520	1 107 000	79 186	-25 571	1 387	305
1967	38 693	22 400	24 700	8321	7350	11 070	1 163 000	44 086	- 6 585	- 5 198	- 1 144
1968	40 541	23 500	11 620	9313	7530	11 360	1 193 000	20 792	4 751	- 447	- 98
1969	45 517	26 400	11 720	7150	7720	11 620	1 222 000	20 981	4 949	4 502	990
1970	49 678	28 800	-10 925	9305	7560	11 400	1 198 000	-19 515	27 735	32 237	7 092
1971	50 046	29 200	-20 600	9015	7330	11 030	1 160 000	-36 847	36 102	68 339	15 035
1972	51 080c	29 600	-11 430	7436	7330	11 030	1 160 000	-20 417	27 663	96 002	21 120
1973	50 560			3060c							
1974	50 850										
1975	43 840										
1976	41 110										
1977	43 520										
1978	45 680										
1979	47 770										
1980	49 240										
1981	50 600										
1982	51 590										

Notes:

- Col. 2. Includes engineering technology degrees, estimates 1972 and after, from the U.S. Office of Education.
 Col. 3. This is 58 percent of the engineering degrees awarded, and represents the percentage that stays in engineering.
 Col. 4. 39 percent of the employment expansion is to cover non-degree people coming into or leaving the field. Another 17 percent of the employment expansion is to cover non-engineering-degree people who enter or leave the field. This hypothesis is verified within less than 1 percent by the accumulated surplus or deficiency (-51 986/1 163 000).
 Col. 6. Deaths are based on an average population sample equivalent to the 1972 Salary Survey, leading to a 6.322 per thousand rate.
 Col. 7. Retirements are based on propagation of 9.52 percent population in the 55-65 age group into retirement at 65.
 Col. 8. This is the number employed from two different series, the latter with corrections in 1972-1973.
 Col. 9. This is the computed employment expansion or contraction from the Deutsch and Shea Index, which equals $75 200 \times [(DSI - 90)/100]$, where DSI is the yearly average Deutsch and Shea Index.
 Col. 10. This is the yearly contribution to a surplus or deficit of engineers.
 Col. 11. This is the accumulated surpluses or deficits. It shows the 1964 recession surplus, the 1966-1968 shortage, and the massive surplus from 1970 through the present.
 Col. 12. This is the accumulated electrical engineer surplus or deficiency at 22 percent of the engineer population.
 *Changed series from National Science Foundation 68-38 to Bureau of Labor Statistics Current Population Survey (unpublished).

of students for the class of 1977. Relative starting salaries and their influence on course selection is treated by Freeman [1].

The "58 percent degree" column of Table I is the long-term yield of engineering students into engineering occupations. This illustrates the fact that most of those educated in engineering stay in engineering. Table 3.18 from the 1960 U.S. Census Study [2] of the college educated population shows 58 percent of the Bachelors degree holders staying in engineering. The percentage of Bachelors-plus degree holders is the same. The percentage for Masters degrees is 57 percent, and the Doctors degrees number is 80 percent. When the argument is made that many engineers go into other fields, the above figure will support such an argument. The majority, however, does not go into other fields. We have thus taken into account "loyalty" in determining the effective supply.

The "56 percent expansion" column is 56 percent of the

expansion or contraction of employment of engineers. It is made up of 39 percent to account for non-degree people taking engineering jobs and being classified as engineers. Table 4, "Age and Highest Degree, etc.," from U.S. Current Population Reports [3] shows 61 percent of those employed having Bachelors degrees or higher, leaving 39 percent without Bachelors degrees. The other 17 percent is to account for those with other than engineering degrees being classified as engineers. Table 4.2 from the 1960 U.S. Census Study [4] shows the sources of other degree people. No 1970 data is available.

I have hypothesized that entry and exit from engineering for the non-degreed and other degree people is a function of the growth or decline in employment. I believe that these two groups are drawn into engineering activities when there is a shortage, and are the first to go when there is a surplus. No study by survey techniques has been made, and no statistics are available to prove it conclusively, but the

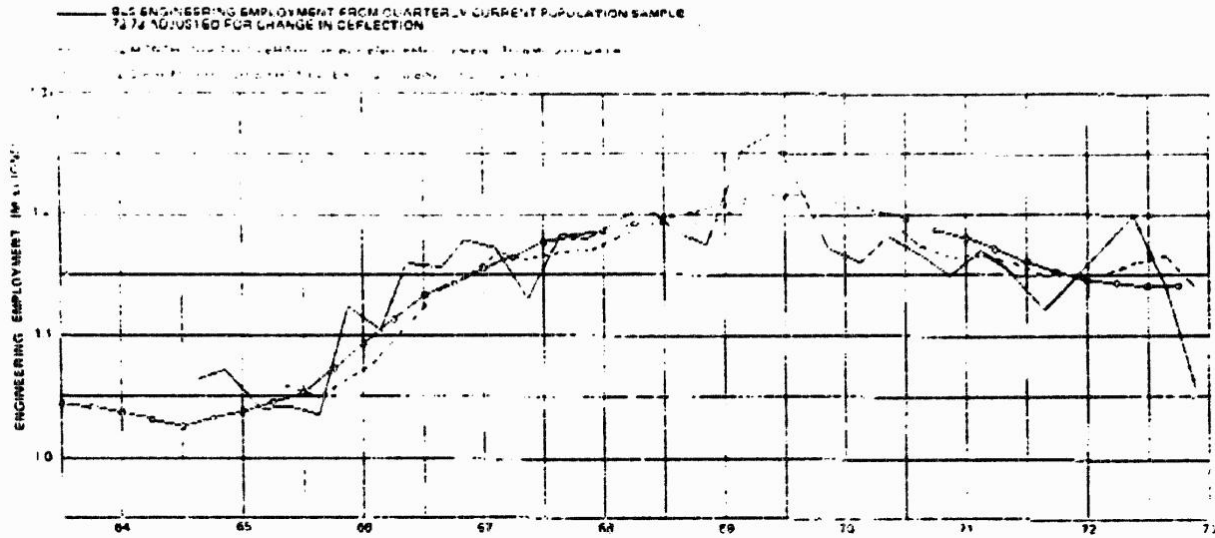
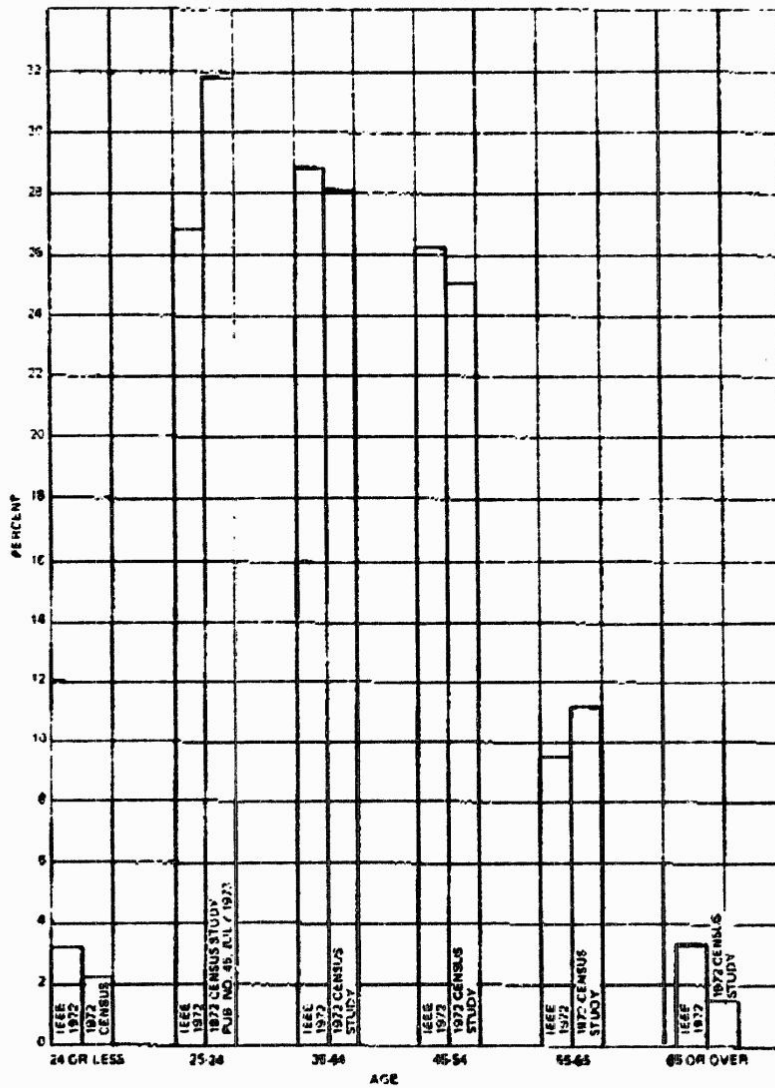


Fig. 2. Correlation of the Deutsch and Shea Index with Bureau of Labor Statistics unpublished data.

Fig. 3. IEEE and engineer population distribution.



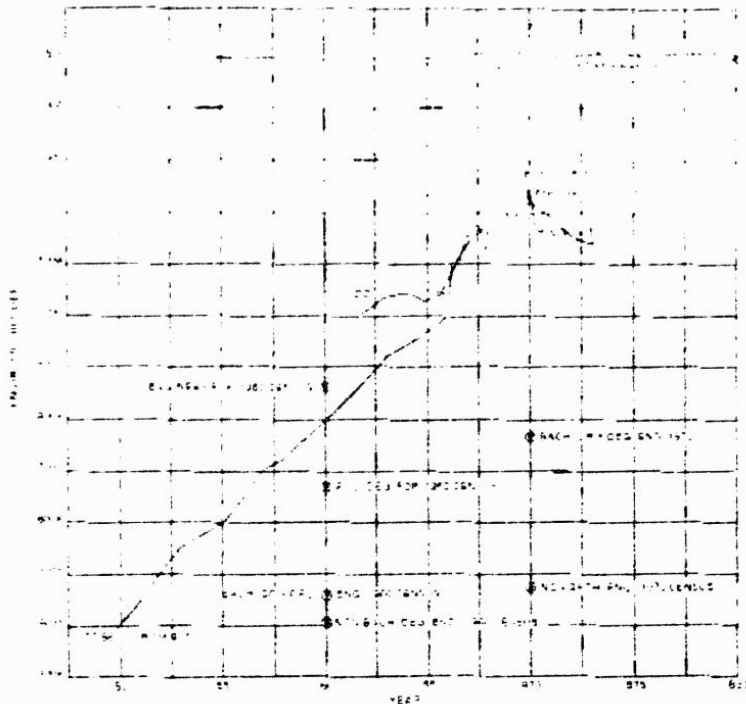


Fig. 4 Engineer population, degree and non-degree, employment, and projections.

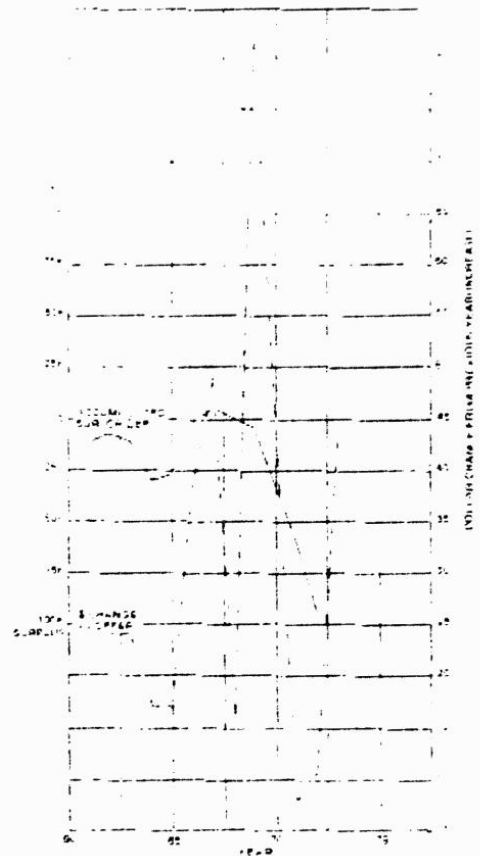


Fig. 5. Accumulated surplus or deficit from Table 1 and dollar change of starting salaries for B.S. graduates in electrical engineering from the College Placement Council Annual Report of beginning salary offers.

an above normal rate of expansion in engineering demand equal to or greater than that of 1966. The decrease in engineering employment has stopped. The Deutsch and Shea Index indicates an increase in employment of 677 engineers in the first quarter of this year. An indicated weak employment increase for the year of 4000 will result in an additional 10 000 displaced engineers for a total of 106 000. We have a supply system geared to a normal increase in employment of 35 000 engineers per year. Decreasing or static demand can only result in further dislocation. Future work on an advertising lineage index for electrical engineering specialties will result in a specialty demand index useful for personal career planning.

References

[1] R. B. Freeman, *The Market for College Trained Manpower*. Cambridge, Mass.: Harvard University Press, 1971.

[2] M. A. Schwartz, "The United States college-educated population 1960," National Opinion Research Center, University of Chicago, Ill., Rept. 102, October 1965.
 [3] U.S. Bureau of the Census, *Current Population Reports*, P. 23, no. 45, "Persons in engineering, scientific, and technical occupations: 1970 and 1972," U.S. Government Printing Office, Washington, D.C., 1973.
 [4] W. Warkov and J. Marsh, "The education and training of America's scientists and engineers: 1962," National Opinion Research Center, University of Chicago, Ill., Rept. 104, October 1965.



Robert Alfred Rivers (A'44-M'53-SM'71) was born in Phillipston, Mass., September 5, 1923. He received his B.S. degree in EE from MIT in 1953. In 1954 he founded AIRCOM, Inc., and has remained as President since that time.

Mr. Rivers is a member of Eta Kappa Nu and Tau Beta Pi as well as a Senior Member of IEEE.

March 31, 1992

The Honorable Howard Wolpe
Subcommittee on Investigation and Oversight
Room 822 House Annex #1
US House of Representatives
Washington, DC 20515

Subj: Investigation of Engineering Shortage
American Association of Concerned Engineers (AACE)
Supplemental Information

Dear Representative Wolpe:


As a member of AACE I have watched with deep concern the loss of jobs by many engineers primarily due to transfer of manufacturing operations to overseas locations. MTS Sensors Division, the company I work for has just introduced a new line of position sensors ("Control Engineering" magazine reprint attached). This new product line developed by engineers and technicians here at MTS will when fully marketed produce a number of new manufacturing jobs and the subsequent support positions. I am tooting our own horn, but these are the types of products which will allow us to compete internationally. We need the bean counters heading most major corporations today to realize that pushing all monies to the bottom line for the shareholders will end the needed research and development which creates new products and manufacturing jobs.

We have seen the results of no new engineering and development in the television and VCR industries as well as auto manufacturing. The auto industry is playing catch-up but at a much reduced scale due to their previous shortsightedness.

We have the engineering expertise in this country to compete in any market if we will plan far enough ahead to allow for strong quality product development. We certainly don't have any engineering shortage now or in the foreseeable future, but, with some real long term planning by the corporations in this country we could certainly hire back some of those working at a reduced level or those that have been pushed out of engineering altogether.

I look forward to seeing some feedback on these hearings.

Sincerely


Chuck McAlister
7500-202 Cadbury Court
Raleigh, NC 27615

cc: Representative David E. Price
1224 Longworth House Office Building
Washington, DC 20515

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.¹ 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

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 survey³ 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 Larson⁴ 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 that "The Electrical Engineering shortage no longer exists"⁵ 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, rather than a realistic assessment of the long term trends."⁶

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

- 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

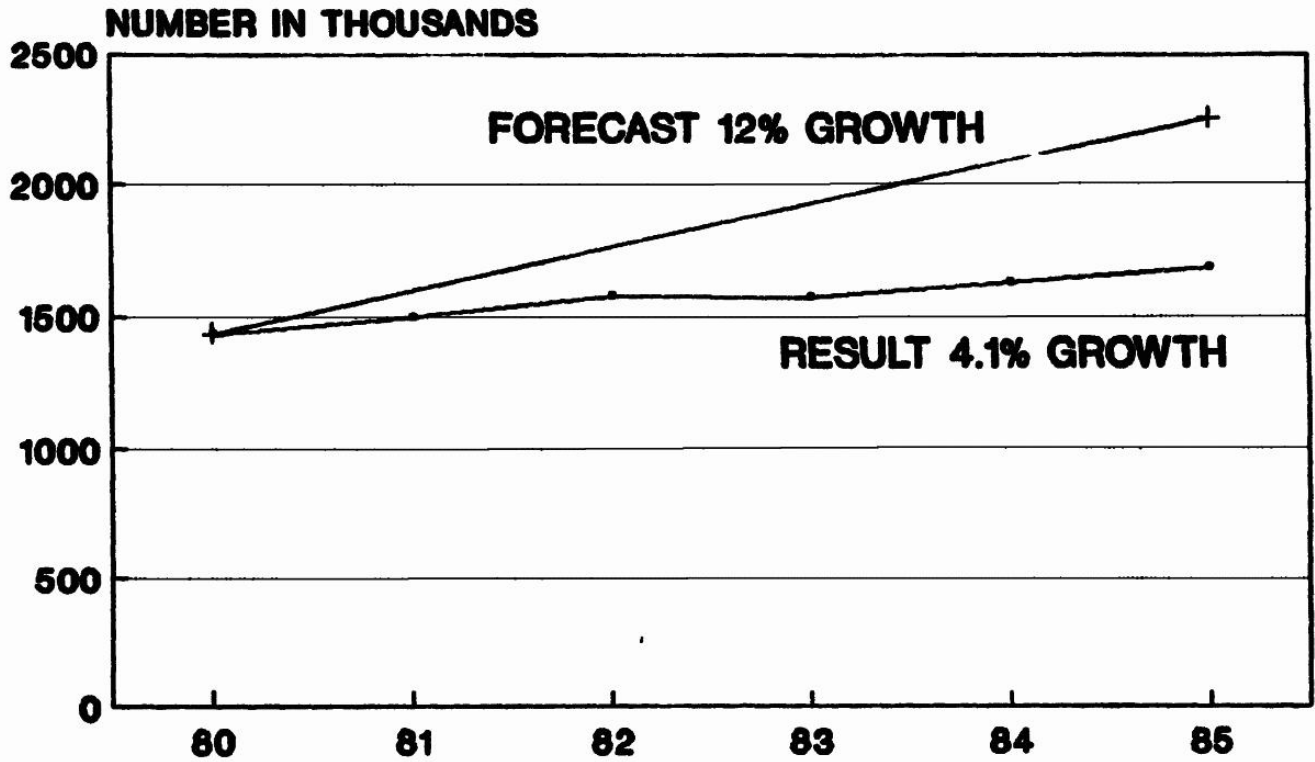
7. National Science Board, Science and Engineering Indicators-1990, Washington, DC:U.S. Government Printing Office, 1989.(NBS89-1)

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

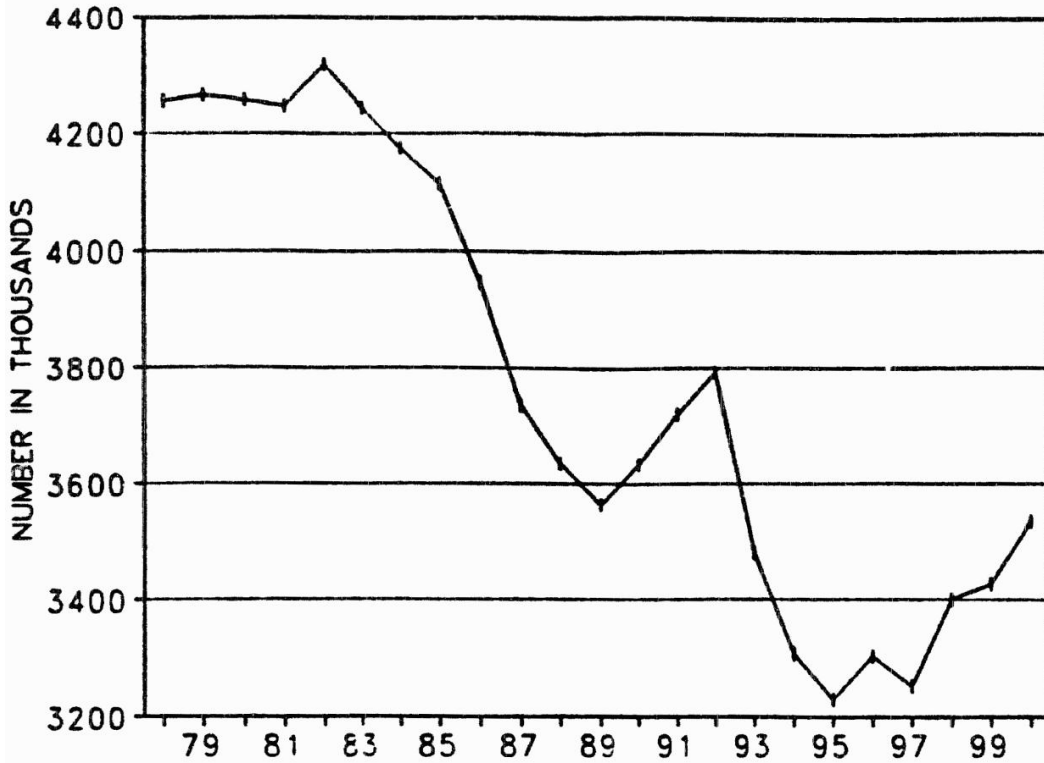
AMERICAN ELECTRONICS ASSOCIATION MANPOWER FORECAST MAY 1981



DATA FROM BLS QTR SERIES AVG

FIGURE 2

NUMBER OF 22 YEAR OLDS



BS DEGREE GRADUATES

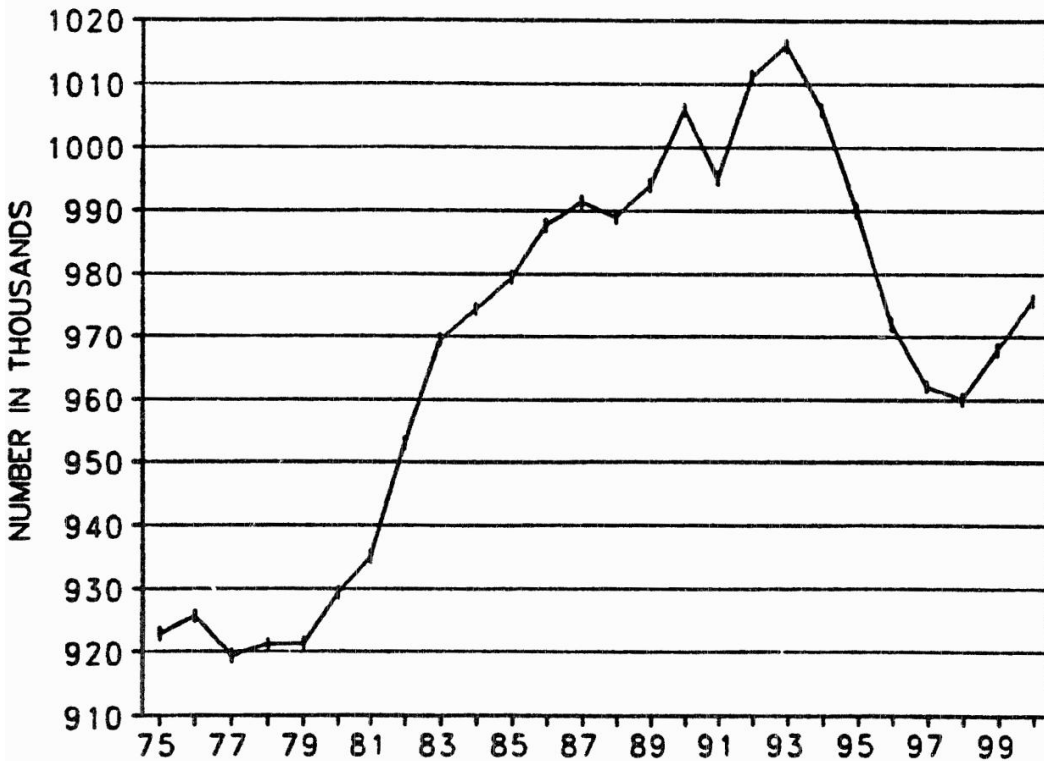
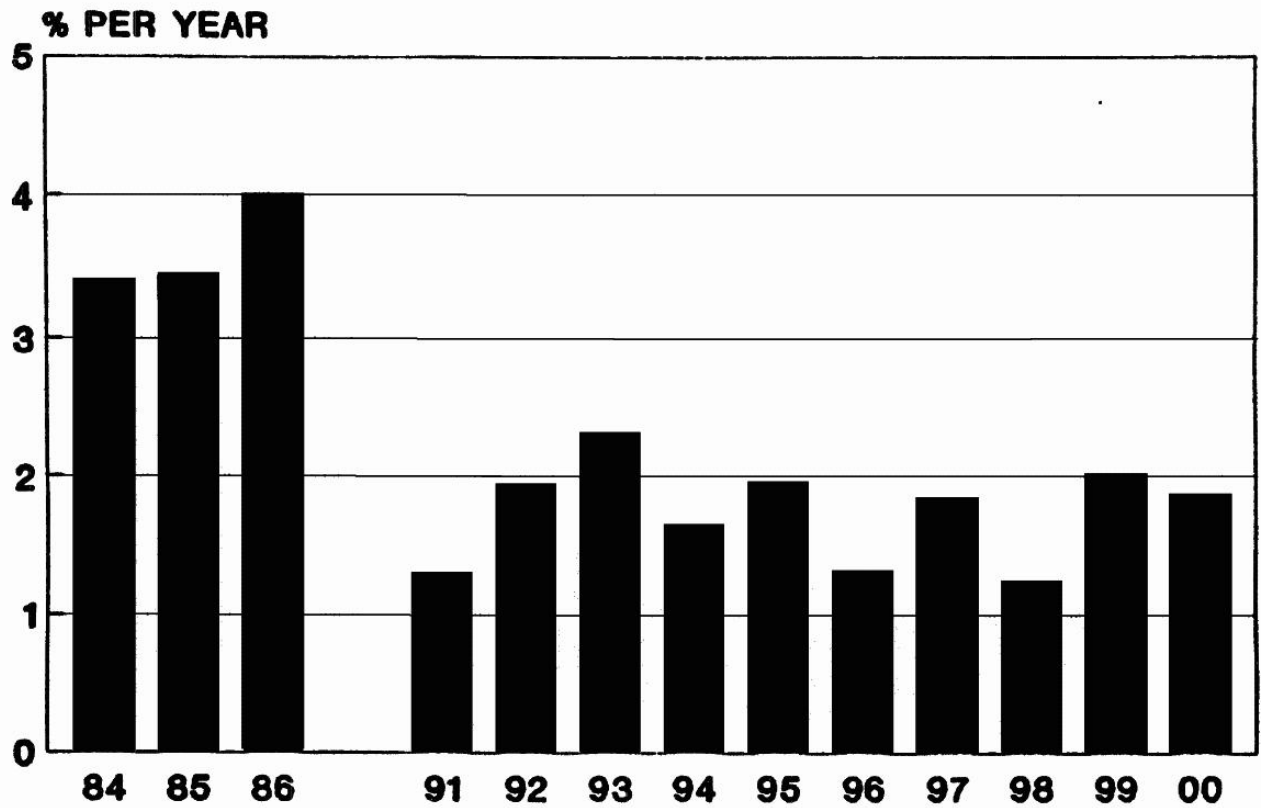


FIGURE 4

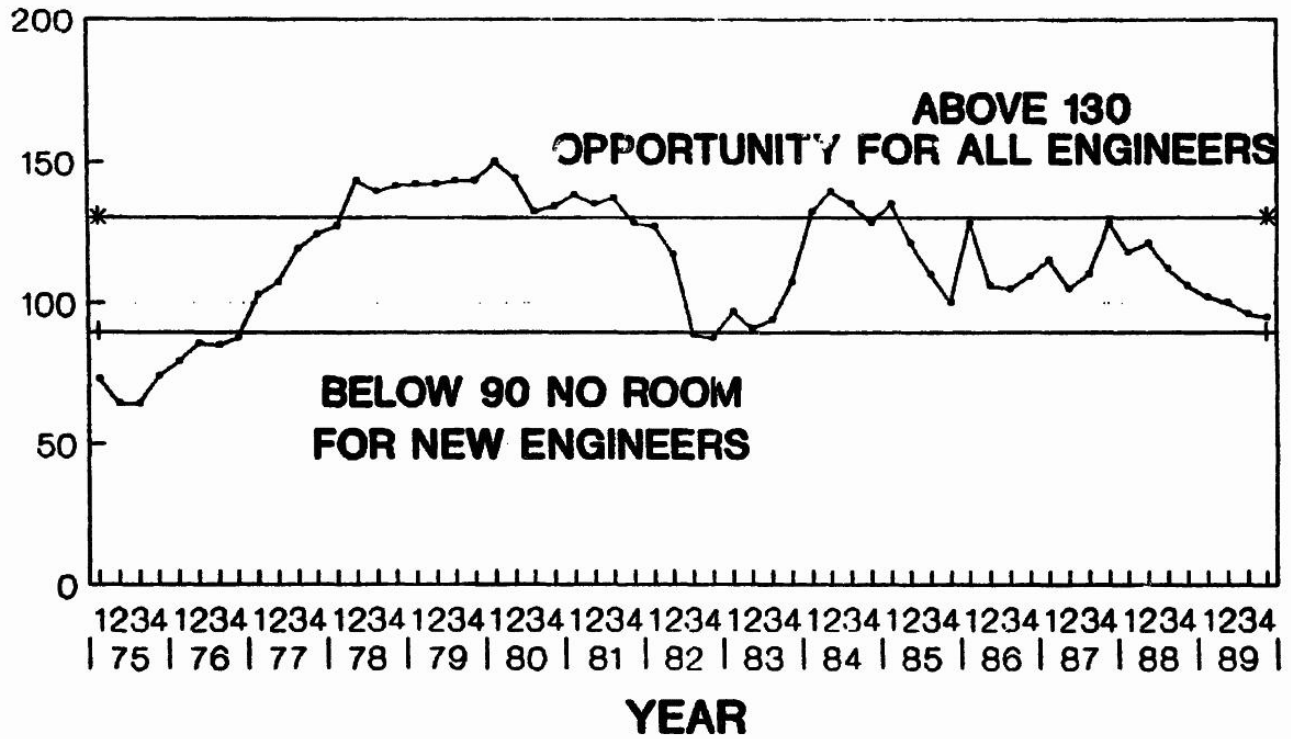
ENGINEERING GROWTH



DATA FROM NSF

FIGURE 6

DEUTSCH, SHEA & EVANS HIGH TECHNOLOGY RECRUITING INDEX



1961- 100 BASE
FIGURE 8

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 "woe," 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

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

Why Technical Leadership Matters

D. 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 salients 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 Engineer Shortage Propaganda (ESP) to satisfy the needs of the colleges at the expense of the public. The distortions are real, very bold, and lauded 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 tenuous 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

wants 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 leading 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 Alpern, 509 Green Pond Road, Rockaway, N.J. 07866.

Call the local Talk Show:
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 36 percent of the

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. 23) 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.

Bureau

SOMETIMES
GUYS WOULD
TALK TO
ME TO
ASK FOR
REASONS.



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 named 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 "fantasy 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. "Baked 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,

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, such 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 800,000 veterans with 832,000 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'Entree Plaza Hotel in Washington, N.C.

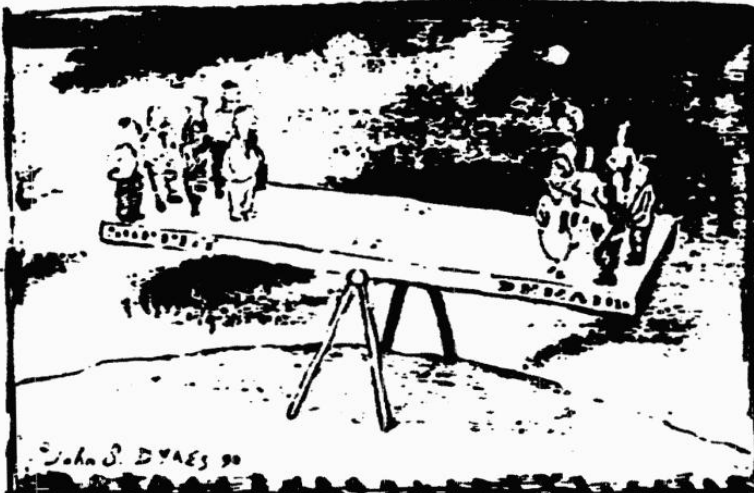


Illustration by John B. DVAES

- 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 granting of fewer degrees than in 1984-86 does not necessarily translate into a "shortage" of new graduates.

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 analysis should be interpreted as conditional."

But Rivers said that not all NSF reports have offered sufficient warnings about the slowness 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 area, from with engineering sci-

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 Appollo	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 Electrnc		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	ATOCHEM		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. Competitiveness 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,

The 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 CHAIRED BY 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 dis-

Editorial ✓

Burying the EE shortage myth

IT'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? These Cassandras can't even agree on the numbers or what the National Science Foundation *actually* said.

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.

The NSF complains that people are stretching "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,



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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 Bellini

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 remove the offending passage on short-

PACE NEWS

By R. Tax

One student entry!!

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

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

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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 USA3 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 the most obvious comments about the committee's

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"

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Company _____ Phone# _____

Address _____

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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 sub-contractors; 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.

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MEMBER ONE was prepared by the Regional Publications Committee.

Any news items, comments, suggestions or criticisms should be welcome. Just write to the Editor: Edward B. Forbes, 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

NEWSNET ONE

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 Deutch, 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.

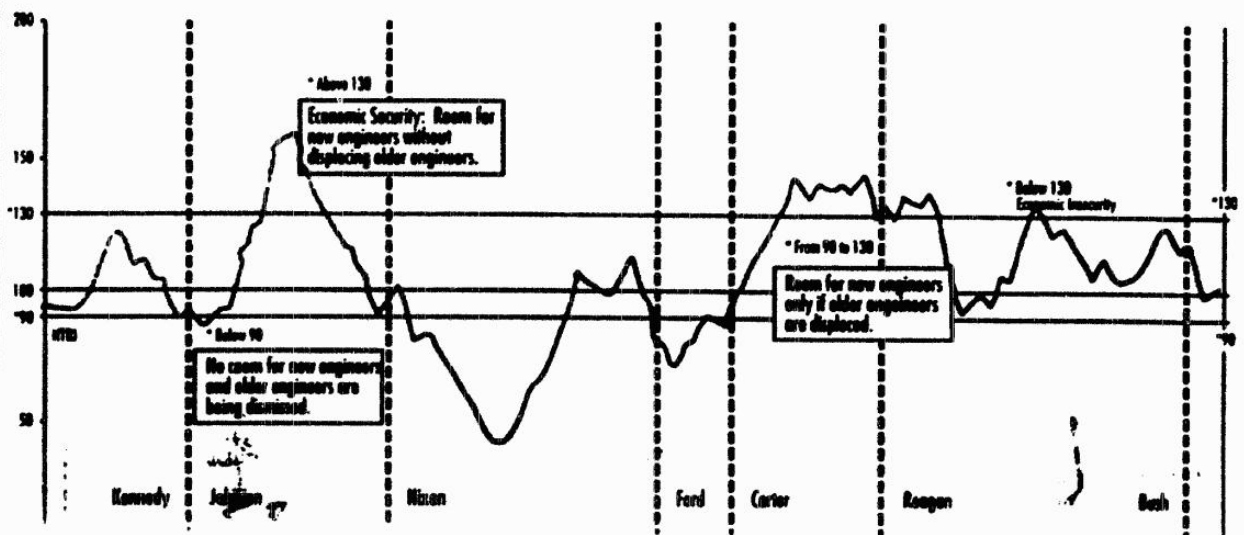
There are very good reasons for addressing the issue of fluctuating engineering manpower demand. First, this affects the lives and careers of all engineers, recent graduates and students who may choose engineering as their field of study. Second, this indicates that the engineer shortage reports were 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.

Deutch, 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.

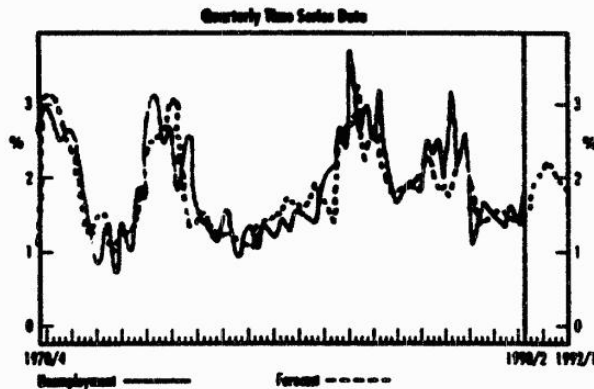


Figure 1. Percentage Engineering Unemployment & Forecast

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 1988 to 1989 was only 16,000 contrasted with an average for the decade of 46,000 per year.

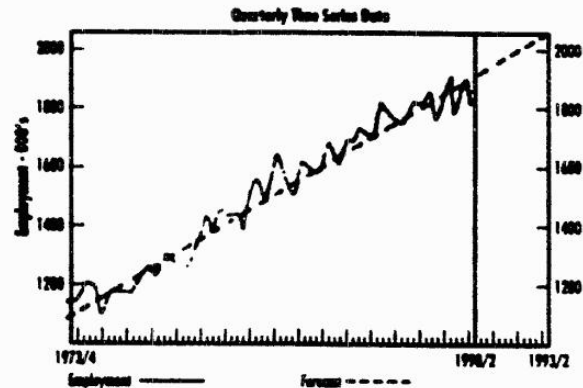


Figure 2. Engineering Employment & Trend

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.

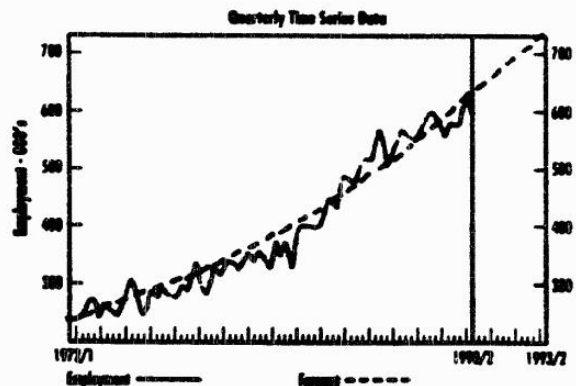


Figure 3. Electrical Engineering Employment & Trend
by Robert A. Rivers For IEEE-USA 7/12/90

FILE COPY

NO COPY
4/2/9242 Maple Street
Auburndale, MA 02166
March 11, 1992Dr. Saul K. Fenster
President
New Jersey Institute
of Technology
323 King Blvd
Newark, NJ 07102-9938

Dear Dr. Fenster:

In the Summer 1991 issue of Planning for Higher Education, you coauthored an article titled, "Attracting Blacks into Engineering." In that article you included a statement, "By the year 2010, the United States could face a shortage of a half million technically trained professionals."


Your source of data can be indirectly traced back to the National Science Foundation. The study has been widely discredited, by no less than the National Academy of Engineers. A copy of Alan Fechter's paper has been enclosed for your information.

You and others that quote a study that is technically deficient in methodology and widely discredited are doing a disservice to young people that may choose to study engineering. What will you tell them when they have trouble finding jobs when they graduate or are terminated after 40 years of age and no longer can find professional employment?

I find serious ethical considerations in what you are doing to young people. You either knew or should have known that the NSF study had serious defects in its methodology.

Minorities and women have been able to determine where the rewards are in our society. They have been choosing careers in accounting, business, and law. These areas do not need to use exaggerated forecasts of future needs to recruit young people. Why do you and others use these unethical methods?

Sincerely,


John P. Densler
617-244-4417
att.cc
Bob Bruce, American Engineer
Dick Lowrie, ACE News
Bob Bellinger, EE Times

As a national shortage looms, universities try more daring approaches.

Attracting Blacks into Engineering

Phyllis Denbo and Saul K. Fenster

By 1995 eight of the ten fastest-growing occupations in America will be science- or engineering-based. Between now and the year 2000, the demand for engineers, scientists, and technicians will increase by 28 percent (Commission for Professionals, 1987). By the year 2010, the United States could face a shortage of a half million technically trained professionals (Task Force on Women, Minorities, and the Handicapped, 1989). Already several other industrialized nations produce more engineers per capita than the United States does. This year Japan will graduate as many engineers as America will, despite the fact that Japan's population is half the size of this

Phyllis Denbo is director of the Office of Planning and Evaluation at New Jersey Institute of Technology (NJIT). A graduate of Barnard College with an M.A. from the University of Pennsylvania, she formerly served as assistant director of research at the N.J. Department of Higher Education.

Saul K. Fenster, a fellow of the American Society of Mechanical Engineers, is president of NJIT. He graduated from CUNY and earned his Ph.D. at the University of Michigan. The author of two textbooks and numerous research papers, he has worked as a research engineer in industry and is a member of the National Action Council for Minorities in Engineering.

nation's. Business firms in several sections of the United States are beginning to worry, and some are starting to invest in science and engineering education.

Overwhelmingly, the scientific and engineering workforce, and even more the U.S. science and engineering professoriate, are white males. But by the year 2000, roughly 75 percent of the new entrants to the U.S. workforce will be minorities and women. Therefore, if America is to address its coming shortage of scientists and engineers, colleges and universities must plan now to educate more black, Hispanic, and women engineers and scientists.

The number of females in science and engineering has been increasing somewhat, though women received only 7 percent of the doctorates in engineering in 1988 (Sylvia, 1991). The number of Hispanics is also increasing slowly. But the paucity of African-Americans in the fields of engineering and science is alarming.

In 1988, there were 139,000 black engineers and scientists employed in the entire United States, representing only 2.6 percent of the workers in these categories. In contrast, African-Americans accounted for 10 percent of the total U.S. employment and nearly 7 percent of all professional and related workers, according to the National Science Foundation. The underrepresentation of black engineers and scientists with doctor-

42 Maple Street
 Auburndale, MA 02166
 January 19, 1992

Ms. Angela B. Ginorio
 Director
 Northwest Center for Research on Women
 Imogen Cunningham Hall AJ-50
 University of Washington
 Seattle, WA 98195

Dear Ms. Ginorio:

I offered to be a participant in your survey. In the draft report, the widely circulated NSF numbers were used. I have shown that the methodology used in the report is wrong. This has been also supported by Alan Fechter from the National Academy of Engineering. Before you continue to quote discredited work, please check to see if there are any problems with the work. I understand the NSF has withdrawn their "non released", but widely quoted study. Perhaps, you should check with the authors before you write your final report.

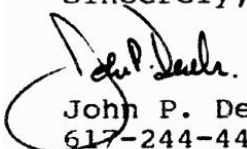
The Institute of Electrical and Electronics Engineers has a manpower committee. The chairman of that committee is Paul Kostek, Apt 406H, 13517 Empire Way South, Seattle, WA 98178. His telephone numbers are: (O) 206-867-2815, (O)206-885-8750, and (H)206-271-8908. You may be able to get a new perspective in speaking with him.

A number of experienced engineers are increasingly concerned that academics are attempting to recruit women and minorities into science and engineering, presenting an overly optimistic perspective on the future opportunities. If people are doing this, they are indeed doing a disservice to young people. A more reasonable approach is to use undergraduate engineering or science as a better preparation for business or law careers.

If I have raised some doubts about science related career prospects, a simple model of funding for science and engineering research can help to confirm your doubts. How many of your own science researchers been able to get funding for their own proposals? Has the competition become more difficult?

We have a great deal of information on this topic. We would be happy to share it with you, if you are interested.

Sincerely,


 John P. Densler
 617-244-4417
 enc.

No reply
 4/2/92

Draft Report

Survey of Career Change for Scientists

Over the next decade, the United States could be faced with a shortage of crisis proportion in the scientific workforce. According to National Science Foundation (NSF) predictions, a shrinking college-age population in the 1990s will result in a shortfall of 675,000 scientists and engineers by 2006. A shift in the composition of the U.S. workforce, to include a growing numbers of women and minorities, will further influence the future technological workforce (Holden, 1989). Today, the underrepresentation of these groups in science is increasingly discussed in terms of the impending shortage; women and ethnic minorities being the most underutilized pools of talent in this country. For example, in 1988 women received 32% of the doctorates awarded in science and 7% of those awarded in engineering (17, xii). "Despite progress, there is persistent inequality of opportunity for women in science and engineering, both in education and employment. Numbers are tapering off; recent gains may not endure" (Vetter, 1987, p. 2). In order to avert a long-term shortage of scientists and engineers, increasing numbers of women and minorities must enter and remain in these careers.

What factors contribute to the success of women in the sciences? From personal characteristics to family background, educational experiences to socialization, researchers have identified a wide range of possible influences. Factors related to the educational experience have received a fair amount of attention in the women and

American Association of Concerned Engineers Inc.
P.O. Box 667 Trilby, FL 33593

April 4, 1992

Monica Roblewski
Subcommittee on Investigation and Oversight
Room 822, House Annex #1
Washington, DC 20515

Dear Ms. Roblewski,

The following is a statement prepared by AACE, Inc., for the committee's consideration in connection with the hearings on the surplus and unemployment problems of engineers.

The American Association of Concerned Engineers, Inc., (AACE) states that, based on studies and many letters from its national membership, there is no engineering shortage. In fact, there is a large surplus. Furthermore, based on several factors, it appears that this surplus will continue to exist and even worsen for the foreseeable future, at least until 2010.

There are a large number of unemployed engineers and scientists available and looking for work at this time. AACE has received numerous letters from engineers all over the country testifying to the great difficulty of obtaining a job, in some cases even when a highly educated and experienced engineer is willing to go from \$50,000/yr. to \$12,000/yr. just to survive. There certainly is no shortage now and none likely for at least 15 years.

Reasons for the engineering manpower surplus include:

- (1) severe defense cuts,
- (2) cuts in the engineering workforce by many companies in the face of reduced sales and heavy competition,
- (3) a large influx of technically trained immigrants under the Immigration Act of 1990 (PL 101-694) which allows 120,000 engineers and scientists each year to come to the U.S.,
- (4) U.S. manufacturing and related design jobs being moved to low labor rate foreign countries,
- (5) Japanese competition in many fields of electronics, machine tools, appliances, autos, etc. which have eliminated many products and jobs from the U.S. workforce,

- (6) the move towards a service economy which does not need R&D or engineers,
- (7) a large population of engineering students in U.S. colleges, with the production rate exceeding the demand, and
- (8) under-utilization of engineers.

The quality and cost-effectiveness of our products are directly related to the amount of engineering content. While many highly qualified American engineers are denied employment in the interests of "economy", and engineering is held to a miniscule percentage of the total costs, America's competitive position continues to slide. To turn this situation around, this nation must give its engineers a chance to restore its position of technological leadership.

Let us put our engineers to work and take advantage of the very large surplus of engineering talent now available. Businesses must have tangible incentives for doing so. Leadership from Washington can help by providing retraining assistance for engineers and others displaced by defense cuts, by eliminating unfair "free trade", by cutting back on almost unlimited immigration, by providing incentives to keep manufacturing inside the U.S., by encouraging industrial R&D, and by maintaining a long-term stable tax policy.

Unless the basic causes for the engineering surplus and declining U.S. technology are removed or ameliorated by appropriate legislation, the US will continue to suffer a severe decline in technology and competitiveness.

The AACE is an independent non-profit national organization formed in 1990 to improve the stature and professionalism of engineers.

Signed, AACE, Inc.:

E. Cohen

W. Heithaus, P.E.

R. Lowrie, P.E.

C. McAlister, P.E.

E. Cohen
by *Rwl*

W. Heithaus
by *Rwl*

R. Lowrie

C. McAlister
by *Rwl*

Enclosures: AACE Newsletters, (marked up).
AACE brochure.

1300

A A C E

American Association of Concerned Engineers, Inc.

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