

in the interests of teaching, which is the primary business of a university, such devotion to one problem is undesirable, as tending to one-sidedness.

There are also difficulties in obtaining the co-operation of manufacturers with universities and in the application of university work to industry, which I see no hope whatever of overcoming; the universities do not understand the requirements of the manufacturer, and the manufacturer distrusts, because he does not understand, the language of the professor. Moreover, it is quite essential that any investigator who has worked out a new process or material should be able to apply his work on a semi-manufacturing scale, so that it can be transferred to the factory by skilled men who have already met the general difficulties which would be encountered in factory application. This development on a semi-manufacturing scale is, indeed, one of the most difficult parts of a research resulting in a new product, and the importance of it is shown by the fact that all the large industrial research laboratories, however concerned they may be with the theory of the subject, have, as parts of the laboratory, and under the direction of the research staff, experimental manufacturing plants which duplicate many of the processes employed in the factory itself.

All these arguments tend to show that an industrial research laboratory must necessarily be of considerable size, but this requirement is much accentuated by another consideration altogether.

Except in a few branches of pure science small research laboratories are relatively inefficient, in the technical sense of the term—that is, they require more time and cost more money for the solution of a given problem.

When considering this subject it is necessary first to dismiss completely from the mind the idea that any appreciable number of research laboratories can be staffed by geniuses. If a genius can be obtained for a given industrial research, that is, of course, an overwhelming advantage which may outweigh any disadvantages, but we have no right to assume that we can obtain geniuses; all we have a right to assume is that we can obtain, at a fair rate of recompense, well-trained, average men having a taste for research and a certain ability for investigation. The problem, then, is, how can we obtain the greatest yield from a given number of men in a given time? Investigation of the subject shows that the yield per man increases very greatly as the number of men who can co-operate together is increased. The problems of industrial research are not often of the type which can be best tackled by one or two individual thinkers, and they rarely involve directly abstract points of theory, but they continually involve difficult technical and mechanical operations, and most of the delays in research work arise because the workers engaged on the subject do not know how to do some specific operation. In my own experience, I have seen a good man stick for six months at an investigation because he did not know and could not find out how to measure a conductivity with a precision higher than one part in a thousand, a point which was finally found to be perfectly well known to several scientific workers in the country. Again, it took another good man three months to learn how to cut a special form of section, but, having learned the trick, he can now cut sections for all the workers in the laboratory with no delay whatever.

In this connection the advantage of permanent set-ups of apparatus may be pointed out. Among a large number of chemists some one will continually be wanting to photograph an ultra-violet absorption spectrum or to take a photomicrograph, and if the apparatus for these purposes is erected and in charge of a competent man who understands its use, the work can be

done without any delay at all, the photography of the absorption spectrum of an organic liquid by a man who is used to the work taking only an hour; but if this point is vital to the research, and the chemist is quite unacquainted with the technique of the subject and has no apparatus available, it may easily take him six months to find out what has been done on absorption spectra, to buy and erect the apparatus and become skilled in its working.

From these causes, then, the efficiency of a laboratory increases very greatly with its size, provided that there are good arrangements for co-operation between the different workers of the laboratory, so that they are kept informed of each other's problems.

When considering the efficiency of research work it must be remembered that the efficiency is necessarily extremely low, since it is very rarely possible to arrange any research so that it will directly proceed to the end required.

(To be concluded.)

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

BIRMINGHAM.—Dr. O. F. Hudson has resigned his post as lecturer and instructor in assaying and special lecturer in metallography in order to take up duties as assistant investigator to the Corrosion Committee of the Institute of Metals.

The degree of Doctor of Science has been awarded to the following: Elizabeth Acton (botany), Henry Briggs (mining), George William Clough and Albert Parker (chemistry).

LEEDS.—On the occasion of Degree Day on July 1 the vice-chancellor (Dr. M. E. Sadler) in the course of an address reviewed the position of the university, with special reference to the war. Of nearly fourteen hundred associated with the university who are on active service, fifty-one had received military distinction. The war has found the university able and ready to give the nation unforeseen and many-sided service, and the long vacation is little more than a name for those in the university who are doing scientific or administrative work in connection with the war. The war, Dr. Sadler remarked, has already enriched the university with a deepened tradition of fellowship in public service. In the years to come it will be called upon to prove the power of patient but imaginative investigation, of trained judgment, and of unjealous and patriotic energy in helping forward whatever will impart a finer quality to the social and economic conditions of the national life. Grateful mention was made of the recent benefaction of Sir James Roberts for the endowment of a chair of Russian language and literature—an act of international significance. As important and opportune would be the foundation of a professorship of Spanish language and literature.

Alluding to the future of the universities, Dr. Sadler said, whilst they must continue to work in intimate co-operation with the great local authorities and the Government, it must never be forgotten that the living power of their work will depend on their continuing free from mistaken, however well-meant, kinds of external interference. Germany has failed, in spite of her brilliant endowment of knowledge, to keep unsullied in her universities freedom of moral judgment in respect of some vital questions of duty to mankind and to the State. She has gradually and half-consciously undermined, by subtle pressure of State control and by inducements of official distinctions, independence of moral and political judgment in some of the teachers through whom that higher education is given. This should be a warning to us.

ST. ANDREWS.—At the summer graduation ceremony on July 6 the honorary degree of LL.D. was conferred upon Mr. W. E. Clarke, keeper of the zoology department, Royal Scottish Museum, Edinburgh; Mr. C. T. Clough, district geologist, Geological Survey of Scotland; Dr. R. B. Don; Mr. L. R. Farnell, rector of Exeter College, Oxford; Dr. C. G. Knott, lecturer in applied mathematics, University of Edinburgh; Dr. J. Musgrove, Bute professor of anatomy, St. Andrews, 1901, 1914; and Prof. W. R. Scott, professor of economics, University of Glasgow.

MR. ASQUITH stated in the House of Commons on July 10 that he does not propose to advise the appointment of a Royal Commission on Education. The Government is itself engaged in a comprehensive review of the system of education as a whole.

At the invitation of the Paris Academy the Imperial Academy of Sciences of Petrograd has appointed three of its members as delegates to the International Commission established on the initiative of the Paris Academy for the purpose of taking steps, after the war, of restoring so far as possible the library of the University of Louvain burnt by the Germans.

THE recently established School of Slavonic Studies at King's College, London, wishes to form a special Slavonic library, and hopes for the sympathetic co-operation of Russian learned societies by donations of suitable books. This having been brought to the notice of the Imperial Academy of Sciences of Petrograd by the Minister of Public Instruction, the Academy at once expressed its willingness to contribute to the desired end, and directed that a catalogue of the Academy's publications be sent to the school with the request that a list be prepared of the works which it wishes to receive.

NUMEROUS bequests to aid medical science in the United States are reported in a recent issue of *Science*. By the will of the late Dr. J. W. White, trustee of the University of Pennsylvania, and Prof. J. R. Barton, emeritus professor of surgery, 30,000*l.* is bequeathed in trust as a permanent endowment fund, the income to be used for establishing a professorship of surgical research in the medical department of the university. Two hundred thousand pounds will be available for use by the Washington University Medical School, with the opening of the new term in September, through the gift to the school of 33,200*l.* each by Mr. E. Mallinckrodt and Mr. J. T. Milliken, of St. Louis. One fund of 100,000*l.*, to be known as the Edward Mallinckrodt Fund, will be devoted to teaching and research work in pediatrics. The other fund of 100,000*l.*, to be known as the John T. Milliken Fund, will be devoted to teaching and research work in medicine. The funds will enable the medical school to employ physicians in these departments for their full time. The amount, in addition to the Mallinckrodt and Milliken donations, to bring the fund to 200,000*l.* has been given by the General Education Board. A movement has been inaugurated to secure at least 400,000*l.* additional endowment for Jefferson Medical College, Philadelphia. Mr. D. Baugh, founder of the Baugh Institute of Anatomy and Biology, subscribed 20,000*l.*, provided that an equal amount was raised on or before June 16. The executors of the estate of the late Mr. Emil C. Bundy, of New York, have paid over to Columbia University the sum of 20,000*l.* for research work in cancer.

ATTENTION may be directed to the help rendered to manufacturers and business men for some time past

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by the librarian and staff of the City of Coventry Public Libraries. From time to time lists of recent books in technical chemistry, metallurgy, etc., are issued in printed form and circulated widely among those likely to be interested. In addition, lists are prepared and issued dealing, e.g., with a specific metal and its alloys. We have before us one such relating to aluminium, which gives an admirable series of references to original papers and books published in the last ten years. These lists are not only circulated among manufacturers and business men, but are also given a wider publicity by being pasted inside books on the same subject. The Central Library and its branches are well supplied with technical journals, to which the public have access without any restriction. The technical section is reinforced by cutting out the best articles from duplicate and unbound periodicals, mounting them on sheets, and exposing them in boxes where they are classified under appropriate headings. In addition, the staff of the library invites inquiries for information, whether made verbally, or by letter, or by telephone. All inquiries are treated as confidential, and no effort is spared to supply the fullest and most trustworthy information. No doubt the instance we have quoted is not unique, but it appears worth while directing attention to a practice which must be most helpful to the technical staff of manufactories, particularly where, as is so often the case, few, if any, technical books or periodicals are taken. The example of the staff of the Coventry Public Libraries is warmly to be commended.

SOCIETIES AND ACADEMIES.

LONDON.

Challenger Society, June 28.—Dr. E. J. Allen in the chair.—Capt. Campbell **Hepworth**: The meteorology of Davis Strait and Baffin Bay, including ice distribution and frequency. The paper was based on a set of charts that had been prepared in the Meteorological Office.

DUBLIN.

Royal Dublin Society, June 20.—Dr. J. M. Purser in the chair.—Prof. W. H. **Thompson** and J. **Pimlott**: The possibilities of food production in the United Kingdom.—Prof. G. H. **Carpenter**: Injurious insects and other animals observed in Ireland during the years 1914 and 1915. The summer of 1914 was noteworthy for the great abundance of the "diamond-back" moth (*Plutella cruciferarum*) on turnip crops, both in the east and west of Ireland. Nymphs of the large shield-bug, *Tropidocoris rufipes*, were very destructive to young apples in Co. Kilkenny in the summer of 1915. Another unusual observation was the abundance of two weevils, *Phyllobius argentatus* and *Strophosomus coryli*, on larch.

Royal Irish Academy, June 26.—The Most Rev. Dr. Bernard, Archbishop of Dublin, president, in the chair.—M. W. J. **Fry**: Impact in three dimensions. The paper showed that the course of impact in three dimensions can be minutely followed in the most general case. There are two or four directions (according to the value of the coefficient of friction) in which if sliding initially takes place it persists without change of direction, and of these alternate ones correspond to stable motions. Any other direction of sliding tends to get parallel to the adjacent stable direction, and does so if the impact is sufficiently prolonged, and at the same time the velocity of sliding vanishes, but does not if the direction is that special one along which sliding may take place, when