

In so far as specific subjects of the curriculum tend to develop these personal characteristics in students they are useful and that group of subjects giving the best balance in equipment is the most desirable.

There is now general agreement among engineer educators that three classes of subjects should be taught: technical subjects, economic subjects and cultural subjects.

Technical subjects, based upon the physical, chemical and mathematical sciences, give to the student that introduction to professional practice required in order that he may become an engineer. The selection must be made to correspond to the probable range of employment of the average graduate and at the same time to enable the undergraduate, in democratic institutions at least, to earn a living and something more during the holidays. Limitations of time require that only those subjects in which the student most needs assistance shall be taught. Many reading or descriptive courses might, with profit, be left entirely to the student. In presenting those subjects which are given a place in the curriculum, the usual situations and problems should be given priority over the unusual. In the writer's opinion, much time is wasted in giving elaborate courses in higher structures to civil engineering students when only a small percentage of them will, as engineers, have anything to do with such structures. Let the problems that 70 or 80 per cent. of the graduates of an institution will be called upon to solve determine what is taught, rather than those with which 20 or 30 per cent. may occasionally be confronted. Fundamentals, not details, should prevail. Both cannot be taught in college and it is obvious which should give way. The attempt to give manual dexterity in field work, shop work or in routine testing is an anomaly in an institution for the training of professional men. Such is the work of a trade school.

Economic subjects, devised to reveal to the student economic laws and business methods, are being introduced for the sake of the increasing numbers who will find their life work in a combination of engineering and business. Attention should be given to organization, management, finance, business procedure, commercial law and accounting. There are, however, in the presentation of these subjects, the same difficulties as have been noted in connection with technical subjects, particularly the tendency to encumber the student with multitudinous details. The advocates and teachers of scientific management are especially culpable in this respect. If there is any science in management, surely it can be presented in a few simple principles and it is these that the student should hear about.

Cultural subjects are now generally regarded by those who have given study to the matter as not only a desirable but a necessary part of an engineering course. To attain the higher reaches of success, the engineer must be an educated and cultured man. No corporation, public or private, cares to trust large problems and delicate negotiations to an ignorant, unpolished representative with one idea, and that a technical one. Even if the student cannot see far enough ahead to cultivate "the durable satisfactions of life," he should realize that the shortest cut to failure lies through neglect of the things that put him at once in touch with educated men in other walks of life, upon whose favor his professional success will depend.

It is possible, of course, to so select the cultural subjects incorporated in the curriculum as to improve not only the general education of the student but his professional equipment as well. Expression, whether it be in speech or in writing, in his own tongue or in a foreign one, ministers

to both these ends. An acquaintance with literature opens, as Alfred Noyes has put it, "twenty gates to knowledge." Modern, and particularly current, history widens his horizon and makes him a citizen of the world. Sociology introduces him to public problems to the solution of which he should contribute his best thought and effort. In professional as well as in private conduct, a grounding in ethics is vital to him.

Already many institutions have given place to cultural subjects in their curricula. The Massachusetts Institute of Technology strives to carry instruction in English, in one form or other, throughout the four years. Third-year students must spend 45 hours in the first term and 75 hours in the second term on elective work in general subjects. These are arranged in four general options: Economics, English, Modern Languages and History. Fourth-year students may also be admitted to these options without examinations. Beginning with the next session, Columbia University will require for entrance to its engineering courses a three-year college course comprising instruction in English, Modern Languages, History, Philosophy and Political Science. In the new engineering courses recently established at the Johns Hopkins University, 24 per cent. of the total time will be devoted to general educational and cultural studies, comprising English, Modern Languages, Political Economy, Logic, Ethics and Psychology.

It is thus evident that a multiplication of the points of contact with life is the ideal of many engineering educators. Mr. W. H. Rayner, of the University of Illinois, has given effective expression to this view. Says Mr. Rayner: "I believe that it is more important for a senior to gain a good comprehension of present-day labor problems than to spend six or eight hours per week in detailing a plate-girder bridge; and, as an academic means to equip an engineering graduate for intelligent citizenship, it would be more profitable for him to consider the fact that between 10,000,000 and 20,000,000 people in our prosperous America are near the poverty line, and design measures of relief for them, than to design a gas engine."

Methods of Teaching.—Instruction may be imparted by formal or by informal means. The first is undertaken in lectures, recitations and laboratory investigations. The second arises through personal example, inspiration and advice in personal matters not covered by the curriculum. Increasing recognition is now given to the necessity for informal intercourse with students. Only in this way can the teacher really come to know the student and thereby reach and inspire him.

In formal instruction, the best teachers now apparently strive to (a) create and maintain interest in what is taught, (b) indelibly fix the fundamentals in the student's mind and (c) provide the student with means of self-help.

(a) Without interest, the student will carry little away from the class-room or the laboratory. How to develop it is the first problem of the teacher, and evidences are not lacking of earnest efforts to find the solution. For engineering students, there should be at the outset a consuming desire to become engineers and a willingness to make large personal sacrifices in order to do so. To create this desire, the teacher must present engineering in an attractive, if not a romantic, light.

Maintenance of interest is only possible by encouragement and frequent assurance of progress on the part of the instructor. The basing of new principles upon what is already known to the student is to him one evidence of increasing knowledge. The tacit inventory-making involved in tracing the inter-relation of subjects is another.