*Proceedings of*

# CONFERENCE ON UTILIZATION OF SCIENTISTS AND ENGINEERS


EDITOR

**Robert M. Eastman**

*Professor of Industrial Engineering*
*and Chairman of the Department*
*Secretary of the Conference*


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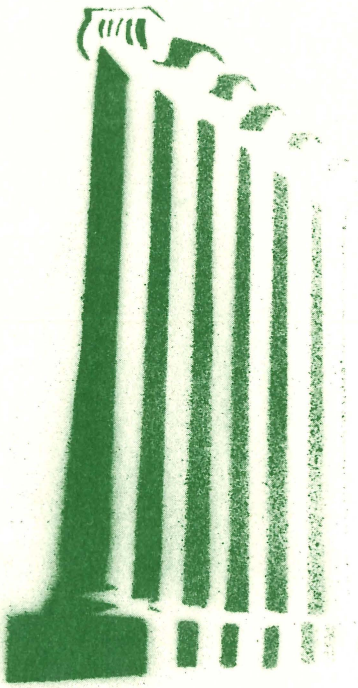

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COLLEGE OF ENGINEERING
THE ENGINEERING EXPERIMENT STATION

The Engineering Experiment Station was organized in 1909 as a part of the College of Engineering. The staff of the Station includes all members of the Faculty of the College of Engineering, together with Research Assistants supported by the Station Funds.

The Station is primarily an engineering research institution engaged in the investigation of fundamental engineering problems of general interest, in the improvement of engineering design, and in the development of new industrial processes.

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*PROCEEDINGS*

*OF*

# CONFERENCE ON UTILIZATION OF SCIENTISTS AND ENGINEERS

Held at the University of Missouri
Columbia, Missouri
October 22-23, 1959

*Sponsored by:*

THE COLLEGE OF ENGINEERING OF THE UNIVERSITY OF MISSOURI
COLUMBIA, MISSOURI

*and*

THE MISSOURI SOCIETY OF PROFESSIONAL ENGINEERS

*In Cooperation with*

DIVISION OF CONTINUING EDUCATION
UNIVERSITY EXTENSION DIVISION
UNIVERSITY OF MISSOURI

*and*

OFFICE OF CIVIL DEFENSE AND MOBILIZATION
EXECUTIVE OFFICE OF THE PRESIDENT OF THE UNITED STATES

*Editor*

Robert M. Eastman

Professor of Industrial Engineering
and Chairman of the Department
Secretary of the Conference

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The United States

## Introduction to Proceedings

*by—R. M. Eastman, Professor & Chairman, Secretary of the Conference, Industrial Engineering, University of Missouri, Columbia, Missouri*

It is with great pleasure that we present the Proceedings of the Second Conference on Utilization of Engineers and Scientists held at the University of Missouri, Columbia, Missouri, on October 22 and 23, 1959. The proceedings contain papers presented at the conference on the vital subject of utilization of Engineers and Scientists. They cover successful utilization policies and practices and discuss the latest trends in this field.

Since the first Conference on Utilization of Engineers and Scientists held at the University of Missouri in December 1957, the subject has continued to be vitally important to the Nation's industries, its people and to the existence of the Nation itself. The demand for competent engineers and scientists still greatly exceeds the supply. An index to the current shortage is the number of pages of help-wanted advertising for engineers and scientists in the Sunday edition of the New York Times. During the past five years, the number of pages has varied from 3 to 20. Recently, the number of pages has been running from 15 to 17. If there were enough qualified technical personnel to fill existing vacancies, this advertising would soon drop to a page or two and be included in the regular "Help Wanted" section.

In addition to the current shortage of engineers and scientists, the United States is faced with trends which will accentuate the shortage in the future. We are competing on a technological basis with Soviet Russia in military and civil areas. Our enemy is channeling a large proportion of his human and material resources into expanding and improving his technological competence. Red China too is devoting a high proportion of its resources to technological development. Red China, which started from a base of almost nothing in 1949, may become a far more dangerous adversary than the USSR in the future. To maintain our military position relative to these two enemies, we must increase the quality and the number of scientists and engineers to meet the demands of the nation.

Even without these dangerous potential enemies, we will still need an increasing number of engineers and scientists. As we use up our readily extracted raw material resources, we will need increased competence to produce the raw materials to maintain and improve our standard of living. Our people demand a constantly increasing standard of living; this can be attained only through technological advances. Every year manufacturing becomes more complicated. Every year manufacturing requires more engineers and scientists and fewer production workers. These trends point to a constantly increasing demand for engineers and scientists.

Against this trend, we have had declining enrollment in engineering colleges in the United States for the past two years. Some of this decline is due to an increase in enrollment in pure science, such as math, chemistry and physics. Much more of the total decline in engineering freshmen represents a substantial decrease in the number of students starting the study of engineering. In addition, the day of the apprentice-trained engineer is rapidly passing. He built our country and its industries; his contribution should be recognized. However, the technological demands of modern industries require a broad engineering foundation which can be obtained only through study in an engineering college.

One important course out of the dilemma which these trends create is better utilization of the scientists and engineers which we now have. The purpose of the Conference is to disseminate and publicize ways and means of doing this. If we can increase the effectiveness of our present staff at least 10%, we will go a long way toward alleviating the shortage of engineers and scientists.

Some of the ways in which this increase in effectiveness can be obtained will be discussed in the following papers. These include: (1) better equipment and facilities; (2) more technicians; (3) additional training of engineers and scientists and (4) other methods and policies.

Motivation is the most important factor influencing an engineer's effectiveness. The desire to do a good job is an essential element in good performance. Industry, research and government must establish and carry through policies which will motivate the engineer and scientist to better work. These policies include increased recognition, improved economic position, security, and other satisfactions of personal goals.

The role of the engineer and scientist in America's modern industrial society is changing. The engineer is no longer satisfied to be classified solely an employee. On the other hand, the industrial organization in modern society requires that the engineer fit into the organization as an effective working member. From these and other social and technological changes, a new status in today's industrial society will come to the scientist and engineer. This Conference is a small part in the discussion of the change in the place of the engineer and scientist in today's society.

The purpose of this Conference was to help each participant to solve his problems in utilization of scientists and engineers. Many good papers were presented. We sincerely hope that you will learn of specific methods and policies which will be of immediate use and value to you and your organization.

## Roster of Persons Attending Conference on Utilization of Engineers and Scientists

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## Utilization of Engineers—The Young Engineers' Viewpoint

*by—George K. Anderson, Western Electric Company, Kansas City, Missouri*

### Introduction

When I was first asked to present the Young Engineers' viewpoint on effective utilization of Engineers, I welcomed the opportunity. At the outset it appeared easy to merely express ideas that were already uppermost in my mind. As it turns out, the task is not easy.

Engineering is not the same today as it was a year ago. Nor will it be the same tomorrow. It is an ever changing thing. These changes are an inseparable part of engineering and a part of our increasingly complex society.

Unfortunately, change is not an ally of efficiency. In fact, it is usually in conflict with established patterns of efficient operation. The element of expediency is ever present in this rapidly changing situation. Society will continue to ask more of the Engineer, demand greater flexibility and seek to expand the areas of application. When it is expedient to direct Engineers into new channels of activity requiring comprehensive knowledge and systematic procedure, it will be done. Increasing numbers of Engineers are continually being utilized quite effectively in management positions. The technical level of certain areas of industry demands Engineering talent, and this demand must be met. The scope is ever increasing. There is no end in sight.

It becomes apparent then that a modern effective utilization program must be flexible. Confining Engineering to fixed areas of maximum utilization is no longer the answer. We as Engineers must make up our minds to the fact that utilization is a dynamic thing. It has to be, and we must participate in a program of awareness.

In answer to the problem of effective utilization, I can only suggest a program of constant re-evaluation of our Engineering situation. The performance of Engineering *can* be made effective if we can understand and define the term "Engineering" and assign it a worthy need or "cause".

Permit me to review with you some very basic factors which may serve as a guide in a program of continual re-evaluation.

ENGINEERING AS A SERVICE

THE DEFINITION OF ENGINEERING

"Engineering is the Creative Practical Application of Scientific and Empirical Knowledge to the Controlled Utilization of Materials and Forces".

FOUR BASIC FACTORS

- ENGINEERING ASSIGNMENT
- INTEGRATED SYSTEM
- QUALIFIED STAFF
- METHOD OF EVALUATION

PART I AN ASSIGNMENT ENCOMPASSING A NEED FOR ENGINEERING

(1) A clearly defined area of responsibility
 (a) Direction and scope
 (b) Advancement of the science
(2) Authority to plan and control
(3) Matching the individual to the job
 (a) Background—Experience—Training
 (b) Personality factors

PART II AN INTEGRATED SYSTEM FOR EFFECTIVE ENGINEERING

(1) Departmental organization
(2) Non-Engineering Functions
 (a) Secretarial and Clerical
 (b) Expediting
 (c) Technical Assistance
 (d) Other areas and services
(3) Scheduling
(4) Methods and procedures
 (a) Coordination
 (b) Efficiency
 (c) Other
(5) The physical plant and environment
 (a) Quiet office and conference areas
 (b) Technical libraries
 (c) Engineering laboratories
 (d) Special facilities
(6) Advanced training programs
 (a) Company methods and procedures
 (b) Direct training in the field of operation
 (c) Advanced training in the sciences
 (d) Training in the humanities

PART III CHARACTERISTICS OF THE PERSONNEL WHO STAFF AN ORGANIZATION

(1) Supervisory requirements
 (a) Ability to make decisions
 (b) Broad vision and foresight
 (c) A progressive attitude
 (d) Independence of thought
 (e) The ability to delegate authority
 (f) Capability

(g) Courtesy and understanding in personal contacts

(2) Direct engineering qualifications

(a) Qualified by training and experience in engineering

(b) Proper attitude (Mature and in keeping with responsibility)

(c) Judgement

(d) Suitable personality factors

(e) Responsive to instructions and capable of independent action

(f) Attitude and aspiration

(3) Social and economic considerations

(a) Esprit' de Corps

(b) Rapport between engineers and supervisors

(c) Adjustment—Job satisfaction

(d) Suitable social and economic status

PART IV EVALUATION OF ENGINEERING UTILIZATION

(1) The goals and objectives must be clearly defined

(2) The effective system must be established

(3) Actual evaluation must be made

(a) Economic and business results

(b) Technical achievement checked against the plan

(c) Personal aspects reviewed

## Effective Utilization of Engineers Through Technical Communications

*by—Robert G. Calkins, Group Leader, Mechanical Group, Engineering Department, Research & Engineering Division, Monsanto Chemical Company*

### Introduction

If I were asked the question,

"What is one of the most important assets of a successful company?" my answer would be—an excellent internal communications system! Unfortunately, the general area of communications is so broad, complex and interest oriented that I don't believe an ideal system exists in any company today. On the other hand, it is very encouraging to see that industry is giving much greater attention to the subject within the last few years. Furthermore, I predict that the importance being attached to this area will continue to grow, and at an accelerated rate.

Rather than attempting to cover the many different aspects of communications, I want to talk about two items that I feel can contribute directly to the more effective utilization of engineers in industry. The first is a rather unique communications practice in use at Monsanto that may be applicable to many other companies. The second item is a brief glimpse of what the future may hold for technical communications. I hope that my viewpoints and examples will give you some ideas, or perhaps even substantiate your own thinking on the importance of, and the need for, adequate internal communications.

### Engineering Information Program

A major problem in many companies is that of exchanging information between personnel with common interests, and across divisional and plant lines. The larger an organization, the more difficult it is for the information to reach the proper hands. This is especially true of local developments and practices that might be useful elsewhere within a company.

About three years ago Monsanto management charged the Research & Engineering Division with the responsibility of supplementing existing communication channels with a program aimed at developing a free exchange of information on internal developments and practices in all fields of engineering. The primary objective is to provide a coordinated communications system through which such information could be channeled on a company-wide basis, void of red tape, so that Monsanto engineers could benefit from each others experiences. We call it the Engineering Information Program.

For example, assume that Jim Jones in Plant A developed a new maintenance technique, or was able to markedly improve the performance of a piece of equipment. It would be the Program's responsibility to uncover this information, and then distribute it on a company-wide basis, providing it was potentially useful at other locations.

Considerable thought was given to how we could go about finding these unique or new developments, and how to disseminate the information. It was finally decided that the most effective way of learning about developments in detail was to visit each location periodically and discuss possible contributions with many engineers. This decision was based on one simple fact—company engineers are already exceptionally busy. To burden them with requests for additional reports to be sent to some central location would probably result in negligible contributions. Subsequent experience has shown this point of view to be 100 percent correct. On the other hand, engineers are willing to spend 15-30 minutes talking about their work. In fact, most of them are quite eager. Frankly, there appears to be no better way of getting information than through the personal contact approach.

The information on specific items picked up by the Coordinator during visits is then consolidated at the home office in the form of rough draft abstract reports. Because there is always a chance of misinterpretation, the abstract report is returned to the contributor for his comments and approval. An extra copy is also sent to the EIP contact man at the corresponding location. The contact man is primarily responsible for instituting securtiy action on material contributed by his location that should not be issued on a company-wide basis. He also acts as the Program's representatives on routine matters that arise during the normal course of operation.

After the contributor returns his copy to the Coordinator, the abstract is assembled along with several others and distributed on a company-wide basis in one of the monthly issues. Appropriate acknowledgment to the contributor, and the name of the person from whom additional information can be obtained is always furnished on the report. Reference to the contributor or authority on the subject is necessary because the Program aims to encourage the direct exchange of information between technical personnel after the first contact has been established by means of the abstract report.

Currently, each monthly issue includes 7-10 abstract reports. About 375 sets of these issues are distributed and ultimately reach approximately 1200 technical personnel. Participating in the contribution and exchange of information are 21 plants, 5 divisional engineering departments, and several research and special interest groups.

I would now like to read to you an example of a typical report that was previously included in the Program.

Another service that the Program provides is that of furnishing sources of information for personnel who may have technical problems. The Program is a natural place for this function because of the large number of contacts established, and the knowledge developed on possible sources of information within the company. In the event we are unable to offer direct assistance, or to steer a person to someone who might be of help, we still have the mechanism for making inquiries on a limited or a company-wide basis.

A dynamic project such as the Engineering Information Program is continuously subject to changes and additions. Experience has shown up weak spots and areas that should be expanded. Perhaps the greatest shortcoming of a company-wide information disseminating program is the selection of material to distribute. For example, a useful item may relate to a unique instrument application or development. Normally, only the engineers concerned with instruments may find it of potential interest. Therefore, each issue includes a variety of subjects in different fields of engineering so that a general coverage is obtained. Obviously, this is a "shot-gun" approach, typical of most types of circulated information. Personally, I hope to see information on a specific topic channeled only to personnel active or interested in the area.

Experience has also shown that information related to external developments, current activities, tests in vendors' laboratories and many other areas not included in the original scope are of definite interest. To supplement abstracts, we recently started using a Monthly Newsletter, which includes items in these categories. This is proving to be an effective way of disseminating current information which does not have permanent value.

Another point worth mentioning to show how such a program may expand relates to corrosion data. When the Engineering Information Program was first activated, we considered the possibility of including a wealth of corrosion information which is available from the Corrosion Section of the R & E Engineering Department. At that time, however, management felt that corrosion data was being adequately circulated within the company through separate channels.

The latest thinking, however, is that many engineers engaged in design and maintenance work are not benefiting as much as they should from the existing channels of communication, and that an improved method is needed. The communication channels set up by the EIP now appear to be the answer. What remains to be done, however, is to develop an index system compatible with the Program.

I would also like to mention that an exchange of information between Monsanto and several domestic and foreign subsidiaries is also being developed. We took the initiative some time ago and began sending abstract reports to one of our major overseas subsidiaries; we now find that they are profiting from the information. Therefore, since the Program is based on a two-way exchange of information, our subsidiary is developing a comparable system so that they can send us information for distribution.

Once a technical communications program such as ours becomes a reality, the possibilities for expansion and development are obvious and numerous. Even now we are only skimming off a little of the surface of a wealth of untapped internal technical information. Frankly, I foresee the time when this type of a function will be an integral part of a company-wide coordinated communications network.

## Future Considerations

I would now like to shift scenes and take a brief glimpse of what the future may hold for technical communications.

As a company expands, the problem of adequate internal communications grows too, perhaps even more rapidly. As major gaps show-up, they can often be filled by use of such practices as Engineering Information Programs, special information exchange groups, seminars, reports, newsletters, libraries, etc. Add to these practices the necessity of keeping up with the ever increasing volume of technical publications, and the score becomes staggering.

In my opinion, the time is coming soon when the engineer and scientist will have to spend so much time keeping up with communications in his field that he will be handicapped in his work. Streamlined and overall coordinated systems must be developed if we are to continue to effectively utilize technical manpower as well as the wealth of technology being developed at an ever increasing pace.

Looking at the internal and external communication complex from the engineer's point of view, I feel that it is management's responsibility to see that their engineers enjoy the best communications possible. Therefore, I personally think that long-range planning and development of a communication system must be an integral part of any forward looking company.

I have seen evidence that many large companies are starting to staff themselves with specialists in this area. What is even more evident, however, is that the problem is so complex that it will take considerable time before any real progress will be felt. What then should we be thinking about to plan for the day when a streamlined communications system is a must? Here are my viewpoints on the subject.

### INFORMATION CENTER

I believe that most organizations will sooner or later be equipped with a technical information center, staffed with specialists. It will be a major function designed to service and coordinate the information needs of technical personnel within the company. It will include facilities for acquiring, storing and retrieving externally and internally originated information. It may also include facilities for processing information other than technical. Libraries and other existing functions will be an integral part of the program.

Although acquiring, storing, and retrieving will be the basic function of an information center, I feel that the Center's usefulness will be enhanced immensely if it is organized to automatically disseminate newly acquired information to individuals based on their personal interest profiles. In my opinion this is an extremely important point because technical personnel do not have the time to review all important publications in their areas, or to participate in all internal communication functions. Keeping them posted at all times on potentially useful information would certainly be a real advantage to the individual and to the company.

### AUTOMATIC EQUIPMENT

Technical information centers will have to be organized to handle vast quantities of information efficiently and rapidly. Fortunately, some manufacturers of electronic equipment have already recognized the communication problems that are beginning to confront all types of industry. They see a real future market for high speed data processing machines. Suitable equipment for storing, retrieving and disseminating information is not too far off, and will undoubtedly be the heart of the information center. An important item to consider, however, is that every effort must be made to not only evaluate the automation of existing information operations, but to include many others that will potentially enhance the overall efficiency and value of the system.

#### JUSTIFICATION

Information centers will prove extremely difficult to justify on the basis of such things as clerical manpower savings. I will go so far as to say that the situation will be reversed; staffs will be larger, and the cost of operation will be much greater than existing practices. How much, then, will speed, greater coverage, coordination, reliability, direct dissemination on the basis of interest profiles, etc. be worth? I cannot answer this, except to say that it will be great. Perhaps one way to look at it is by asking another question—how much is research worth to keep up with or ahead of competition?

#### Summary

Gentlemen, we have discussed briefly a rather unique, but simple, method by which internal technical communications can be improved, namely, the Engineering Information Program. This practice has proven workable and effective because Monsanto engineers are given opportunities to exchange information on their own experiences. When a technical man profits from another person's work, we can certainly say that he is being utilized a little more effectively.

I feel that the long-range problem of internal and external communications is so important and complex that the time will come soon when stop-gap measures will no longer be adequate. The technical information center will then become a necessity. It will be difficult to develop, and expensive to operate. I believe, however, that the end result will justify the means, namely, greater profits through more effective utilization of technical manpower.

## Opening Remarks

*by—Dean Huber O. Croft, College of Engineering, University of Missouri, Columbia, Missouri*

#### Members of the Conference:

It seems to me that this is a most appropriate time to again discuss the many problems involved in the Utilization of Engineers and Scientists.

These are critical days for determining the future of American industry since plans which are now being formed may not become realized for perhaps five years from now, and we also now know that our industrial competition will come from all the free world—as well as the iron-curtain countries.

In order to meet this universal competition, American industry must utilize their engineers and scientists in the most effective way. It is for the purpose of discussing these methods that this conference has been called.

A discouraging factor in the present situation is that the fall enrollment in engineering, nationally, decreased about 4.5%—with a 11% decrease in freshmen enrollment. This decrease in enrollment came when there was an unsatisfied demand for about 10,000 engineers to replace those missing due to deaths and retirements, and to assume new openings.

The fact that again this fall the engineering enrollment was below that of even last fall, on the national basis, should give us all questions to ponder: Why should these conditions prevail, and what may be done now to alleviate this situation by next fall?

Upon behalf of the College of Engineering, I wish to express our gratitude to those of you who are taking part in the program. Without your help, this conference would be impossible. I would also like to express our appreciation to President Arlow Ferry, of the Missouri Society of Professional Engineers, for the valuable assistance that Society has given in the arrangements for the conference; and to Dr. William Torpey, of the Office of Civil and Defense Mobilization, for his advice and counsel.

## Introductory Remarks

*by—Arlow V. Ferry, Office Engineer, Black and Veatch, Kansas City, Missouri*

In my capacity as President of M.S.P.E., I am happy to share with Dean Croft the chairmanship of this meeting and hope that all of you will benefit by this conference. I also hope you will receive information concerning the benefits to be derived by the engineers in your organization becoming more professional minded.

This is the third Utilization Conference held in Missouri. The first one was held here at the University of Missouri in December 1957. The next one was held in Kansas City at the University of Kansas City in April of 1959. In addition to these conferences other activities have been carried on by the Professional Society.

Dean Croft, as President last year of the M.S.P.E., held a meeting in St. Louis last spring with 44 leaders of industry who employ engineers. He also had present some of the officers of the St. Louis Chapter of M.S.P.E. The purpose of this meeting was to acquaint these industrial leaders with the desirability of making engineers a part of management, to assist in planning, operation, maintenance, and other areas where they could be of assistance, and to let these leaders of industry know the desirability of engineers in industry becoming registered and members of the Professional Society. This was a very successful meeting. (Yellow cards were left with these leaders of industry to give to their engineers who were interested in becoming registered. Over 100 of these cards were sent in to the Board of Registration indicating the interest of these engineers in becoming registered.)

Dean Croft this year is chairman of the *Engineers-in-Industry Committee* of M.S.P.E. In this capacity he has held and will continue to hold meetings with engineers employed in industry and explain to them the advantages of professionalism, including registration. The State Board of Registration issues a certificate as an E.I.T. to the recent graduate engineer, or the young engineer who, by experience and education, successfully passes the examination. Then after four years of practical experience in engineering work he would be qualified to take the professional engineer's examination.

Engineers who have charge of projects involving the public health and safety must be registered to practice engineering. This includes the consulting engineer in private practice and would include such projects as water supply treatment, pumping and distribution; sewage and waste disposal; structural design of buildings, and many other types of improvements.

Is it not also desirable to have the engineer-in-industry registered, since he is designing and supervising the construction or manufacturing of equipment to be used by the public, where safety would be involved; such as boilers for heating or power generation, steam turbines, unit heaters, and hundreds of other items produced by industry to be used by the general public?

M.S.P.E. is the Professional Society in Missouri and is affiliated with the N.S.P.E. as are 51 other states including Washington, D. C., Puerto Rico, and the Canal Zone.

M.S.P.E. has 12 local chapters in the State of Missouri where in most cases meetings are held once a month from September through May, to provide the membership with information on good professional conduct and engineering ethics, as well as many other professional matters.

Dr. Robert Howard, who is the Head of the University of Kansas City's Engineering Department, and who is treasurer of the Western Chapter of M.S.P.E. received a call several days ago from one of the industrial companies in Kansas City asking his advice on how they might set up a means of classification for the advancement of their Young Engineers.

He suggested to them that registration would be a good means of doing this; that the Young Engineer who successfully passed the E.I.T. examination given by the State Board of Registration for engineers could be classed as a Junior Engineer, and as he received more experience other classification could be used; then after four years of experience he could take the full professional examination and upon successful completion could be classed as an Engineer. In this way industry could use the Registration Law as a means of classification and advancement of their engineers.

## Luncheon Address

*by—J. O. Grantham, Vice-President of Employee Relations, Northern Natural Gas Company, Omaha, Nebraska*

"The social forces which play upon the engineer and scientist in industry today are having a profound impact upon his own professional feelings and upon his attitude toward the organization wherein he works. These forces, namely complex technology, masses of people with which to deal, and arrogant self-centered attitudes among the population in general, are causing the engineer to feel less and less like a professional person and more and more like a cog in a machine. The opportunities for him to express his individuality, the very foundation of professionalism, are becoming less and less. This is why he is joining unions or leaving the profession.

Yet we recognize that the battle for survival of our western culture is rapidly maturing into a technological battle wherein the engineer and scientist play a most critical role.

The challenge thus facing statesmen, industrial managers, and college educators is profound in so far as the motivation of the scientist and the engineer is concerned. Sufficient quantities of our young people must be encouraged to enter scientific and engineering fields. (Quality is to be stressed rather than quantity.) The education which the budding scientist and engineer receives must be technologically sound and yet awaken within him a sense of his social responsibilities. The supervisors and managers of engineers and scientists must awaken to their responsibilities as leaders of professional people. Statesmen and politicians must come to respect the scientists, and engineers, opinions regarding science and technology. (This does not mean that the scientist and engineer can assume that he is all-knowing in the field of politics.)

Western civilization has championed the right of the individual man. This idea has sparked the creation of this society we now enjoy. We must not accept the Russian view that we are at the zenith of our growth and, like the former civilizations of Persia and Rome, are becoming decadent and ready for the barbarians to conquer. We must once again take up the pursuit of excellence and demonstrate for the world to see that the growth of western civilization is only beginning.

## Selection for Long-Time Retention

*by—Dorsey W. Hurst, Area Personnel Relations Supervisor, Southwestern Bell Tel. Co., St. Louis*

*The search for engineers,* scientists, and management talent grows apace year by year.

Not too many years ago very few business firms sent men to the college campus to hire graduates.

Business usually expected the "Right Man" to walk in.

Looking back 20 years, I remember that it was mainly the so-called blue chip companies that bothered with campus recruiting.

Today, recruiters looking for engineering graduates outnumber the graduates themselves at some colleges.

*This mounting competition* for the "Right Man" began to pose serious problems a few years back.

Questionable recruiting practices was the worst problem.

It was so bad by the middle Fifties that the Midwest College Placement Association proposed a code of recruiting ethics. Perhaps some of you studied this problem with us who attended the 1955 conference of the MCPA.

You will recall that the MCPA formulated a code of "Principles and Practices of College Recruiting" at its 1956 conference. That code has since been adopted by placement associations throughout the United States.

I am encouraged by what I have observed, at the MCPA conferences, about the kind of men on placement work in the colleges and industry. Here are men:

—competent and of high principles,

—responsible and exemplary in their conduct,

—all striving their utmost,

—to get the Right Man on the right job.

By adopting and adhering to ethical recruiting practices, they pushed aside the temporary hindrance to their quest for the Right Man. *He* is their Holy Grail.

*The question is:* How DO you find the Right Man?

What ways for finding him do *you* have that may be shared with others here today?

What ways do *we* have in the Bell System?

To stay in business, we *all* need the Right Man.

We need him:

—to find better ways of doing things,

—to solve the problems facing us now and those we don't yet perceive.

We need him:

—to keep pace with change and growth,

—to better enable the business to serve its basic aims.

In business or out, we *all* need him. We need him:

—to help us meet the challenges in outer space and overseas,

—to answer Chairman Kruschchev's promise to to bury us,

—to lay down challenges of our own . . . great challenges for freedom of the human spirit and for personal growth.

Last week I received a long distance call from William Moffet who has shared in some of the atomic bomb tests in his work with the Sandia Corporation at Albuquerque, New Mexico. That company does R & D in atomic missiles. He said:

"I'm in urgent need of a man to do research on devices for making measurements at extreme altitudes. He ought to have a BS in EE or physics and an MS in meteorology. Can you folks help us find the Right Man?"

*To find the Right Man,* all of us need every bit of help we can get.

In this clinic today let us exchange ideas, principles, and procedures which have been helpful to us and may help others in their placement work.

I think that in the placement field our basic principle must be this:

To help every man we see be so placed that his potential will not be wasted. We owe it to the college, to our own business, and to our country to help put him where his talents may be used to the fullest.

*In this spirit* I should like to discuss briefly the elements of the plan we employ in the communications business.

*Annual forecasts* from actuarial studies of requirements for men is the first element.

Comparison of the ages of present managers, engineers, and research and development (R & D) men against the calendar tells when retirement or death is likely to take them.

You know what your experience is with resignations and other separations.

Include a figure for growth and changes in the business . . .

Now, you have just about all the factors for *estimating annual college graduate hirings.*

*Yearly recruitment through the thick-and-thin* of the state of business is an essential element.

Men are not on a shelf to be taken down when wanted.

They must be hired far enough in advance that they will be ready for the jobs sure to be vacated or created.

They do not walk in today. We must go to the campus to recruit them.

*A team of well qualified men* who organize and conduct on-campus recruiting of college graduates plays the biggest role in Bell System selection of the Right Man.

The team at an engineering college, for example, consists of experienced men from middle management:

One from the Southwestern Bell Telephone Company. He is our Area Employment Supervisor, William J. Van Nice, who co-ordinates the recruiting work of the team on the campus.

One from the Bell Telephone Laboratories. He is a top man who knows what a *basic good man* is for R & D. He knows the traits and abilities required.

One or more recruiters from the Western Electric Co. who know what a *basic good man* is for manufacturing engineering, for manufacturing management, for missile work with the military.

One from the American Telephone and Telegraph Co.'s Long Lines Department who knows what a *basic good man* is for communications management or engineering.

One from the Sandia Corporation who knows what a *basic good man* is for R & D work on atomic weapons.

And finally . . . one from Southwestern Bell who knows what a *basic good man* is for management or engineering work in the communications business.

This team, we feel, offers advantages to the student, to the college, and to the Bell System Companies represented on the team.

*Collective judgment in placing the Right Man* on the right job is the primary advantage. Several or all members of the recruiting team interview each student interested in the Bell System.

Each team member is a man of keen perception about the kind of men it takes for his work. Every branch of the business is represented including:

—research and development,
—manufacturing and production lines,
—engineering and operations,
—atomic research as applied to missiles,
—management in all its aspects.

By pooling their judgment of the qualifications and interests of the student, they bring collective judgment to bear.

They are thus more likely to be right, consistently, in finding the *basic good man* for our work and in matching his interests with ours.

They help the student find the branch of the business most likely to fit his qualifications.

Since every branch is represented, he and the interviewers have a full range of opportunities to explore.

*A visit to the company's* headquarters is a vital step in the plan.

This has two aims:

1. To give the student a firsthand picture of the company, its work environment, the management, and the employees.
2. To let departmental management talk with the man and agree or disagree with the recruiter's appraisal.

Here, again, the *collective judgment* process is applied.

The man is made a job offer based on the pooled judgment of top management people.

An offer usually means that *everyone* is *for* him. He thus gets powerful backing from the start.

*One more element* comes into play after the student is hired.

He is given training designed to orient him quickly to his employment and to help find the particular work that best fits his success pattern and potential.

Most important: He is given challenging assignments as soon as possible.

*Where is the scientific proof* that this plan assures long-time retention of the Right Man?

There isn't any. "It works fairly well," is about all I should say. But I *will* add this:

Walter LaRoy Wilkins, A.M., Ph.D., Professor of Psychology and Director of the Department, St. Louis University, asked me if there is scientific proof that we hire the Right Man. I said:

"No, there isn't. We feel our plan works most of the time. We can't say why it works any more than we can explain how a *black* cow can eat *green* grass and give *white* milk."

## Industrial Development of Missouri—Source of Engineering Opportunities

*by—Richard M. Kinne, Industrial Director, Missouri Division of Resources and Development*

Missouri's industrial development program on all levels—community, area and state, is aimed primarily at creating additional jobs for the young people born into our state. Our population is estimated to increase at an annual rate of about 7.2 per cent during this decade, as compared to a national figure of 13 per cent, based on 1950 to 1957 growth rate. During the years between the Census of Manufactures in 1947 and 1954, the change in manufacturing employment changed very little, less than 10 per cent, indicating while our birth rate is increasing, the job opportunities are not increasing as rapidly. One recent writer estimated we must provide about 25,000 new jobs yearly, to keep up with our growing population. Records from our office indicate that from 1954 to 1958, we added a total of only 24,799 new jobs. In other words, we are already 3 years behind.

Actually, the 1957 Survey of Manufactures shows that Missouri held her rank of thirteenth in the nation in value added by manufacturing from the 1947 Census. Thus our productivity is still high, and we are keeping up with the 12 states that have a higher total value added by manufacturing.

Missouri's growth has been diversified—manufacturers of machinery and transportation (both large employers of engineers) created the most new jobs. Transportation equipment, rubber and electrical machinery plants hired the most workers per plant, averaging 261 per plant, as compared to a state average of only 68 per plant. Our growth has been in small plants, going into small towns—37 per cent in cities over 50,000, 14 in cities 10 to 50,000, and 49 per cent in cities under 10,000 (and, 27 per cent were in towns 1,000 to 5,000 population).

Why this growth in Missouri:

1. Rail transportation—main arteries to the southwest, Mississippi Valley and Western growing markets.
2. Water routes—about 1400 miles of navigable waterways.
3. Highways—a system of about 81,000 miles of surfaced roads.
4. Labor—a supply still anxious to produce a day's work for a day's pay.
5. Resources—mineral, agricultural and forests. These include what might eventually be proven to be the richest body of iron ore in the United States; agricultural production ninth in the Nation; and forests over one-third of our land.

What do we need to do to guarantee this growth will continue and speed up? You as engineers and trained scientists have a dual role. First, you must be ever aware of new possibilities for company growth in your own company or community. Ten years from now fifty per cent of the products being made are not now being produced. New advancements in technology, new markets to aim at, all should be considered by any firm in Missouri of which you are a part. Second, as citizens of Missouri you have a responsibility of maintaining and improving the good business climate we now have, and of working to make your town a better place in which to live, work and play.

We must all work together, as employees, supervisors and management are interested in seeing your firms prosper and expand. You are interested in seeing that job opportunities are created to keep our youth, our most prized resource, here in Missouri. And, you want to see to it that your family will have the best community facilities it can get for happy growth.

## Better Engineering Through Better Utilization

*by—Eugene O. Klimt, P.E., McDonnel Aircraft Corporation, St. Louis, Missouri*

### Summary

Probably the most practical and readily available source of additional manpower for the scientific and engineering field is within the field itself. The current level of utilization of engineers is only moderate, and more and better engineering (if wanted) can be had to a highly worthwhile degree by exercising simple methods and techniques of better utilization. This is the conclusion drawn in this paper after "an engineer looks at utilization."

The paper defines utilization and shows how it can be measured. The paper includes answers to such questions as: Does Malutilization Exist?, Where? and Why? Concrete up-to-date examples and the results of an original survey are given which reflect the extent of engineer utilization in the St. Louis area. To achieve objectiveness, the method and type of material was gathered independently of current parallel investigations, particularly those of the Office of Civil and Defense Mobilization.

### Introduction

I appreciate the opportunity of appearing before you today to give my testimony on the question of engineer utilization. Because I am not an expert on scientific manpower nor a manager of personnel problems, it seems to me the most useful role I can play is to very briefly comment on the personal observations I have made during the past few years and the conclusions which I have drawn concerning utilization.

If the United States is to maintain a role of adequate and permanent leadership for the free people of this world then all of us must think and work with the utmost efficiency and utilization to that end. The responsibility belongs to all of us. We, as engineers, are especially concerned with the efficiency and effectiveness with which we perform our everyday engineering duties. The day to day news of technological challenges and attendant advances, particularly in space activities and civil defense, is a constant reminder of the great import of our particular contribution. The need for an adequate quantitative and qualitative supply of scientific and technical personnel on a national scale in these United States has become a matter of unprecedented concern. With that need, the efficiency with which we work, and our utilization, is also our concern.

To insure objectiveness, the material presented in this paper was selected and gathered independently of current parallel investigations, particularly those of the Office of Civil and Defense Mobilization. As a result, the opinions expressed herein are entirely those of the speaker, and do not necessarily reflect those of the Missouri Society of Professional Engineers, the University of Missouri, nor the McDonnell Aircraft Corporation.

### Defining and Measuring Utilization

In order to establish a solid foundation for our discussion and stimulate a better understanding of the problem, let us consider what is meant by the word *utilization.* For the purpose of this discussion, the definition given by Webster will appropriately serve. Utilization: the act of making useful; turning to profitable account or use; making use of.

Think of *utilization* as the first of two basic requirements, the second being *efficiency,* i.e., effective activity; capable; competent. Hence if one is utilized and is efficient he will produce a decided result without waste.

Now that we have tentatively defined utilization in words let us determine how to measure it. It should be borne in mind that this discussion of utilization is applicable to groups as well as to individuals. Since an understanding of the former can be obtained by generalizing the concepts pertinent to the latter, we shall, for purposes of clarity confine our attention to the individual case.

It is believed the extent of utilization of an engineer may be expressed as a function of time and capability. For example, if an engineer's capability is perfectly *matched* to a particular work project, then he is fully utilized capability-wise and his total utilization is a factor of the percent of his time spent in that capacity. If he was actively engaged at full capability, but only for 50% of his time then he would be only 50% utilized because he could have doubled his output had he worked 100% of the time.

On the other hand, an engineer that spends 100% of his time on a work project that requires only half his capability is operating at a total utilization of only 50% because he could have doubled his contribution had the work project required it. These examples are best shown on the curves in Figure 1.

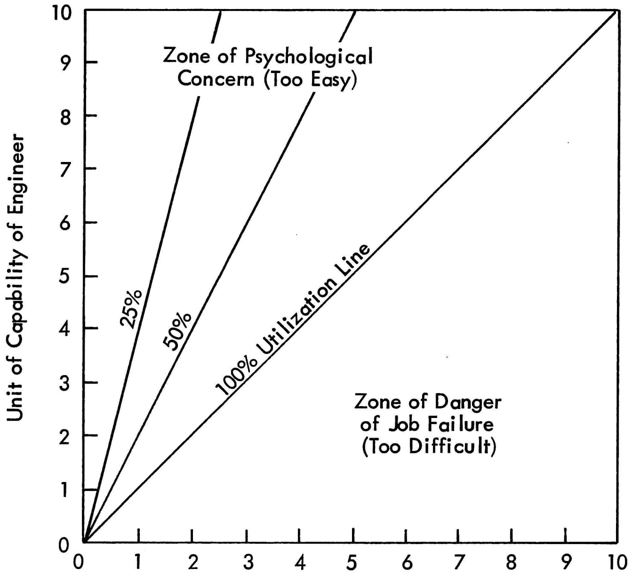


Fig. 1 Curves Showing Total Utilization for Various Degrees of Capability and Job Difficulty

Here the "unit of difficulty of job" and "unit of capability of engineer" are shown as equal and linear scales on the abscissa and ordinate respectively. Utilization is then shown as a point on a line. The 100% utilization curve is the 45° sloped line beginning at the origin which represents a series of points of equal capability and difficulty. The upper left half of the figure is a zone of psychological concern because the engineer is working at less than full capacity and is subject to discontent and numerous other personal aggravations resulting therefrom. The lower right half of the figure is a zone of danger wherein a job theoretically cannot be completed because the difficulty of the job is greater than the engineer's capability available to overcome it. This condition is the inverse of engineer utilization; it is misassignment of the job. In this case, the company as a business is subject to "discontent" and other problems because the job *cannot* be completed. This conclusion is based on a ground rule that an engineer with a given capability cannot accomplish a job requiring a relatively greater capability even if given more time. It is agreed that given more time one can probably accumulate the necessary knowledge and skill to eventually complete the job, but in effect this raises one's level of capability and shifts the initial conditions of the problem. For clarity, the discussion is based on "current" capability and job requirements.

The following formula is submitted as an expression of utilization:

*THE 4-T FORMULA*

$$U = \frac{T_1}{T_2} \times \frac{T_3}{T_4} \times 100$$

where:

U is the overall utilization in percent

$T_1$ is the time the engineer works at the job.

$T_2$ is the time required to complete the job at a talent level of $T_3$.

$T_3$ is the talent required to perform the work project.

$T_4$ is the maximum talent possessed by the engineer.

and

$T_1 \leqq T_2$

$T_3 \leqq T_4$

The total utilization of an engineer then may be calculated by inserting the four variables into the equation. It may be stated thusly: "The combined utilization of an engineer's time and talent is equal to the product of the ratio of his time expended ($T_1$) over the time required ($T_2$) multiplied by the ratio of the talent required ($T_3$) over the talent possessed ($T_4$), multiplyed by 100." The equation is plotted as a family of curves in Figure 2.

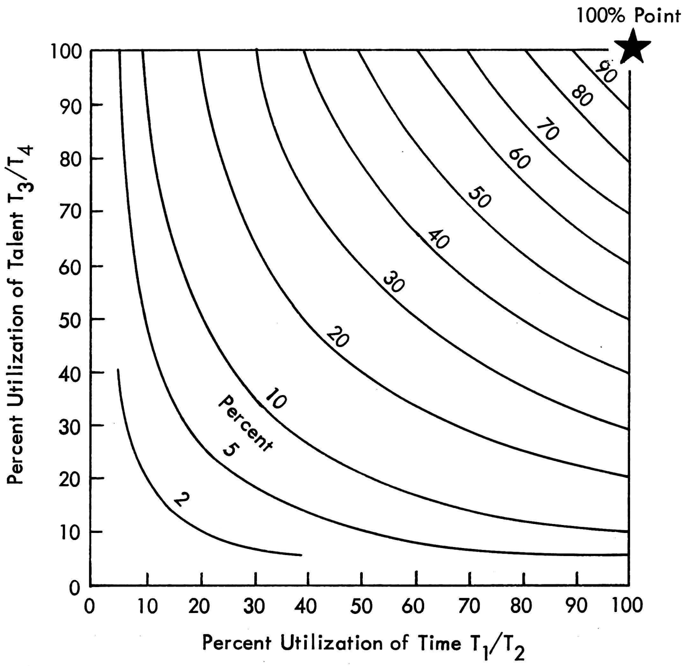


Fig. 2 Curves Showing Total Utilization Plotted as a Function of Time and Talent

It should be noted that personal factors such as fatigue and work breaks are necessarily involved in the normal functioning of a job but these are held as constants and are omitted from this discussion. Also note that the *efficiency* with which one works is a factor independent of utilization. Efficiency is an expression of a comparison of *a way* one does a job in contrast to the *best way* to do the job. One who is overtalented for a given job can probably do it very well and as a result the job in itself could be done efficiently but the person would not be fully utilized nor need he work efficiently.

In summing up, we are now able to define utilization in a practical sense—"Maximum utilization is that condition wherein a person undertakes a task which requires his full time and his full talent."

## Does Malutilization Exist?

A. *Indications of Malutilization*

We might ask, "Is there really a problem?" One answer may be gotten by reading the help wanted ads for engineers in current newspapers and technical magazines.

Here are some examples exactly as worded:

a. "Disenchanted engineers—if your employer has failed to utilize your full potential—"
b. "—make an important individual contribution to your nations progress—"
c. "our environment stimulates professional creativity—"
d. "Exciting opportunities exist—"
e. "Technological challenge—assures our engineers—that their contributions will have lasting significance"
f. "need elbow room?"
g. "enjoy stimulating—activities—add a dimension to your career—"
h. "are you boxed in?"
i. "—challenging opportunities—"
j. "—unmatched opportunities—"

And so they go. In believing the objective of these advertising men is to drive home a point that really means something to the reader, it appears engineers have indicated, at least to these prospective employers, that they are dissatisfied with their utilization in their present assignments.

Now let us look at some more concrete reasons why poor utilization can or does exist.

B. *Dynamics of an Expanding Industry*

Perhaps the basic potential cause of under-utilization is that of growing pains. The engineering industry has expanded tremendously over the past 20 years. Many segments have expanded to considerable size in only 10 years. During this growth period engineering needs were the most urgent and most important and it might naturally be expected these would be attended to while administrative deficiencies might go unattended. Some of the "growing pains" most often mentioned by engineers contacted by the speaker are covered in the sections below. The examples are true and are believed to be representative for the St. Louis area; they are not second-source material taken from the literature.

C. *Factors Unique to Engineering*

Of the many factors which can affect utilization some are general and some are unique or especially applicable to the field of engineering. Those unique to engineering will be discussed first.

1. *Hoarding in the Peaks and Valleys*

Hoarding is probably the best example of outright and wholesale malutilization. Hoarding is the practice of an employer retaining employees during slack work periods when their services are not needed for the purpose of having them immediately available at a subsequent date when their services will again be needed. It is a difficult task to assign personnel in a manner such as to smooth out these peaks and valleys which are caused by a changing workload. Fluctuation in the workload is caused on a large scale by the winning or losing of whole jobs or contracts, and on a small scale by the timing and scheduling of an already existing job. It is difficult to complete all jobs on time and to do so by having all jobs filled constantly by the right people. I will not pass judgment on the practice of hoarding because there are many important variables that must be considered in each particular case, such as the balancing of skills, time, and numbers of people, the relative cost of hiring and training new employees, and the effect of a hire-fire routine on the company's reputation in the community. Moreover many customers, particularly government customers, like to be assured that a sufficient number of employees are "ready-to-go" before a contract is signed. They don't want delivery of the end item to be delayed and they know it is unlikely that X number of persons with proper qualifications can be hired immediately after "go-ahead". Looking at it from another angle, more than one large manufacturer has been known to lay off hundreds of engineers upon learning a hoped-for project had not materialized. One might naturally ask (and Senators have concerning government contractors) "What were these engineers doing just prior to the time employment was terminated?" It is obvious they were not being fully utilized.

But right or wrong, the engineer being hoarded is by definition not being fully utilized. Further, he knows he isn't doing anything important and as a result probably is working without geniune enthusiasm and direction. This loss of talent is compounded, we are told by personality experts, by the fact that the temporarily idle employee later reappears at a full time job at a new reference of efficiency which is lower than that where it would have been had he been continuously and fully occupied.

2. *Duplication of Effort*

Duplication of effort is malutilization in another sense. In this sense an individual (or group) may be fully utilized on a project but if another individual (or group) who may also be fully utilized is working on the same project, the cumulative utilization is less than maximum. Discussions of this issue usually result in the merits of healthy competition being introduced and the argument stalemates. The value of competition in private enterprise cannot be questioned; it is largely responsible for our high standard of living. Let it be said for the sake of argument that competitive like effort is probably justified if the overall aim is to save time, maximize efficiency, or have a back-up program to maximize success. Dual projects for weapon systems, resulting from threats to our national security, are well known examples of this. This philosophy stems from the fact that a single team sometimes produces nothing, and progress of basic research and complex development projects typically cannot be scheduled by dollars.

However, let it be understood that duplication and crash programs cost more money than a single effort. Further, the principle of "regulated monopoly" has shown that it can produce the same results as duplication, and with much less money, if a program is administered and performed with true honesty, integrity, and efficiency by those involved. In other words, in fields other than basic research, say design, and production, word has a way of getting around as to where one can get work done satisfactorily, on time, with a high degree of capability, and at a reasonable cost.

This can occur on a small scale, say within one company, or on a large scale, say within one nation. A single company may have two or more groups of engineers working with the same or overlapping job functions. Examples of unquestionable duplication on a national scale are the much publicized major weapon systems. The Army Jupiter and Air Force Thor need no elaboration, nor do the Atlas and Titan missiles. Other general duplications are: the Army Nike and Navy Talos; the Army Nike-Hercules and Air Force Bomarc; the Navy Regulus and Air Force Matador; and the Navy Sparrow and Air Force Falcon. It is to be regretted that these particular examples of overlapping were corrected, to an extent, only after billions of dollars and manhours had been expended. There are currently other duplications in the fighter, bomber, ground equipment, and space craft groups.

It cannot be denied that effort on the same job with the same requirements and objectives, within one company or one agency or group, with scientific teams all over the place doing the same thing, and resulting from ignorance, lack of communication, or political purposes is duplication of effort, and not competition, and as such is a gross violation of good utilization of talent.

3. *Aides for Engineers*

There are gray areas where an engineer's work ends and someone else's begins. These areas, which are familiar to most of you, are:

a. Administration
b. Buying and selling
c. Cataloging and filing
d. Computing
e. Drafting
f. Field engineering
g. Inspecting
h. Secretarial
i. Specification writing
j. Technicianing

Unfortunately there is no fine line showing just where an engineer's should stop. For the sake of continuity of thought, or occasional urgency, an engineer can and should continue on into these non-engineering spheres. As a general rule, however, if an engineer can explain to a helper, a secretary for example, in a short period of time, a job that would require a relatively long period of time for him to do, then he should do so. In any case, the everyday misapplication of an engineer's time on a job that any intelligent, non-engineering perso can do as well, is an example of gross waste of engineering talent.

Some engineers devote so much time to experimenting that they cannot keep a full-time secretary busy. However, other engineers create a vast amount of paperwork, the tidying up, production, and distribution of which can be done by a secretary. The extent of aid supplied to the engineer depends on the particular circumstances. It must be remembered in discussing this matter of engineering vs. non-engineering type of work we make the assumption that those persons designated as engineers are upper caliber people by merit of education, experience and capability, and are, in fact, capable of accomplishing the complicated tasks normally assigned to them, and are not by design assigned to non-engineering work.

In discussing with fellow engineers this question of engineering aides, several definite conclusions seem to prevail. As far as secretarial service is concerned, it is believed competent stenographic personnel are in a minority, especially those trained to record and transact scientific language and complex mathematical data. Typing pools set up for scientific personnel do the best work because they are especially trained for speed and variety of work, as well as accuracy and neatness. A common complaint against this otherwise excellent service is that one must occasionally wait several days for his work to be processed and the problems of discontinuity of work and thought appear.

Without a doubt most managements are cognizant of the need for a high degree of utilization. However, their efforts in attaining this goal are probably not as effective as they would like them to be. The misapplication of engineering talent is probably caused by the fact that "talent control" is a regular, continuing part of the day-to-day job of managing—and not just a one-time problem to be solved when a work project starts. One engineering company which has a general policy to provide facilities and services as necessary has two dictating machines "available to the engineers"—to approximately 500 engineers—and these two machines are semi-permanently stationed in the manager's office. The practice certainly cannot be called promoting the use of such time saving instruments. In another case where mostly desk engineers are located, there is a ratio of about 50 engineers to each secretary. These are only two examples which in a way are petty, but which may be seen day after day and cumulatively seem to indicate that the non-engineering activities of today's engineers are not held to a minimum.

It is only fair to include, that in the opinion of most engineers, physical facilities necessary for the advancement of engineering work, such as offices, laboratories, equipment and other hardware, appear to be amply and readily available to the engineers.

The prevalence of these and other engineering aids will be further elaborated in Section E, following.

D. *Some General Factors*

There are many factors which are not unique to engineering but which must be present in proper perspective for any job to function normally. Some of these, for example, are: adequate communication; defining responsibility; delegating authority; planning a goal; defining the problem; making decisions; scheduling the day; and so on. I will not elaborate on these general factors except to say that the need for their efficient inclusion cannot be over emphasized. It is the magnitude and consistency with which these problems prevail in the engineering field that is most curious. Engineers seem to complain more about the "management" of their jobs than do other work groups. The engineers either think longer and deeper on these problems and are correct in their observations, or else they are collectively more sensitive about normal and unimportant deficiencies and thereby sulk in costly and unnecessary consternation. It is believed this condition results from the fact that the typical engineering mind does not lend itself as readily to managerial types of problems because its primary attention is of a technical bent through interest, training, and habit. The situation is further aggravated because the few high echelon engineering individuals who are in actual control and who are in a position to observe and correct these things have usually reached that position as a result of technical proficiency rather than managerial ability. It is a case as far as managing is concerned of the blind leading the blind. The problem simply stated is—"most engineers are better engineers than managers".

Some of the more popular areas of conflict are touched on below.

1. *Relinquishing Duties*

Too many high level engineering management persons fail to relinquish the duties and responsibilities they held as first line supervisors. They haven't put away their slide rules and other work habits. One manager was recently seen with slide rule in hand and a desk full of papers arguing with a designer because their "numbers" didn't agree. This kind of activity leads to unrest by the engineers down the line who in a sense are robbed of the responsibility and satisfaction of doing their jobs. Some persons have entertained the idea to place a non-technical person in charge of a technical project, thereby forcing that person to perform the prime functions of management, i.e., planning, organizing, staffing, directing, and controlling.

2. *Legislated Decisions*

Many times a high-level person in an organization hands down a basic and momentous decision based on his "engineering judgment." The junior members of his organization are then asked to "investigate" the subject problem area and the decision to the extent of verifying the legislated decision. This is malutilization in a new sense. The verification may indeed require highly skilled engineering talent, but the over-all success of profit realized may be penalized since the effort definitely was not objective and may have been completely in the wrong direction. In any case, the junior partner senses a feeling of falseness and servitude rather than that of creativity or invention. There will, of course, be a few instances where the senior partner is an expert on the particular subject and a correct decision will have been made, but here the junior partner will participate very little since there is little to investigate.

3. *Deprivation through Poor Supervision*

A third common resentment is that advancement of engineers up through the ranks in the past has been too heavily based on technical competence and not enough on supervisory and managerial ability. Aside from personal frustrations, dissatisfaction, increased turnover, and other morale problems on the part of subordinates, this situation can be the direct cause of poor planning, poor utilization, low efficiency, and low work output. It is believed engineers should be selected for supervisory positions on the basis of wearing two hats, i.e., engineering *and* supervision. Also, the higher one goes in the organization, the more supervision and less engineering he should do. Most companies have a practice of providing lectures and other training aids for new supervisors—but this is really too late. A person should already be a good supervisor when he accepts the position; he should not wait until appointment and then learn on the job. Further, the lectures for operating supervisors should be "refresher" type material, not "introductory" material, and they should not be one-shot affairs but instead recur frequently to re-stimulate the supervisor lest he grow stale.

4. *Broadening the Engineer's Scope*

Care must be taken to not "catalog" engineers and continuously assign them to narrow specialties and as a result cut off the source of replacement talents for the future. In other words there is justification for one to do a job that another could do better because the desire may be for him to learn and gain a broader background. Specialized programs to train engineers on the job for skills unique to the local operation are a necessary part of every company. Also, in order that our younger engineers—the senior engineers of the future—will not fall into the ranks of mediocrity, they should be provided the opportunity and encouragement to exercise their ability (with monitoring) to solve complex problems which have and still do vex the more mature engineers. This is a much practiced procedure in the medical and legal professions. The point is this principle should not be exercised at the direct and uneconomical expense of the project or personalities. There have been instances where a supervisor was not adequately versed on his particular assignment—and he was placed there simply because he was an "available" man in the proper pay bracket. In this role he learns-as-he-goes—good experiences for him perhaps, but not for the people under him who are supplying the know how, and not good for the over-all efficiency of the job. During this learning period, which can last for years on certain jobs, he is continuously tempted to make off-the-cuff decisions of varying importance, thus by-passing the embarrassment of "asking" the people below him. Here, the full capability of the group is not utilized and obviously the job output is reduced, and most important of all, the perspective of on-the-job training is lost.

5. *Job Definition*

Many engineers complain that titles, duties, and responsibilities are seldom defined, and if they are, it is often not until the job is practically completed. It must be appreciated that with today's rapid technological developments the requirements for engineering jobs change equally rapidly. Some firms participate in such dynamic projects that their organizational structure is also dynamic and changes from week to week. But the need for a job title and other definitions is almost self explanatory. A person has the right to know what is expected of him on his current assignment, and also what is expected of him in order to develop into a higher level job. It appears that responsibilities and authority for individuals are sometimes not officially and specifically designated because of inter-company politics or friction, or because the immediate supervisor is reluctant to formally admit the particular employee's capability.

As a result of this lack of job definition an engineer occasionally is told he is "in charge" of a certain job only to find that one or more other persons are also "in charge" of the same or similar job. There is first of all the question of whether the budget can afford this duplication and subsequent waste of manpower and money. But also important is that this seemingly unimportant matter of indifferentism toward talents uselessly employed has a far reaching and lasting influence on the thinking engineer. Individuals with the drive necessary to complete a difficult college course in science are usually inherently ambitious and inquisitive. Such insolent procedures are soon recognized for what they are and are justifiably resented. It is a rare individual who is able to satisfy all his needs in any job or position. A mature person recognizes this. But to dismiss the problem simply as evidence of lack of maturity would be to slough off the very real responsibility management has to solve it.

The lack of adequate job definition also contributes to the never ending problem of empire building—where some persons are purposely and unnecessarily kept busy with menial jobs and others are kept busy checking or repeating the work done by others before them. There are, of course, other motives for empire building such as ignorance of the job, and/or personal gain, but it is believed specific job definitions can check these also, and keep utilization on this count at a maximum level.

6. *Standardizing Procedures*

Another fertile source of increased utilization is the practice of using standardized methods and procedures. Certain technical problems can be handled quite expeditiously through a centralized bookkeeping system set up pertinent to a company's special field. The simpler jobs that are performed over and over again fall into this category, and are typically the jobs that take more of an engineer's time than ability. The use of charts, manuals, tables, graphs, formats, and written methods and procedures is suggested.

E. *A Utilization Survey*

In collecting material for this paper it was decided that the personal opinions of some twenty or thirty professional engineers would be most valuable.

Thirty-eight engineers were contacted and twenty-seven responded.

The survey was designed to include only graduate engineers, employed in different capacities, at different industrial concerns. Those polled represent eight different companies in the St. Louis area, and the number polled per company was roughly in proportion to the number of engineers employed. The types of companies are:

| *No.* | *Type* |
|---|---|
| 1 | Aircraft |
| 2 | Chemical |
| 2 | Consultant—Construction |
| 2 | Electrical/Electronic Equipment Mfgrs. |
| 1 | Public Utility |
| 8 | Total |

Those selected were asked to indicate the general level of their position, i.e., junior engineer, senior engineer, supervisor engineer, middle management, or top management. About half the group indicated they were senior engineers and the other half indicated supervisor engineer. While recent graduates(who would fall in the junior class) were not purposely omitted from the sample, they constitute a very small portion of the sample. It is believed, however, they would have less experience in evaluating their utilization than would persons with say five or more years of experience. On the other hand, they would probably rank at the highest degree of utilization because, as will be explained below, the survey was based on utilization according to capability. None of the engineers contacted responded as top management; this is to be expected, however, because the ratio of the number of working engineers to each director or vice president of engineering is typically 100 to 1 or greater. Those who listed themselves in the senior and supervisor classes are known by the speaker to be in an age group of 30 to 45 years old, and have total professional engineering experience ranging from 5 to 15 years. While the speaker believes three persons in the group should have listed themselves in the middle management class, they for some reason preferred to list themselves as supervisor engineers.

The survey asked each participant to "estimate the proportion of time spent in various categories of capability during the past six-month period". The exact wording may be seen in the appendix. Briefly, the categories were: work above one's capability; work parallel to capability; work less than one's capability but requiring a degree; engineering aide type work; and completely wasted time.

Averages for the categories are shown on the graph in Figure 3. Engineering work parallel to capability averaged only 43 per cent. Work requiring engineering capability at a lower level ranked at 26 percent, while work requiring a greater capability ranked at only 1 percent. "Any alert person" could have accomplished 21 percent of the work, and the remaining 9 percent of the time was essentially wasted.

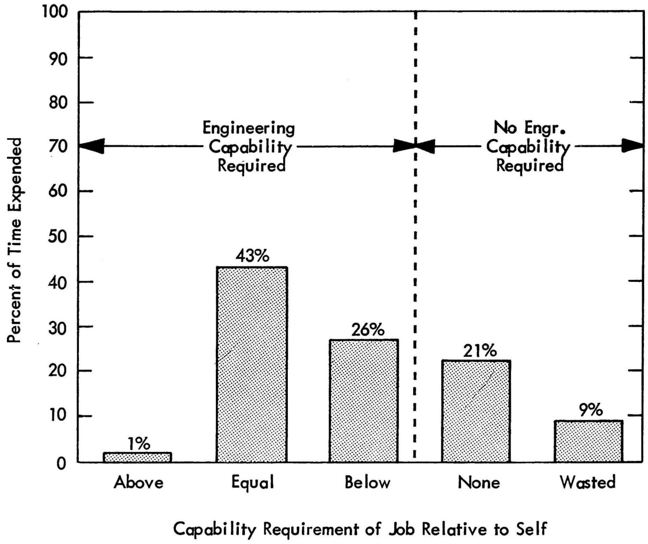

Fig. 3 Graph Showing Percent of Total Time Spent at Various Levels of Job Capability Requirement

It is known that almost any survey can be influenced by indoctrination and education submitted prior to the questions. Also, had the questions been worded differently, the answers could be expected to be different. No instructions were given prior to this survey. As a result, it is believed the survey, good or bad, indicates what the engineers *actually* think about their own utilization. It is interesting to note that psychologists contend most people possess ability and skills of which they are not conscious, and that these could be put to profitable use. On this basis, if a person is not using all the capability he knows he has, then he is surely working at a level of utilization well below his actual maximum level.

*The significant conclusion drawn from this survey is that these engineers are utilized to full capability only 44 percent of the time.* If the time spent on engineering work requiring less than full capability is added to this, the total is 70 percent—a level of achievement considered barely passing by ordinary standards. Adding again to this the 9 percent of time which can be allotted toward work breaks, etc. the total is still only 79 percent, leaving 21 percent of an engineer's time which can be saved and better utilized by allotting the remaining work to technicians, draftsmen, etc.

*In other words, proper utilization will permit the output of a given engineering endeavor to be increased from a factor of .79 to 1.0, an increase of 27 percent.* Stated another way, proper utilization can effectively increase a given number of engineers by 27 percent. While this paper does not admit or deny the existence of an engineer shortage, it should be noted that the factor of 27 percent far exceeds the magnitude of the alleged shortage given in popular estimates, and also exceeds the combined engineering graduating classes for several years to come.

## Conclusion

A. *Malutilization Does Exist*

My conclusion is very simple. Malutilization does exist. Probably the most practical and readily available source of additional manpower for the scientific and engineering field is within the field itself. The current level of utilization of engineers is only moderate, and more and better engineering, if wanted, can be had in highly worthwhile amounts by exercising simple methods and techniques of better utilization.

B. *Program for Action*

Malutilization of engineering skills exists in various ways, to different degrees for many reasons. In the sphere I have investigated and discussed this morning there is definite room for improvement. Because these deficiencies are not the result of any single cause they will not be solved by any single remedy. Quantitative data are not available to give sufficiently intensive and precise information. For example, how does one exactly determine the degree of skill, the capacity, and the degree of utilization of these engineers? Regardless of the extent of perfection with which we can pursue this subject, it must be admitted that the existence of malutilization can be detected and its general intensity can be measured. Here are some ways we can achieve better engineering through better utilization:

a. Avoid duplication of effort where it is not absolutely necessary and purposely wanted.
b. Provide adequate engineering aids—personnel and facilities.
c. Select engineering leaders on a basis of both engineering *and* leadership ability.
d. Maximize and control the everyday requirements for producing efficient engineering output, i.e., define responsibilities, set objectives, stimulate creativity, standardize procedures, improve communications, etc.
e. Minimize hoarding. Government and Industrial customers cooperate to eliminate prerequisite of having sufficient employees "ready-to-go".

It is believed this approach of improving from within is more realistic than trying to artifically stimulate the interests of our 14 year old youths in high school.

One more point on this "self-improvement" approach—we don't have to go far to recognize a sizeable portion of the trouble. A partial remedy is simply a matter of self-appraisal and subsequent house cleaning. The greatest offender, I believe, is the supervisor of chief engineer who passes down from above ambiguous policies, half-truths, and unsound decisions in order to postpone or avoid embarrassing and difficult situations. Perhaps he does this in the belief that he is faithfully performing his duties in conformance with company policy. I believe that many times this mythical group above him, sometimes called "they", have not evaluated the problem, nor understand it, nor even know that it exists. One of the needs that I see—and again I don't address myself to this as a specialist but just one who has had some experience—I believe this group called "they" is the same group doing the pointing, and that top management would prefer that the chief engineer and those below him speak up, voice their opinions, and offer solutions rather than assume a current unsatisfactory condition is being given due investigation by others. Top management cannot be expected to solve problems that are not made known to them by the people who have the problem.

Engineering groups, individually and collectively, should unite their thinking and define their objectives. I can't think of a better way to accomplish this than through the Industrial Relations Committee of the National Society of Professional Engineers. The principle used by the Inspector Generals office of chceking the efficiency, progressiveness, and morale of various groups is applicable. Feedback has been known to stabilize otherwise unstable elements.

As I come to the end I am quite aware that I have been trying to break into a widely discussed and controversial subject without being able to offer a perfectly defined solution. These are difficult problems and cannot all be answered at one time. But at the same time, these are the things that we must solve, and to pass them off as inherent difficulties that we simply must live with is not enough. We have much to be valued, prized, and guarded and a profession to be continued and further developed. So let us follow the motto "we owe our profession more than our profession owes us", and further our efforts in this area until it is no longer a problem.

## Appendix

21 September 1959

TO: ____________________

FROM: E. O. Klimt

Subject: Engineering Utilization Survey

1. You can help me with a problem if you will. In preparing conference material on the subject of Utilization of Engineers for the Missouri Society of Professional Engineers, I have need of a survey of the per-

sonal opinions of some 20 or 30 engineers. The extent of "selection" is based on the fact that I know you and you are employed by an industrial concern.

Please fill in the blanks as indicated. Do not make exceptions nor additional entries.

*INSTRUCTIONS*

*Estimate the proportion of your time spent in the various categories during the past six months.*

Do not sign your name.

If you would like to know the results of the survey, enclose your name and address on a separate sheet. In any case, this information will be treated as confidential.

Thank you for your help.

Eugene O. Klimt

EOK:pg

| *Level of Work Performed During Past 6-Month Period* | *Percent of Total Time Consumed* |
|---|---|
| 1. Engineering work definitely above your capability. | ____________ |
| 2. Engineering work parallel to your capability—i.e., requiring your particular level of education and experience. | ____________ |
| 3. Work requiring an engineering degree and/or some experience but below your particular level. | ____________ |
| 4. Work that could have been done by any alert person, say, a high school graduate, clerk, housewife—or a person with no formal engineering training but perhaps with some specialized training such as draftsmen and technicians. | ____________ |
| 5. Work that was strictly routine, boring, physical motion—no mental exercise required. | ____________ |
| TOTAL | 100% |

Please check your category:

| | |
|---|---|
| Junior engineer | ______ |
| Senior engineer | ______ |
| Supervisor engineer | ______ |
| Middle management | ______ |
| Top management | ______ |

APPENDIX

PERCENT OF TOTAL TIME EXPENDED

| Individual | Grade of Individual | | | | | Capability Requirement of Job Relative to Self | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Junior | Senior | Supervisor | Middle Mgt. | Top Mgt. | Above | Equal | Below | None | Wasted |
| 1 | | x | | | | 0 | 40 | 20 | 70 | 70 |
| 2 | | | x | | | 0 | 60 | 20 | 10 | 10 |
| 3 | | x | | | | 0 | 10 | 20 | 40 | 30 |
| 4 | | x | | | | 0 | 90 | 10 | 0 | 0 |
| 5 | | | x | | | 0 | 60 | 20 | 10 | 10 |
| 6 | x | | | | | 0 | 1 | 11 | 88 | 0 |
| 7 | | | x | | | 5 | 40 | 20 | 70 | 15 |
| 8 | | | x | | | 2 | 43 | 25 | 20 | 10 |
| 9 | | x | | | | 0 | 10 | 40 | 30 | 20 |
| 10 | | x | | | | 0 | 60 | 20 | 10 | 10 |
| 11 | | x | | | | 5 | 50 | 15 | 25 | 5 |
| 12 | | | x | | | 0 | 55 | 10 | 5 | 30 |
| 13 | | x | | | | 0 | 50 | 30 | 5 | 15 |
| 14 | | x | | | | 5 | 65 | 70 | 10 | 0 |
| 15 | | | x | | | 0 | 20 | 60 | 15 | 5 |
| 16 | | x | | | | 0 | 60 | 20 | 15 | 5 |
| 17 | | x | | | | 5 | 15 | 35 | 40 | 5 |
| 18 | | | x | | | 0 | 60 | 25 | 15 | 0 |
| 19 | | x | | | | 0 | 50 | 35 | 15 | 0 |
| 20 | | x | | | | 0 | 45 | 20 | 30 | 5 |
| 21 | | | x | | | 0 | 35 | 40 | 15 | 10 |
| 22 | | | x | | | 5 | 30 | 30 | 25 | 10 |
| 23 | | | x | | | 0 | 35 | 60 | 5 | 0 |
| 24 | | x | | | | 0 | 60 | 30 | 5 | 5 |
| 25 | | x | | | | 2 | 85 | 7 | 5 | 1 |
| 26 | | x | | | | 0 | 10 | 60 | 25 | 5 |
| 27 | | x | | | | 0 | 10 | 10 | 60 | 20 |
| | | | | | Total | 29 | 1149 | 713 | 563 | 246 |
| | | | | | Mean | 1.1 | 42.6 | 26.4 | 20.8 | 9.1 |
| | | | | | Mean | 1 | 43 | 26 | 21 | 9 |

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## Engineering Education in The U.S.S.R.

*by—Ralph A. Morgen, President, Rose Polytechnic Institute, Terre Haute, Indiana*

There apparently is nothing in Russia comparable to the complete university which is so familiar in the United States. The universities confine their work to the humanities and the so-called "pure" sciences, whereas the VTUZ's confine their activities to the so-called "applied" sciences. Even though some of the VTUZ's are called polytechnic institutes, there are no complete engineering institutions similar to those which exist in the United States. A polytechnic institute may consist of about 10 to 15 specialties in two or three of the broad areas covered in the U. S. by aeronautical, chemical, civil, electrical, mechanical, or metallurgical engineering. No single institution gives curricula in all of these broad areas.

The number of students admitted is based on the estimated number of jobs that will be available in each specialty five years hence. Thus, the entering student at about seventeen years of age is selecting his life work down to the specialized industry in which he hopes to be employed and from which there is little chance of escape.

However, while in some areas the USSR may be ahead of the USA it appears to this observer that chemical engineering per se in the USSR is somewhat behind that in the United States at the present time. This was explained by various persons as due to the fact that the USSR is now in that stage of its economy where it is building its capital goods industries. Thus the major effect has gone toward development in the electronic and mechanical areas rather than in the chemical areas.

According to the plan, the amount of consumer industry development will increase rapidly in the next five to 10 years. Then a need for more rapid development of chemical engineering will be evident. This theory was verified by the fact that in several instances the visiting delegation was shown plans for expansion and actual spaces in laboratories where equipment was to be installed for chemical engineering students' use in the years 1960 or 1961.

In the Soviet Union the Plan provides that the normal student will go to work in industry immediately following graduation from the 10-year school. After a year or two in industry he will then take examinations for entrance into a particular specialty at an institution of higher learning. It is the hope of the government that 80 percent of the students will follow this path and only the brightest 20 percent will go immediately from a 10-year school into the institutions of higher learning.

There seem to be several different identifiable reasons why the Government is so interested in getting the young men and women to enter industry immediately after graduation from a 10-year school. One of the reasons apparently is to close the widening breach between the worker on the one hand and the more educated engineer and scientist on the other hand. Another, and probably more significant factor at the present time, is the manpower squeeze caused by the low birth rate in the early 40's during World War II. As a result the present graduating classes from the 10-year schools are smaller in size than in previous years and thus not enough factory workers are being produced. Therefore, there is greater need for getting more people into industry in order to meet the big production quotas of the five and seven year plans. Since the birth rate in Russia did not start to climb until about 1947 or 1948, it is anticipated that this manpower squeeze and small graduating classes will continue until about 1965. At the time of this visit no official census had been taken in Russia, therefore the actual manpower figures are only educated guesses, but the figures on students enrolled in the 10-year schools were available.

In all of the institutions visited it was said that most of the failures occurred during the first year, and that the failure rate was about twice as great for those students who entered institutions of higher learning from industry as compared to those who came directly from a 10-year school. This explains, at least in part, the opposition of the educators to the work interval between the 10-year school and the institutions of higher learning. The over-all graduation rate in five years from the institutions of higher learning is 85 percent of the entering class.

The most noticeable difference between students in VTUZ's and the students of the engineering schools in the United States is the greater concentration of the USSR students on their studies. The answer, apparently, is the extreme motivation in the USSR for a student to obtain a diploma. Without a diploma from an institution of higher learning it is virtually impossible for a person to rise above the grade of foreman in any industry in the country. Those good foremen who show promise and could be promoted above that grade are urged by their supervisors to either enroll at night school or a correspondence school. They are given time off from work to study, to take the examinations, and to attend certain laboratory courses as long as they progress well toward their diploma. The promotion does not come, however, until the diploma is achieved.

On the other hand, graduates of the VTUZ's are guaranteed a job at least the equivalent of foreman or better in an industry of their specialty immediately upon receipt of the diploma. As a matter of fact, the Minister of Education continues to have responsibility for the student for three years after he gets his diploma. During that period the Ministry of Education checks to see that the industry employs the student in his specialty and at a level commensurate with his education. After the three-year period, apparently, the students are on their own.

Another striking difference between the United States and the USSR is the proportion of women students and women employed in all engineering. In the fine chemical industries or radio manufacture and in the specialties leading to degrees in those areas, the proportion of women may run as high as 65 to 70 percent, whereas, in the heavy chemical industries or the construction industries the proportion of women may drop as low as 15 percent. On the general average throughout the various engineering specialties which this writer visited, the total number of women students seemed to run between 35 to 40 percent.

The budget of the institution which is supplied by the Ministry of Education is insufficient to support the required research load. The institutions must contract for additional support for research with various industries and with the academies of science. It is for this type of research which the professors and docents receive the 50 percent addition on their salaries. Any professor or docent who is worth his salt is engaged in this type of research and gets the maximum salary of 7500 rubles per month. This is about ten times the salary of a skilled workman. The professor and the intellectual in general are the real privileged classes in the USSR today.

## Engineers and Scientists as Managers

*by—Paul Q. Olschner, Area Sales Manager, Westinghouse Electric Corp., St. Louis, Missouri*

In considering the proper utilization of engineers and scientists, I believe we should break down their contributions into two general groups. First, is the group of engineers and scientists who are individual contributors and second is the group who are managers. These managers are usually selected from the group of individual contributors.

Are all of you convinced that you are properly utilizing engineers by putting them in management positions? Is it necessary to "use up" good technically trained men by making managers of them? I believe the answer to this has been proven to be an emphatic "yes." Dr. C. Y. Thomas, in his talk at this conference two years ago certainly documented this thesis. He showed that one of the big factors in Britain's decline as world leader in manufacturing goods, which she held from 1899 to 1937, was that in the board rooms of well over a third of the British Companies in engineering, no qualified technical voice was ever heard. Accountants and bankers outnumbered engineers in top management of the many companies studied 5 to 1. In contrast, in the United States, the position of the engineer has changed in the last forty years. There is a very high percentage of engineers in leading positions in industry. Why is this? I subscribe to the statement that "engineering schooling and work result in a disciplined training which gives an engineer an objectivity which is particularly well adapted to managerial roles."

And there continues to be a great demand for top executives in industry. Major industry needs more than 5,600 top executives within the next six months. This was determined in a survey of 1700 of the nation's leading companies, and was reported in September of this year. 25 percent of the demand for executives was in the manufacturing production field but close behind was the need for executive engineers at 23 percent. And when management was asked what "top drawer" openings would be toughest to fill, they listed engineering first, sales second and manufacturing-production third. Also interesting and reflecting a very optimistic outlook, was that more than half of all executive openings will be newly created positions, with the remainder slated to be replacements of current jobs. These companies also reported that more than one-fourth of the executives placed in the $15,000 to $100,000 salary category had to be found outside the company. This was despite the fact that 62 percent of the companies said they have an internal management development program and many others said they planned to launch such a program.

So gentlemen, we definitely have the problem of filling these positions and I feel sure that you, individually, either have or will very shortly have this problem facing you. And at this point the problem of the proper utilization of engineers comes into sharp focus, and we must keep this uppermost in our mind both for the good of our country and the good of our individual company.

Therefore, my additional remarks will be related to two major phases: first, how to screen and pick the best potential managers from those available in your company and second, how these men should be trained to become better managers for your company.

In doing this I will draw heavily on methods used in the fast growing electrical industry, and particularly from Westinghouse, since information is readily available to me.

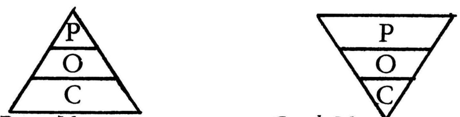
So, first, how are we going to pick the best potential managers? It has been shown that information accumulated by psychological testing is one useful tool which is available to assist in the successful selection of managerial employees. Of course, there is no satisfactory substitute for experience and judgment, but these test results give objective standards which can be considered with all other information when a judgment and decision is made in the promotion, transfer, or employment of a managerial employee.

From tests on 73 successful managerial employees of a transmission line company the following significant conclusions were reached: (1) Good managers rank high in mental ability. In this particular sample only 12 percent of the managerial employees fell below the average of the general population in mental ability. (2) The temperament characteristic called "leadership" or "dominance" is possessed in a much higher degree by successful managers than by the general male population. (3) Successful managers tend to be emotionally more stable than the average male. This means they can remain reasonably calm under pressure, and act calmly in emergencies. (4) Quick-acting, quick-thinking energetic characteristics are significantly higher for better performing managers, and (5) decision making is faster for the successful managerial group than for the poorer performing managerial men.

These same mental ability tests were applied to 55 successful service representatives in this company and a curve plotted to compare their mental ability with the 73 managerial employees. It showed that the two groups differed substantially, with less than one-fifth of the managers falling below the average of the service representatives in mental ability. On the other hand, 10 percent of the service representatives possess mental ability equal to or greater than the managerial average. This means that the group of service representatives has a number of individuals who possess the mental ability to make successful managers, if they possess other requisite qualities.

Before going any further let's define the purpose of management in engineering work. A top executive of the General Electric Company has stated that the purpose of management in engineering work is to accomplish objectives on time, at reasonable cost, and with reasonable human effort. To do the management part of the work a person is prepared when he has a working knowledge of the social sciences, human relations, measurement of results including accounting, and the principles of management of men, materials, machines, time and money. In its fundamental aspects, management is the same regardless of the kind of business enterprise. Effective management of engineering work is accomplished by applying the basic principles of management to the work of engineering.

In a recent Marketing Management Course which I attended at Pittsburgh, at the very beginning of the course a very simple, graphic, illustration was used to explain the broad concept of three functions of management. (1) planning, (2) organizing, and (3) controlling, and the importance of the amount of time spent in doing each.




*Poor Management* *Good Management*

The director of Training in the Industrial Relations Dept. of Westinghouse stated, that, to him, management was the development of people, not the direction of things. A very difficult management lesson to learn is that to do a thing well is not enough. As a manager your success depends on getting others to do it well. A manager's job is to (1) plan and determine objectives (2) determine what is to be done (3) select the most qualified people to do it (4) check periodically on how well they are doing it (5) find methods by which they can do it better and (6) motivate them to want to do the job better. I wanted to list these functions and responsibilities of the manager at this point, so that you would be thinking about them in relation to your job in selecting men as managers and potential managers. It certainly does *not* follow that just because a man is a brilliant scientist or engineer or is a star salesman that he will make a successful manager. In fact I sincerely believe that industry too often makes this very mistake, and you should guard against it.

In this matter of selection of management as well as management development wouldn't it make good sense to apply the principles of good management—planning, organizing, implementing, coordinating, controlling—?

The director of Management Development of Westinghouse believes we should (quote) apply to the building of managers the things we are building managers to apply (unquote).

So with this principle in mind following an accelerated period of research, trial and discussion in staff meetings, the conclusion was reached at Westinghouse that a thorough program to meet our needs should consist of several phases and each should be developed from the preceeding phase.

The first three step were:

1. *Position Specifications.* All managers were required to write a Position Description and a Position Requirement for their respective assignments on a self-analysis basis. Each manager then reviewed his completed write-up with his immediate supervisor, so that differences could be reconciled and a common understanding reached as to exactly what is expected of him in his assignment. The Position Requirements established for each position have proved to be of great value as a guide in evaluating the qualifications for candidates for key positions, and in suggesting needed developmental action.

2. *Appraisal.* All individuals included in the program are appraised annually with respect to current performances and potential ability. Appraisal of performance naturally follows the establishment and review of the specific responsibilities listed in the individual Position Description, and is intended to reflect the degree to which all responsibilities are discharged. The Evaluation of Potential in all cases is intended to be a forecast of a man's ability to handle satisfactorily the responsibilities at the next higher management level, based on his qualifications and his present performance.

The Performance part of the completed Appraisal forms the basis for a required discussion of performance with the man being appraised. This annual interview provides an opportunity to review systematically the responsibilities which comprise his assignment, relating them to the standards of performance which are required in accomplishing the overall objectives of the department of which he is a part.

3. *Inventory.* When Appraisals are complete the head of each unit prepares a Replacement Table listing each position, the present incumbent in that position, and both a first and a second replacement. These are subject to reviews and approval by higher management.

These steps, Position Specifications, Appraisal, and Inventory, make up the procedural, or fact finding elements of the program. Of course, the real value of the program depends upon the extent to which these data are put to work at the local line level.

The fourth step—Taking Action of this Westinghouse program falls under the second phase of my remarks—how these potential managers and managers should be trained—and will be discussed then.

So, in this matter of screening and selecting the proper men to be managers, please don't do it haphazardly. You might not get a good manager that way and you also might lose a good engineer. In that connection, I believe the economic compensation possible in your company for the good "individual contributor" should be such that this man will not be forced for economic reasons to attempt to go the managerial path when he really does not want it and may not have the abilities to succeed at it.

Let's get into the second phase of my remarks, how should the managers, which you choose, be trained to fill the requirements of the managerial positions in your company?

First, let's recognize that as a specialist goes up the ladder to manager he must let go his tendency to do things himself and start getting things done through others. This is not as simple as it sounds. The shift is a very difficult one, but it is a very vital one and the ease and completeness with which it is made is one of the criteria of management effectiveness. No longer is the vital question, "How much does he know, and how good is he in the application of his knowledge?" but rather, "How does he get along with other people,and how well is he able to direct, guide, lead, and inspire other people into doing things?" Too often the specialist has not been prepared for this shift and I believe this is particularly true of engineers.

It has been said that a good manager does not have to have technical knowledge of what he is managing, because specialized skills are at his disposal. I do not subscribe to this in total. It is a matter of degree. The successful manager cannot dry up. He must continue to acquire as much general knowledge as he can about the various specialist fields for which he is responsible as a manager, so that he can make fullest use of the engineers whose full time responsibilities are to give technical aid. Generally he must do this by supplementary reading and study. I believe this applies in the sales engineering management field, as well as product development, basic research and production management.

In the Fourth Step of the Westinghouse Program of Management Development—Taking Action—it is management's objective to expose all "Management Development Personnel" as determined in the steps mentioned above to opportunities for self-improvement and undelayed advancement in accordance with their current capabilities. Our management believes that while it is the responsibility of headquarters to lead the way in establishing a general program of management development, the actual development of personnel is primarily the responsibility of the line organization. Procedural tools and recommended practices constitute the headquarters guidance and direction that are provided.

So, broadly, action at this stage includes evaluation, management coaching, and counseling to encourage needed self-development. Such action is intended to result in clearer understanding and improved methods of carrying our present responsibilities, as well as to stimulate men to look ahead and prepare for broader responsibilities.

A select group of non-supervisors should definitely be included in this training and development program. This recognizes not only the need for early identification and preparation of potential managers, but also the need for developing and retaining their interest in the many opportunities that lie ahead.

Our aim is to make effective counseling an integral part of the supervisor's operating procedure and relationship with the subordinate. This is considered to be the most important element of his responsibility.

In order to implement and strengthen the basic counseling approach practical self-development opportunities are recommended. Included in these self-development opportunities are Public Speaking, Planned Reading, night school participation in our Graduate Study Program, and many others.

To implement their responsibility further, local management liberally applies new and expanded supervisory training courses developed by our Industrial Relations Department.

In our experience one of the very basic needs of engineers and of engineers who are managers is good human relations and too often the engineer manager is lacking in this. We have held a number of human relations courses with excellent results.

In addition to the procedures mentioned above we have a number of middle and top management development programs to develop a management reserve to meet existing and future top level position requirements.

You might say—that's well and good for a large company—they can afford to do these things, but not a small company. It's my contention that no company, large or small, can afford to neglect this major job of effectively selecting and training its managers. There very well may be a difference in degree, but even in the smallest company a great deal of thought and planning should be given to this problem. Dunn and Bradstreet says that most business failures are not due to poor salesmen, not due to poor production workers, but says that 50 percent of all business failures are directly traceable to poor managers.

So in directing our thinking toward the proper utilization of engineers and scientists as managers, let's summarize as follows:

(1) We are *not* improperly utilizing engineers and scientists by making managers out of them, *if* we prop-

erly select and train them for the management job.

(2) We must be careful not to promote a good engineer to a position as manager just because he is a good engineer. We might get a poor manager and lose a good engineer.

(3) Engineering schooling and work result in a disciplined training which gives an engineer an objectivity, and ability to get the facts, which is particularly adapted to managerial roles, but we must recognize that the engineer is weak in the ability to understand that there may be two or three possible answers and that he must make a decision.

(4) A recent survey shows that 5,600 top executives are needed in major industry in the next six months and that 23 percent of them are engineer executives, and that 25 percent of them are in the manufacturing-production field which will be mainly filled by engineers.

(5) One of our major jobs in the proper utilization of engineers and scientists as managers is in screening and selecting the engineers who have management potential, and then in the proper training of these men.

(6) Don't overlook psychological testing methods as one useful tool available in proper selection.

(7) If you do not have a management selection and development program in your company, you should weigh the desirability very carefully. There is a vast amount of good published information on the subject.

(8) Effective counseling of the people under his supervision is a predominant responsibility of all managers. To be effective in this field a manager must be adept at practicing good human relations. Quite often engineers are poor in this field, and a definite effort should be made to correct this if the engineer is to perform as a good manager. Studies have shown that a large percentage of good people who leave the employ of a company leave because of poor supervision.

(9) Dunn and Bradstreet says that 50 percent of all business failures are directly traceable to poor managers.

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## Training Engineers for Management

*by—Colonel Charles B. Schweizer, District Engineer, U. S. Army Engineer District, St. Louis*

Naturally, I am very pleased to be here. I personally appreciate being invited and feel honored that an officer of the United States Army is included in this distinguished company. My experience for the last 23 years has been as an officer in the United States Army, so naturally much of what I have to say should be considered in that light.

My observations have been that civilian life and military life have very much in common. As the District Engineer at St. Louis with a $20,000,000 annual budget, I have the opportunity to meet many people in responsible positions. I find that civilians, generally, break themselves down into managers and subordinates just as we in the Army have commanders and technicians.

In the Army we have two types of General officers:

Generals of the line

and

Generals of the technical services

The Generals of the line are the commanders. They control the troops; make the major decisions; reap the glory; or suffer the shame. The Generals of the technical services make the minor decisions; do a tremendous amount of detail work; and are, generally, unkown. Now, what is the background of these Generals, and what makes some of them Generals of the line and some of them Generals of the technical services?

As I review my service, I see that the Generals of the line have come from the Infantry, Artillery, and Armor. I can remember no Engineer officers who were appointed directly as Chief of Staff, Army Commanders, Corps Commanders, or Division Commanders. There are some Generals of the line who were engineers, but they left the Corps early in their careers to become Infantry, Artillery, or Armor officers.

Now I ask again—what makes these commanders different from their engineer equivalents? Is it brains? No, not by a long shot—many of the smartest graduates of West Point have for many years chosen the Corps of Engineers as their basic branch. So, brains alone are not sufficient. Commanders have plenty of brains but they also have brains plus something else. What is it that commanders have? I will list of those attributes which I have observed. I do not consider them to be all inclusive, but I consider them to be paramount.

a. *Inspire Confidence.* All the commanders we read about exude confidence. They are sure that what they do is right. They have confidence in their subordinates. A commander or manager must be able to tell his subordinates what he wants and then let them bring the completed solution to him. If an engineer must check all of his subordinate's work, it indicates little confidence in the ability of his subordinates; and, in my opinion, he has one strike against him as a manager.

b. *Decisive.* Commanders make decisions. They make decisions based on the best information that they can get. Now these decisions are not made from intuition. General Patton was a demon for detail. He had his staff work on myriads of plans. When the time came for a decision, he knew what to do and was able to put a selected plan into action.

I think one of the greatest difficulties that engineers have is the desire for the perfect plan. We wear a project out engineering it. We study and restudy a problem until it is out of date. We spend a great deal of money attempting to get the best for the least. Managers aren't too interested in detail and this is one of the things that keeps many engineers from being managers. If engineers are to manage, they must be able to come to a decision within the time required.

c. *Motivation and Control.* Commanders are constantly on the go. They inspect their units; they know their men and their problems; they are alert to what is required; and they are always seeking to obtain their objectives within the time allotted. Now most anyone can plan, organize and control. These are essential to success, but a manager must make his unit do what he wants and do it within the time that he determines. Any commander who sits behind his desk and manipulates charts will soon be replaced. Any engineer who sits behind his desk and manipulates charts is no manager.

d. *Idea Man.* Sometime ago, I read that an executive is a man who has good ideas. I know this is true. Already I see men about my age who are satisfied to do something the way they learned to do it 20 years ago. Many engineers are as distrustful of the IBM machine as those workers in the industrial revolution two centuries ago. I believe that a man must be able to accept new ideas and new advances if he is going to be a manager.

e. *Assume Responsibility.* Finally, commanders accept responsibility for their decisions. They do not alibi or attempt to pass the buck. If their people do a good job, they reward them; where there is a failure, the inefficient are removed. Engineers, generally, are very willing to accept the responsibility for decisions where they can be checked, double checked, triple checked, and proven mathematically. To be a manager, an engineer is going to have to accept responsibility with less backup than that.

Now that I have listed those traits which I think any engineer should have in addition to his technical proficiency, the question comes up; "How does one train an engineer to be a manager?" I do not subscribe to the theory that managers are born. I feel that some people can assimilate these traits faster than others. So, I think that a man can be educated to be a manager. I also think that an engineer, whom we all recognize as a brainy individual, can make the best manager possible. This is because of his ability to reason and for his logical approach to a problem, but he also must have those traits which I have just discussed.

I subscribe to the theory in education of giving an individual a well-rounded technical education rather than a very specialized one. The Army has long felt that the first year that a West Point graduate serves as a 2nd Lieutenant is really a financial loss to the Government. It takes him that much time to find out what is going on and to begin to apply the knowledge that he has absorbed at the Military Academy. From my observations of civilian life, this is also true. Any college graduate coming to work for the Corps of Engineers spends the first year learning what his particular assignment is and the details of carrying it out. He uses only a portion of the knowledge which he has gained in college, and in every case what he has learned in college merely scratches the surface of what he has to do. So, I think that a college education should offer courses toward making engineers managers. Here is what I think these courses should include:

a. Potential leaders should be chosen from engineer students by testing, personal observation, and past records.

b. These students should be provided with courses in leadership.

c. These students should be provided with opportunities to develop their leadership ability. For example, they should be urged to be active in the ROTC.

d. The specialization requirements for degrees for which they are working should be changed to offer them such courses without impairing the value of their degrees.

After a man graduates, industry should be interested in developing engineers as managers because of their mental abilities. I believe that it would be to the advantage of every industry to have a program for development of engineer managers. These could include:

a. Establishment of company schools.

b. Enrollment of employees, at industry's expense, in local colleges for selective courses.

c. Rotation of the potential leaders through different assignments.

d. Recognize their achievements by accelerating promotions.

We do this in the Corps of Engineers. We have a competent training program to improve employees abilities. We enroll employees in the local colleges for specialized courses. For example, we recently sent several of our people to Washington University for instruction in the use of the IBM machines for engineering computations. While we do not rotate employees through different assignments as they climb the ladder, we do have a student training program for his first year with the Corps of Engineers. In this way, we rotate them through the major phases of the District work and then decide where they will work permanently.

Before I close, I would like to call your attention to a pamphlet which I consulted in preparation for this discussion. Its title is "Executive Development of Young Engineers." It was written by Melford E. Monsees and published by the Massachusetts Institute of Technology in May 1958. Before reading it, I independently outlined the items I have talked about as my own observations. Then I read this pamphlet. I think, of course, that the pamphlet is far better than what I had to say, and it should be for it represents many months' work. However, I was conscious of the fact that the conclusions and general ideas on the subject were strikingly similar to the ones that I have just expressed. I commend it to you who would like to develop this subject further.

## Effective Recruitment and Long-Time Retention of Scientists and Engineers

*by—Max Sinnett, Director of Product Engineering Professional Development, Radio Corporation of America*

I wish to verify much of Mr. Waggoner's and Mr. Hursts' comments. One noticeable trend in RCA is the increase in demand for Ph.D's.

In my division, RCA employs approximately five thousand persons in all catagories. In the area of recruiting, the Company decides two to three years in advance on probable openings for B.S. and M.S. Degrees. Then recruiting is geared to meet this forecasted need. Historically, we have been able to obtain about 80 percent of all our forecasted needs which is considered satisfactory. There are three main contributors to this effective recruiting.

One is established college relations groups which permit college personnel to meet with RCA engineers and managers on specific occasions.

Second, college graduates are hired and placed immediately into a training program. This program lasts one year and has a variety of assignments which gives the employee and employer an opportunity to subsequently locate the employee where he will receive the most satisfaction and be most effectively utilized.

Third, the Company's educational program which is developed in conjunction with nearby colleges and universities is an important factor in recruiting and retention of engineers and scientists. These are the three main contributors to RCA's high percentage in meeting engineering manpower needs and subsequent retention of them.

## How Effective are Management Development Programs

*by—Arnie Solem, Regional Director, Bureau of Employment Security, U. S. Department of Labor, Kansas City, Missouri*

The subject assigned to me is "How Effective Are Management Development Programs." I am going to take some liberties with that title. First, I want to underscore the importance of good management in the utilization of scientists and engineers. Then I want to discuss the kinds of management development programs that I consider the most effective and illustrate my thinking by describing a program with which I am closely associated. I also want to touch on a few special considerations involved in developing the management talents of scientists and engineers. Finally, I want to express my opinions, for whatever they are worth, about the effectivenes of various kinds of management development programs.

We in the Department of Labor are vitally concerned with promoting the most effective use of our human resources because of the impact on our standard of living and on our national security. Scientists and engineers constitute one of our most precious human resources and I want to commend the sponsors of this conference for bringing to a focus the various measures for increasing their effectiveness.

I am pleased also to have the opportunity to speak on the management aspects of increasing the effectiveness of scientists and engineers. We have serious shortages in a few professions that are highly strategic because they have such an important impact on other human resources. One of the most serious shortages in such strategic personnel is the shortage of qualified managers.

Some of you will recall a story that was current during our efforts to launch Vanguard. It had been decided to install flood lights to light up the Washington Monument. It was decided also to have Vice President Nixon make an appropriate speech and then suddenly turn on the lights. All of this would be done late at night so as to get the maximum in dramatic effects.

That same evening two sailors were trying to make the most of a short leave and, after taking on a few drinks, wandered down toward the Monument. The ceremony came off as scheduled, but, as the flood lights flared up, one sailor turned to the other and said, "I'll bet you a buck they will never get it off the ground."

I tell this story, not because it is particularly new or funny, but to take you back to the atmosphere of those days when, in spite of our capacity to laugh at ourselves, we were developing an inferiority complex over our engineers and scientists. Some of our more recent failures are beginning to revive that feeling.

But was the failure of Vanguard the fault of our engineers and scientists? Why did our rockets fail? Each of the separate parts had been tested vigorously and proved to be without fault. When they put the whole works together, however, the rockets failed. They failed because there was lack of coordination among the various scientists and engineers, such as the fuel chemists, the meteorologists, the aerodynamic engineers, and all the other specialists who made up this modern Tower of Babel.

Now we know, of course, that tying together all the various specialists is one of the central functions of management. The failure of Vanguard, therefore, was not due to the failure of our scientists and engineers *as* scientists and engineers but to a failure of management.

This happens to be one of the more dramatic illustrations of the importance of good management. We could go down the roster of our leading corporations, such as Ford, Dupont, and General Motors, and find case after case where they were in serious trouble until they installed professional management. A widely recognized cause of small business failures is lack of good management.

And our cold war adversaries—the Russians—owe much of their success to the application of American scientific management to large segments of their economy. One of the first things that Lenin said to his followers after the Russian Revolution was this: "We must now proceed to apply the scientific management of the American industrialists to the building of Russia." Good management is the most fruitful skill because it contributes the most toward the success of all other functions of the enterprise. It is unfortunate, therefore, that our shortage of good managers is more pronounced than the shortage of persons with any other skill—including even the shortage of scientists and engineers.

Obviously, the shortage of management talent can only be estimated but there is much evidence to support my statement. There is also much evidence to support the statement that there is more training given in management, both in private industry and in government, than in any other field. It is entirely appropriate, therefore, in the face of this paradox, to ask the question, "How effective are management development programs?"

Many people do not appreciate the fact that management has become one of our great technologies. To become a good manager, the scientist or the engineer must master as much as possible of this technology and also develop skill in the application of it. He must learn to appreciate the proper use of qualified specialists, such as personnel managers, in helping him do the management job.

The main contributions to this technology stem from the work of Frederick Taylor and from the researchs of our psychologists and sociologists. I want to describe each of these contributions briefly because they point up, what seems to be the most useful content of management development programs.

Modern personnel management came to life right after World War I. The Army had used psychological tests on a large scale and many people were impressed with the wide range of intelligence and aptitudes that they revealed. Books appeared on personnel management and personnel departments sprang up in many companies. Under the aegis of industrial psychology, the field of personnel management grew rapidly.

The Department of Labor, if I may put in a commercial, made a major contribution with the development of the Dictionary of Occupational Titles, and the General Aptitude Test Battery, on which we have received hundreds of testimonials because of its effectiveness in cutting down on training time and turnover.

Undoubtedly there were many benefits to industry and to the individual from these improved personnel selection and management methods, but there was also much ineptitude and amateur bungling. In most organizations, we find professional standards in such fields as engineering, accounting or scientific research, but it seems that almost anyone can become a personnel man. Also, it is becoming recognized that more and more of the personnel management job must really be done by the managers, with the assistance, hopefully, of really well trained staff experts in the field of personnel.

This early work in personnel administration had to do largely with the individual worker. The famous Hawthorne studies and the research of such social psychologists, as Kurt Lewin, focused attention on the feelings and motivations of workers as a group. Out of this research and insight has come at least one brand of "human relations."

There are many notions floating around as to what we mean by "human relations." Whether you consider my definition of it reasonable and useful is for you to decide. But first, let me tell you some of the things which I believe human relations is *not.*

There are those who say that "human relations" is simply being nice to people. Now that is an admirable philosophy of life, but to me it is not "human relations" as we understand it in management. As a matter of fact, some managers are so anxious to be "nice" and are so unskillful in dealing with human relations problems that bad situations get worse and worse.

Then there are those misguided people who believe that "human relations" consists of clever ways of manipulating people. There are few things that demean people more, or are more repugnant to our American concepts of the dignity of the human personality, than the idea of manipulating people like puppets. If the manipulator is caught at it, he has probably lost an important ingredient in good human relations, which is mutual respect. Furthermore, people are not so dumb as to fall for this kind of "human relations" over any period of time.

The most useful concept, it seems to me, is to view "human relations" as an applied science. It is basically a study of why people behave as they do. Even the experts in this applied science often make mistakes because there are so many things that no one knows about the causes of human behavior—just as there are many things the doctors don't know about the causes of the common cold. But the main problem in management today is not so much how to increase our knowledge of human relations as it is to bring about acceptance and use of what we already know.

We know, for example, that in addition to the skill and knowledge that he uses on the job itself, the worker, and particularly the scientist or engineer, brings to the job a well-trained brain that can contribute many useful ideas for improving the management of the enterprise.

In our efforts to improve the utilization of our human resources, therefore, we need to consider not only how to make use of that part of the worker which makes up his skill, but also the important part which stems from his brain in the form of ideas. Furthermore, we must learn how to capitalize on his potential in the way of feelings, attitudes and motivations, because what a worker produces may be as much a matter of motivation as of skill or ability.

Let me now discuss those aspects of management which stem from the work of Frederick Taylor. No matter how expert a manager may be in human relations, he cannot contend with the many problems that arise from lack of planning, a poorly constructed organization, and all the friction that arises in a disorderly working environment. If two supervisors are given responsibility for the same function, for example, there are likely to be many human relations problems.

It was my good fortune to be associated for several years with Harlow Person, Managing Director of the Taylor Society and to take courses from him in scientific management. He called it the "engineering approach" to management and said it was the only logical and consistent body of principles and techniques in that field.

Taylor started with the proposition that the workers wanted, above all, high wages, and management wanted to produce at low unit costs. He developed methods for planning the flow of work and controlling its execution that were far in advance of previous management systems. Rule of thumb was replaced by research and as little as possible of the success of the enterprise was left to chance.

These principles and techniques of scientific management were not developed as theoretical abstractions but were tested out in the realities of the steel mills where Taylor moved into positions of increasing responsibility.

But the most important principle of scientific management in the opinion of Taylor was the need for hearty cooperation throughout the enterprise. He obviously could not foresee the great advances in achieving this cooperation which are made possible by the use of modern human relations psychology, but it is fashionable now to look down on him for not doing so. We must grant, of course, that there have been considerable refinement and improvement in scientific management since Taylor's day, but most of it was implicit in his system.

When you amalgamate this orderly production planning and control which Taylor envisioned with modern personnel management and human relations you have, in my opinion, the highest form of management of which we are capable today. But these three rivers of management must flow together as one stream. For example, we must invite participation in developing the plans, procedures, and goals that Taylor stressed. We must delegate in such a way that the employee has not only a clear-cut assignment but a sense of responsibility and of freedom to act. If we think about it, I believe we will realize that those are the conditions which motivate us and will also motivate others.

As an example of the application of some of these ideas to the development of executives, I would like to describe briefly a 4-week institute for managers of public employment offices which has just been completed by the University of Iowa. They began work on this management development program six months before it was offered. Much of that time was taken up with research into the kind of management training that these managers needed. They interviewed the managers themselves to find out about their problems and their concepts of management. They also talked to their subordinates and to the executives to whom the managers report. They then designed a 4-week training institute which would not only diminish the present weaknesses of these managers but would maximize their strong points.

Basically, about a third of the training time was given over to helping the managers acquire a better understanding of their administrative duties, such as the development of realistic plans of action, evaluating progress in relation to those plans, maintaining a sound organization, coordinating operations, and trying to keep the workload flowing as smoothly and efficiently as possible. Then they were given training in the psychology of human relations, with ample practice in the application of psychological principles to their own human relations problems and to their public relations. Through role playing and similar devices they improved their score at getting over on the other fellow's side of the fence. They were shown how to analyze and organize their own jobs as managers.

The executives to whom these public employment office managers report were given the same basic training, plus training in how to appraise the qualifications of their managers and how to help them develop into effective executives. They will assist managers in applying their management training to their work. The key note of these sessions was how to give personalized and specialized assistance to their managers so that they can develop their management skills through counseling and coaching, further study, and the right kinds of management experience.

This is a management development program designed specially and after much research for a group of public employment office managers. A management development program for industry might call for more training in such things as market research, cost accounting, quality control, operations research, and work measurement.

In any event, the basic program should be fitted to the company and the needs of their executives. Then there should be careful followup so as to assist these managers in developing their management talents and applying what they learn to the job.

Back of this, of course, is the idea that we do not "train" managers; we select persons who have the interest and the ability to become good managers. Then we give them every opportunity to develop by counseling them, by exposing them to good management experience and to appropriate development programs.

What are some of the special considerations that might be mentioned in management development for scientists and engineers? The engineer, to my way of thinking, has certain important assets in the management field because of his training in such things as blueprinting the work ahead—or planning—and in solving problems objectively. He is usually conscious of the need for standards and has a good sense of production.

It is to the human relations part of his training that the scientist and engineer needs to pay particular attention, in my opinion. In the first place, what is his motivation in this transfer from work as an engineer to work as a manager? Is it solely more pay? If so, does he really want to work at this business of "getting things done through people" or would he prefer to work as an engineer or scientist? I believe we should give equal prestige and pay to the outstanding engineer and scientist as to the manager so that persons who prefer to work in scientific research, are not turned into supervisors of people unless they have aptitude for it.

It is to the best interests of scientists and engineers to encourage the selection of people for managerial jobs who have an interest in management and the aptitude for it. A few days ago, for example, I talked to a man in an organization managed by a doctor who treated his subordinates as if they didn't know very much. While this may be necessary in the doctor-patient relationship, it made for very poor human relations in a management situation. He also bypassed his subordinates and made important decisions without consulting them. While he was undoubtedly able to alleviate suffering as a doctor, he apparently caused a lot of it as a manager.

There are more and more such situations where a doctor or engineer or scientist must of necessity head up the organization because of the nature of its work. For example, we have had an expansion in research and development in this country from $3.7 billion in 1953 to $7.3 billion in 1957. Most of this research must of necessity be managed by scientists and engineers.

Research is one of the most difficult forms of production to manage; namely, the production of ideas. It calls increasingly for the coordination of many disciplines; it involves large amounts of money that may or may not produce results. It is also very difficult to determine whether or not operations are really effective.

We hear many stories, also, of the difficulty of supervising groups of scientists. They may not like company working hours, and their loyalties may be to their profession rather than to their employer. What the employer may want to keep secret, they may want to publish; what the employer wants developed in order to make money for the company may not suit their idea of scientific worth. Even the best of human relations training might be inadequate under such circumstances.

In these situations I believe we should train the scientist, engineer, or other specialized person in how to manage rather than bring in the so-called "administrative expert." I believe that, given people with the aptitude for it, they can acquire the skills needed for management.

Let us now get back to the question that is the title of this talk, "How effecive are management development programs?" In the opinion of people whom I consider leading authorities in this field, a lot of our traditional management training is not very effective. The end results of increased production and increased satisfaction on the job just don't materialize.

Many of us have undoubtedly had the experience of sitting through long-winded talks on "human relations" by people who are totally unfamiliar with the scientific findings in this field. Furthermore, our leading authorities on human relations training are convinced that lectures by themselves are of little value in developing human relations skills. The result is that the manager has learned a certain amount of folklore which he can play back but which does not solve the human relations problems of his office.

Contrast this with a program where top-flight psychologists analyze the human relations problems of the group and devise a specific training program for them. They will lecture on the psychological principles involved, such as causation in human behavior and frustration. Then the group is given ample practice in the application of these principles to their own human relations problems. There may be role-playing of certain problems so that the executive takes the role of a subordinate and gets the "feel" of being on the other side of of the fence. It may take several weeks to provide such human relations training, but the results in terms of a lessening of human relations problems are usually impressive.

A few months ago, at a meeting in Kansas City, I made a plea for increasing another one of our strategic human resources—competent vocational counselors—who can help our youth assess their real abilities and interests and find their place in our complex society. At the conclusion, Governor Brooks of Nebraska made the comment that people will look all over town for a good mechanic to ding up their cars but let any amateur work on what is infinitely more complex and important—the vocational guidance of their youth. I am afraid that we are also content with much less than the best in the highly strategic personnel concerned with management development.

A recent University of Chicago survey showed that 75 percent of the scientists were dissatisfied with the way their laboratories are run. People want an orderly, organized working environment in which they can find satisfying careers and do effective work.

In a study of supply and demand factors for engineers and scientists in the Kansas City area, sponsored by the Department of Labor several years ago, we found that only 10 percent of the graduates in science and engineering stayed there to work.

Recently I spent an evening with about 25 budding scientists and engineers at M.I.T. Many of them felt they would lose their individuality if they went to work for one of our large corporations. Several quoted William Whyte's "The Organization Man" as evidence of pressures toward conformity in thought and action, and such pressures, in their opinion, were particularly damaging to a research person. They quoted studies to the effect that liberal arts college students showed a wider range of problem-solving ability and imagination than persons who had worked a long time for a large company. These considerations of individual development and freedom of action were so important to some that they were thinking of switching to other fields of work.

One of the characteristics of the younger generation, we know, is rebellion against the rules of the world in which their fathers work. Nevertheless, there is a challenge to our management today to create those conditions which make for the fullest possible development and freedom of the individual. In years past, the main bottleneck to industrial progress was capital and efficient machines. Today it is trained manpower. The company or community or nation that wants to move ahead must have the kind of management which makes careers in science and engineering attractive.

The challenge to engineers and scientists who aspire to management positions, then, is to become really professional managers, who can create a productive and satisfying working environment for their fellow scientists and engineers.

It is my sincere belief that it will take the very best management development programs that are available today in order to equip them to meet this challenge. If we do provide such management development programs they will, in my opinion, increase the effectiveness of our scientists and engineers more than through any other course of action.

## Upgrading Technicians to Professional Work

*by—N. F. Tamm, Personnel Engineer, Missouri State Highway Commission*

I consider it a pleasure and a privilege to be asked to address this assemblage on the subject of upgrading technicians to professional work.

This process of upgrading is long and tedious, yet it is one of the most important tasks confronting those who are charged with the responsibility of training programs for technicians.

Before we delve into the subject of upgrading technicians, I would like to dwell for just a moment on some of the problems which have made the upgrading of technicians a necessity.

A well known industrialist once said that his factories and his money could be taken from him, but if his men were left to him, his organization could again rise to a position of leadership. People are only one of the elements required in a successful business or enterprise, yet they are becoming recognized as the most important one.

A great deal of effort has been expended in developing new products and more efficient methods of producing them, however, until just recently, little attention has been given to developing methods whereby the productivity of the individual might be increased both in proportion to and in relation to the product. Yet this same individual has been expected to guide and carry out any operation entrusted to him. How can we hope to expect as much as we do from such individuals when we have sadly neglected their development?

Problems are a part of our everyday lives. This particular problem of increasing the productivity of technicians is not new, or at least, we have not suddenly been faced with it. We have seen the problem growing for some time but only recently, after the realization that a national shortage of engineers and scientists does exist, have we made any tangible move towards solving it.

Present day statistics on the shortage of engineers and scientists often tend to confuse rather than enlighten the issue, however, the fact remains that we do have a shortage of adequate and competent personnel in the right places.

Our population has increased so rapidly that the number of individuals availing themselves of the engineering and scientific opportunities afforded has not proportionately kept pace. Add to this the increasing number of technological jobs to be staffed, and the desperate need for technological manpower becomes clearly evident.

Both private industry and governmental agencies, the two largest groups employing engineers and scientists, have felt this shortage of qualified technical personnel in the process of adequately carrying out their programs. Of the two, governmental agencies have probably felt the shortage more acutely, due to inadequate salary levels to attract or retain technical personnel.

In order to alleviate successfully this engineering shortage, our first problem lies in convincing high school freshmen and sophomores that engineering is a profession in which they would like to engage. If we, by our actions and words, or lack thereof, fail to create in these young men the desire to become engineers, then we have failed at the source to accomplish that which we have set out to do. In this respect those of us who are registered professional engineers have, perhaps, also fallen down in our obligation to the profession by failing to create a favorable impression of engineering to the young men in or just emerging from high school. Too little publicity is given to the many interesting and involved emergency problems with which engineers are constantly dealing. We must impress upon the high school student and graduate, the attractiveness of engineering as a career.

A secondary problem in coping with the engineering shortage is to remedy the pathetic waste of engineering talent so prevalent in government and industry today. Literally thousands of graduate engineers are "wasting" their time and talents doing the jobs of technicians. I am here using the word "technician" as a man very skilled in his job, accurate and dependable, but neither having nor requiring a fundamental knowledge of the underlying principles of engineering.

An engineer, by comparison, has either had many years of progressive experience, or has spent thousands of dollars and at least four years at college obtaining a degree. Understanding and the ability to apply it, are the primary factors separating the engineer from the technician. An engineering professor once stated: "A technician asks how to accomplish a task, while an engineer asks for an explanation of why and how it occurred."

Some so-called engineering colleges tend to turn out technicians in preference to engineers, though pressure from government and industry could soon change this if men were used according to their abilities and not their titles.

A technician can ordinarily become competent in his field in a significantly shorter time than that necessary to develop a competent engineer. For an engineer, some degree of specialization is necessary early in high school plus the usual four or more years at college, bringing the total time for education to or beyond six years. To the education, add approximately four years of experience in a specialized field of engineering, and the product is generally a competent engineer.

In view of the time involved in training, and the prediction that the need for engineers will outstrip the numbers of graduates for possibly the next ten years, it becomes apparent that the number of college graduates, even though increasing, does not offer an immediate alleviation of the shortage.

This brings us then, to a practical and at least partial solution to the shortage, the upgrading of technicians, through training and the most efficient application of manpower presently available. This process involves two major problems:

First, the procurement, primarily from the ranks of engineering aides, of a sufficient number of recruits with the desire and capabilities to develop into technicians. This is basic. To upgrade the technician to professional work we must first have the technician. The individual must have a strong desire to advance within the organization, and must be willing to undergo the additional work and study which is necessary. He must also have the capability to do the work. The organization, for its part, must offer a sufficient salary inducement to make the venture attractive and worthwhile. This type of person can be developed to supplement the engineering staff, relieving engineers presently performing technicians' tasks for work more applicable to their capabilities.

Secondly and obviously the most difficult is providing for the education necessary to transform these recruits into skilled technicians through both study and experience. On this subject, I will confine my remarks to the experience of the Missouri State Highway Commission in dealing with this problem.

Missouri has definitely felt the pinch of an insufficient number of technicians to supplement the engineering staff in carrying out the vast road building program of the State. This situation was boldly laid in our lap with the adoption of the 10 Year Highway Program by the Commission. We were short of engineers, of technicians, and in some cases, even skilled workers. With the initiation, and later the speed-up, of the federally supported Interstate Highway Program the condition became progressively worse.

We have taken the problem seriously and have adopted several methods designed to upgrade or improve the productivity of the engineering aide, and later, the engineering technician, to a point where he is capable of performing professional work. Some of the methods are presently in use and some have yet to be tried.

When an engineering aide has been developed to the status of a technician, the principal and first requisite of our goal is to instill in him the desire for more knowledge in the field of engineering. Without that spark of desire both his time and that of an instructor are wasted. Once the technician has acquired the "will to do" and the desire to learn, his efforts at the time he is doing his hardest work should be rewarded with commensurate salary raises.

You may ask, now that the technician has the desire to learn and progress, how we go about the process of providing additional education and training?

First, we have adopted a job rotation program. This program provides the technician with the opportunity to acquire a diversified knowledge and awareness of the affairs of other fields of operation, broadening his general knowledge and thereby equipping him more fully to recognize and to take advantage of the liberal education to which he will be subjected in the months to come. This program, by determining the phase of engineering work to which the individual's mental capacity, educational ambitions, interests, and personal characteristics are best adapted, is perhaps the quickest way to obtain the technicians' maximum usefulness.

The prime requisite of developing a technician to his maximum value or worth is in discovering, through association and work with other technicians and engineers, his apparent latent abilities. Perhaps, unknown to him, he may singularly be qualified to perform the functions of a particular phase of highway work, and as we all know, a man reaches his maximum productivity when he is doing that part of his overall job which he especially likes and for which he is especially adapted.

When the technician has been placed in the position for which he is best fitted and from which he gets the maximum enjoyment in fulfilling, he is then in a more receptive mood toward suggestions for improving his capabilities and his productivity.

Secondly, we have provided educational leaves of absence without pay for those men in our organization who wish to begin or continue their college education in engineering. Providing an educational leave for the technician gives him more or less a sense of security while attending college. He knows that a job and the opportunity for advancement will be waiting upon his return. This serves as an excellent incentive towards reaching his maximum productivity, through education, as quickly as possible.

Thirdly, the Commission has an arrangement with a correspondence school giving individuals, who wish to increase their efficiency through education but who are unable to attend a college, an opportunity to engage in correspondence studies at a reduced cost.

While these methods for upgrading the technician are presently being made possible, additional methods are under consideration which would help the technician, if he so chooses, to become a registered engineer and would at the same time, increase his usefulness to the benefit of both himself and the Commission.

One of these methods under consideration is the setting up of basic courses in engineering within the Department, probably night classes, using our own engineers as intsructors. These basic courses would be for those who have had little or no previous formal engineering schooling or experience. If successful, the next step would, of course, be the establishment of advanced courses in engineering for the technician who has had some previous experience or schooling within the Department, again using our own engineers as instructors. We feel that this in-department schooling could be accomplished at a minimum cost with a maximum of results.

A second method under consideration is that of assigning outstanding technicians as understudies to qualified engineers within the Department of certain phases of work.

In general, if we are to upgrade properly technicians and prepare them for more advanced work to alleviate the engineering shortage, it is necessary that they be given the opportunity to demonstrate their ability to get the job done, to get along with people and to provide an opportunity to demonstrate or exercise their creative ability and their ability to solve tough new problems. And above all, the encouragement of the expression of their ideas to those in charge of the operations in which they are working.

Those technicians who succeed in reaching the status of the professional engineer through the various methods of upgrading and experience should be subject to legal qualification by examination and registration before full recognition of such professional status is granted.

The foregoing procedures do not necessarily produce engineers in all cases, but they do provide additional qualified personnel to aid in bridging the gap during this shortage of engineering manpower.

In addition to our above efforts for developing technicians we are also attempting to provide additional engineers through an educational work program.

In 1955, the Missouri State Highway Commission initiated a Co-Operative Training Program in conjunction with both the University of Missouri and the Missouri School of Mines and Metallurgy at Rolla. This program was set up in an effort to help develop more engineers for employment with the Highway Department. In addition, it provides high school students with engineering aptitudes, who might not otherwise be able to attend college, an opportunity to continue their education. These high school graduates enroll at one of the sponsoring institutions and alternate between the classroom and Highway jobs until they receive their degrees. They are then employed as engineers with the Highway Department. During their undergraduate years, while working for the Department, they are employed on technician jobs at a level commensurate with their education and past performance with us.

In conclusion, let me emphasize the fact that we, as engineers, must pursue every known and conceived method for training and developing qualified men to their peak of production if we are to keep pace with engineering and scientific programs which cannot, and will not for long, lag behind the population and economic growth of our country.

# Recent Developments in The Training and Utilization of Engineering Technicians

*by—Dr. William G. Torpey, Consultant, Office of Civil and Defense Mobilization, Executive Office of The President*

In these days of the Space Age, the technological team in science and engineering includes three types of trained personnel—the professional type or the scientist and engineer, the sub-professional type or the scientific and engineering technician and the craftsman type or artisan. Each type has a vital role to play in technological progress. The importance of the scientist and engineer has often been stressed. At this point in the program, attention will be focused on the scientific or engineering technician.

The definition of a "technician" has not been uniform. The term "technician", as used here, applies to the individual who performs specific tasks which are functional parts of scientific or engineering activities requiring knowledge of fundamental theory. The work activities sometimes require highly developed, manipulative skills, as in the use of instruments, tools or special devices. The range of work activities varies in complexity, but it usually embraces a specialized field of research, design, development or construction, exploration, measurement, analysis or application of basic scientific concepts; or control of production facilities and manpower. The performance of such work activities is based on: (a) knowledge of underlying scientific, engineering or mathematical principles related to the specialized field of work, and (b) the application of established scientific techniques and methods toward the solution of practical problems encountered in the field of specialization. Technicians usually become qualified through technical institution-type training (beyond the high school), or on-the-job training, or a combination of both.

## Emphasis on Technicians Through The President's Committee on Scientists and Engineers

In 1956 President Eisenhower established The President's Committee on Scientists and Engineers to coordinate and stimulate the Nation's efforts to meet growing needs for scientific and engineering manpower. The membership of this temporary committee was drawn from major citizens' organizations concerned with the education, training and utilization of scientific and engineering personnel. One of the early actions of the Committee was the appointment of a working group to review problems connected with the development of supporting technical personnel for scientists and engineers.

After an eighteen months' study, the working group recommended to The President's Committee an action program to effectuate efforts already under way to improve the role of the technician. Of the major topics featured in the report of the working group, four topics—status of technicians, size of enrollments in technical institute-type schools, development of more adequate teaching staffs in such schools and better use of technician personnel—have direct bearing on the purpose of this conference. Findings in these four areas, together with a brief indication of some action which has been taken on a national level in connection with each area, follow:

(1) Status of technicians—The status accorded technicians has often lagged far behind their responsibilities. Title, promotion opportunities and prestige as a respected member of the technological team are essentials. The working group noted, however, that recognition currently given in many companies and agencies to technicians is often non-existent. This condition, in turn, induces a situation whereby parents, guidance counselors and others are hardly aware of the many opportunities frequently awaiting properly educated technicians. The recognition needed is not limited to the individual; schools offering technical institute-type courses sometimes lack academic recognition. Not all conference participants here today may be aware of the fact that, during the last decade, professional standards have been established which many of these institutions have met. Accreditation of educational programs by regional accrediting bodies, for example, not only is a mark of academic status; accreditation is also helpful in terms of recruitment of qualified teachers and of attracting qualified students. The working group believed that further work needed to be done in the accreditation field. As a result, The President's Committee contacted the National Commission on Accrediting and requested that regional accrediting agencies review the possibility of broadening the scope of the accreditation process to include endowed schools offering technical institute-type education. Subsequently, this problem was explored by the six regional accrediting agencies, and, at the present time, five out of six agencies have adopted, or are in the process of adopting, a system of extending academic accreditation to programs of cer-

tain types of technical institute-type organizations which meet stipulated standards.

(2) Size of enrollments in technical institute-type schools—as an index of manpower supply, there has been a need for accurate annual national statistics on enrollments in technical institute-type educational organizations. The President's Committee recommeded that the U.S. Office of Education undertake the task of compiling such statistics. Subsequently, the U. S. Office of Education embarked upon a program under which it now collects annual statistics on enrollments in technical institute courses offered throughout the Nation; this information is now published annually by the Office of Education. Furthermore, the American Society for Engineering Education, at the suggestion of The President's Committee, includes annual statistics on accredited curricula in its Journal.

(3) Development of more adequate teaching staffs in such schools—The lack of qualified teachers in technical institute-type schools has been a critical problem inasmuch as the quality of teaching exerts such a direct influence on the competency of the graduate. The working group recommended fellowships from private sources which would help keep qualified teachers in the teaching profession by enabling them to take advanced training without loss of income or living standards and the lending of scientists and engineers by industry to technical institute-type schools for part or full-time teaching assignments. Through The President's Committee, the U. S. Labor Department in conjunction with state employment offices initiated a program under which qualified individuals have been referred directly by state and local employment offices to individual technical institute-type schools for consideration for faculty appointments. In addition, after motivation by The President's Committee, opportunity has been provided for faculty members of technical institute-type schools to attend special summer institute training programs held on various campuses, with financial assistance from the National Science Foundation.

(4) Better use of technician personnel—The working group found that a much better use of technician personnel could be made. Observation and experiences of members of the working group prompted the recommendation of a series of corrective points with respect to the under-utilization of technicians. Through the President's Committee, action was initiated on five related fronts:

(a) Development of a better understanding of the role of the technician among employers; to this end, a pamphlet directed to employers and entitled, "Answer Your Engineering Manpower Problems", was prepared and published by The President's Committee. Thirty thousand copies have already been distributed, only on specific request.

(b) Promotion of team work between industry and schools to set up more technical institute-type courses in higher education; to this end, the installation, or in some cases the greater use, of advisory committees has been effected through efforts of The President's Committee.

(c) Establishment of job definitions to spell out accurately the work done by scientific and engineering technicians; to this end, upon request of The President's Committee, the Department of Labor has undertaken a study of selected jobs held by technicians engaged in research and development work; this study is scheduled for publication in December 1959 and will offer the basis for a clearer delineation of technician tasks.

(d) Revision of the Dictionary of Occupational Titles—A revision of the Dictionary of Occupational Titles was considered necessary for aiding in the proper identification of technician positions; to this end, upon request of The President's Committee, the Department of Labor has embarked upon a project to publish a separate supplement to the Dictionary of Occupational Titles, which will include some 600 scientific and engineering technician occupational titles; subsequently, these data will be included in the next edition of the Dictionary of Occupational Titles.

(e) Development of flexible curricula through industrial collaboration to reflect industrial changes quickly and accurately; to this end, a Special Task Force on Curricula jointly sponsored by The President's Committee and the ASEE made an analysis of employer and educator attitudes with respect to the adequacy of current course offerings in technical institute-type schools: the Task Force completed its report a year ago but there were no funds for its publication until a few months ago. Copies are now available to you here today, this being the initial conference distribution of the report. Your attention is especially invited to these conclusions contained in the report, namely, (1) that there is a distinctive lack of agreement in industry concerning the exact nature of the proper work of technicians; (2) that employers who hire technicians from accredited schools were more satisfied with these graduates; (3) that many industries favor a curriculum containing a high degree of mathematics, sciences and laboratory techniques; (4) that there is strong evidence of the acceptance of the bona fide role of the technician and his actual and potential contribution; (5) that there is a lag in the currency of curricula of some technical institute-type organizations, and (6) that educational institutions appear to be fully conscious of their responsibility to refine, improve and upgrade their curricula. The nine recommendations found on pages 12-14 of the report merit your careful consideration.

## Obstacles and Solutions

Up to this point we have sought to review various actions, stimulated through The President's Committee, to enhance the role of the technician. We shall now turn to obstacles and solutions related to maximizing the use of technicians in industry and government.

During the twenty-seven local utilization conferences already held, discussions of the role of technicians have brought forth several obstacles to the effective use of technicians. One or more of these obstacles may be characteristic of your own work environment here in Missouri. A brief review of five of these obstacles, together with related suggestions which have been made by participants of other conferences, follows:

(1) One obstacle to more effective use of technicians seems to be that a sizeable segment of managerial personnel does not understand the proper place of the technician. One suggestion for improving management understanding is the use of work analysis studies to identify technicians' jobs: the resultant identification may suggest up-grading of certain positions or employees to the professional level and downgrading other positions or employees to the intermediate subprofessional level. Other suggestions to improve management understanding are the inclusion of material on the proper place of technicians in the executive development program of the organization, the participation of managers on educational advisory committees which would provide greater insight into the curricula of technical institute-type schools, and visits by managers to other companies and agencies successfully employing technicians with the objective of obtaining accurate, firsthand information about the role of technicians in these companies and agencies.

(2) Another obstacle cited is the reluctance of some supervisory scientists and engineers to accept the technician as a necessary, useful member of the technological team. Many professional persons have been trained to perform varying degrees of manual work and have difficulty in changing their accustomed work patterns. Suggestions to reduce this reluctance include the establishment of in-plant training programs to orient professional supervisory personnel in the potential use of technicians, the creation by management of an adequate number of billets with necessary funds to permit the appointment of needed technicians, and the use of incentives for scientists and engineers who as supervisors do make successful use of technicians. Programs of professional societies also have been suggested as a means of overcoming reluctance on the part of the professional employee. From a longer range viewpoint, new concepts in engineering education at the collegiate level which portray the proper role of the technician are helping to improve this condition.

(3) A third difficulty is the practice of considering the technician as an engineer-in-training. This attitude is somewhat understandable because the technician is often associated with an engineer. Thus, the technician's normal line of promotion may seem to be through the engineering classification. It is strongly suggested, however, that the advancement of the technician should be more properly considered within the framework of his own education and ability. Methods already mentioned above to overcome the first two obstacles (such as, emphasis on the proper place of technicians and work analysis studies to differentiate professional versus sub-professional work) are other recommendations.

(4) A fourth difficulty is that some individuals classified as technicians are inadequately trained to perform the duties reasonably expected of technicians. One solution is improvement in the selection of students by schools and in the quality of graduates: management may exert positive influence in this direction through closer relationships with educators, especially through participation on educational advisory committees. Improved selection standards used by employers is also advocated. Some conference participants recommend the establishment of in-service, up-grading training programs for technicians which stress fundamentals of subject matter.

(5) A fifth difficulty is shortage of specific types of technicians in specific geographical areas. It is suggested that managers assure that the technicians already on the payroll are performing bona fide technician duties; in some cases participants recommend the hiring of clerks and other types of routine workers to relieve technicians of some non-technical duties. Personal interest on the part of managers in the educational system is also recommended as a means of reducing shortages. There is some feeling among participants of previous conferences that the competency of guidance personnel needs to be broadened—particularly through the help of employers and professional societies—before sufficient numbers of youth will seek formal training which prepares them for technician jobs.

A fundamental solution to the problem of maximizing the use of technicians which has been recommended by several participants of previous conferences is establishment of a separate set of personnel policies and procedures applicable specifically to technicians as a key group of employees in an organization. Some participants have felt that the effective use of technicians calls for special treatment of technicians, personnel-wise, as distinguished from the personnel treatment accorded rank and file non-professional workers. This approach means the creation and application of carefully considered and specially devised personnel policies and methods for technicians to embrace such functions as recruitment, selection, compensation, training, promotion and recognition. Advocates of this approach contend that management should seek better utilization of technicians on the basis of the unique nature of the work of technicians.

### The Manpower Area of the Office of Civil and Defense Mobilization

Incident to the termination of The President's Committee on Scientists and Engineers on December 31, 1958, the utilization program of the Committee, including the action plan related directly to technicians, was transferred to the Executive Office of The President, Office of Civil and Defense Mobilization, where the Manpower Area is carrying forward the program.

The Manpower Area of OCDM has the responsibility for directing and coordinating the development of peacetime readiness programs and emergency plans for the proper utilization and control of the manpower resources of the Nation under various emergency situations. To carry out this responsibility requires a manpower organization in place and ready, an adequate knowledge of our present and potential manpower supply and requirements, and action to eliminate or reduce present and foreseeable shortages of manpower. This conference typifies action through responsible local groups and organizations to eliminate or reduce actual or potential shortages in scientific and engineering manpower fields.

In conclusion—and beyond the subject of the training and utilization of technicians—there are two points which I wish to stress: (1) the need for follow-up on the part of participants after the conference is over, and (2) the desire of the Manpower Area to learn of specific company or agency utilization techniques or practices which are proving, or have proven, helpful in promoting better utilization of scientific, engineering and technician personnel.

Our Office does not view this conference as the end in itself; rather, we regard each conference as a vehicle for stimulating action at the local level by local participants. It is believed that the general and panel sessions of this conference provide such stimulus for group thinking and individual action with respect to particular phases of the utilization problem. The success of this conference will really be measured in terms of subsequent concrete actions taken by conferees after a self-analysis of company or agency manpower policies and programs in the light of the total conference discussion. We urge that, among other suggestions made and to be made here in Columbia today and tomorrow, you give most careful consideration to action which would result, if appropriate, in your more effective use of technicians for subprofessional tasks.

President Eisenhower has encouraged the publicizing of possible solutions to the problem of increased demands for scientists and engineers. One aim of the Manpower Area is to disseminate to other conference groups information describing helpful company or agency practices or procedures which foster maximum utilization of scientific and engineering skill. We, therefore, will appreciate your alerting us, through this conference framework, to particular company or agency practices, such as an effective incentive program or training program, which may be helpful to other industries, government agencies, and educational institutions.

Last June in New York City the parent body of one of the sponsors of this conference, the National Society of Professional Engineers, held its Silver Anniversary meeting. Those of you who were able to be in attendance at the New York City meeting will recall the emphasis given to the need for proper utilization of professional personnel—including the appropriate use of technicians—not only as a matter of intelligent management, but also as a matter of professional pride. This same concern has been expressed on previous occasions by other organizations and individuals at the national, state and local levels. It is our hope that this conference here in Columbia will be a dynamic vehicle for enhancing the conservation of skilled brainpower in this area.

## Effective Recruitment and Long-Time Retention of Scientists and Engineers

*by—David F. Waggoner, Director, Salaried Personnel Placement, General Motors Corporation, Detroit, Michigan*

It is important that a company avoid crash recruiting programs to solve technical know-how shortages. Companies that entertain such measures frequently develop a reputation for ineffective technical ability and find themselves continually in critical need of engineering talent. Unless a company establishes a long-range recruiting program, which is effectively geared to the needs of the firm, recruiting results will be unsatisfactory and the company will experience a continuing weakness in engineering talent. Effective recruiting cannot be tied to a company's business cycle. In other words, it should not be such that when business is booming recruiting is accelerated and when business is poor recruiting is relaxed.

Openings in a company primarily develop from retirement, other normal turnover, and company expansion. Consequently, recruiting is a continuing need.

One of the techniques G.M. employs in planning its recruiting is to analyze certain trends.

First, The number of high school graduates going to college. This is important because industry finds itself relying more and more on colleges for capable people to fill their technical and management needs. Previously, there was an economical problem which caused some capable people to enter directly into industry without going to college. But as the general income level has improved, there are fewer and fewer capable persons available directly from the high school level.

Second, The increasing trend in the number of white collar workers which creates more management needs and consequently increases the importance of recruiting capable people that can work and organize administrative functions.

Third, The trend of more complexities in industries. This is essentially a result of technical progress and the trend towards the automated type of industry. This is increasing the need for engineers and scientists who have an understanding of such complexities.

Last, The trend towards an increase in graduate degrees. This is making available to industry, on an increasing scale, a higher educated individual.

Some of the programs that will assist in providing effective long-range recruiting are as follows:

First, Company public relations through educational conferences with faculty members of the universities.

Second, More frequent and better planned student tours through company facilities.

Third, Summer employment of high school teachers to acquaint them with latest developments in the company operations.

Fourth, Scholarship and fellowship programs supported by the company.

Fifth, Advertising through appropriate journals and papers.

Sixth, Increased contacts between top management of companies and top administrative executives of universities and schools.

Last, and probably the most important is that of summer employment programs for undergraduates. This is very effective as a device to establish a continuing reputation on campus. Providing a summer program that is well organized and effective will also provide a good means of selecting permanent employees as the company has an opportunity to see a potential employee's work.

In summing up, it is important that companies realize the responsibility for growth of those that are recruited and that a company have a definite need for the individual acquired or recruited. The effective analyzing of trends, and improved industry-education relations, as provided through the before mentioned methods, will assure effective long-range sources of capable manpower.

## PUBLICATIONS OF THE ENGINEERING BULLETIN SERIES

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