chapter 6

Factors That Determine Success

AT THIS point we need to give specific attention to the factors that will affect one's success in engineering, both in college and after graduation. In our preceding discussions we have emphasized the importance of aptitude, interest, industry, and personality. Now we will talk about success, to see what it is, how it may be measured, and what each man may do, or avoid doing, to achieve it.

HIGH SCHOOL PREPARATION

The foundation for a successful four years in the engineering college is laid in high school. This consists, in part, of adequate and effective preparation in mathematics and the sciences. These have been described in Chapter 2 where we have discussed aptitudes and interests. Because this preparation for an engineering career does begin in high school, it is important that the prospective engineering student shall have rigorous and adequate discipline in his high school mathematics and science courses. If he has that type of "conditioning" in his high school courses he will be reasonably well prepared for the demands of an engineering curriculum. Some of the engineering colleges require an applicant to pass an entrance examination before he may be admitted. The typical requirement for his unrestricted admission is graduation from an accredited high school where his program shall have included the following subjects:

Subject	Units
English	3
Social Studies	1

Algebra	1½
Plane Geometry	1
Physics or Chemistry	1
Science	1
Additional work in above subjects	3
Other subjects	3½
Total	15

SUCCESS IN COLLEGE

Those who pursue an engineering curriculum will encounter many interesting experiences. There are hazards, too. Between forty and fifty per cent of those who begin engineering will complete the program and receive a bachelor's degree. Approximately one-third of those who fail to finish have scholastic troubles; the other two-thirds fail because of lack of interest, finances, health, conduct, marriage, and other personal reasons.

We will look at the causes of scholastic failures. One-half of them are chargeable to lack of ability and lack of interest; one-sixth to poor preparation; the remaining one-third to a group of causes, including lack of effort, too much time for self support, too much time on extraneous (sometimes extra-curricular) activities, health, and entrance conditions.

The significant lesson that a prospective engineering student may learn from these figures is that he should do his best to estimate his ability and interest before he begins an engineering curriculum. It is probable that a large percentage of those who failed to graduate in engineering because of lack of ability could have graduated in another curriculum for which they did have the aptitude and interest. These failures to graduate represent loss of a substantial amount of time and money as well as disappointment to the student. Perhaps he made an equivalent gain from the courses which he did complete, but he could have had more for his money in the proper curriculum.

A few students will fail in spite of their best efforts. Many fail because they lack the ability to adjust themselves to a new type of living. They need training in character development and need the will-to-do. The man who is ready for college is prepared for his college studies and for college *life*. He who would be successful in college and later must do these things: (1) make his own decisions; (2) steer his own course; (3) do his own thinking; (4) accept his responsibilities; (5) perform his daily duties promptly and regularly without having someone remind, urge, or order him.

Earning One's Way. Too much outside work in trying to earn their way while attending college has paved the way for the down-

fall of many earnest and well-meaning college students. It is creditable to earn one's way while at college. But carrying a normal engineering schedule is a man-sized job which requires approximately fifty hours per week — thirty in classroom and twenty at the study table. An excessive expense-earning program is apt to result in (1) inadequate class preparation, leading to low scholarship, which may bring a low quality point average and deferred graduation; (2) overwork; (3) no opportunity to participate in college life. So, in the end, the attempt to do too much may bring a "below-average" scholarship record or injured health, neither of which is necessary if one uses good judgment in planning his work program. The secret is moderation in all things.

It is well known that many college students fail during their first year because they neglect their studies. Some of these are the unwitting victims of their own inexperience. Others follow bad examples of older students who are "getting by." The engineering college is *different* from high school. The standards of performance are higher and more exacting and the amount of work (studying) is much greater. Yet that college work is not too difficult for those who are well prepared, industrious, apt, and systematic in their studying. The man who cannot determine when he shall study, what he shall study, and how he shall study will waste many precious hours. That is the reason for the following section, "How To Study."

HOW TO STUDY

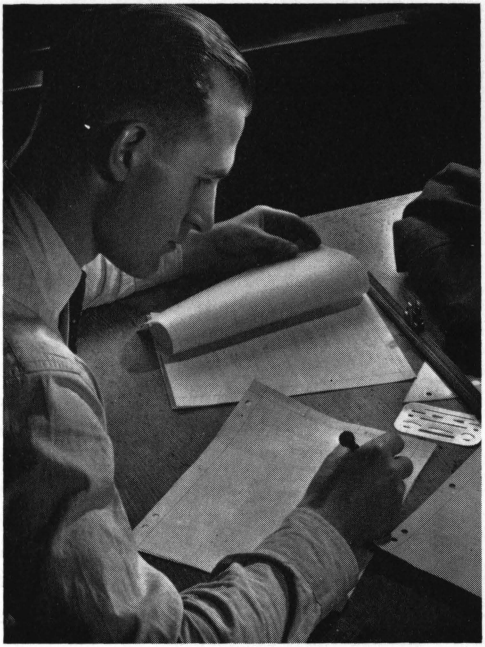
Good study habits are important because the study not only brings information for use at the moment but it also brings *mental habits,* which are likely to be *more lasting* than the information itself. The *right mental habits* are particularly important to an engineer because the study of engineering is intensive and aims at a mastery of fundamentals, the development of a point of view, and a systematic way of solving problems.

Physical Conditions of Study

1. The room should be clean, in good order, well ventilated, and at a comfortable temperature — not too warm.

2. Chair and table should be at the proper height for the individual. In general, study may be done best at a study table. Sitting in an easy or lounging chair usually leads to drowsiness and lazy thinking.

3. The student should be comfortably dressed for the night's study. Although brief and intensive study periods between classes



The engineering student and the practicing engineer have to make many calculations. This calls for good mathematical ability, the capacity to analyze and create, accuracy, and persistence.

are valuable, the engineering student will find that his most effective studying is done in his room after he has eaten a moderate evening meal.

4. The light should have the proper intensity and should be properly located. It should come to the student's book or paper so that there will be no shadows on his work. The purchase of a study lamp will prove a good investment.

5. Equipment should be good. Everything should be at hand and in good shape before study begins. Dull pencils, balky fountain pens, and inaccurate scales and slide rules are annoying and often are the cause of poor and incorrect work.

6. Avoid studying when fatigued, either mentally or physically. After a couple of hours of intensive study a few setting-up exercises or a walk around the block may help to regain the "second wind." Some students prefer to do all of their studying before going to bed; others prefer to rise early and study before breakfast.

7. In regard to conversation, remember that there is a time and place for everything. Some of the most pleasant memories of college are oftentimes associated with the gatherings in study rooms (familiarly known as "bull sessions"). But they can become most prodigal wasters of time. There is always a group of students who seem to have little studying to do, and others who are looking for excuses to defer studying. Frequently, these men make nuisances of themselves when they gather in the convenient rooms of men

who would like to study. This is a form of robbery, because they are stealing the precious study time of men who wish to work.

Study Aids

There are four aids that may be helpful in directing and concentrating one's attention upon the significant subject matter.

Underscoring key words and phrases makes the meaning of a passage stand out boldly. This is an aid during the intensive studying, and later during review. But promiscuous or copious underlining is worse than none at all because it obscures the words and confuses the meaning.

Marginal notes may be of two kinds: (1) supplementing or amplifying the text, (2) outlining the passage's meaning with a few key words, using words from the text or synonyms. The use of question marks, exclamation points, and "catchy" remarks should be avoided because their meaning or significance is sure to be lost at the next reading.

Outlining the subject matter of the text is a splendid although time-consuming way to gain a comprehensive view of the material. There are two advantages of an outline. The first of these is the thoroughness with which one learns his material, and the second is that in preparing an effective outline one must establish the relative significance of the various points of the text. An outline may be made on the margin of the book's pages. But to be fully effective it should be written in a notebook or on a blank page of the textbook, because the outline might not follow the text's sequence of paragraphs.

Briefing is a very valuable aid because to prepare an adequate brief, one must have a thorough understanding of the subject matter. A good brief is a very short summary of the substance of a chapter. Sentences of the brief should be complete in thought and structure in the student's own wording.

Every student should practice **note-taking** right from the beginning. Its value has been demonstrated many times. Engineering students do so much problem work that they are prone to overlook the importance of good note-taking in lectures. Some students argue that they can gain most from the lectures if they listen attentively without taking notes because, they claim, note-taking requires dual concentration. The weakness of their argument is that experience has proved that they cannot and do not retain the essential parts of a lecture without notes.

SUCCESS AFTER COLLEGE

At this point we need a different measure of success. All through the academic process we have measured success in terms of scho-

lastic grades. After college, on the job there are no such simple criteria.

What is success? H. G. Wells says that "wealth, notoriety, place, and power are no measure of success whatever. The only true measure of success is the ratio between what we might have done and what we might have been on the one hand and the thing we have done and thing we have made of ourself on the other."

Another idealistic conception of success is well expressed by "Success is persistent, consistent, systematic application to something worth while." Thus, anyone who sets up a legitimate and worthy goal in life and attains his objective is a successful man.

An editorial in *Mechanical Engineering* for September, 1931, expresses the thought nicely. It says: "How to acquire this powerful quality that is so important to success wherever human beings are concerned we do not know. If a man is not born with it in his character he quite possibly may never acquire it. If he does not cultivate it he squanders a precious heritage. If he does not realize its absence he is likely to be doomed to a thwarted and disappointed career should he attempt one in fields where such a gift is necessary. All in all it is a fundamental to be thoughtfully considered lest a lame man become soured and find life fruitless and unhappy because he cannot run a race."

There are two ways by which success is commonly defined and measured. One is the degree to which a man has achieved material competence, designated usually in terms of his salary or income; the other is the degree to which he has attained eminence in his profession. The first is the best known, most commonly used, and most easily applied of all criteria. It places the emphasis upon material success. The second gives somewhat more attention to spiritual values and tends to emphasize the professional and ethical aspects of success. Data on salaries are relatively easy to obtain. The degree of eminence may be determined by the judgment of one's contemporaries, usually through a questionnaire; inclusion in Who's Who books; a consideration of the special service rendered in one of the professional societies, as holding office and membership in standing committees; and service as a public or corporation official.

Factors That Determine Success

Much has been said about the traits or factors that are determinants of success. Several surveys have been made to find a quantitative answer. The oldest and best known of these surveys was made by C. R. Mann for the Carnegie Foundation in 1916. Later studies have agreed generally with those figures so we may as well look at those data.

He listed **six groups of traits,** as follows:

1. Character, integrity, responsibility, resourcefulness, initiative.
2. Judgment, common sense, scientific attitude, perspective.
3. Efficiency, thoroughness, accuracy, industry.
4. Understanding of men, executive ability.
5. Knowledge of the fundamentals of engineering science.
6. Technique of practice and business.

Returns from this questionnaire, which brought 7,000 replies, showed that the engineers considered the first four of the above group, the character traits, to have contributed 75 per cent to their success, and the last two, the technical traits, to have contributed 25 per cent. Of course, character is essential in any field. Furthermore, the significance of technical proficiency must not be discounted. A man cannot be an engineer at all without a good rating in the technical groups.

Scholarship. Probably a man's scholarship rating is the best single indicator of the range of his success after graduation. This is for the reason that the qualities which enable a man to make a good scholarship record are the qualities which operate to make him successful later.

Several surveys have been made to find, if it can be done, what factors during a man's college life seem to contribute to his success later. From these studies it is safe to draw the following conclusions:

1. No man can succeed without a good character. Without it none of the other traits can matter much.
2. Good scholarship, plus campus achievement, plus a favorable personality are important.
3. A man must be able to adjust himself to the environment of his home and his business.
4. He must have interest in and aptitude for the work which he has selected for his life work.
5. It is important that the organization for which he is working can offer rewards and opportunities which are in line with his fundamental motives.

Plato pointed out the significance of individual differences about 400 B.C. when he wrote that "No two persons are born alike, but each differs from the other in natural endowments, one being suited to one thing and another to another, and all things will be produced in superior quality and quantity and with the greatest ease when each person is engaged in a single occupation for which he is by nature best fitted."

Know thyself is the lesson for the seeker of success. Success is not a will-o'-the-wisp; yet it cannot be measured in absolute terms. Each man must take his own God-given qualities and weave them

into a harmonious pattern that will spell success for him. Scholarship, personality, and activities play important parts. Their relative importance will differ as people differ. There is no "most important."

SALARY AND SECURITY

Everyone wishes to have a good salary, and permanence, and security of employment. Perhaps too much emphasis has been placed on security. To some "oldtimers" it seems that some young men are so anxious for security that they are willing to sacrifice future opportunities, which seem to involve some risk, in favor of what appears to be security. However, salary is an impotrant item and the prospective engineer should know about salary scales.

The following tabulation has been adapted from a 1955 report on salaries conducted by the American Society of Civil Engineers.[1] The data are from 103 consulting firms and 7,070 engineers. The figures are annual salaries.

ANNUAL SALARIES FOR ENGINEERS, 1955

	Entrance Rates			Maximum Rates		
Grade	Median	Middle 50%	Total Range	Median	Middle 50%	Total Range
I	$ 3,920	$ 3,660 4,$20	$ 3,140 5,370	$ 4,570	$ 4,210 4,910	$ 3,770 6,220
II	4,480	4,250 4,810	3,600 5,710	5,380	4,970 5,820	4,210 7,270
III	5,110	4,530 5,580	3,770 7,130	5,920	5,500 6,620	4,630 8,840
IV	5,810	5,500 6,050	4,680 7,300	6,800	6,370 7,240	5,350 9,230
V	6,500	6,020 7,160	5,070 8,670	8,140	6,790 8,620	5,960 10,880
VI	7,400	6,630 8,450	5,480 10,800	8,880	8,240 9,850	6,800 13,820
VII	8,560	7,300 9,900	6,470 12,470	10,840	9,390 12,410	8,170 15,430
VIII	9,170	7,940 10,650	6,730 14,630	11,850	10,150 13,910	8,780 20,400
IX	12,820	9,810 16,130	9,230 19,380	17,620	14,810 25,780	11,380 37,600

[1] Proceedings of American Society of Civil Engineers, Vol. 81, Paper No. 761, August, 1955.

This tabulation has been arranged to give a wide range of information about salaries. The entrance rates and the maximum rates are given for each grade. For example, in Grade I some men began as low as $3,140 and as high as $5,370 per year. In the middle fifty per cent of the beginners the range was from $3,660 to $4,120 per year. The median, which is the middle (not the average) of any group of figures, was $3,920 for this middle fifty per cent. The striking feature of the salaries is the wide range between the lowest and the highest. Again referring to Grade I, we note that salaries in this grade varied from $3,140 to $6,220 per year. It will be noted, too, that there is an overlap in salaries from one grade to the next one.

These are professional grades adopted by the American Society of Civil Engineers in 1946, and based on professional grades of the U. S. Civil Service Commission that were designated P-1 through P-9 before 1949 and GS-5 to GS-16 after that date. "These classifications include all classes of positions, the duties of which are to perform operational, creative, advisory, administrative, or research work which is based on the established principles of civil engineering profession. The fundamental prerequisite for every position to be classified in these grades is professional, scientific, or technical training equivalent to that represented by graduation from a college or university of recognized standing."

"Grade I includes all positions, which involve, under immediate supervision, the performance of fundamental civil engineering duties requiring professional training but little or no experience (Federal GS-5)."

The successive grades call for increasing experience and responsibility to reach Grade IX.

"Grade IX includes all positions, such as

a) the administrative and professional head of an important engineering organization with full authority and responsibility for conceiving and executing all the plans and functions of the organization, directing an administrative and professional engineering staff engaged in varied important projects; or

b) positions requiring highly specialized professional engineering or scientific ability (Federal GS-16)."

There is a growing tendency in many trades and some professions to fix wages or salaries by some artificial means. This is done by controlling the entrance requirements or the number of entrants and the method of entrance of those who would join the group; or through the establishment of bargaining agencies that are powerful enough to use whatever means are necessary to enforce their de-

mands. Labor unions are the best-known example of the latter. There are active and aggressive groups who believe that engineers should become members of the organized union movement. Most professional engineers oppose that point of view.

Factors That Determine Salaries

Engineering salaries depend upon many factors, among which are: the type of industry, the prosperity and progressiveness of the industry, character of work, degree of skill required, supply of engineers, number of possible employers, standard and cost of living, hazards of work, regularity and permanence of employment, vacation and pension provisions, section of the country, professional growth of the engineers, and others.

It has been said facetiously that a man can put up with anything if he is paid enough. Actually, each man must determine the weight which he personally wishes to give to the several factors that influence his salary and living conditions. A surprisingly large number of men become unhappy, or imagine that they are unhappy, in a certain section of the country and express a desire to get back to "God's Country"; others wish to live in a small (or a large) city; others must be near kinfolks; others are bothered by the climate.

Leaving these more or less whimsical factors aside, there are some significant items that should receive consideration. The most important thing to remember is that in choosing an engineering career one chooses with it certain elements and conditions of employment. These have been discussed under the various departments and employment opportunities. We have mentioned the cost of living, which includes food, rent, clothing, and transportation. Another item is the permanence and the continuity of tenure. Some positions carry fairly high list salaries; but layoffs without pay, or a reduction in the number of working hours with a corresponding reduction in pay, are frequent. Some include vacations with pay; some include sick leave; some include bonus provisions; some include provisions for retirement. Environment, both working and living, will become increasingly important as one becomes older and has a family for whom he desires pleasant, healthful, and convenient surroundings.

In many cases, size of beginning salary is not the most significant item, because opportunities to advance will have greater weight, finally. This brings us to an important point which is overlooked by many men in their eagerness to get ahead. Present inconveniences and hardships form a substantial and solid portion of the foundation upon which permanent success is built. A young

man should be careful to avoid passing judgment too hastily, particularly in cases where his present job displeases him. He sees other men who seem to be doing better than he thinks he is. It would be enlightening for him if he could know what those favored (he thinks) men are thinking about their jobs.

Most salary studies agree that (1) the difference in earning power between highly paid men and men in the middle and lower salary ranges is strikingly great, and that (2) the higher salaried men are those who combine with their technical ability the capacity to handle independent businesses or to manage men or affairs.