

The Universities and Technological Education.<sup>1</sup>

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NEARLY three centuries ago Robert Boyle came to Oxford aglow with zeal for the pursuit of chemistry, a study which he was the first to establish as a science and to endow with the title of a philosophy. His work, it appears, aroused bitter animosity; he was attacked in the University pulpit for his theories and their corrupting influence; above all, indignation was felt that he, a gentleman by birth and position, should concern himself with low mechanical arts.<sup>2</sup>

If times had not greatly changed, the prospect of those coming here to-day to proclaim the University rights, not of pure science, but of technology, would indeed be cheerless. But times have greatly changed, and whilst, as the centuries have passed, the best of the ancient ideals that dominate this illustrious seat of learning have become more precious and inviolate, and whilst the chief glory of the University still lies, I suppose, in the realm of ancient studies, there has been so wide an expansion of intellectual sympathy that to-day natural science is in brilliant display, and technology itself is not only condoned, but in a measure also practised here.

It is no part of my purpose to urge upon Oxford an extension of this latest province of her work. It would be an impertinence, even if I felt eager, as I do not, to suggest it. But I hope it will not be an impertinence to make into something of a text the historical facts just recalled. I have always thought that our difficulties with technology have arisen chiefly from the belated and stunted cultivation of natural science in the ancient universities. For it is they that have to so large a degree given the law intellectual and set the currents of our education. If natural science as it arose had been gathered to the older studies and had flowed in its natural courses, the mechanical arts and those who follow them would surely have been brought long since into a very different relation with the academic world.

Those arts which are first in importance to hungry, naked, and pedestrian man were the last which man learned to imbue with rationality. The succeeding arts, which regulate communal life, gave birth to professions that soon became learned; the economy and safety of communal life gave leisure for the disport of fancy; and so it happened that when the range and achievements of man's intellect in the pursuits that relate to human intercourse and to the imagination had already reached such magnificence as to send illumination down the ages, the science that intellectualises the mechanical arts was only just emerging from the close concealment of its material garb. The early promise soon was blighted, and natural knowledge languished through the Middle Ages, leaving industry to make its progress in the light of art, but in the gloom of empiricism.

When at last science took on rapid growth, when the stir of invention quickened the pace of humanity and we entered upon the riot of the industrial age, there ensued a period lasting until now when industry has been struggling, consciously and unconsciously, for its intellectual rights, lacking most grievously the sympathy, the prevision, and the leadership that should have been forthcoming from the established centres of educational influence, the universities. And so we find ourselves in a land that has been forced

to provide for itself as it could its bread-and-butter studies, its rations of useful knowledge dealt out to the toiler when his day's work is done, its technical schools, commercial academies, colleges of science, and I know not what else, standing outside and in the shade—improper still, I think, in many minds to what is education proper. We are not to blame those who have been busy in this work. "Necessity has no law, and expedience is often one form of necessity. It is no principle with sensible men of whatever cast of opinion to do always what is abstractedly best. Where no direct duty forbids we may be obliged to do, as being best under circumstances, what we murmur and rise against as we do it. We see that to attempt more is to effect less; that we must accept so much or gain nothing; and so perforce we reconcile ourselves to what we would have far otherwise if we could . . . it may be the least of evils . . . it may be professedly a temporary arrangement; it may be under a process of improvement; its disadvantages may be neutralised by the persons by whom or the provisions under which it is administered."

But we live in a time when we are forced as never before to consider our ways, to look beneath the surface of things, and to take thought for the future. It is a time when we must go back to principles and consider what, in Newman's words that I have just quoted, is "abstractedly best," a time when we may be excused for aggressiveness in asserting the fundamental principles of our faith.

Speaking in terms of our subject to-day, we may say that we find ourselves a people far spent by the cost of victory over a nation of technologists, a nation which had carried to the highest point the training of its people in applying exact knowledge to the mechanical arts of both peace and war, the knowledge that enabled it under stress to make gun-cotton from wood and air, to conserve its fats for food by making glycerine from starch, to fire a shell seventy-five miles, and to do a great many other marvellous things in the mastery of matter. I have not heard of any direction in which our late enemies could be charged with faults attributable to a neglect of technology. On the other hand, there is abounding evidence that without it they would have been defeated in a year. The tale of the forced march of our own technology in this war of chemists and engineers has not yet been fully told, and perhaps its triumphs are only dimly understood.

In the face of all this it would be excusable perhaps to make this the occasion to preach the urgency of technology. But that is not my intention; I am far more anxious to raise my voice against its unbridled pursuit, to direct attention to the restraints under which it should be fostered, and to plead for what seems indispensable to its worth.

Whatever may have been the ultimate source of German decadence, it has proceeded step by step with changes of outlook, of aim, and of organisation in education that were of melancholy significance to those who had any knowledge of the Germany of old. The reproach was not in their becoming a race of technologists, but in their education from beginning to end yielding to the domination of a spirit which set above all else the worship of power and material efficiency. Surely the supreme educational lesson of the war is that we teachers should stand shoulder to shoulder against all the forces that tend to the vitiation of the atmosphere of education and to the desecration of our temples of learning.

<sup>1</sup> From a paper read before the Congress of the Universities of the Empire at Oxford on July 6.

<sup>2</sup> Prof. H. B. Dixon, Address to Section B, British Association Reports, 1894 (Oxford), p. 596.

Unaltered as is my eagerness for the promotion of technological studies and undiminished my belief in their university rights, I can therefore, and do at the present time, listen at least with patience to alarmist voices more than hinting at the elimination of technologies from our universities. It is more grateful to the ears than some other prescriptions coming from advisers who would act on the precept that it is lawful to learn from the enemy, but would, it seems, have us learn just the wrong thing.

But we must be careful not to be thrown off our balance by a laudable emotion. It is perfectly certain that our national circumstances require, and will require in an increasing degree, the application of the highest knowledge to the industrial arts. An increasing proportion of those endowed by Nature with the best brains and the strongest elements of character will be absorbed by industry, simply because the maintenance of industry is a condition of existence, and its maintenance becomes more and more exacting of both mind and character.

The tendency of those who are so susceptible to anything that seems to threaten a depreciation of university life to say, "Let industry have the brains it wants, get them trained how it wants, and where it chooses—*anywhere but here*," seems to me a fatal closing of the eyes to what is written in blood on the pages of recent history.

Not less wrong, in my opinion, are those who still maintain that the universities have done their whole duty when they have provided the unspecialised studies that are fundamental to industrial science. We know, indeed, that these are all-important, and that men well trained in them, if properly used, will learn elsewhere in the end effectively to apply them. But that there exist ranges of special knowledge, essentially high science, lying between the abstract sciences and the mechanical arts, and that a training in this knowledge may be organised to great advantage in teaching institutions, will not be disputed by anyone who has regarded the evidence at hand. Certain it is that these so-called technologies will be taught somewhere, just as the specialised high studies of theology, law, and medicine are taught, and where they are taught well, there will they be sought. They will be sought now as never before, and what appears to be the matter most needing consideration in our discussion to-day, the point on which I wish to focus attention, is this: that unless the universities collectively embody enough high technology to meet adequately the prospective demand, we shall inevitably cast a large section of our best industrial manhood into institutions wholly devoted to one type of studies and dominated by aims which, however worthy, are directed to the object of immediate material utility.

I cannot believe that any thoughtful Englishman can now regard such a prospect with equanimity. He has surely realised too well the functions of a true university, and what we must exact from it for the education of our race: that it must be, above all, a centre of life in which we secure the influences that will regard and tend the idealism of youth, that will bring into good fellowship and sympathy young men coming from all quarters, cherishing every kind of healthy interest and going out into the world to every kind of legitimate pursuit. It must be a community where traditions of honour and high aims are created and impressed, and where no study is at home that is not fraught with a continually disinterested exercise of the mind.

"It is pledged to admit," says Newman, "without fear, without prejudice, without compromise, all comers, if they come in the name of Truth; to adjust views, and experiences, and habits of mind the most independent and dissimilar; and to give full play to

thought and erudition in their most original forms, in their most intense expressions, and in their most ample circuit. Thus to draw many things into one is its special function."

It must be, in short, the place that Milton conceived as giving the "compleat and generous education that fits a man to perform justly, skilfully, and magnanimously all the offices both private and publick of Peace and War."

It is in such an environment surely that we must educate as many as we can of those who are to be the guiding spirits of the working world.

It has, I believe, seemed to many of us here, and certainly to some in the country itself, that the technological universities of Germany, the much-vaunted "*Technische Hochschulen*," have, in the field of education, been strikingly symbolic of a change of spirit in that nation. True it is that they have not usurped the very name of "university," but they made pretensions and acquired prestige and powers that in effect gave them an equal place, or even a prior one, in the esteem of their country. The German, it is true, has never abandoned his formal homage to the older university ideal, just as he has maintained in external form, over much of his educational system, the discipline of what are called "humanities." We have found the modern German still in a way informed in things intellectual, moral, and æsthetic, but we have felt that this equipment was becoming more and more a conventional outer garment, according less and less with the spirit it enveloped.

Nothing has happened that can rightly lead the Germans to relax their cultivation of technology, but among the signs of their regeneration we shall surely look for the return of a true allegiance to their older ideals of universities and all they must stand for in the scheme of a truer civilisation. They must acknowledge that there is something in university life transcending in importance the achievement of efficiency, and that the first care of the nation should be to see that its education proceeds where influences prevail that will touch the spirit of youth to right ambitions and ideals of life. Among the excesses of regimentation the Germans have, I think, good cause to reconsider their educational plan of isolating seminaries of technology.

If thus, in the light of recent history, I am brought to plead more earnestly than ever for the ranging of this set of studies for their own sake within the university, it is in no spirit of condescension or without a strong conviction that they have much to give as well as to gain. It has been my own fortune to live in a university which, perhaps more than any other, has made ventures in the domain of technology and has sought to bring into an articulated and harmonious whole, without preference or priority, without caste social or intellectual, on equal terms and with equal rights, the studies, teachers, and students concerned with both professional and industrial occupations. I do not know that there is one among our teachers who would not acknowledge advantage from this association and bespeak from it, when rightly achieved, a broadening rather than a narrowing influence on the best elements of university life.

I hope I am not insensible to the safeguards that must be observed. A tendency to extravagance lies in every new movement, and in relation to technology it is most important that there should be restraint of ill-considered plans. These safeguards I endeavoured to outline when speaking on this theme at the congress nine years ago. It is perhaps permissible again to urge that the universities should observe a due proportion and economy by differentiation in their technologies according to the natural homes of these, that they should study co-operation



in policy and encourage interchange of students. More important still as an actual need of the day seems to be this: that universities which associate themselves with technological institutions of originally independent growth shall bring the studies, teachers, and students effectively into the precincts and life of the university. Equally important does it seem that this should be done so far, and only so far, as these studies, teachers, and students can be rightly regarded as conforming to the standards of a university. It is to be feared that there lie here practical problems of grave difficulty, and that we may be entering upon a troubled time. The difficulties for the universities lie mainly in the suspicion, which they so easily incur, of possessing all those failings that are apt to beset aristocracies, and when they are prescribing restrictions in the light of experience and with a disinterested desire for the common good, they may easily enough be regarded as acting merely in a disdainful spirit of exclusiveness. Another danger, of course, lies in an eager spirit of accommodation, a disposition to please the multitude, and a love of peace, amid which essentials may be sacrificed to gain the mere semblance of success.

In the restlessness of our present world it is difficult to gauge the currents of opinion that will mould or

remould the institutions of our country. But so far as education is concerned it seems clear that, if we are to accept their spokesmen, the rank and file of the teeming world of labour have set their heart in something like clear purpose to the ends that shall be sought. They will not have it that their new and increased education shall be permeated and dominated by a sordid or material aim. They begin to suspect the agencies that make their chief promise a cleverer performance of the daily task or the earning of a larger wage. In their revulsion from such an object they threaten to repudiate what in truth in its proper place, among other things, will lighten and enlighten their labours.

There is no sign of the times that to me seems more hopeful, for I see in it the promise of an end to the far-reaching and incalculable mischief that has come of a false distinction between useful and useless knowledge. But there are opposing forces to contend with.

It seems to me that there is no service of universities more needed now than to exhibit in the centres of highest education, which can so easily lead the way, the true intellectual nurture of industrial life—the embodiment of technology in full and fruitful fellowship and interplay with accepted liberal studies.

### New Apparatus for Showing the Tracks of $\alpha$ -, $\beta$ -, and X-rays.

IT will be remembered that Mr. C. T. R. Wilson described his original cloud expansion apparatus as used for showing the tracks of  $\alpha$ - and  $\beta$ -rays and of X-rays before the Royal Society in April, 1911, and at that time the Cambridge Scientific Instrument Co., Ltd. (now the Cambridge and Paul Instrument Co., Ltd.), took up the manufacture of this apparatus. The manufacture of apparatus of this class was, however, entirely stopped by the war.

Lately Mr. Takeo Shimizu, of Japan, working at the Cavendish Laboratory, Cambridge, has considerably modified Mr. Wilson's original apparatus, and the Cambridge and Paul Instrument Co., Ltd., is now putting the improved design upon the market. In Mr. Wilson's original apparatus only a single expansion was obtained. It was thought to be necessary to give a comparatively rapid expansion in the working chamber, and this was obtained by connecting the space under the moving piston to another space which was previously evacuated. The moving piston was, in consequence, suddenly sucked down against a rubber stop. Mr. Shimizu has found that the sudden expansion is not necessary, and has, therefore, arranged for a reciprocating piston, and he obtains cloud tracks of the rays at each expansion, which may be timed to occur at rates from about 50 to 200 per minute. The instrument thus designed is extremely simple, but there are several important points to which attention must be given for successful operation.

The apparatus is shown in Fig. 1. The crank (not seen in the illustration), which is driven either from the hand-wheel B or by means of a small motor, drives an upright connecting rod, which in turn drives a horizontal connecting rod D. The far end

of D slides in a sleeve E, which is free to rock in the piece F. The piece F can be adjusted in a horizontal direction by means of the screw G. The piston-rod H is connected near the middle of this latter connecting-rod. Since the crank is of constant length, the horizontal adjustment of the piece F alters the length of the stroke given to the piston-rod H. By this means the expansion ratio at each stroke in the working

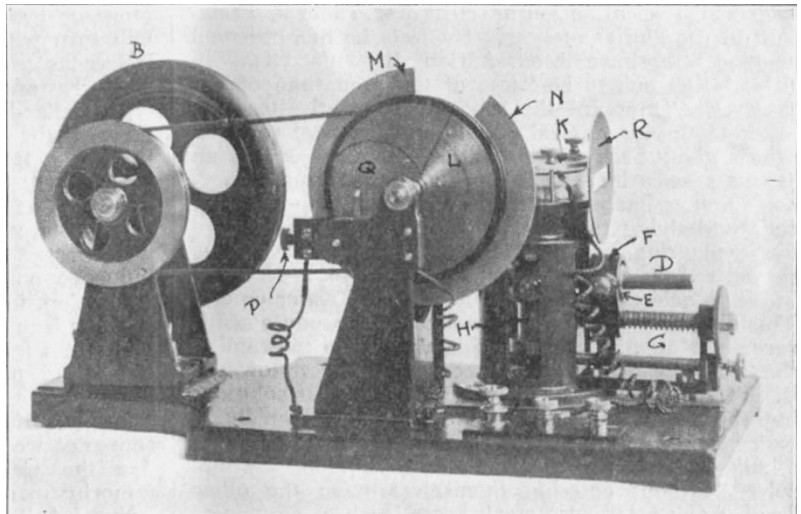


FIG. 1.—Shimizu expansion apparatus.

chamber K can be adjusted while the instrument is in operation.

In order to obtain a good picture of the rays which become visible at each expansion by the formation of linear clouds on the ionised particles in the ray tracks, it is necessary that these clouds be dissipated during the compression stroke. This is done by forming a vertical electrostatic field in the expansion