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Engineering and Scientific Manpower— A Scarce Resource for the 1970's

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INTRODUCTION

Today our friends in the news media are asking, "Where are the unemployed engineers and scientists of 18 months ago?" Recruiters are already voicing alarm! They are *not filling* their *quotas* at the better institutions. It is *doubtful* that they can fill their quotas even from the schools with lesser reputations. It will be easier for the recruiters seeking PhD's as the demands in education for these advanced degrees are not now as great.

Shifts in national priorities have naturally caused personnel changes in all fields, *not just in engineering and science* as you might have been led to believe. For example, the SST was anticipated and engineers and scientists were hired to implement this program. So naturally when this program was *cancelled abruptly, these people had nothing to do.* This *surplus* was like the flood from a broken dam. It takes time for any professionally trained person to relocated wisely. Relocating has been the answer for most engineers and scientists. *The reservior no longer exists.*

ANNUAL DEMAND NOW EXCEEDS ANNUAL PRODUCTION

Many of the unemployment problems publicized about the so-called engineer were brought about not by the degreed man from a good institution, but by the technicians, who were holding jobs with the title of "engineer". Unfortunately, the Department Labor and the press made no differentiation between these subprofessionals and the qualified, degreed engineers. Some of these good technicians are still trying to relocate as engineers rather than seeking a technician's job for which they are qualified.

The following thoughts on supply and demand relate to a 4-year degreed engineer or scientist, or one with an advanced degree, not to the technicians.

SUPPLY

Data are not so readily available for scientists as for engineers, but the trends are usually similar. Fig. 1 shows the BS degrees awarded in the U. S. since 1960 and the projection through 1976. The projections are accurate because the 1976 graduates are already freshmen. We are not sure about the projection beyond 1976, but unless there is a national move by industry and government to interest high school graduates in entering these fields, the number could go even lower before starting up again. Masters and PhD degrees are also expected to decrease up to 1975.

DEMAND

The annual demand in these fields has historically been cyclic. Periods of war and peace affect this, and a rising economy amplifies the demand. The priority government places on research varies demands, and construction and numerous aspects of technology affect demands. The current national emphasis on pollution control and solution of societal problems will drastically increase the demands for the future. Engineers going into new fields such as insurance and finance will also create an even greater demand for their services. They are found to be most valuable in assessing risks, establishing safety standards and resolving claims in many fields of concern. An engineer may also be of value in assessing the feasibility of a product or operation being considered for a new stock issue or for listing with a security exchange.

I feel that more and better technology is required to restore the balance of trade to a favorable level for the U. S. If this occurs, it will place an even

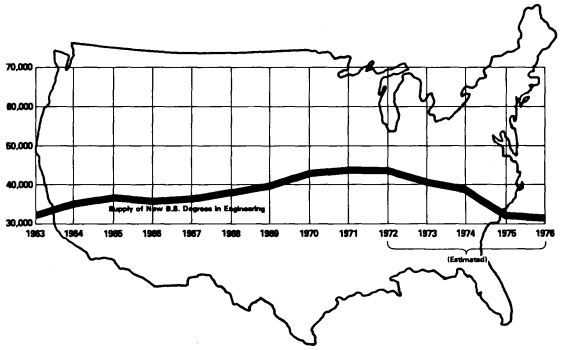

FIG. 1 — U. S. ENGINEERING MANPOWER SUPPLY AND DEMAND.

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greater emphasis on the demand for scientists and engineers.

As an engineering educator, I do not claim to be an expert in predicting the demand for scientific and engineering manpower, but for the remainder of the decade my experience does give me confidence in the following.

1. The historic cycle of demand for engineers and scientists for traditional work will not be significantly altered and the next 5-year period will be a period of upswing on the cycle based on economic forecasts.

2. Superimposed on this are new demands to meet the problems of society and new areas for technically trained people.

3. Also added is the technology thrust needed to improve our balance of trade.

4. The technology required to cope with the energy crisis has to be an added capstone. This need was clearly proclaimed by Monday's speakers.

5. Improving the environment is almost open-ended in the requirements for engineers.

Quotes from selected publications support my thesis of an increasing demand over the next 7 years. With a shortage already with us, the question is: "How severe will be the shortage by 1976 and 1980?" The success of efforts in productivity, industrial health and safety, energy and pollution are being threatened by the tightening supply of engineers.

Fig. 2 is my best estimate of what the 1976 demand will be. If the supply increases significantly after 1976, the demand will level off between 1977 and 1980, but much over supply.

If the supply fails to increase in 1977, the demand is projected to increase until 1980 and beyond. All of you interested in engineers and scientists are reminded that what happens to the supply in 1977 is dependent on the size of the entering class of the fall of 1973. At this time, there is no clear evidence that it will increase. If the annual demand levels off at 50,000 to 60,000/year, what will be the accumulated deficit occurring between 1973 and 1977? With only 29,000 BS graduates expected in 1976, you can see that the *deficit is serious.*

Fig. 3 shows my best prediction of demand over supply. I do not expect any valleys in the demand before 1980, and this steady rise is a departure from the up-and-down cycle of the last decade.

WILL THE ENGINEER OF 1973 TO 1980 BE DIFFERENT FROM THOSE OF THE PAST

In the future, I believe the engineering graduate will be equally well-qualified technically, as in the past, and will have a greater social awareness. An institution with the emphasis on science and engineering like the U. of Missouri at Rolla, will find it easy to achieve this goal because engineering and science students are closely related to the small number of liberal arts students in class and in student activities. However, most engineers in this country are trained on general university campuses, and hopefully engineering students will not continue to be isolated from the other parts of the campus. This has happened too often in the past.

My concepts of the new look of the engineer are as follows. The modern-day 4-year engineering graduate from the better institutions in the U. S. is primarily trained as a *decision maker* and as a *problem solver.* He is broadly trained and has the advantage of having a good balance of science, mathematics, liberal arts, and engineering that gives him a focused outlook. He knows that his decisions have to be technically sound, but also that they must be *socially beneficial* and *economically feasible.* Engineering graduates of the past were taught primarily to make sound technical decisions, so the new look requires much more.

A 4-year engineering graduate can enter many fields of employment, without further training, and even in the tight job market of 1970-72, found that these opportunities were numerous. But even more important, it is increasingly evident that the new-look engineer has an excellent foundation for added further specialization.

Graduate work in engineering is suggested for those who desire to make more advanced technical decisions or do research. Today, many are finding that an engineering degree qualifies them to pursue further training in law, medicine, business, government, and management.

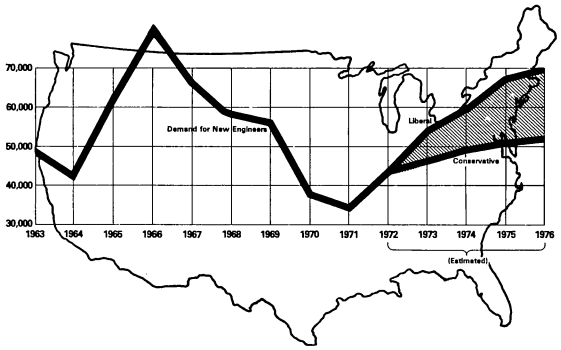

FIG. 2 — U. S. ENGINEERING MANPOWER SUPPLY AND DEMAND.

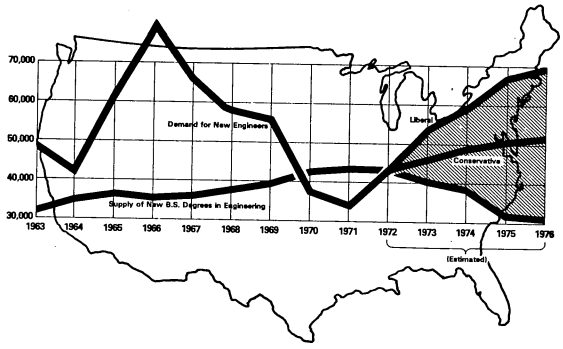

FIG. 3 — U. S. ENGINEERING MANPOWER SUPPLY AND DEMAND.

For the practice of engineering, he may find that a professional emphasis degree, master of engineering, would be rewarding. A student entering a good 4-year engineering program today does not have to decide on his career until graduation. He has a foundation for unlimited opportunities.

During his 4-year engineering program, he is urged to pursue, as a secondary effort, related fields of interest such as music, art history or literature, as these supplements can be most important in his search for solutions to societal problems.

After all, the basic objective of engineering is to take the discoveries of mathematics and science and apply these to solve the problems of society. The new-look engineer is the interface between scientific and technological knowledge and people. He creates machines and processes to benefit people and does not make people slaves to machines. There is little that the medical profession can do to change the physiology of man, but the engineer has an almost *unlimited opportunity* to *change* man's environment to better serve him.

If this concept is correct, better-trained technicians are needed to assure dependable operations of established processes and operation. my concept of the 4-year technician is as follows. Just as the medical schools supervise the training of allied health personnel, the engineering schools must supervise the training of the 4-year engineering technician. This should help to avoid the problem of the technician masquerading as an engineer. He often confuses the public and sometimes even employers. The 4-year engineering technician should be paid in accordance with other college graduates with comparable ability and skills. *He should be clearly differentiated from the 4-year engineering graduate.*

State registration laws should probably be modified to make a slot for him. But it is imperative that he not be registered as an engineer. This will not only destroy his identity, but will cloud the public view of the modern engineer.

The following is quoted from my talk at the 1972 Purdue Distinguished Engineering Alumni Convocation entitled "How does the engineer differ from the technician?" "In developing thoughts on the leadership role of the engineer, we first need to know who he is, and secondly, how he differs from other groups with whom he works. We all have our preferred distinctions, but let me use my favorite for this discussion. An engineer is creative and innovative while a technician executes, in careful detail, an established plan or process. Accordingly, an aircraft control tower operator is a high-level technician. He must carefully execute established plans. On the contrary, none of us as a passenger on an aircraft would want this man replaced by an engineer experimenting with ways to improve the plan. The engineer's work is in the laboratory for improvements."

REWARDS TO THE INDIVIDUAL

This year a young person electing to embark on a study program leading to a degree in engineering or science may be assured of (1) professional challenge, (2) an opportunity to serve society and a great sense of satisfaction in this, and (3) good financial rewards. The top BS-level salaries from UMR this May are expected to be above $14,000/ year and the top PhD above $20,000. Averages will not be much below these by 1974 or 1975.

Probably more important than salary to challenge the young engineer is the opportunity to serve his fellow man. President Clarence Linder of the National Academy of Engineering, in a 1971 Washington address, stated that tremendous changes are now taking place in value judgments. These affect national goals, utilization of resources, environmental control, attitudes, and policies. He also reported that engineers are involved more than ever before in management and policy decisions. This involvement will help to avoid abrupt changes in direction in the future.

Congressman John Brademas of Indiana urged engineering educators to prepare graduates who can meet the present challenges and demands of society through an application of technology. He also suggested that we increase our capability by bringing into the profession more *women* and more people from *minority* groups. These appear to be excellent suggestions.

I believe that the future demand for scientific and engineering manpower in quantity and character has been well documented along with the opportunities afforded the individual. These are all promising for the engineer and scientists, but to further support my position, let us explore what is happening in Russia.

It is generally accepted that Russia graduates about 120,000 engineers per year. This is about *three* times as many as are graduated in the U. S. The general opinion in this country is that the quality may be lower in Russia, but a recent article in *The Journal For Engineering Education* reveals that the Russian engineer is probably better trained *technically* than the American engineer.

"Soviet universities grant degrees in the usual liberal arts and science areas, but most engineering education is carried out in separate technical institutes that are modern derivatives of the old French institutes. The students follow a course of study that requires about 5½ years to complete."

"Upon graduation, the student is awarded a *diploma* that is the approximate equivalent of the U. S. *master's degree*, although the content of the curriculum is significantly different. Some of the *Diploma* graduates are encouraged to continue in graduate study where they earn a *candidate* degree after a period of 3 years. This degree is equivalent to our doctorate, including some course work and thesis."

"The highest Russian degree is their doctorate,

which has no U. S. equivalent, and is awarded some 5 years after the candidate degree to those who have demonstrated special competence in their field through publications, inventions and the like."

"Most students in the institutes receive a government stipend. *Diploma* graduates not going to graduate school are assigned to a particular job in a particular region for a period of 3 years during which time they 'repay' the state for their education. After this initial assignment, they are free to try to find a new position and to relocate in a region of their choice."

"The social status of engineers is very high in the Soviet Union — well above the medical profession, but slightly below that of political leadership. Academic engineering faculty rank at the top of the profession, and frequently hold multiple appointments to highly influential political committees. The high calling of the engineer is made known to children at an early age."

As a result of the status accorded to engineering, there is a high degree of competitiveness among the brightest young talent to gain admission and remain at the institutes until graduation. No thought is ever given to possible unemployment for obvious reasons. The 5½-year *diploma* is probably superior technically to our 4-year degree and with numbers so great, the Soviet Union is developing tremendous technological strength.

In his famous speech at Fulton, Mo. in 1946, Winston Churchill said, "The United States stands at this time at the pinnacle of world power. It is a solemn moment for the American democracy. With primacy in power is also joined an awe-inspiring accountability to the future. As you look around you, you must feel not only the sense of duty done, but also feel anxiety lest you fall below the level of achievement. Opportunity is here now, clean and shining, for both our countries."

I am sure that Winston Churchill could not forecast the relative strength of the East and West in science and technology in 1973, but I think those of us familiar with these fields today must confess that his advice concerning national strength applies to science and engineering just as well as to political, industrial, economical and military strengths.

The 1973 questions: Is the U. S. keeping up in science and technology? Would our Congress appropriating scholarship money for science and engineering students? Could a higher percentage of Federal and state funds profitably be spent in better facilities and faculties for educating the engineers and scientists that are so vitally needed in solving the societal problems through industry and other avenues? Is it reasonable for universities training scientific manpower to expect some assistance from industry?

Scholarships and words of encouragment to the potential student are urgently needed. News released by industry to the general media and in their own publications could be most effective in attracting the attention of parents and students to the shortage we face. If we do not do most or all of these, I am indeed pessimistic about our manpower supply in science and engineering.

Let us discuss more about Russia. Russia established an "academic city" at Akademgorodok in 1957, now consisting of more than 45,000 people — mainly scientists, engineers and supporting personnel and their families. All aspects of the city seem designed to make the life of the people there as productive and as pleasant as possible. For example, the only "private" homes seen by a recent visitor to the Soviet Union were there. Some scientists had large 8- or 10-room houses, with an acre or two for their exclusive use. Students from throughout the Soviet Union are given an opportunity to study there and to participate with scientists in research. The young talent is discovered through contests conducted to find the most able among the youth.

UMR's current engineering enrollment is 4,916. In 1971-72, some 894 BS degrees were awarded — 425 masters degrees, and 58 PhD degrees. This will probably retain UMR's position as graduating the second largest number of engineers in the U. S. But with Russia and other countries producing so many more engineers, the concern over our technological lag is real, not imagined. For example, the Leningrad Electrotechnical Institute is the oldest in Russia and has 14,000 students.

America must be urgently concerned about the high probability of a shortage of engineers and scientists to meet its need in this decade. It must be aware of the tremendous strength of other countries as more than one of these are likely to be ahead of us technically.

I have confidence in the future as our people in the past have rallied to meet the need, and our free enterprise system enables us to bring more out of them than socialistic systems. But if we fail, the results will be *serious!*

What would happen to our economy if we were exporting mostly agricultural products and had to import high technology items plus crude oil? This could happen. If the trend in science and engineering enrollments is not soon reversed, it is a real possibility.

I feel that we will train engineers with the *quality* necessary for a better environment, but I worry about having enough of them to do the job.

We have taken great pride in our country's technological strength; yet our profession is probably not generally held in the same high esteem as it is in the Soviet Union. What can you do about this?

In conclusion, I urge professional societies to take leadership in the following.

1. Help engineers to make socially acceptable and economically feasible judgments as well as technically sound ones;

2. Help engineers to design machines and processes to improve our environment — even if this causes turbulence with "company policies";

3. Help build the public status of our profession;

4. Help coordinate the role of the technician apart from that of the engineer; and

5. Actively work to encourage capable young men and women to enter the engineering and science professions.

When success is achieved in these five areas, we will have a better environment and be on the way to regaining our relative technological strengths.

★★★