SCIENCE

FRIDAY, JUNE 10, 1921

MSS. intended for publication and books, etc., intended for review should be sent to The Editor of Science, Garrison-on-Hudson, N. Y.

INAUGURAL ADDRESS [1]

THE institute, like every other educational enterprise, has its individual problems and needs, but these I do not yet sufficiently understand to make a public discussion of them profitable to anybody. What I shall say, therefore, bears on technical education in general without reference to the separate needs of this or any other school.

I

Many of you who have lately become familiar with Mr. H. G. Wells's interpretation of history will realize new significance in the fact that children are born into a world that is already old. For many thousand years before our generation men were experimenting with Nature, with social, economic, political, and religious ideas and practices. Our civilization to-day is the forward-borne product of this slowly and painfully acquired experience of the race.

The whole educational process, broadly seen, is the problem of putting our young people in touch with the more outstanding results of this age-old accumulation and of giving them exercise in the most direct thought processes by which this experience and knowledge have been acquired; processes by which experience and knowledge may be enlarged and extended.

The education of boy or girl, therefore, consists in bringing them up to the present day, so that they can enter independent life as useful thinkers and doers in the world as it is. Dreams of what the world ought to be are not only stimulating but indispensable to human progress, but each generation must begin building on the world as it finds it.

Expressed otherwise, our educational effort

[1] Given by Dr. Ernest Fox Nichols on the occasion of his installation as president of the Massachusetts Institute of Technology.

is directed to give a young man of intellectual interests and possibilities the main features of his racial background and especially to acquaint him with the best and most significant things which have been thought and done in the world, so that at maturity all new things which present themselves to him, he can in some measure appraise in their relations to this background.

I know no better measure of a man's real education than the adequacy of his thought and action in whatever actual situations he may find himself, for adequacy of thought and action imply some hold on world experience. Our daily use of the phrase "common sense" has no other meaning.

Vital possession, conscious or unconscious, of this world background enables a man sanely to face and interpret reality. You rarely find such a man seriously occupied in chasing rainbows or fighting windmills. His chief mental characteristics ars breadth, balance, sanity. To train such men and women should be the dominant ideal of the educational process. How often and how far, alas! do we fall short of attaining it.

Mr. Chesterton's recent amusing raillery at "The ignorance of the educated" would lose none of its charming humor and would gain in truth and pungency if he changed his title to "The ignorance of the half educated." These are the really dangerous men, for they are facile of speech and wholly unaware of their intellectual limitations. By contrast the adequately educated man knows always just where he stands. Ought not an engineer to know enough of philosophy and its uses not to be misled into dogmatizing upon its technical intricacies: and should not a philosopher be taught enough about bridges and dynamos to be satisfied with dwelling on the broad scientific principles they illustrate without venturing to criticize minor details of construction?

Education interpreted as a background builder is far wider than the schools and stretches endlessly from the cradle to the grave. Yet a careful scrutiny of the course of individual development shows that in the latter half of the period of adolescence, say from eighteen to twenty-five years of age, lie the strategic years of education. It is in this period that wisely directed teaching can do most to integrate and interpret this background, do most to give it unity of form and grouping, color, symmetry, and depth. During this formative period no great department of human experience can be safely ignored, if our purpose is to train adequately educated men and women.

The department of human experience and action on which the major emphasis shall fall is a matter wisely left to the individual preference, aptitude, and taste of the student. In schools of technology this emphasis falls naturally on the study of science. But studies in science can be made as narrow as can studies in philosophy and the arts. Narrowness of outlook, always a major defect in our efforts at education, we must strive unceasingly to avoid. All fields of knowledge and experience form a whole, and, in our teaching, their vital interdependence must be most clearly emphasized.

With his characteristic grasp of essentials, President Nicholas Murray Butler has stated these traits of the educated man: (1) Correctness and precision in the use of English; (2) refined and gentle manners; (3) power of reflection; (4) power of growth; (5) sound standards of feeling and appreciation; (6) the ability to do efficiently without nervous agitation. To these I venture to add yet another trait of the *usefully* educated man: Power to marshal the world's experience in at least one field, and to use it effectively for further constructive achievement.

Engineers have, surely, the same broad, educational rights and responsibilities as other professional and non-professional men, yet, amid the growing complexities and perplexities of technical education there has been, and is, a steady and strong temptation to introduce more detailed technical courses at the expense of other background building studies. This temptation, weighty as are the arguments for yielding to it, must nevertheless be steadily and firmly resisted. The problem of modern technical education is indeed most intricate and difficult, but other solutions must be

earnestly sought, for we can not afford to sacrifice the breadth of a man to create a too narrowly efficient machine.

II

When President Maclaurin said "A technical school was not doing its whole duty unless it kept in the closest touch with industry," he spoke the minds of many thoughtful men.

The two outstanding industrial problems to-day are: (1) The more intensive application of scientific knowledge and research to the processes and products of industry; (2) the cultivation of more understanding and wholesome relations between labor and management. Both of these problems may rightly claim attention in any modern scheme of technical education. On each of these questions I wish to speak very briefly.

Of scientific research there are two more or less distinct types. Both embody the genuine spirit of inquiry; both use the same tools and instruments under similar laboratory conditions. The essential difference between them is not in method but in aim and intention. In applied science research, the controlling purpose is to reach a definite and predetermined result which can be immediately applied to the material profit, convenience, or comfort of man. In pure science research, the only purpose is the discovery of new knowledge without thought of any material benefit to anybody. The fundamental discoveries from which applied science gets its raw material for useful applications come out of the pure science laboratory. That you can not apply knowledge you haven't got needs no proving.

Take any familiar application of science you choose, and one, two, or at most three backward steps bring you to the pure science laboratory where the fact or principle employed was first discovered. Sir J. J. Thomson has said in substance, "If you want improvements in industry, you may turn with confidence to applied science. If you want to revolutionize an industry or create a new one, you will do well to search the innermost recesses of the pure science laboratory." The difference between the man of theory and the practical man is one of suggestiveness and scope.

Applied science research in the modern sense is of comparatively recent origin. What we now call pure science is centuries older. At its beginning, therefore, applied science had the accumulated results of centuries of pure science to draw upon, but, due to the brilliantly amazing progress of applied science, that surplus in many fields is nearing exhaustion.

With depleted reserves applied science must soon face one of two alternatives. Either it must descend from its past and present rapid succession of great achievements to a more modest hand-to-mouth existence, reworking old ones and consuming next year whatever pure science, at its present working rate, may discover this; or else the hosts of pure science research must be vastly strengthened, and the volume of their yearly output many times increased.

That some of our more progressive industries already realize the situation is amply proved by the very rapidly increasing amount of pure science research issuing from the research laboratories of our optical, chemical, electrical, and other highly developed industries.

Under these circumstances technical schools owe to modern industry the more intensive cultivation of research with increasing emphasis on pure science. Every possible means should be used to train up more men in pure science, men competent to enter the fruitful and important field of research, to supply the rapidly increasing demand for workers in the fast multiplying laboratories of progressive industry.

In every fruitful cooperation between technical education and industry, our schools should be prepared to give more than they receive and to lead, not follow.

III

Under the present organization of our largest industries the conscious responsibilities of real ownership have become somewhat vague. Industrial ownership to-day is widely diffused

and dispersed. Shares of ownership are bought and sold daily by hundreds of thousands. Certificates of ownership are often regarded by their holders more as sources of income than as symbols of responsibility.

As a working plan the rights and duties of ownership are delegated to boards of directors, and the active management of our industries rests in the hands of employees. Thus the older distinction of employer, meaning owner, and employee, meaning workman, has largely ceased in our largest industrial corporations. All are essentially employees but of two distinct classes, brain workers and hand workers. The brain workers build up, maintain, and manage the business, and direct the hand workers, as brain directs hands in the individual, with this important and sometimes vaguely realized difference, that the hands in this case are not instruments only but independent thinking, feeling personalities.

The older or traditional attitude toward labor unrest was that the questions involved were purely economic questions. More thoughtful and more widely informed people, and there are many of them, feel that the problem is not so simple, but involves many additional elements, chiefly those which enter into all human relationships.

Purely for the sake of illustration, let us take the case of a not uncommon type of workman who becomes dissatisfied with his job. He feels little or no loyalty to the business nor to the foreman or manager who personifies it. He understands neither the manager's work in relation to production, nor the manager's pay.

There are further enviable differences between the manager's apparent freedom of action, his more comfortable working surroundings and those of the laborer. The laborer fails to realize the economic reasons for these differences. The manager in his sight produces nothing, hence the laborer doubts in his heart the importance of managers and higher officials in general. From his warped outlook, wages would be higher if these men who meddle, but do no real work, were removed from the payroll.

Thus he feels little respect or liking for the management. The manager may also seem lacking in respect for a sour-tempered operative. The motives behind the simplest manifestations of good will may be misconstrued and distrusted. Thus a mutual economic necessity is the only binding material which holds these two together, and each chafes at the bond.

Dissatisfied, the laborer shirks and hates his employment which, in this mood, is without human appeal or interest for him. Furtively shirking, he loses some of his sense of personal dignity and much of his self-respect. Sooner or later, as circumstances favor, he will try to regain a feeling of self-importance by trying with others who are like-minded a concerted conflict with the management in the form of a strike.

If the strike is won, the worker feels his course justified, his conduct approved, his self-esteem in a measure restored. If lost, he returns to his work liking it and his superiors none the better, only to wait sullenly for another trial of strength.

The laborer's indiscriminate and integrated discontent he is likely to attribute to the specter called capitalism. Capitalism is, therefore, his enemy. This monster he attacks in the one spot where he believes its nervous system is centered—its purse. To the agitator of disorganization this mass of accumulated and unsorted discontent is his one great opportunity, and we know he is quick to make the most of it. To the typical proletarian, not the least of the attractions of a world-leveling-down program is the removal of the people he believes respect neither him nor his labor.

This brief view of the tangle of disorders and misconceptions, which may arise in a workingman's mind, shows mental states of by no means infrequent occurrence.

Now the true essence of successful industry is mutual respect between employee and manager, willing cooperation, a sense of mutual opportunity and responsibility, and a shared personal or institutional loyalty. But these factors are human rather than economic. Economic necessity alone is not only powerless to

create them but oftener operates to weaken or destroy them.

Human relationships in industry we have now and always have had, and, whether recognized or not, they have caused quite as much trouble as purely economic conditions, for the state of a laborer's mind, more even than the state of his purse, determines his acts.

No industrial question is of greater importance than human relations in industry, and none is more complex nor baffling. Yet no pains can be spared, or are being spared, to find remedial measures. Many hopeful schemes for a better human organization of industry have been suggested and are under trial, some fortunately with encouraging promise.

The dominant bearing of this discussion on technical education is this: Our technical schools are training the future brain workers and managers of industry. We may, therefore, well ask ourselves, at this time, if there is anything we can do beyond what we are now doing to train our students to understand more fundamentally and to meet more successfully the gravest of all their future repsonsibilities, the organization and management of men. A responsibility which they and we owe, not industry alone, but the whole economic, social, and political stability of the nation.

ERNEST FOX NICHOLS

SCIENCE AND COMMUNITY TRUSTS

THE Research Information Service of the National Research Council recently compiled available information about funds for scientific research. It appears that there are hundreds of special funds, trusts or foundations for the encouragement or support of research in the mathematical, physical, and biological sciences, and their applications in engineering, medicine, agriculture and other useful arts. The chief uses of these moneys are prizes, medals, research scholarships or fellowships, grants, sustaining appropriations, and endowments.

So numerous have been the requests to the Research Council for information about sources of research funds, availability of support for specific projects, and mode of administration of particular trusts or foundations that the Research Information Service has created a special file for this information which it is proposed to keep up to date for the benefit of those who may desire to use it. Furthermore, in order to give wider publicity to the immediately available information, the Council has issued a bulletin under the title, "Funds available in 1920 in the United States of America for the encouragement of scientific research." This publication has been distributed widely to American scientists and to those who are interested in furthering the development of science.[1]

In the course of search for data on research funds, it was discovered that some of the recently created community foundations or trusts control funds which may be used, at the discretion of their distributing boards, for scientific surveys or for research. If the resources of community foundations be added to the funds at present listed by the Research Information Service as primarily for research in the natural sciences, the total approximates five hundred million dollars. It is estimated that for the encouragement and support of scientific research through medals, prizes, grants and research scholarships and fellowships, between forty and fifty million dollars is spent in the United States annually.

The "community trust" idea is of peculiar interest and significance in this connection. In the year 1914 certain wise and far-sighted citizens of Cleveland decided to organize for the benefit of the community a trust to be known as the Cleveland Foundation. This, the original community trust, has grown to a fund of approximately one hundred million dollars, either given or bequeathed. Following the lead of Cleveland, more than forty other American cities have organized similar trusts, primarily to assure greater security of principal, flexibility in the use of income, and prevention of obsolescence.

[1] Inquiries concerning research funds should be addressed to the National Research Council, Information Service, 1701 Massachusetts Avenue, Washington, D. C.