

Bridging the Gap between College and Career

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● ANDREW CARNEGIE once stated that you could take away his factories and money, but that if you left him his men his organization could again rise to a position of leadership. Although people are only one of the elements required in a successful business or enterprise, they are becoming recognized as the most important. A great deal of effort has been put into developing new products and more-efficient methods of producing them. Until recently little attention was given to increasing the productivity of the people themselves who must guide and carry out any operation. The problem of improving the value of the individual's work output has become important because of the increased complexity of our modern industrial work, the interdependence of the problems, and the shortage of men, particularly of good technical men.

Some of the things which can be done to help this problem are to give the individual incentive to improve his productivity by putting into effect personnel and supervisory practices which give recognition, promotion, and pay based on present and future productivity and merit. Also the output can be increased by putting the person on work which makes maximum use of his most-valuable abilities and providing training which will increase these skills and abilities. In this discussion let's limit ourselves to the training phase of this problem and, in particular, to the principles and mechanics of developing to the fullest extent young engineering graduates when they first begin a career in industry or government service.

First we will set down some broad objectives which will bring benefits both to the organization and the man. Then some of the principles of operation of a program which will meet these objectives will be discussed. We have found it advantageous to provide general training for all of our young engineers. Intensive advanced training is provided for those young men who display high ability and ambition and will become the company's potential technical leaders. Because of the great importance of people

in this latter category, we will discuss in detail methods of finding and developing these individuals.

DESIRABLE CHARACTERISTICS OF A TRAINING PROGRAM

Management has as its responsibility (1) the setting up of objectives or goals, (2) the bringing together of people and facilities which will most efficiently in the long term carry out these objectives, and (3) the reviewing of the progress of the organization. The second item in this definition of management infers that in a training program we are trying to maximize the ratio of the increase in value of the man's productivity brought about through training over the cost of the training.

Now what are some of the things the organization can do which will increase the value of the person's work? Let us make the important assumption that our personnel and supervisory policies give incentive to the individual to increase his productivity: (1) Determine the area of work which will make maximum use of the man's mental ability and education, ambitions and interests, and personality characteristics. (2) Give the individual knowledge required or helpful in his work at a faster rate than he would get it by "learning the hard way" through experience on the job alone. (3) Develop latent abilities possessed by the man which are valuable in his area of work, particularly his ability to get things done, ability to get along with people, creative ability, confidence and ability to solve tough new problems, and his ability and willingness to express his ideas.

We feel that training programs have been or can be developed which will help meet all of these objectives, particularly in finding the best area of work and getting across factual knowledge. The third area of developing latent abilities is a more difficult, time consuming, and costly matter, but we are convinced that we have found ways of improving creative ability and the ability to solve tough new prob-

lems, so that the resulting increase in output far outweighs the cost of the training. At the present time, considerable effort is being devoted to finding ways of improving human relations, but we do not have sufficient experience with any given technique to know if the results justify the effort.

Before going into the operating principles involved in setting up programs to meet these objectives, let's look at some of the problems of the young graduate engineer through his eyes. On first entering a job in industry or government, he finds himself, probably for the first time, in a complex industrial organization with a high degree of specialization in the various jobs, well-defined lines of authority, and established behavior patterns. Often he feels that he is not doing work which utilizes his abilities or leads to the position of prestige he had visualized. He is shocked by the tremendous gap in experience between himself and a recognized engineer or manager. Probably he is trying to establish a family on a meager income; and the reality of having to earn an income in a competitive situation means a difficult change in attitudes from the ones prevailing in the collegiate atmosphere of the campus.

During this transition period from college to career he would like: (1) a chance to find work which gives him satisfaction and a sense of accomplishment; (2) recognition as a person and not one of a mob of employees; (3) opportunities to advance and be paid according to his present productivity and future potential; (4) training and good supervision to help him in his development; and (5) information on his progress at regular intervals, especially during the early part of his career.

Of course, the ultimate success of any program incorporating these ideas depends to a large extent on the willingness of the young engineer to apply himself. The trainee must realize that he must first put full effort into his work before looking to the employer for help. He must realize that his employer is providing a program which will permit him, early in his career, to help himself under capable guidance and that later he must set up his own program of self-improvement. The employer should provide the opportunities and counsel necessary in the young engineer's training but should be careful not to pamper or give the

trainee a crutch which would destroy his initiative or distort his attitude toward work in a competitive society. The best way of building a constructive attitude is to treat these men like professional people and demand professional actions on their part in return.

PRINCIPLES AND MECHANICS OF A GENERAL ORIENTATION AND TRAINING PROGRAM¹

In the general training lasting for a period depending upon the complexity and diversification of product, the primary emphasis should be put into general orientation, evaluation of the man to establish the general functional type of work best matching the man's abilities, giving knowledge helpful in this type of work, counseling the man on his professional goals and progress in meeting them, and placing the man in a "permanent" job or on a program of advanced study if he possesses high potential.

We believe the backbone of this training should be a series of four or five carefully selected work assignments supplemented by instruction and homework. The assignments should be such that the man is doing the caliber of work and associating with people which approximate as close as possible the conditions he would find if he were permanently working in that area. The first couple of assignments should be in varied types of work, so the man and those responsible for guiding his training can determine the general type of work best matching his abilities. Then the man should be encouraged to begin classwork to establish an approach to problems. His assignments should be in this type of work so as to establish more definitely the level of work, type of product, and organization best suited to the man and the needs of the business. Often after the area of work has been established the man should be placed in an assignment to get a necessary background for his type of work. For instance, a potential engineering salesman in turbines should have an assignment in the

¹The booklet "The First Five Years of Professional Development" gives a very complete survey of general and advanced training programs offered in industry and government service. Recommendations are made for training and guiding the young professional employee during the first five years of his career. A copy of this booklet can be obtained by sending \$3 to the Engineers Council for Professional Development, 29 West 39th Street, New York.

factory running final performance tests on turbines before the machines are shipped.

We have found that initial training consisting of a series of work assignments is better than immediately placing the man on a "permanent" job and giving him classwork, etc., because the type of work making best use of a man's abilities can most accurately be determined by observing the man's performance actually doing the various types of work. Often the new graduate has formed his job interests on hearsay or short associations, and his expressed interests may not agree with his abilities. These assignments in various types of work give the man a chance to learn by doing the work he enjoys most. Luckily the man usually wants to do the type of work he does best.

Another advantage of a series of work assignments is that it gives the man a broader, more-meaningful orientation as to the different kinds of jobs required to produce the organization's products or services. Again, this is the idea of learning by doing. In an assignment he finds it necessary to get the help of other groups in getting his job done and senses a real need to find out who does what. In this manner the trainee gets a good idea of the way activity in one group affects the operation of another and learns where he can get help, and the general way the organization carries on its business. Working in these various activities and supplementing this by classes, inspection tours, and discussions gives a better orientation than classes by themselves.

At the beginning of the training the graduate's abilities and interests should be evaluated by his past school record and a searching and extensive interview. In this way his assignments from the start can be chosen to best orient, evaluate, train and develop the individual man. Evaluation of the trainee's performance on a given assignment is best done by his work supervisor. A rating sheet is essential in this process. It must be remembered that this information can serve: (1) as a basis for telling the trainee how he is doing and to counsel him and (2) to evaluate the man for the purpose of placement or recommending advanced training.

We have found that the benefit of these ratings can be greatly increased by having the work supervisor and, if possible, the man guiding his training discuss the eval-

uation of the work personally with the man. In this process of setting goals for the man and then telling him how he is coming in attaining these goals, you must be careful that you do not try to cast people into a mold. If you straitjacket the young man, particularly the man with creative ability and originality, you may destroy these characteristics which are so important to progress.

During the general training the assignment work should be supplemented by classwork and homework emphasizing an organized approach to problems in the broad type of work best suited for the man. Because of the many different specific jobs in a type of work, fundamental principles should be presented which, when understood, may be applied to a large number of problems. This approach to solving problems can best be mastered by building the course around the homework problems and not trying to add much new factual knowledge.

The success of any of the phases of this general training depends upon the enthusiastic support of management and the caliber and interest of the men counseling and supervising the work of the trainee. Always put a capable man who is interested in training and developing people in charge of the program. He must then gain the help of the assignment supervisors in providing challenging work for the trainees and in evaluating and discussing their performance with them. To help train and maintain the interest of the work supervisors, men responsible for the training must frequently visit their assignment areas.

To get a better understanding of these ideas let's take a look at the general training program employed in the General Electric Company. Because of the number of young professional people hired and

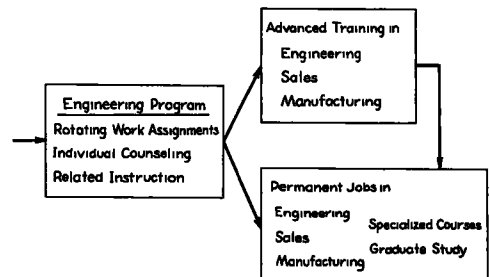


Figure 1. Outline of an actual program.

the difficulty of knowing so many different kinds of work, separate programs are set up for each group of men with common educational backgrounds. In this case there are separate programs for men who have majored in business administration, advertising or journalism, social sciences leading to personnel work, and engineering.

Let's focus our attention only on the engineering program. The new graduate usually reports early in the summer, and after a brief orientation by his training supervisor and an extensive interview, the man is put on a 3-month assignment doing productive work in one of the general types of functional activity performed by engineering graduates during their careers. These, in our case, are sales and application engineering, manufacturing, and engineering. Insofar as possible the man's interests and abilities, as determined in a searching and extensive interview, are followed in picking this assignment. He is given as challenging work and as much responsibility as he can possibly carry, but is under capable supervisors who only step in when they feel it is absolutely necessary.

During his assignment the man is encouraged to find out with a reasonable expenditure of time what the people and groups around him are doing and how they affect his work. He also learns to call on others for help when necessary and to find out about the product division in which he is located. The man's performance is discussed with him midway through his assignment and at the end of his work by his immediate work supervisor, and this evaluation used by his training supervisor to select his next assignment.

As the man progresses through several assignments, his supervisors and the man himself determine whether he is best suited for sales, manufacturing, or engineering. The later assignments are chosen to give the man broad experience in this type of work so as to determine more specifically the work best suited to the man. In engineering the various levels of work are development, design, and application engineering and these vary somewhat depending upon the product produced. After 12 to 18 months of assignments, the man is either placed in a "permanent" job and given specific training in his specialty or offered the opportunity to take broad advanced training.

EXAMPLES OF EDUCATIONAL COURSES

Advanced Technical Course

In the fall our trainee is encouraged to begin an orientation class to supplement his knowledge gained on his assignments of the types of work, and policies and organization of the company. Salary and promotional policies must be understood if they are to provide the desired motivation. He is also encouraged to begin a course of homework problems and class-work helpful in his general type of work. For the man interested in engineering, the "advanced technical course" is offered in each of the major plants of the company. The primary purpose of this course is to develop the potential engineers ability to solve new engineering problems. Participation in any of the educational courses offered by the company is voluntary and men who can benefit from the course are only encouraged to apply and go through the selection process necessary for admission.

In the first semester of the advanced technical course, running from September to December, the emphasis is placed on the development of a professional approach to problems² consisting of the following basic phases: (1) problem recognition, (2) problem definition and setting of specifications, (3) search for ideas or methods of solution, (4) evaluation of methods of solution, (5) detailed investigation and solution, and (6) evaluation and interpretation of results. This approach is applied to problems arising in many technical fields, resulting in an integration of all the technical knowledge the class member has obtained in his undergraduate work.

In the advanced technical course, the class member actually "learns by doing." As homework he solves realistic engineering problems arising in the product departments of the company. One week he may be devising a new means of detecting internal faults in power transformers; the next week he may be studying the heat transfer from a radar circuit chassis when an attempt is made to make the chassis lighter and more compact so that it might be more readily used in an airplane. The

²A complete discussion of problem approach as it may be applied to electrical and mechanical engineering problems appears in "Engineering Analysis", by D. W. Ver Planck and B. R. Teare, Jr. (1954, \$6, John Wiley & Sons, Inc., 440 Fourth Avenue, New York.)

problems are varied and are chosen on the basis of the fundamental concepts and techniques involved. In the homework assignment each week the student spends about fifteen hours of outside preparation and an engineering report is written to present the method of investigation and the results obtained. Frequent evaluation periods are scheduled, at which time the class member and class supervisor discuss the progress of the class member and make suggestions for future improvement. A great deal of personal attention is thus given to each individual class member.

In December men are selected on the basis of their performance in the course and assignment work for further training in the second semester of the advanced technical course or to begin advanced training in the advanced engineering program, creative engineering program, or process technology program. The second semester of the advanced technical course lasting till June continues the type of training given in the first semester. It is primarily for men with broad engineering interests who want to integrate their knowledge and learn how to apply it to solving problems.

COURSES AND ADVANCED TRAINING FOR ENGINEERS

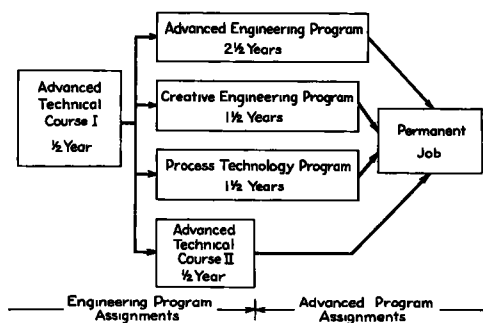


Figure 2.

Advanced Engineering Program

Men who have demonstrated an interest in highly technical engineering and excel in analytical ability are selected for the "advanced engineering program." This 2½-year program develops men who are capable of solving tough new design or development problems. The use of fundamental engineering principles and analytical techniques are mastered by applying them to complex homework problems and to real engineering problems encountered

in their work assignments. Since the major benefit of this program is provided by the homework problems, the class is largely devoted to discussions of the physical and mathematical concepts that contribute to their solution. Classes are held midway between the assigned and due dates for each problem. Unusual difficulties and need for additional facts are uncovered during the initial attack on the problem. Such preliminary work permits efficient class discussion with men who can reveal practical limitations and analytical shortcuts.

The advanced engineering program is extremely fortunate in being able to draw upon a great variety of engineering departments for current and vitally real problems. This allows a thorough coverage of the electrical, electronic, and mechanical phases of engineering. Furthermore, company engineers and scientists, who are experts in the many different areas, are available for discussing during class the significance and modern uses for fundamental material.

The 470 graduates of this program have won distinction in the areas of research, development, design, and engineering management and hold positions of engineering leadership throughout the company.

Creative Engineering Program

This program is tailored to develop engineers who have a high degree of motivation and ability, and who seek a challenging career in design, production, or manufacturing engineering.

The most-intriguing facet of this phase of engineering is the conversion of some idea into a workable and marketable product that commands a selling price which produces a profit. This often may involve the transformation of a development prototype into the final design. Without the often ingenious push the basic idea gets, it might never reach fruition. Here, one must be abreast of the latest developments in materials, processes, new or unusual components, and basic laws or effects; the whole of engineering knowledge plays its role. A broad knowledge and well-organized reservoir of information pays big dividends; an active curiosity constantly adds to this reservoir.

The advanced technical course provides

the first step in meeting the design engineering challenge. This is done through the development of a logical engineering approach to any problem, employing both physical principles and creative or imaginative techniques.

The creative engineering program is a natural second step, for it provides the opportunity for a broad growth by presenting: (1) A sound perspective of all those elements affecting the cost and quality of a product so that one can more quickly factor in specific experiences later when permanently employed in a product department. Without this perspective, it would take years to project specific and isolated experiences into an integrated whole. (2) Additional engineering concepts and mathematical techniques found most useful for efficient performance in design engineering activity. (3) Continued emphasis on the creative phases of the problem approach so that graduates can contribute the new ideas so essential to progress. (4) Practice in learning by doing in all of the three phases just mentioned.

Developing creative ability and its practical application to engineering problems involves four aspects. First the individual must acquire a broad knowledge of the area in which he hopes to contribute new ideas. Often this knowledge is referred to as the reservoir of information from which new ideas are synthesized. Second, the development of imagination is brought about through the use of certain organized techniques which increase the probability of coming up with new ideas.³ Third, the knowledge and ability to evaluate fruits of the imagination are cultivated. Last, the techniques of reducing the ideas to products which may be manufactured for a reasonable profit must be mastered.

In the 16 years the program has been operated, a total of 347 men have graduated from it. An indication of the value of the program to the General Electric Company is reflected by the demand for graduates. These have consistently run many times the number of men available.

Process Technology Program

Men displaying high ability in solving

³ Many of the techniques used in this program to develop creative thinking are found in 'Your Creative Power' and 'Applied Imagination' (with Instruction Manual), both by Alex F. Osborn, published by Charles Scribner's Sons.

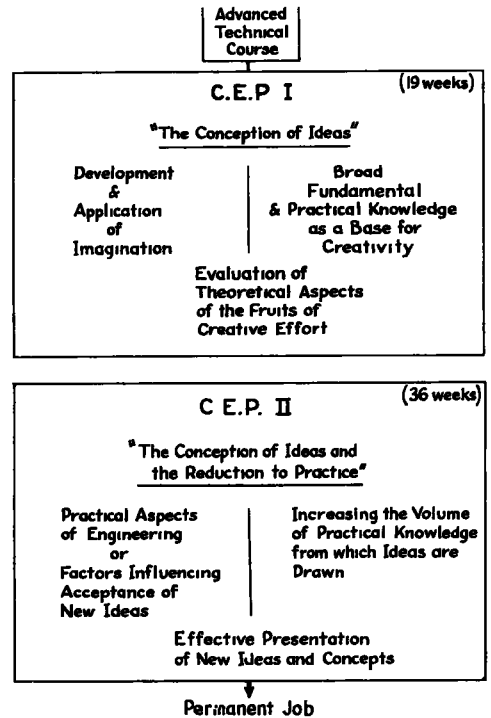


Figure 3.

problems in chemical or metallurgical processes are selected for the 'process technology program.' This program consists of 1½ years of rotating assignments, homework, and classes to further develop these men in the metallurgical and chemical processes.

Training After Taking a Permanent Job

After taking a permanent job in an operation, men can continue their education by taking company sponsored courses to further their knowledge in their specialized work area. Because of the increased responsibility of their jobs and growing family responsibility these courses require less time and effort on the part of the student than do the advanced courses. Those individuals interested in evening graduate work at a nearby college are encouraged to work for an advanced degree if their study will benefit their job. In many cases the company will pay a part of the tuition connected with these courses.

Cost of Training

Many of you must shudder to think of the cost of the kind of training we have

described. Actually the cost can be kept comparatively low if the trainees are engaged on productive work on their assignments. The net cost per man of administering the engineering program is a small fraction of the man's salary. Our educational courses are voluntary and offered as opportunities for the man to help himself. The cost per man of the courses lasting 6 to 9 months and having part-time instructors is not more than several-hundred dollars. Advanced courses like the advanced engineering program, creative engineering program, and process technology program have full-time supervisors for each class of from 15 to 25 men because of the great benefit derived from individual tutoring and counseling in this intensive training. The approximate cost of administering these programs per man is a little over a thousand dollars a year.

We have found that it is a good idea to finance these training operations like a business in that the department hiring a man pays the cost of his training. This gives the training program a real incentive to keep the cost of training in line with the quality of their product; otherwise they are soon out of business.

Very often people ask how we make sure that the improvement in the man's output due to training is greater than the cost of this training. The answer is that we have never been able to do this on a quantitative basis, because of the extreme difficulty in numerically measuring the increase in a professional employee's output. The only way to do this with any degree of accuracy is to select men in the normal fashion for, say, the advanced engineering program, line them up in order of rank, and then train every other man. A comparison of the output of the two groups would give an indication of the benefit of the training.

This plan is good in theory, but we have never put it into practice because of our confidence in the benefits of the training.

The engineering program has been in operation for 60 years, the advanced engineering program for 30 years, the creative engineering program for nearly 16 years. During these periods these programs have been developed and constantly revised to better meet the changing needs of the company. Many of the graduates have risen to key positions as technical specialists or members of management. Furthermore, the demands for graduates usually exceeds the supply especially in the case of advanced course graduates.

CONCLUSION—GET YOUR PROGRAM STARTED

We are firmly convinced that training programs are of real value in helping the capable young graduate bridge the gap between college and career. When coupled with personnel policies giving real incentive they form one of the most important methods of increasing the value of our people. One cannot expect immediate results from his training efforts, just as we cannot begin to clip bond coupons as soon as we have made an investment—and training is an investment.

Very often the small or medium-sized organization will say that it cannot afford such training. Actually the cost of starting a modest program is small. All that is required is the full support of management and a capable man of broad experience in the organization who is interested in training to run the show. All of the highly developed, elaborate programs you have heard about had humble beginnings. The most-important thing is simply to get started.