

## **Engineering Education and Engineering Ethics.\***

BY CHARLES DAY.

I judge that the men gathered here this evening are interested in engineering education and ethics principally in so far as they bear directly upon their daily work and after a few preliminary remarks I will confine myself to this practical view of the matter.

Mr. Fred Taylor in his revolutionary paper upon shop management gives the following qualities as necessary in the well-rounded man: brains, education, technical knowledge, tact, energy, grit, honesty, common sense, and good health. It should be the purpose of education to develop these qualities in a way that will prove most helpful to the community and, at the same time, to discourage tendencies that are opposed to this end. Certain of these qualities, the principal of which is technical knowledge, can be imparted to the student with comparative ease. On the other hand, little mention is usually made in the class room of other matters which the engineer finds, play such an important part in his ultimate success. The reason for this is that a ground work in the technical problems is of first moment, and cannot be properly covered in less time than is now provided in our engineering schools, and also that such qualities as common sense, tact, and integrity cannot be successfully imparted by the methods followed when teaching mathematics or alternating currents. The student has, of course, been told repeatedly the fundamental requirements for success; authors dealing with education and ethics have defined for us time and again codes of ethics; and yet we are informed by prominent employers that the graduate from the technical school requires one to two years practical work before he can be relied upon. The criticism is not that his experience is inadequate, for this is expected, but

that his mental attitude is wrong. So it would seem that he is lacking in a certain fundamental insight required of the successful engineer. I believe this condition can be improved through repeatedly bringing to the attention of the student the real motives governing our actions. We all agree without argument as to the technical and ethical standards that should govern our work; yet, upon analysis, we find our actions not governed, except in small measure, by their consistent application. The problem must therefore be considered as one of much greater breadth than the mere statement of a proper working code, if we hope to effect any real benefit to ourselves individually and our profession.

The advantages offered to the community by engineers are evidenced only through their accomplishment, which in turn is but the summation of innumerable decisions concerning all the factors involved. We are therefore vitally interested in the causes that prompt these separate opinions or decisions, for upon them hinges the worth of our work. The most hasty analysis must convince us that our actions are guided by two factors, namely, intellect and feeling, or, if you wish, logic and inclination. It is through our unwillingness fully to recognize the human element that we are led to believe that conditions can be so readily corrected in this or that field of endeavor. Herbert Spencer tells us, however, that but three tenths of the average man's actions are prompted by intellect or logic, and the remaining seven tenths are dominated by his feelings. In other words, we believe what we want to believe. Here, then, is the initial point to keep ever in mind. We do business with average men. We must gain their approval to accomplish results. But this requires, in addition to technical training which is the engineer's intellectual resource, an understanding of the more important part played by the inclinations and wishes of all concerned. It does not surprise those in charge of our technical

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schools to find that they who graduated the highest in technical matters may not be, in fact usually are not, the most successful all-round business men. It is a question, however, whether sufficient importance is attached to the need of hammering home, during the time the student is acquiring his ground-work in engineering, a realization as to just how great an extent his work is affected by purely technical knowledge. This can in large measure be accomplished by throwing the students in contact with instructors who are essentially business men and whose classroom stories unconsciously spring from the relation of the topic in question to working conditions, whether dealing with alternating currents or business methods. That it is difficult to secure such men is freely granted, and it is a matter of great pride to me as a Pennsylvania graduate to know that we have the influence of such a man dominating this splendid engineering school.

Before devoting a few moments to matters bearing more directly upon the practice of engineering, I wish to repeat a classification of engineers based upon their earning capacity, as it bears out forcibly the important part played in their advancement by matters not usually associated directly with engineering. These divisions are as follows: the mathematical engineer, the contemplative engineer, the rational engineer, the executive engineer, and the business man. The work of the mathematician is almost wholly logical and deals more exclusively with the matters taught in the technical school than does the other classes. As we pass down the list, engineering becomes less and less the dominating quality. As the engineer passes through these divisions, he unconsciously learns that accomplishment on his part is largely dependent upon his ability to direct the inclinations of others, and as this faculty becomes more highly developed it requires the highest integrity in order to conform with the broad code of ethics for which our profession must stand.

The phenomenal development which the industries of this country have undergone within the past decade has brought into existence, a number of concerns who are practising engineering along the most comprehensive lines. I propose to refer briefly to this particular field of work. We will assume that such concerns desire to handle from start to finish complete operations including industrial plants, street railways, power plants, etc. In order to serve their clients properly, their work should conform to three fundamental requirements, which tend to establish conditions favorable to our ethical standard. First, work should not be undertaken unless it is of understood utility. Secondly, the engineering organization must possess reasonable competency for its complete accomplishment. Thirdly, they must be adequately and surely compensated for services rendered.

The essence of service rendered by such an organization arises from the acceptance of the entire obligation incident to the operation, and will not permit a partial answer to any question. The motive from beginning to end must be the most efficient accomplishment of the client's needs. Everything must be taken into account. Service of this kind cannot possibly be rendered by an individual, nor can we ever hope to provide within a single organization men of the attainments required to reach the best possible result from the standpoint of all existing knowledge. In the main essentials, however, essentials which in the past have too frequently been given no consideration by the engineer, the client's interest can be properly guarded and the operation, considered as a whole, can be well handled.

Consequently, before undertaking the engineering details of a new commission, the reasons calling for the work in question should be carefully analyzed and discussed with the client, and it is in this regard that the engineer can frequently accomplish the greatest good. Such a course frequently requires the

complete abandonment of plans which would otherwise have involved the expenditure of many thousands of dollars, and in certain instances the new program will not require the services of the engineering firm. So here we find opportunity for adherence to the highest ethical standard. The engineering organization must not be satisfied to simply know how to solve engineering problems but must insist upon knowing why each move is made. Here again we find the logical part of the work subservient to the many matters requiring the consideration of men whose faculties have been developed along the lines referred to.

The matter of compensation should if possible, be finally adjusted before undertaking any work, and I think that the matter of ethics can be more surely benefited through attention to this than in any other way. We cannot deny the general conclusion that the mental attitude of our engineers depends largely upon the conditions under which they work. The rate of compensation for engineers who work upon a percentage basis has been established by those who have gained high proficiency in their line, whose volume of work and perfection of system secure a minimum of cost, so a fee that may assure a reasonable return to them, proves quite inadequate for the majority of those practising in parallel lines. There is very little consistency in the usual basis of compensating engineers and architects, and many of the evils connected with these professions arise directly from this cause. Such an engineering concern as we are discussing however, must not make this mistake, but must insist upon a fixed sum as profit, the amount of which should be known to the client before undertaking the work. Those who have once established a method of charge based upon actual cost of the work plus an agreed profit, find that they can secure the usual engineering commissions upon an equally favorable basis, and it would be well for the consulting engineers the

country over to appreciate this fact. Concerning the competency of the engineering organization that we are considering, much could be said. Having become assured that a given operation is of direct utility and having arranged a contract for handling the work that provides adequate compensation for services rendered, there should be little or no incentive to depart from the proper ethical course provided the necessary competency for the fulfilment of the contract exists. The moment this is not the case, however, the client's interests are being but imperfectly served, but here we encounter a nicety of judgment requiring a master hand, as the question of competency is entirely relative. This fact must, however, be ever kept in mind by the engineering firm, and they should stand ready at any moment to admit the need of calling upon the outside for further enlightenment.

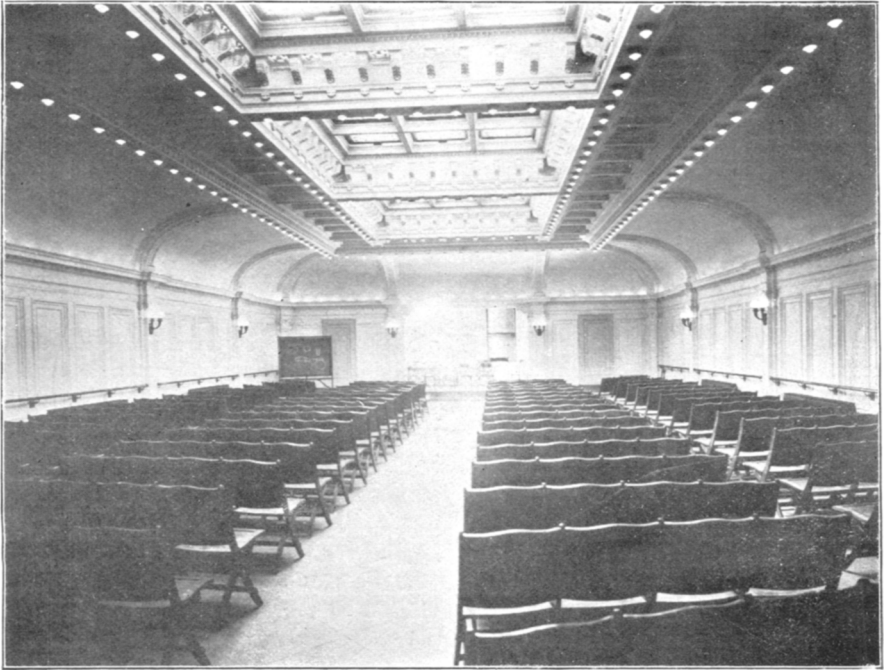
In fact, to render the complete service I have referred to requires that the organization in question not only comprise all the men required to handle the innumerable features incident to investigation, engineering and construction, but that they be in touch with many other sources of information which they may not be permitted fully to control.

When acting as an agent, the individuals of such an organization must not only be men of high integrity, but they must possess the power to analyze their own motives with a view to making them ever subservient to the needs of the client. Men possessing such ability can use it to the great advantage of those for whom they act, but the same ability applied for ones own interests (in the capacity of salesmen, for example) would probably bring results not compatible with the high ethical engineering standard we desire. Stated in other terms, the man most competent as purchaser through his ability to base decision on the essential facts, would be the first to appreciate the possibilities of securing approval through

the feelings, and would likely take advantage of this insight.

The services rendered by such an engineering organization, cover all construction as well as the engineering features, and in fact, this policy upon the part of the pioneers in this field is tending to rapidly elevate the standing of contracting work. Many of the ablest contracting firms now engage thoroughly competent engineers and the old

field of work so that it is but natural that such experts should be brought together under a single administrative head. This condition is also being greatly accelerated through the change in mental attitude of those among whom we look for our clients, it being now recognized by them that continued success requires that they take advantage of every possible means that will point toward more favorable operating



Auditorium, New York Edison Company, 44 West Twenty-seventh Street, New York, where the Institute Meetings have been held since September 22, 1905.

policy of treating the contractor with suspicion is rapidly giving way to the necessary spirit of coöperation.

Some years ago an engineer practicing in a consulting capacity could cover with a fair degree of thoroughness the varied propositions brought into his office, but this is no longer possible. It is acknowledged by all, that we cannot hope to attain competency in more than a comparatively narrow

conditions, and that but a small part of such assistance can be had within their own ranks.

Here then is a field of engineering that I feel sure is going to assume much greater importance as time goes on, and I further believe that a high standard of ethics will accompany its growth, as it is founded upon substantial principles requiring no concealment or subterfuge on the part of any one involved.

In conclusion I think I cannot do better than to quote from the recent presidential address before the American Society of Mechanical Engineers. According to Mr. Taylor, "We are now but on the threshold of the coming era of true co-operation. The time is fast going by for great personal or individual achievement of any one man studying alone and without the help of those around

### **Institute Meeting Halls**

The trustees of the United Engineering Society have decided that the assembly halls of the new Engineers' Building will be available for use in January. It appears probable therefore that the New York meeting announced for Dec. 28, 1906, will be the last held in the auditorium of the New York Edison Company at 44 West Twenty-



Library and Reading Room, New York Edison Company, 44 West Twenty-seventh Street, New York, where committee meetings have been occasionally held since September 22, 1905.

him, and the time ~~is coming when all~~ great things will be done by the co-operation of many men in which each performs that function, for which he is best suited. Each man preserves his own individuality and is supreme in his particular function and each man at the same time loses none of his originality and proper personal initiative and yet is controlled by, and must work harmoniously with many other men." - seventh street. Early in 1905 the use of this hall was offered to the Institute pending the completion of the new building, and it has proved entirely satisfactory. While it has been well filled on many occasions it has never been uncomfortably crowded. Every possible convenience necessary for the proper conduct of meetings has been provided, and the attendants have been willing and courteous. The Law Com-