Certain activities of a health department may be worth continuing for their educational value, although their direct utility may be questioned. Many topics need investigation in order to discover their real bearing upon the public health. Among these are such matters as the effect of a smoky atmosphere, the alleged nervous strain due to city noise and numerous important questions in the domain of food adulteration and contamination. Premature and drastic action by health authorities in matters concerning which there is profound disagreement among experts may cast discredit on other lines of activity in which there is and can be no difference of opinion.

For the present it seems worth while to emphasize more sharply than heretofore the distinction between public health measures of proved value and those that owe their existence to tradition or to misdirected and uninformed enthusiasm. Further study of the results obtained by certain of the usual and conventional health department activities is also much needed, and as a preliminary to such study the proper collection and handling of vital statistics is essential. It is poor management and unscientific procedure to continue to work blindly in matters pertaining to the public health, to employ measures of whose real efficiency we are ignorant and even to refrain from collecting facts that might throw light upon their efficiency.

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THE ENGINEERING SCHOOL GRADUATE: HIS STRENGTH AND HIS WEAKNESS[1]

So much has been written and spoken of late concerning the success or failure of the various engineering courses in our schools of technology that a reason should be offered for the introduction of this topic at this time. It is to be found, I think, in the general and increasing interest in these matters which is leading the practising engineers, the manufacturers, the men of affairs, in short, the consumers of the product of the engineering schools, to examine and evaluate the work of these schools. This interest has voiced itself more and more freely in the daily press, the engineering journals, and the occasional address. Some of the comments thus made are harshly critical, some are based upon sadly insufficient knowledge of existing conditions, but many are sane and helpful. It is the duty of those of us who are charged with the conduct of those courses to give heed to these utterances and to avail ourselves of the helpful counsel which many afford; but it is also a privilege which we may sometimes allow ourselves to present the case as it appears to us, and this anniversary occasion seems to suggest both retrospection and introspection.

The complexity of the educational problem is nowhere greater to-day than in the training of the engineer, using that term in a broad sense to include the man who applies his science to concrete ends, whether he be, for example, civil engineer, research chemist, or field geologist. The boundaries of all the sciences have been extended at a rate which has far outstripped any reasonable alteration of educational methods to meet these changing conditions; for, over against the charge of undue conservatism which is commonly made with respect to educational practises, should be placed the fact that seven years is the minimum period which must elapse before the ultimate success or failure of an educational experiment can be determined, and since the remodeling of a course or system of

[1] Presented before the Congress of Technology at the fiftieth anniversary of the granting of the charter of the Massachusetts Institute of Technology.

instruction to utilize successfully such of the newly acquired knowledge as it is possible to include must often be the result of gradually accumulated experience, it is plain that rapid and frequent alterations are both unwise and unprofitable. Such advances in scientific knowledge as, for example, those relating to wireless telegraphy, the turbine engine, or aeroplanes, which are of such immediate significance as to seem to imperatively demand a place in our courses of instruction, can not be allowed to displace other older topics of permanent importance, and in many cases these later developments of science are based upon abstruse principles, the proper teaching of which, in turn, demands much time.

The educational problem has, moreover, been rendered more difficult of solution by the concomitant increase in the number of men to be educated. It is no longer possible to give to the undergraduate that measure of personal attention from a mature teacher, of strong personality, which characterized successful teaching in the young manhood of our fathers, and resulted in the production of what may be termed "hand-made engineers." And, again, the increased ease with which our young men can now obtain educational advantages is sending to our schools a much larger proportion of students who, while they are earnest to a high degree and constitute a most desirable class of pupils, have not descended through generations of ancestors with scholarly or scientific instincts, and have not been surrounded by an atmosphere which is at all closely in harmony with that of the lecture room or laboratory. That most of these young men meet with success is the more to their credit; that some others meet with only measurable success in the scientific professions, and that distinct limitations, both professional and social, manifest themselves in the post-graduate development of some, is not surprising; but the cause is often mistakenly ascribed to faulty educational methods when in truth it is far more a question of raw material than of manufacturing process.

The product of the engineering schools has not escaped the universal demand that all products should advance in quality without increase in cost, which, in this instance, means with little or no increase in time expenditure. One needs only to review the conditions of the last quarter-century to realize that an extraordinary change has taken place in the position of the engineer in the community. None of the older professions have been called upon to face such kaleidoscopic conditions and it is not strange that there should be a dearth of men immediately adapted to meet the altered situation, or that many should be found to be partially lacking in the extremely composite training which would lead to complete command of the field. It may not be irrelevant to ask whether the so-called learned professions, so long regarded as superior to the engineering professions, would have fared distinctly better under a like extreme test.

The wholly successful engineer of the day (I do not speak now of the recent graduate) must be a man possessing a capacity for logical, quick and exact thought; a detailed knowledge of some portion and a broad knowledge of the whole of his professional field; and be master of a certain amount of the technique of his profession. He must have the ability to select and guide competent and trustworthy associates and to obtain from them loyal and willing service. He must be strong in his sympathies and generous in his public services, and while quick to enlist desired interest in his enterprises he

must be shrewd in detecting avarice or perfidy. He should be a loyal husband and father, and should find opportunity for that enjoyment of art and literature which will afford him present pleasure and ensure the happiness of advanced years. It is a matter for sincere rejoicing that the engineering profession has reached such a commanding position in our national life that only a man of this type can completely fill it; but the imperfect portrait just drawn is evidently that of a man for whom nature must have done much at the start, and toward whose efficiency many elements must have contributed. Of the need of such men there is no doubt, and it becomes a question of paramount importance to ask how far the engineering schools, as such, or, indeed, how far our entire educational machinery, can contribute to the desired end. The most obvious function of the engineering school is to afford a fundamental knowledge and understanding of the principles of the sciences underlying engineering operations. Failure to do this seems to be without excuse, yet it is almost inseparable from another important function, namely the development of the power to think (for there can be no adequate understanding of principles unless one can think logically in terms of them when considering concrete problems), and it is just at this point that much of the current criticism is aimed. The candid teacher must admit that there is truth in the charge that the graduates are too often lacking both in a capacity for logical thought and in an ability to command the knowledge which they actually possess to the degree needful for immediate or perhaps ultimate success in their vocation. But it should not be supposed that he is indifferent to this state of affairs. It is within bounds to say that it is the supreme desire of every worthy teacher to encourage power of thought rather than mere acquisition of knowledge on the part of his pupils and that he is constantly devising and testing new means to that end, but a moment's consideration will show you how much this depends upon personal contact —now so difficult in even the smallest practicable subdivisions of large classes— and will convince you that there must also be constant conflict of judgment as between the extent of the field to be covered in a given subject (rarely more than the minimum quantity now-a-days) and the time which can properly be spent in that drill which is necessary to develop the powers of the average student; for it is against the average student that the criticism is most valid. I do not make these statements to condone the conditions but rather to show you that the teachers recognize them, deplore them, and are striving against them, but the contest is an unequal one, at best.

Let it be remembered, moreover, that some responsibility for these conditions rests upon our public-school system, and also that the sort of thinking which the engineering professions demand is of a kind which is more exacting than is essential in the more common vocations, and that *no* system of education has yet succeeded in training a large proportion of exact thinkers, however much such a result is to be striven for. Let us also admit for our encouragement that, after all, there is a considerable proportion of our engineering graduates who *can* use their brains effectively and do have their knowledge in available form, and my observation leads me to believe that there is a much larger proportion who appear deficient in these respects at graduation who develop unexpected power when they have opportunity to concentrate their efforts in a more limited field. Remember that many of these youths have been in some sort of educa-

tional training for a continuous period of fifteen to seventeen years, during which there has been a constant (but sometimes unwise) increase in the pressure put upon them to cover more ground. Is it strange that they have lacked an opportunity to sort their immense stock, or to become familiar with it? They are, I think, entitled to charitable consideration for a time after entering their vocation, but if, as a class, they are deficient after three years, the criticism of them or of their training certainly becomes valid.

The public has a right to look to the engineering schools for sound instruction in fundamentals, including, of course, physics and chemistry, as well as the mathematics and drawing which must form a part of the equipment of every competent engineer. In addition, they may demand that the fundamental principles and something of the technique of those subjects which are of general application within a given profession shall be thoroughly taught, and that this shall be done with reference to development of power and the inculcation of useful habits, rather than the mere acquisition of information. While this is a demand which no engineering school would desire to evade, let us recognize that it is, of itself, no light task to accomplish.

But in our epitome of the distinctly successful engineer of maturer years was included *breadth* of knowledge within and without his profession, the quality of leadership, which means power of initiative and a knowledge of men, and the ability and inclination to fulfill the requirements of good citizenship. Are the graduates from the engineering schools, as a class, in line to develop thus symmetrically? Let us admit again that many are not and that that is the occasion of the general charge of "narrowness" and inadequacy which is directed against our courses. But here again I venture to assert—not, however, in a spirit of complacency—that the situation is more complex than is generally admitted, and that there is a good deal that is encouraging in the situation. Recall once more how short a time it is since the engineer has occupied a position in the community which is recognized to be of equal dignity with that of the so-called learned professions, and recall how recent is that evolution of our industrial system which has as its most important feature the recognition of the fact that the engineer and the financier, if not combined in the same individual, must be on a parity with respect to influence and authority, if efficiency—the watchword of the hour—is to result. Is there not cause for congratulation that some have been found in the engineering ranks capable of meeting this surprising increase of responsibility rather than ground on which to pronounce the general result of engineering education a failure, as some seem inclined to do?

It is well known that the Massachusetts Institute of Technology endeavors to stand to-day, as it has from its beginning, for the largest measure of breadth of training and education which is compatible with thoroughness of fundamental scientific instruction. An inspection of its courses as prescribed for the various professions shows that, notwithstanding the pressure resulting from the growth of science and technology, about one eighth of the total hours which a student spends at the institute is devoted to subjects which are cultural studies, using that term to distinguish them from those scientific subjects which may be regarded as tools of trade, although many of these, notably such as physics, chemistry, biology or modern languages, if properly taught, will contribute much to the cultural development

of the well-rounded engineer and the useful citizen outside of his strictly professional field. In this respect the institute has been a pioneer in engineering education and its founders took a position far in advance of the times. Nevertheless the Institute has not escaped the charge of narrowness and this has sometimes come, alas, from some of her own sons who were not over-zealous in availing themselves of the opportunities actually offered during their student days. More specifically, as has already been implied, it is charged that the graduates from engineering schools are not as a class showing themselves capable of development into men who can occupy successfully the commanding positions already described; and again the institute is not exempted. So far as this charge relates to breadth of view within the professions it is the immediate and vital concern of these schools. So far as it relates to those traits which go to make up the accomplished man of affairs it is serious, and demands earnest attention, but the remedies are less obvious; for these remedies must mean the superimposing upon an already heavy burden, a task which should be begun in the home and largely completed there; a task, indeed, which no college has satisfactorily met with respect to all of its professional or non-professional graduates. So far as books can help, an added year of student life would seem to afford a remedy and there has been much discussion of the desirability of extending the undergraduate course to five years, and of making the engineering schools graduate schools. The arguments can not be reprodueed here, but it seems clear that the added expense incurred and the increased age at which the young man enters his life work, militate seriously against the adoption of either of these as a universal procedure. For those to whom such opportunities are open they are likely to prove of great value, and it is interesting to note that each year seems to bring to the engineering schools a larger number of young men who have already graduated from some college, and encouragement is also to be found in the fact that more and more of these men have planned their courses during their college years with reference to later work in the technical school, a procedure which is much more to their advantage than what Professor Jackson refers to as a "butt-joint" between a general college course and a later engineering course. It should also be remembered that this is a recent educational development and that these men have not yet been tried out.

One serious difficulty which technical schools are encountering has been frequently referred to by recent writers, but deserves a mention here, namely, that of securing and holding broad, cultured teachers. Specialization has seriously invaded the teaching profession, especially in scientific lines where the mastery of any large field of knowledge to a degree corresponding to the needs of the expert is rarely possible. The specialist is apt to use the microscope far oftener than the field glass and this habit is partially reproduced in his students. It is encouraging to note that certain schools are now recognizing the need of men who are efficient teachers with a broader outlook, to deal especially with the younger men. They are recognizing that not every eminent specialist or successful investigator is a successful teacher, more particularly in this very matter of breadth of view, and are leaving the specialists greater opportunity for the presentation of their specialties to the older classes, while improving the instruction in the more general courses. It is obvious that these difficulties are enhanced by the larger financial rewards which tempt the broad-minded

engineer away from the schools—a serious matter which can not further be discussed here but lies close to the root of much of the cause for criticism. It is interesting to note how even a single instructor, who keeps himself and his pupils closely in touch with current events, and leads them to understand that no single human attainment, however complete or final it may appear, necessarily represents the best that can be done, and that it may well be the privilege and the duty of any one of his hearers to extend the boundaries of such attainment, will give an impetus to successful effort that will be felt in the entire lives of his pupils. It is to be hoped that no one of us is unable to recall with gratitude some such instructor. We need more of them. A single instructor, again, who exemplifies the cultured scholar and gentleman in ease of manner and grace of diction does more for the cause of scholarship and culture than any quantity of sound advice can do; for, I fear that it is utopian to hope that a majority of the students with whom the study of engineering is the main purpose will ever believe that any man is disinterestedly sincere in his advice regarding such subjects as literature, language, art or economics, unless he makes it quite clear to them that these subjects have a distinct significance to him and are a part of his life. Just here lies one of the great obstacles to the elimination of "narrowness."

If the inculcation of breadth of view and love of the refined in life is difficult, the development of qualities of leadership is even more so. That these qualities are largely conferred at birth will, I suppose, be generally admitted, but I take it that the criticism of lack of leadership is really directed toward an alleged culpable lack of facility in getting the best from others, of appreciating the point of view of others, or of presenting our own views to others. If this indicates a failure on our part to stir the ambitions of our students to avail themselves of opportunities which come to them, or to plan for themselves a really worthy career, then we are at fault; but if it means that the faculties of engineering schools should further encourage those forms of activity commonly designated as "college life," then I believe that we are on debatable ground. Of the importance of those traits which enable a man to win the confidence and respect of his fellow men, to "succeed" among men, no one could be more conscious than I. In individual cases they may indeed be more potent factors than accuracy of scientific knowledge in securing preferment, and any man is fortunate who combines engineering skill with ease of manner and persuasive speech. But the real function of these schools is, after all, the training of capable engineers and it is very easy to pass the line beyond which there is grave danger that both the quantity and quality of individual attainment will be lowered because of time and energies devoted to social affairs. By all means let the schools realize their responsibilities for the development of men as well as engineers, and encourage by precept and especially by example an interest in all that tends toward a better understanding on the part of our students of their human relations, including prudent encouragement of the so-called "student activities." But let those who lack a realization of the great changes which the student life at our technical schools has already undergone in the last few years, and who therefore constantly clamor for more of what is called "college life," reflect that one of the greatest assets which a graduate from one of these schools can take with him when he leaves it is the well-established habit of "doing a

day's work in a day," of meeting his obligations on time, and let him realize that this can not be reasonably demanded if the instructors must in fairness accept excuses because of an undue diversion of time and energy to other things. Although the sciences actually owe many of their advances to "grinds," it is probably fortunate that few of our engineering graduates of to-day belong to that class; but there is little likelihood of an undue increase in the proportion of such over-developed scholars under existing conditions! An impartial survey will, I believe, show that our recent graduates are, as a body, less open to the charge of lack of adaptability, and want of social resources than formerly and that they are improving in this respect as the need of such improvement is more generally realized, and also that there is ground for the belief that this has so far been accomplished without serious sacrifice of professional efficiency.

In what I have just said I have had in mind particularly the business and social relations of the young engineer with his colleagues and superior officers. It is often stated that some or many of the graduates also lack an appreciation of the proper way to deal with those whose labors they must direct. This, again, is doubtless in some considerable measure true, and in fact it can hardly be otherwise when nearly all of these young men pass directly from the public schools to the higher educational institutions. It is not, however, true that no effort is made to bring this phase of their future responsibilities to their notice, for not only is the subject discussed in its general aspects from the lecture platform, but the young men are advised to secure summer employment as far as possible to the end that they may learn to know industrial conditions.

In this connection I should like to point out to those in control of our industrial establishments that there is a large store of energy, combined with a desire for opportunity to work and ability to render intelligent and willing service, which goes to waste in the summer because our students are unable to secure temporary positions. This is particularly true in the industries into which the men in whom I am especially interested, the chemical engineers and chemists, will go. I am, of course, aware that the net return in value to a concern from this temporary service is not relatively large, especially during the first summer, and that in certain industries there is a risk in trusting to the integrity of these men with respect to information acquired regarding operating methods. But I can not avoid the conviction that if the industrial managers would cooperate with the engineering schools in the consummation of an arrangement whereby young men whose ability and character could be vouched for could be given summer employment for two or three of the successive summers intervening during the four years of study, the concerns thus cooperating would actually find that they would derive appreciable benefit from the plan. That it would enable the schools to add at least fifty per cent. to their efficiency so far as these students are concerned, I have no question whatever, and surely no better means could be afforded for the acquisition of a knowledge of the problem of the laborer in the works. Let me add that I do not urge the placing of these young men at once in positions of responsibility but rather in such positions as will afford them working experience under industrial conditions. It seems to me, however, that it is not improbable that, say, in a third summer the majority of such men might be utilized to much advantage in the immediate direction of specific processes or operations,

they themselves acting under general or specific direction.

Some of us are just now concerned to know how with respect to chemical engineering we can give the young men an opportunity to come into contact with the actual practise of their profession before they leave the school, and the advisability of the equipment of laboratories of chemical engineering is under careful consideration. While it is no doubt true that, from its nature, chemical engineering offers less abundant opportunities for industrial work during the vacation interval in a student's career than many other professions, notably less than civil engineering, and at the same time is a profession the actual practise of which it is exceedingly difficult to reproduce in an educational plant, I suspect that similar general conditions exist in other lines. Here, again, is a problem with no small dimensions or importance with which we are wrestling, and one step toward its solution may be made through the greater cooperation on the side of the industrial managers for which I have just appealed.

If I have dwelt more upon the alleged weaknesses of the engineering school graduates than upon their strength, it is because the latter is attested by the engineering advance of the recent past to which they have contributed to an extent which would not have been possible had not the majority of them received from the schools an education and training which has proved useful, dependable and stimulating.

I believe that the large majority of the engineering school graduates are virile, intelligent, industrious fellows, with sound habits of thought and great capacity for work, ambitious to make the best of themselves, possessing a sincere desire to acquit themselves honorably, both in private and public life and with an increasing ability to do so. As such, we, their instructors, honor them and ask your cooperation, advice and encouragement in our efforts to give to them what they deserve at our hands. We ask you also to recognize that while for the moment the rapidly changing social and industrial conditions may have outrun our ability to adapt our educational practise to them, we are not lacking in an appreciation of the significance of these changes, or of our obligations for the future.

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CHRISTIAN ARCHIBALD HERTER.

The death of Dr. Herter on December 5, 1910, terminated a life of only forty-five years, a life which had been rich in endeavor and was synonymous with the conception of intellectual cultivation as the happiest outcome of temporal existence.

Dr. Herter graduated from the College of Physicians and Surgeons in 1886 at the age of twenty-one and in the same year married Miss Susan Dows, who throughout his career sustained him with sympathetic power and intelligent appreciation of the value of his work. After graduation he studied with Welch in Baltimore and with Forel in Zurich. He then began to practice medicine, specializing in the diseases of the nervous system, on which subject in 1892 he published his first book. His mind, which was ever active, did not permit him to receive his knowledge through second-hand sources, and in 1893 the upper floor of his house was converted into a series of laboratories in which work could be accomplished according to his liking. It was the beginning of the "Laboratory of C. A. Herter," the contributions of which are known throughout the world. To appreciate the significance of all this, it should be remembered that with the exception of the work in the pathological laboratories of the colleges, the work of the board of health, and the work done by Dr. Meltzer, there was practically no scientific