# THE ENGINEERING CRISIS

## —and what you can do about it

By JOHN R. WEIR

AS MANY CALTECH graduates know, being a scientist or an engineer is an excellent way to make a living. By and large, engineering is one of the best paying major professions in the country, and in addition has a world-wide market. If you were to travel abroad you would probably never be in a country where sooner or later you would not encounter an American engineer. It seems to me there is probably no more stimulating, rewarding and exciting profession on earth.

Engineers and scientists represent less than one half of one percent of our total population, yet they are one of the primary sources for the progress and security of our nation at peace or at war. Look around you. The dwelling you live in, the water you drink, the clothes you wear, the car that carries you, the streets you drive on, the lights you light, the hospital that helps you—every piece of equipment indispensable in your life and mine is a product of America's small and talented family of engineers. Each is a fruition of an engineer's dream, and we have as yet only touched the borders of the needed engineering achievements.

It is the engineers who enable us to avoid the limitations of a standstill economy. They are truly the new aristocracy, and as far as personal opportunities go, let me point out the amazingly widespread climb of engineering-qualified students to the top as general executives in American enterprise.

The priceless ingredient of adequate management is judgment. This means knowledge, balance and the courage to make hard decisions. It means basing conclusions on facts, but with the training, ability and vision to weigh these facts as realities, and to exercise judgment on them on an overall basis. This ability does not come as a result of a hunch, or on a personality basis, but rather from a broad and inclusive training.

On the record there is no better training than engineering for general advancement in business and industry. This is indicated by the results of a recent Columbia University survey which states that "40 percent of industrial management is engineer-trained, replacing both the lawyer and the banker in top industrial posts."

More specifically, there are 13 presidents of the subsidiary companies of U. S. Steel who started as engineers. There are 20 presidents of associated companies in the great Bell Telephone System; of these 10 graduated as engineers. Fourteen members on the Board of Directors of the Standard Oil Company of New Jersey are engineers. At least 15 top executives of Anaconda Copper and its major subsidiaries are graduate engineers. Over half the vice presidents and 90 percent of the top executives in the five divisions of Union Carbide started up the ladder as engineers. Nearly half the top officials of the General Electric Company started as engineers. Within the General Motors Corporation the Chairman of the Board of Directors, the President, one of the four executive vice presidents, sixteen of the vice presidents, and sixteen of the members of the Board of Directors are engineers.

Of the graduates from M.I.T., 930 are listed in *Who's Who in Engineering*. Of Caltech graduates, about one in every four occupies an executive position of one sort or another.

If a student goes to engineering college: he is 44 times more likely to be an officer in American industry than if he goes to no college at all; he is 30 times more likely to be an officer than if he goes to some kind of college other than engineering; and he is 12 times more likely to be president of a company than a graduate of a liberal arts, business, law, or other non-engineering college.

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How about the dollar income of engineers and scientists? A survey by the Los Alamos Scientific Laboratory covering over 31,000 professional scientific personnel employed in 167 private organizations, gave the following results: A student graduating from an engineering school with a bachelor's degree can expect to make an average of $3500 to $4000 a year. At the end of ten years this will increase to roughly $6000 a year. If he has a doctor's degree he can expect to begin work for approximately $7500 or 8000.

There are, then, very considerable rewards in engineering and science in America. Yet there exists today a critical shortage of engineering personnel.

At the present time there are about 400,000 engineers in the U. S. There is an estimated present shortage of about 95,000; that is, there are 95,000 military and civilian jobs now vacant. The rock bottom estimate of the number of new graduate engineers which will be required each year for the next four years is 30,000. The present shortage of 95,000, plus the need per year for the next four years, indicates an accumulated demand in 1955 of nearly 215,000 new engineers.

## Engineers—how's the supply?

Now let's look at the supply side. How many engineers will become available during these next four years? This is the number currently enrolled in our engineering schools who will graduate by 1955, for it takes four years to make an engineer. In June, 1951, about 38,000 engineers graduated from engineering schools. According to present enrollment figures there will be 26,000 in 1952; 17,000 in 1953; and 12,000 in 1954. An optimistic estimate of this number is 70,000, leaving a shortage over the next four years of 145,000.

There seems to be general agreement in industrial management that within five years there will be about 60 percent fewer engineers than our economy needs to preserve our standard of living and to make this nation secure in war.

It seems obvious that, except for occasional recessions, the demand for scientists and engineers will continue to rise at an increasing rate for an indefinite period of time. There are no clear signs of easing of world tension; there are no indications of a decline in the opportunity for America to continue its world leadership; and throughout the world, wherever one looks, one can see increasing opportunities for technological advances. The ability of man to consume is unlimited, and will not be denied; the age of science and technology has just begun.

It seems to me there are two major reasons for the present and prospective shortage. One set of factors tends to reduce the supply of engineers, the other serves to increase the demand for them.

Two quotes from two notable teachers epitomize one of the major influences in reducing the supply. "The major concern of thoughtful citizens today is the alarming over-emphasis on mechanics aside from technology," says one. And another: "What a laugh it is when we consider the root cause of our current world crises stems from the fact that our technical scientists in their perfection of techniques for destruction are so far ahead of our social scientists whose principal job it is to teach men how to live together peaceable and constructively."

Statements like these have obviously served to channel adolescent high school graduates into the social sciences and humanities rather than into the scientific and technical professions. The new hero is the manipulator of men rather than the manipulator of machines. This interest in people is a particularly desirable life goal for the adolescent, for he is most concerned with people and what they think of him.

## Overstocked on engineers?

Another important influence which has reduced the supply of engineers was a report of the Department of Labor issued on March 8th, 1950. It predicted, in part, that "so many engineering students will be graduating in the next few years, 1950-54, that many graduates will be unable to get engineering jobs."

The effect of this report was immediate and profound. Young folks and their parents seemed to drop the idea of an engineering education like a hot potato; engineering schools immediately suffered a drastic drop in enrollments. Percentage-wise, the drop was nearly three times as large as the drop in other collegiate groups.

The final trend that might be mentioned in this regard is the drop in enrollment in high school physics classes. It is a practically universal rule that an applicant cannot obtain admission to an engineering school unless he has had physics in high school. Yet the enrollment in high school physics, in the Los Angeles area, has dropped from 19 percent in 1900 to 8.5 percent in 1939, to 5.6 percent in 1950. The reasons for this are two-fold. First of all, the subject is relatively difficult and most high school students prefer to elect easier ones. Secondly, high school study counselors—who are usually not professionally trained, and thus are not aware of many job opportunities and requirements—tend to encourage students to look around, to study in broad areas before they begin to specialize. As a result, the specialization necessary for engineers in about the tenth or eleventh grade fails to take place.

## And the demand?

These are some of the factors affecting the supply of engineers. What are the factors affecting the demand? The most important are the military and defense demands. These services are taking from 25 to 50 percent of all engineering graduates. This can be easily understood when one recognizes the increase in complexity of military equipment: For example, it takes three times as many engineers to make a jet plane as it did to make

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a reciprocating engine plane. It took nearly 3,000,000 engineer man hours to put the thunder jet fighter into the air.

Another important factor is a population increase of roughly a quarter of a million a month, or approximately 2½ million per year. This alone would demand an important increase in the total number of engineers if our technical complexity were merely to stand still.

Finally, and equally important, is the ever-increasing consumption of technical equipment, material, and knowledge which grows as man becomes more familiar with and accustomed to the conveniences and pleasures afforded by the development of modern science and engineering.

This crucial shortage of engineering and scientific personnel, then, has three significant aspects.

## What the shortage means

First, it represents a tremendous threat to the security of the free world, for this security is based upon our technological development and the shortage places a very real limitation on our national defense effort and the production of defense equipment.

Secondly, as the shortage causes engineering personnel to be spread thinner and thinner, it seems to me that we may expect a considerable amount of second-rate engineering to be done on essential national products. This would mean the production of second-rate goods and equipment at a time when we need the best possible quality and quantity.

Thirdly, this shortage means a limitation in the quantity and quality of the engineering personnel working in private industry. I think I may safely predict that in the future it will become increasingly difficult to get graduate engineers and scientists to staff our industrial plants.

## What can be done about it

What can be done about this? Several things can best be done on a *national* basis. (1) Suggestions have been made to the armed forces that they use their drafted or enlisted engineer personnel more efficiently. (2) Some kind of educational campaign is needed which will demonstrate the irrationality of the argument that technology is the cause of all the world's many ills. (3) Suggestions have been made that engineering personnel who have been given jobs which do not involve activities in the engineering field be relocated to function in technical capacities. (4) Highly-trained engineering personnel can well be relieved of much routine detail and also work, which might be done by less highly trained people, and finally, (5) there is hope that something can be done to reduce the shortage by the National Science Foundation, a nation-wide government-sponsored training program for engineers and scientists. (Note, however, that the budget for this foundation was recently reduced 77 percent, providing an additional illustration of the trend in this field which is under discussion here.)

## And what YOU can do

Now I would like to suggest some specific procedures which engineers themselves might instigate. The first is that of spreading information. It is necessary that some one provide some kind of continuing information for the use of high school counselors. This information should concern job opportunities and job specifications in engineering and science. It should contain a description of what being an engineer involves, what he does, what kind of people he works with, how much money he may make—the employment possibilities. It should also list the job requirements—what he will have to learn to become an employable engineer.

I would like to suggest that engineers and scientists working in industry go out of their way to talk to groups—either parents or high schools groups—concerning engineering and science as an occupation, including what it has meant personally to the engineer who is doing the talking.

I would suggest a coordinated campaign to make available to high school students instructional tours of plants, with considerable emphasis on the specific functions and activities of the scientist and the engineer within the plant.

The second major activity is that of providing student scholarships to enable the needy students to go to technical school.

I would suggest that various industrial concerns provide scholarships for these students; that they establish contests for the promotion of engineering and science students with scholarships as the reward; that they provide the possibility for the most promising of their employees to go to engineering or technical school.

President DuBridge has suggested that the engineering societies get together and raise, by mutual industrial contribution, a scholarship fund to send to engineering schools each year, one hundred boys who cannot go without financial help. For $200,000 a year they could offer 100 four-year scholarships averaging $2000 each; that is, $500 a year to 100 of the most promising applicants—and his guess is that for each winner, about three to five others would have their interest sufficiently aroused by the contest, so that they would find other sources of funds, and go to college anyway.

Any or all of these procedures may be carried out by individual companies. However, it seems to me the ideal solution would entail the formation of a committee or foundation from among all industrial and engineering firms in an area. This group would have charge of the planning and execution of the procedures designed to relieve the shortage. The problem demands measures commensurate with the seriousness of the threat to the American way of life.