industries. Industry needs to recognize its own interest in selling research to a selected few young men, especially among its own employees. Industry needs to send selected men, of clearly indicated ability, back to the graduate schools for further preparation. Both the industries and the organized profession have a duty to make it possible for men of high creative abilities to remain in professorships without undue sacrifice of financial and professional opportunity. American schools of engineering enjoy an unparalleled freedom from outside regulation, but suffer from being left to fend for themselves in the face of conditions such as these. As a representative of the schools, the speaker yields to none in the frank criticism of their defects, but he wishes to assert that the engineering profession and the technical industries have received as much as they have deserved at the hands of the colleges, and even more. Without a heightened sense of responsibility on the part of these bodies and a more effective collaboration between them and the schools, there is little prospect that the defects will be mended.

W. E. WICKENDEN

THE DOCTOR OF PHILOSOPHY AND HIS BUSINESS[1]

IN the few minutes at my disposal let me offer some observations on two topics: (I) *The business of making a doctor,* and (II) *The doctor's business after he is made.*

I

And let us observe that the business of making doctors is one of the major industries of our country, a flourishing business. It is worth noticing that in our 576 colleges and universities the value of plant—that is, the value of buildings and grounds, of libraries, laboratories and material equipment—stands at over two billion dollars, and the annual budget for maintaining graduate education is well over $350,000,000. In these half a thousand institutions, over 150,000 graduate students are under discipline, and about 20,000 graduate degrees are awarded each year.

But this great industry is a young one in this country. Yale University, one of our oldest, conferred its first Ph.D. in 1861, and its list of awards at the present moment stands at 1,374.[2] Our own university, one of the youngest, has given, up to the close of the present academic year, 2,134 Ph.D degrees[3]—and all these since I first came as a student to the campus.

[1] Address at the annual luncheon of the Association of Doctors of Philosophy of the University of Chicago.

[2] *School and Society,* June 2, 1928, page 656.

[3] F. J. Gurney, Recorder, University of Chicago.

Not only is this business of making Ph.D.'s one of the major industries; it begins to look as though we were taking on the airs of mass production. But our task, though expressing itself in large figures, is not so simple as a major *commercial* industry. Our program can be stated as simply as the engineer states the business of making automobiles. In an automobile factory there must be: (*a*) an establishment of standards; (*b*) the machining of raw material into finished form, and (*c*) the grading of product.

But the engineer's problem is simple. The raw materials are uniform in quality. One bar of steel is like the next bar of steel. And though standards of accuracy read like fiction—the dimensions of shafts and bearings, for example, must be true within a tolerance of error of 1/4000 of an inch—there is no serious problem in obtaining uniformity of product.

Our business, the business of the staff, is likewise the establishment of standards and the grading of product—but our problem is not at all easy. Our material—men and women—is far from uniform. Individuals vary widely:

(*a*) In native ability. The Lord did not make them equal in any way. There are geniuses, and mediocrities. And the genius is usually a lopsided individual. He may be quite as marked in deficiencies as he is in excellences, when he is brought up before any set of standards.

(*b*) They may vary widely in preparation and training for the work we have to offer. Often their training has been haphazard and incomplete.

(*c*) They will vary in their response to discipline. Some are young and flexible, others have come late to their advanced work, and in some people the intellectual skeleton begins early to ossify.

And so, although we may establish ideal standards of accuracy, of competence and of refinement, it is hopeless to expect equality. We may not expect it in either rate of growth or in performance or in ultimate power.

To get this complicated raw product milled into a quality which may some day bear the label Ph.D. the seminar is established, and before the seminar the candidate brings a part of his prepared work to be criticized by the entire group. But good as this discipline may be, it is time consuming, and in a large group the individual candidate has a slender chance of having his own particular shortcomings brought home to him for elimination or amelioration. Individuals can not be ground effectively *en masse.* They require *individual* attention.

An eminent professor in Columbia University told me some years ago that he had twenty-seven candidates for the doctor's degree working under his sole supervision at one time. That is "mass production"

with a vengeance. Frankly, it can't be done. There are not hours enough in the working day to do it, if it is done individually, as it should be done. Almost up to the present moment, the administration has expected an instructor to do full work in class instruction and to take on the special training of Ph.D. candidates on the side, extra, without credit and without pay. That is an evil condition, and it must be remedied before we can do our whole duty by our graduate students.

The finished product in a Ph.D. requires infinite pains and endless hours on the part of the instructor as well as the student. The personal conference is invaluable. It is the one thing which counts. An instructor often spends more hours on one individual than in lecture or recitation work on an entire class.

And it is this personal contact with the teacher which means most to the student. Each one of us can recall with pleasure the one inspiring teacher or the one helpful critic whose influence was vital in our making, whose inspiration stands out clearly as a landmark on our journey onward and upward. It is my firm conviction that the torch of knowledge, of culture, of inspiration, is passed on from hand to hand, from individual soul to individual soul, *not* from the individual to a mob or even to a committee. You may recall the advice which Oliver Wendell Holmes gave to his son when he entered Harvard—the same son who is now associate justice of the United States Supreme Court. "My son," he said, "I would advise you not to choose courses; choose *men.*" And one of the professors he was urged to choose was Henry Wadsworth Longfellow.

In the personal conference with the instructor all the faults of the individual student turn up—mental obliquities, faulty preparation, lack of logic, deficiencies in language. The first great virtue to be impressed upon the student is the absolute need of intellectual integrity. It is *the* fundamental virtue. Without it there can be no progress in science nor any upward trend in social evolution. A candidate who discloses a laxness or an obliquity in this one ethic should be discouraged or prevented from taking a Ph.D. degree. The poorest use any university can make of its funds is to train cheats and thieves.

The faults in preparation are legion. It seems that few candidates, in the scientific departments at least, are adequately prepared in English. It is claimed, and I think truly, that few scientific men in America can either write or speak effectively. Certain it is that in our department by far the most of our time in coaching candidates for higher degrees is spent, first in the application of logic in the analysis of the problem and the organization of material for presentation; and, second, in the presentation of their findings in acceptable English. The latter, as a rule, is the harder problem.

What do the schools do with their time? The majority of students are inadequately prepared in English when they enter college. And the majority of them are still weak sisters in English when they come into graduate work.

In our particular longitude we are still handicapped with the poverty of our pioneer fathers. With the best of intentions and ideals it has not been possible to provide all comers with adequate consecutive schooling. We have endless wealth, but it is not well distributed. The most of the students in advanced work even at the present time are sorely handicapped by the need of earning their daily bread and of laying by a fund to pay for an education. This makes it impossible for the student to get consecutive training. It burdens him with work and responsibility, which are alien to scholarly growth. It brings him often to his advanced work rusty and weary, and without the fire and elasticity of youth.

These handicaps are tragically hard, and they are the lot of most of the candidates for Ph.D. degrees with whom *we* have to deal. Yet as handicaps they do not compare with *easy money,* with *wealth assured.* Studies have been made which show that up to the present time the men and women in this country who have made the bulk of worthy contributions in productive scholarship, in science, art, literature have come from the farms and villages, and from homes of moderate wealth or no wealth. So far as my observation goes, easy money in the hands of the student, with its evil concomitants of idleness, dissipation and impatience, goes farther to prevent achievement in scholarship than all the poverty of pioneer conditions.

This does not augur well for the future of productive scholarship in America. For we are immensely rich, and growing rapidly richer. And there seems to be a disposition on the part of the college administrations hither and yon to put up the financial bars higher and yet higher. At every boost of the tuition rate some discouraged young men and women have to drop out. They can not make the two ends meet. Of course there are plenty of applicants ready who are not embarrassed by high tuition rates. The number of students who *come* to college grows less, and the proportion of students who are *sent* to college increases. In an institution of restricted enrolment, like our own, it will not be long before it has become a rich man's college. But that, for obvious reasons, will be an evil day for the future of productive scholarship. Out of such a college candidates for worthy rank in higher education fail in large measure to materialize.

It is doubtless idle to complain about this condition. But some one with vision ought to face it without delay. And generous people *have* thought of it, and have endowed scholarships and fellowships. But that is not an unmixed blessing. A fellowship which furnishes tuition, and a financial margin over, which the candidate can count on to help defray his living expenses, may provide just the condition which will make it possible for a worthy candidate to carry on, in his graduate work. So universities have vied with each other. The better-endowed institutions offer more fellowships, and financially more attractive ones, and the search for a fellowship may become a game. The candidate may shop around, in his choice of an alma mater. If so he no longer chooses courses, or even *men,* he chooses bargains.

Giving money outright is an exceedingly hazardous venture. The hardest thing a man of wealth has to do is to give without pauperizing the recipient. Why not tackle this situation seriously, and try to improve it? Wouldn't it be vastly better for us to give one third, say, of all the students admitted to our graduate work free tuition, on the basis of distinction in scholarship and fine promise of accomplishment. And as an incentive in graduate work, in aid of those financially handicapped, offer as large as possible a number of fellowships which carry free tuition, and the privilege of borrowing from a loan fund at no interest during the period of residence and at a low rate of interest thereafter; but the loan to be paid back as fast as the candidate is able to pay, when he resumes his regular work. The idea is not a new one. Such funds are in successful use in our own university, but they should be greatly amplified.

Such fellowships should be given only to candidates of exceptional merit and proved ability. The granting of such fellowships does not tend to pauperize the recipient, and the award repaid, becomes a perpetual fund, in aid of worthy students forever.

II

Let us now consider the doctor's business after he is *made.* That, after all, is the reason there are universities. Think of the rate at which doctors are being turned out! What becomes of them all? The original doctors were trained avowedly as teachers. But a wonderful change has come over our education in the last two generations. Science in its many aspects has led all departments in the number of degrees granted. Chemistry, physics, geology, engineering and biology, including bacteriology, are furnishing the expert investigators who are building the scientific foundations in industry, commerce, sanitation and preventive medicine. But in spite of that the most of the doctors are still in the teaching profession. Of the 1,374 Ph.D. degrees granted at Yale, 712—over half of all of them—are in college teaching or administrative positions, and I have no doubt that much the same story will be told by other universities when the facts are assembled.

Some alarm was expressed in Germany not long ago, that there were too many doctors being produced. But it depends upon what field the doctorate is in. There are not many positions open for doctors in Latin, Greek, Sanskrit and Egyptian. The market can be easily overstocked. In the first year of the great war a German doctor in geography came into my horizon, wanting a place to earn a living. His specialty was in ancient maps. I asked him about a map issued about 1790, but he quickly assured me that he didn't pretend to know anything about maps later than 1760!

But think of the opportunity for service in preventive medicine, whether the special study be in bacteriology or in chemistry! Think of the revolution already wrought by chemistry in synthetic dyes and resins and fuels and drugs! Think of the marvelous developments in physics, especially in electricity, in motors, in lighting, in the telegraph, telephone, radio! One manufacturing company alone, the Du Pont company, has over 300 Ph.D.'s in constant service and is taking on more all the time, and many other industries are falling into line.

The researchers in these various sciences have provided for more progress in the world in the last two generations than was won by all the brains and brawn of the men of the preceding 200 centuries. And we are just beginning our great march of scientific conquest.

But at the present moment, more than half of our doctors must look for teaching positions. Here again there is room for criticism and need for improvement. Most of these potential teachers have spent most of their time in compassing the subject-matter of their field, seemingly unaware that teaching is an art, and that, like any other art, excellence in it is arrived at through careful training, almost, as our fathers would say, by fasting and prayer. And while for positions in high schools, as principals and superintendents, special training in pedagogy is expected or required, it is not so for teaching positions in colleges and universities. Young doctors are plucked raw from the convocation and plumped into responsible teaching positions, often with evil consequences. I have been told by reliable observers that they have seen worse, half-baked performances called teaching in classrooms of our university than one might ever expect to find in high schools. We do not need to suppose for a moment that our university is exceptional in that regard.

I am told that at least one leading university in Canada has for some years required of Ph.D. candidates some serious preparation in the art of teaching on the part of those planning to accept teaching positions. It is high time that our colleges and universities took similar action.

Until such action is taken, we should help our young doctors to think gravely and seriously of the responsibilities and opportunities of the teaching profession. The first position is not likely to carry a generous salary. But let's not be so naïve as to seem to excuse our sloppy teaching on that score. I remember an honest Minnesota girl who had a school, and not much education or skill to go with it. When some one called attention to her poor work, she excused herself by saying, "Ah, it's little they pays me an' it's little I taches thim."

Research is good, and the extension of the horizon of human knowledge is good. But it may be good for nothing, if it can not be translated into the lives and accomplishments of mankind. Many a researcher's efforts have been lost because human society was not ready to make use of the new knowledge. Let us never forget Thomas Huxley and his teaching—a great scientist adding great contributions to the sum of human knowledge, but a great teacher as well, and never satisfied until his science could be "vulgarized," as the French express it, that is, until his science could be presented clearly to intelligent people not specialists in science. *That* is the teacher's mission, his opportunity for human service. And I wish that each one of the army of new doctors who goes out to his chosen work each year, whether in teaching or in research, might take with him the spirit of Huxley, as a real religion in his daily work. I can not wish for him greater happiness.

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SCIENTIFIC EVENTS

THE IMPERIAL CHEMICAL HOUSE IN LONDON[1]

NOT content with its achievement in erecting a landmark in the history of chemical industry, Imperial Chemical Industries, Ltd., has provided the Imperial metropolis with an outward and visible expression both of its work and of the status which that work has won for the company. Down by the River Thames, close to the Houses of Parliament (the division bell of which rings on the directors' floor) there has arisen in a surprisingly short time a noble building designed by Sir Frank Baines to combine beauty of form with commercial efficiency of a high order, and that degree of comfort which ministers to both; many will like to regard it as a new monument dedicated to chemists, physicists, engineers and chemical engineers of the past, the present and the future—a whim which will seem not altogether to lack reality when the carved portraits of Liebig, Priestley, Ludwig Mond, Alfred Mond, Harry McGowan, Lavoisier, Mendeléef, Cavendish, Dalton and Berthelot are seen surmounting the arches of the main façades. Faraday is selected for special honor, for one of the panels on the massive main door—that intended to represent the achievements of modern science—will portray a lecture by Faraday at the Royal Institution.

Imperial Chemical House, which had to be designed while the construction progressed, contains 700 rooms, with a total floor area of 370,000 square feet, and its successful completion in less than one third of the time which would normally have been required is no empty tribute to the efficiency of the scientific coordination and control which has been applied to the task. Modern methods have been freely brought into service; ultra-violet rays will penetrate into the rooms; rubber flooring will contribute its special advantages; the artificial lighting will be exclusively of daylight quality. The requirements of a large staff have been amply and sympathetically considered; there is carving in the spirit of Grinling Gibbons and in the technique of the Wren period; the globe desk-lights bear a map of the world. These three representative facts in juxtaposition surely indicate that the company intends to advance beneath a banner inscribed "What is worth doing is worth doing well."

[1] From *Nature*.

THE NEUROLOGICAL INSTITUTE OF NEW YORK

OF the $2,000,000 required to erect and equip the new building of the Neurological Institute at the Medical Center, $1,800,000 has been raised, and the trustees of the institute now seek $2,000,000 additional for research.

The building, at Haven Avenue, 168th Street, west of Broadway, was dedicated on March 15 in the presence of distinguished neurologists from New York and other cities, officers of the institute and of Columbia University, officials of city and state, leaders in philanthropy and representatives of medicine and allied sciences.

The speakers included Robert Thorne, president of the institute; General William Barclay Parsons, chairman of the trustees of Columbia University; Commissioner Frederick W. Parsons, of the Department of Mental Hygiene of the State of New York, and Dr. Frederick Tilney, professor of neurology and neuro-anatomy in the Columbia Medical School.