psychiatrie, Dr. R. Pierrac, new edition; Manuel d'électrothérapie et d'électro-diagnostic, Dr. Albert-Weill, new edition, illustrated. *J. and A. Churchill.*—Surgery in War, Major A. J. Hull, with an introduction by Lieut.-Col. E. M. Pilcher, illustrated. *W. Heinemann.*—A Text-Book of Nervous Diseases, Dr. R. Bing, translated by Dr. C. L. Allen, illustrated; Pathological Lying, Accusation, and Swindling: A Study in Forensic Psychology, Dr. W. Healy and M. T. Healy; The Practitioner's Pocket Pharmacology and Formulary, Dr. L. Freyberger; Medical Ethnology, Dr. C. E. Woodruff; and new editions of A Text-Book of Operative Dentistry by various authors, edited by C. N. Johnson, illustrated; Emergency Surgery, Dr. J. W. Sluss, illustrated. *John Lane.*—Vivisection, Hon. S. Coleridge. *H. K. Lewis and Co., Ltd.*—Localisation by Roentgen Rays and Stereoscopy, Sir J. Mackenzie Davidson, illustrated; The Pathology of Tumours, Dr. E. H. Kettle, illustrated; Essays on Practical Medicine, Dr. T. B. Scott, with a preface by Sir Lauder Brunton; Notes on Faradism and Galvanism, Dr. Magill, illustrated; The Adolescent Period: its Features and Management, Dr. L. Starr; Mentally Deficient Children, Dr. G. E. Shuttleworth and Dr. W. A. Potts, illustrated, new edition; Gould's Pocket Medical Dictionary, new edition; Diseases of the Nose and Throat, Dr. H. Tilley, new edition; and a new and revised Medical Dictionary. *J. B. Lippincott Company.*—A Text-Book of Physics and Chemistry for Nurses, Drs. A. R. Bliss, jun., and A. H. Olive, illustrated. *Longmans and Co.*—The Endocrine Organs: an Introduction to the Study of Internal Secretion, Sir E. Schäfer, illustrated; The Involuntary Nervous System, Dr. W. H. Gaskell, illustrated; The Physiology of Reflex Action, Dr. C. S. Sherrington; The Conduction of the Nervous Impulse, Dr. K. Lucas; The Physiological Basis of the Action of Drugs, Dr. H. H. Dale; The Secretion of Urine, Dr. A. R. Cushny; The Nature of Muscular Movement, Dr. W. M. Fletcher; The Cerebral Mechanisms of Speech, Dr. F. W. Mott; Tissue Respiration, Dr. C. L. Evans ("Monographs on Physiology"). *Methuen and Co., Ltd.*—The Care of the Body, Dr. F. Cavanagh; The Care of the Teeth, A. T. Pitts; The Eyes of our Children, N. B. Harman; The Health of the Skin, Dr. G. Pernet; How to Live Long, Dr. J. W. Carr, The Prevention of the Common Cold, Dr. O. K. Williamson ("Methuen's Health Series"). *The Oxford University Press.*—The Evolution of Modern Medicine, Sir W. Osler. *Kegan Paul and Co., Ltd.*—Nervous Disorders of Men, Dr. Bernard Hollander; Nervous Disorders of Women, Dr. Bernard Hollander; Abnormal Children, Dr. Bernard Hollander.

TECHNOLOGY.

Cassell and Co., Ltd.—Drawing and Design for Craftsmen, R. S. Bowers; Electric Bells and Telephones, illustrated; Workshop Hints for Munition Workers, illustrated; Electric Lighting, A. H. Avery, illustrated ("Work" Handbook Series). *The Electrician Printing and Publishing Co., Ltd.*—The Theory of the Submarine Cable, Dr. H. W. Malcolm; Electric Switch and Controlling Gear, Dr. C. C. Garrard; Electric Measuring Instruments: their Design, Construction, and Application, Dr. C. V. Drysdale and A. C. Jolley; Electric Hoists and Lifts, G. Rowe; The Localisation of Faults in Electric Light Mains, F. C. Raphael, new edition; Primary Batteries: their Construction and Use, W. R. Cooper, new edition; Secondary Batteries: their Manufacture and Use, new edition. *Crosby Lockwood and Son.*—The Manufacture of Earthenware, E. A. Sandeman, illustrated; Munition Workers' Handbook, E. J. Pull, illustrated. *Kegan Paul and Co., Ltd.*—Flour-Milling, Dr. P. A. Kozmin, illustrated. *G. Routledge and Sons, Ltd.*—Painters' and Decorators' Work, H. G. Dowling, illustrated ("Broadway Text-books of Technology"). *Whittaker and Co.*—Telegraphy, T. E. Herbert. *John Wiley and Sons, Inc. (New York), and Chapman and Hall, Ltd.*—The Canning of Fruits and Vegetables, J. P. Zavalla.

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F. Alcan (Paris).—La Science et savants germaniques, edited by Prof. Gabriel Petit. *Baillière, Tindall, and Cox.*—Analytical Psychology, Prof. Jüng, translated by Dr. C. Long, illustrated. *H. Holt and Co. (New York).*—First Course in General Science, Prof. F. Barber and colleagues. *Macmillan and Co., Ltd.*—Discovery: or the Spirit and Service of Science, Prof. R. A. Gregory; The Statesman's Year Book, for the Year 1916, edited by Dr. J. Scott Keltie, assisted by Dr. M. Epstein. *The Open Court Company.*—The Contingency of the Laws of Nature, E. Boutroux, translated by F. Rothwell; The Collected Logical Works of George Boole, vol. ii., containing The Laws of Thought; The Early Works of Diderot (Letters on the Blind and on Deaf-Mutes, etc.), translated and edited by M. Jourdain ("Open Court Classics of Science and Philosophy"). *The Oxford University Press.*—Sadoleto on Education, a translation of the "De pueris recte instituendis," with notes and introduction by Prof. E. T. Campagnac and K. Forbes; Sir Walter Raleigh: Selections from his "History of the World," Letters, and other Writings, edited, with introduction and notes, by G. E. Hadow; A Documentary History of Yale University, F. B. Dexter; Architectural Acoustics, W. C. Sabine; A Study of the Economic Life of a Bengal District, J. C. Jack. *Kegan Paul and Co., Ltd.*—The British Coal Trade, Prof. H. Stanley Jevons, illustrated. *T. Fisher Unwin, Ltd.*—Instincts of the Herd in Peace and War, W. Trotter.

THE ORGANISATION OF SCIENTIFIC RESEARCH.[1]

AMONGST the indirect results of this appalling war, we may hope that there will be some increased appreciation in the minds of the politicians who govern us of the enormous influence of scientific research and discovery, even in its most abstruse forms, on the prosperity and safety of the Empire. We have had brought home to us that this war is a war quite as much of chemists and engineers as of soldiers and sailors. Hence, from the point of view of national security alone, we must take steps to foster scientific investigation. We shall probably never succeed in convincing the unthoughtful multitude of the manner in which the highest scientific researches affect human life in innumerable ways, but it will be sufficient if that fact is brought home to the consciousness of those who have political position and power, and if we can impress upon them that theirs will be the responsibility if they neglect to encourage it.

Methods of Scientific Research.

The great bulk of all our scientific discovery and research in the past has been due to individual labour and initiative; much of it a labour of love, unrecognised at the time. Men of great genius have opened up new lines of thought or pursued private researches often with very inadequate appliances. In fact, the greater part of past British scientific research may be said to have been amateur work, not in the sense that

[1] Abridged from a paper read before the Royal Society of Arts on February 9, by Prof. J. A. Fleming, F.R.S.

it was lacking in the highest qualities, but only in the sense that it was pursued for the sheer pleasure and interest of it by private individuals. It was done mostly at odd times, and nearly always at the worker's own expense.

The point seems to have been reached at which the first attempt to organise research should be to create something more resembling an army out of the multitude of independent scientific workers. An army is not a collection of armed individuals, each pursuing his own aims and ideas. It is a complex organism in which each man has place and duty. No great enterprise can be carried out unless there is some degree of surrender of initiative and acceptance of directions from a higher command. To carry out this principle in scientific work we require to a fuller extent than we have it at present the system of scientific work done to order. This means that young investigators, and even the older, shall be content to take up pieces of prescribed work, quantitative or qualitative, and carry it out individually or conjointly in connection with certain large plans of operation.

This conjoint or co-operative work would have several advantages. It would save much reduplication, and it would train beginners in the best methods of research. It would effect a saving of time and enable us much more quickly to reach a given point. There is much plain and straightforward research which can be carried out when its general lines are indicated to those not possessing very great originality, but yet having perseverance, accuracy, and skill.

If, however, such work is to be undertaken by those who may perhaps be called the privates and non-commissioned officers of the scientific army, then it presupposes a directing power which shall supply what I have elsewhere called the strategy of scientific research. This must, of course, come from the more experienced and able workers, and it is to them that we must look for ideas. If some men are to surrender initiative in their work, then others must give time and thought to planning the outlines of the scientific campaigns.

We need not only the regimental officers but the General Staff if there is to be effective achievement. My contention is that this specification of the main lines of suggested research is a matter which should largely occupy our learned societies, and in particular the Royal Society, from its broad and general character and unique position.

But something more than this is necessary. We have to formulate in precise detail the suggestions for future work, and bring them to the notice of those who may be able or willing to work them out. The White Paper, which was issued last July by the Board of Education, signed by Mr. Arthur Henderson, seems intended to bring into existence some machinery for effecting this desired end. So far as the "Scheme for the Organisation and Development of Scientific and Industrial Research" outlined in this White Paper is formulated in detail, it appears to consist in the establishment of (i) a committee of the Privy Council, which will be responsible for any expenditure voted by Parliament for scientific and industrial research; and (ii) a small advisory council, composed mainly of scientific men and men actually engaged in industries dependent upon scientific research.

The primary functions of the advisory council are stated to be to advise on:—(1) Proposals for instituting specific researches; (2) proposals for developing or establishing special institutions for the study of problems affecting particular industries; (3) the establishment and award of research studentships and fellowships.

The White Paper tells us that it is contemplated that the advisory council will work largely through sub-committees reinforced by suitable experts in the particular branch of science or industry concerned on which it would be desirable to enlist the services of persons actually engaged in science, trades, or manufactures.

It is clearly impossible for any single board composed of a few men, however eminent, to deal in any reasonable time with all the research problems awaiting solution in physics, chemistry, inorganic, organic, and technical, metallurgy, engineering, electrotechnics, bacteriology, agriculture, etc., and the questions concerned in the recovery of our trade in dyes, drugs, glass, ceramic ware, ferro-alloys, and scientific apparatus.

Hence separate bodies of experts will unquestionably be required to deal with the different subjects in order to bring to bear upon them the proper technical knowledge and to guide research on the right lines. But now, if this is the case, the question at once arises: Why is it necessary to create a new machinery for dealing with these matters? Have we not already in the councils of our learned and technical societies, or in committees of their members, all that is required to form these boards, which might be called Permanent Advisory Committees on scientific research? Why is it considered necessary to create new committees?

The proposition I submit for your consideration is that the organisation of scientific research should be a matter undertaken by scientific men themselves, and should not be taken over independently of them by a Government Department. The essential matter is that this organisation of scientific research should not become bureaucratic or academic, but should be conducted by bodies represenative of the best technical and scientific opinion, and be closely in touch with the members of all the various scientific and technical societies. If these permanent advisory committees in the different subjects were elected from the councils or members of the various societies, we should have in them men who are closely in touch with those particular branches of pure or applied science.

If public funds are to be administered, then it might be proper that certain of the members on each board should be appointed by the Government Department concerned, say, by the Board of Education; but my contention is that the organisation work should be the work of scientific men as a whole and not any small section of them, or be carried out by Departmental officials over their heads.

Suppose, then, we assume that we have created permanent advisory committees for the different branches of pure and applied science, the duty of which should be the organisation of research in their respective departments. Their first work should be to draw up as comprehensive a report as possible, pointing out the general needs of each department of knowledge and the most necessary directions of research in it.

The first report would no doubt have to be concerned chiefly with the deficiencies in the appliances and means of conducting it, such as laboratories and apparatus. Also with the numbers and supply of men available for undertaking it or actually engaged on it. Later reports would then be properly occupied with the more detailed discussion of the problems awaiting investigation and particular suggestions for directions of research. Each advisory board should have its salaried recorder or secretary, who should be a scientific man with some literary attainments. Each board should, of course, have taken evidence from all kinds of experts in its own subject in drawing up its report, so that this document would then be not the mere embodiment of the opinions of a few, but the concentrated wisdom of all those engaged in

the same field of work. Such reports, if made annually, would come to possess immense value and form a solid basis for suggested practical reforms.

It has sometimes been suggested that the State should make pecuniary rewards for scientific discoveries or inventions, but this is not a very practicable proposal. It is extremely difficult in most cases to appraise the value of a scientific discovery or invention in its early years, and in the next place there are pieces of scientific work the real value of which does not appear until long after the death of the originator.

Who, for instance, could have set a value on Faraday's discovery of induced currents or magneto-electric induction, when in ten days of intermittent work at the Royal Institution in the autumn of 1831 he gathered in new knowledge of surpassing importance to mankind? These facts had no apparent value at the time, yet their application has brought wealth in untold millions into the exchequer of nations.

I remember speaking, shortly after Clerk Maxwell's death in 1879, with an eminent Cambridge mathematician concerning Maxwell's great paper published in 1865 "On the Dynamical Theory of the Electromagnetic Field." He told me in all seriousness that the impression produced on his mind by this great paper was that it was one of the most exalted productions of the human intellect. Yet it was twenty years, and long after Maxwell's death, before this paper brought forth its fruit in Hertz's work, and thirty-five years before we saw the final outcome of it in the achievements of wireless telegraphy.

How would it have been possible for contemporaries properly to give a value to that suggestive paper in terms of current coin? I believe the only practical method of assisting scientific research is by a well-devised system of research scholarships, fellowships, and professorships renewable annually or at longer intervals, and in any case held subject to productive work.

If we combine such a system with the above suggested advisory boards, there is a possibility of creating a workable system for the endowment and encouragement of scientific investigation which will be kept in close contact with practical necessities as well as with the most fertile regions of scientific thoughts.

Provision of the Means for Conducting Scientific Research.

One rather startling experience at the outset of this great war was the discovery of the extent to which we had become dependent on Germany and Austria for these implements of research. We found that our sources of supply of chemical glass such as flasks, beakers, tubes, graduated vessels, and more complicated pieces of analytical apparatus was cut off. Also porcelain crucibles, basins, tubes and retorts, filter papers, and large numbers of research chemicals were not produced in England of the requisite quality.

Amongst pharmaceutical chemicals a very large number have been unobtainable, or obtainable with difficulty, since the war—such as salicylates, salvarsan, veronal, and phenacetin. My colleague, Prof. Cushny, informs me that all the more complex synthetic chemicals, such as those used as indicators, stains in microscopic work, etc., have been obtained from Germany and are now unobtainable.

In physical and electrical work there has also been the same difficulty. Before the war we obtained many necessary materials from Germany which ought to have been made here. I instance such things as types of electric resistance furnaces for laboratory and assay work. Kathode ray oscillographs and the proper type of electrostatic influence machines for working them. Certain types of mechanical pumps for making high vacua. Extremely fine wires of different materials necessary for thermo-electric ammeters for high-frequency current measurements in wireless telegraphy, and also special alloy wires for electrical resistances, and many other similar materials.

We were at one time even entirely dependent on Germany and Austria for electric arc carbons, and only the enterprise of one British firm saved the situation. We are even now in difficulties as regards some electric fittings and appliances.

As an instance of the way in which the Germans look forward and anticipate the future, we may note the case of tungsten ore. When, after prolonged scientific researches, the metallic filament electric lamp made with drawn or pressed tungsten wire had ousted the carbon lamp, and when the immense importance of tungsten-steel had been recognised for high-speed tools and magnet manufacture, German interests set to work to secure the control of sources of supply of tungsten, even within the British Empire. One of the chief sources of supply of wolframite, an ore from which tungsten is obtained, is in Burma, which produces about one-fifth of the world's supply. Before the war the Germans used to secure nearly all this ore and carry out the reduction in Germany. Consequently, when the war broke out there were few or no reduction works in England capable of supplying tungsten or ferro-tungsten.

In spite of this extremely valuable tungsten supply in Burma, which is the largest mineral-producing province of India, the local government was not provided with any mining expert who could have advised them in this matter.

It is satisfactory to note, however, that steps have been taken to remedy the state of affairs. The Lieutenant-Governor, Sir Harcourt Butler, visited Tavoy, the centre of the industry, last December and addressed the Chamber of Mines. He urged the concessionnaires to do all that was possible to obtain the wolframite required at present for the making of munitions, and represented that if private owners did not meet the British demand, concessions would be cancelled and the Government would take possession. Nevertheless, the Germans have provided themselves with large stocks of this valuable material already, without which it is impossible to make modern high-efficiency incandescent electric lamps or high-speed cutting tools for engineering work. This is only one out of many instances which might be quoted to show our extraordinary want of scientific foresight in allowing absolutely essential materials to be taken by Germany both before and during the war.

This partial famine in essential scientific materials and apparatus is not due to any real want of scientific ability on the part of British inventors or manufacturers. It is due to causes which are very deep-seated. For one thing, our easy-going national temperament has found it less trouble to buy from abroad than make for ourselves. Labour difficulties, our fiscal policy, and other causes have rendered it difficult to compete with German prices.

Above all, the mistakes and ignorance of politicians who allowed themselves and others to believe that there was no real danger of a rupture of peace, and that Germany's tremendous preparations for war had no other object than defence against sudden attack by jealous neighbours, acted like an opiate on our spirit of commercial enterprise and dulled our instinct of self-preservation. Meanwhile, it is to be hoped we are now awake to facts, and that scientific men, manu-

facturers, and our statesmen will unite in remedying the present serious condition of affairs.

Now the question is: Are we going back, when peace returns, to the old easy-going habits of importing German-made scientific apparatus? Surely the answer is, No! a thousand times No! But unless we wish Germany's crime-stained hands to take back in commerce what she has lost in war, we have to create and maintain an entire scientific and economic independence of our own. For this purpose we need, for one thing, a properly-complete Scientific Intelligence Department.

The different agencies, committees, and institutions which have been endeavouring to supply scientific information as to manufactures should have as their resultant a single organisation, the function of which should be to collect and distribute all possible information concerning the mode of manufacture and cost of production and information concerning the patent position, if any, of all the appliances and materials used in scientific research. Such a scientific intelligence and information bureau might need subsidising at the start, but it might be possible later on to make it self-supporting by the subscriptions of firms and persons who desired information on particular matters. Just as one can pay a fee to a patent agent to conduct a search for anticipations on some particular subject, so this information bureau should have as its object to collect and supply to its subscribers all possible information concerning the manufacture or supply of the materials and implements of scientific research. This bureau might have certain laboratories or workshops attached to it where information could be tested and specifications issued for the manufacture of the materials and appliances used in research. It should not be concerned either with actual trade manufacture or with researches *per se*, but should enable anyone to find out with the least expenditure of time the exact way in which certain scientific materials or instruments are made and under what conditions they can be produced, and to supply this information to the trades concerned who are its supporters or subscribers.

Training of Men to Conduct Scientific and Industrial Research.

Whilst the highest achievements in scientific research and invention must always depend to a great extent on that indefinable quality we call genius which cannot be made to order, it can scarcely be doubted that much can be done to foster and assist it.

The nation must be educated to see that the men with high scientific and inventive ability in it, not by any means too numerous, constitute a national asset of inexpressible value. This power, when it exists, should not be allowed to dissipate itself in a struggle to secure the means of living, but be given an opportunity for the fullest exercise and use. There can also be no question that we have it in our power by suitable methods of education to develop such nascent ability.

Our present systems of education, and particularly the system of written examinations which are dependent so much on good memory for success, do much to destroy originality. In spite of all that has been written and said on this subject, we do not seem to be nearer to essential reforms. The object of all education is threefold: first to train character, will, and that power of selecting the best amongst various courses of action which we call right judgment; secondly, to impart necessary information and ability to do certain things well; thirdly, to develop initiative and the power of handling new problems or investigations and a certain alertness in dealing with new situations. Our present methods of education are far too much directed to supplying ready-made and peptonised information.

The great outstanding fact in modern life is the degree to which the energies and materials of Nature are employed to overcome the difficulties created by the increase and concentration of population. We have to make the earth bring forth her increase at a greater rate, to supply the ever-increasing necessities of growing populations and the many artificial wants which have been created by progressive human desires. Hence an absolutely essential part of any complete education is some knowledge of science, and especially of its influence on the welfare of mankind. Yet the people we put in a position of authority over us are, for the most part, not only ignorant of science, but not even interested in it. In our public schools we train boys chiefly by directing their attention to words in the form of the grammar and literature of two dead languages, and we neglect to give them any wide and sufficient knowledge of things—viz., the physical phenomena of the universe in which they live.

Is it, then, any wonder that when these boys grow up and take their places in Government offices, in the Law Courts or on the Press, or any other influential position, they are oblivious to the last degree of events taking place in the world of science which have in them the power to make or destroy national industries or affect the living of large populations? The destruction of the madder industry of France and the indigo industry of India by German synthetic chemistry are now old and familiar stories.

The point, however, to notice is that the scientific chemical discoveries were not allowed to remain mere laboratory feats. They were transformed into successful commercial enterprises. The Badische Anilin- und Soda-Fabrik is said to have expended 1,000,000*l.* and taken seventeen years' work in translating Baeyer's scientific synthesis of indigo into a factory process. But the result has justified the foresight of those who expended it. This is only one instance out of many which could be quoted to show the blows that can be inflicted in this industrial warfare, the weapons in which are not shot and shell, but scientific discoveries and inventions.

The supremely important question is: What are the steps we are taking to train the men who will enable us to hold our own in this commercial conflict? It avails nothing to point out that the beginnings of many of these achievements were laid by British scientific discoveries or original suggestions. A truth or a suggestion which is not followed out or pressed to the point at which it becomes practically productive is like a seed which is not planted in the ground. The intellectual perception of a truth or principle requires behind it the driving force of character and will if it is to pass into the useful stage.

Some people might be inclined to ask why there should be this competition and pressure to invent? What difference does it make who discovers a new fact or makes a new application? If scientific knowledge were a mere matter of intellectual curiosity concerning the secrets of Nature it would not matter much, except for national honour, who made the discoveries or applications. But scientific knowledge has become much more than this. It has become the means of increasing national wealth, and also by which national wealth can be taken away. Again, in virtue of our patent laws, it has become possible for alien inventors to prevent us from even using in our own country in particular ways the waste products of our own industries, as in the case of certain coal-tar products. Hence scientific knowledge can be applied so as to become a tremendous weapon of destruction as well as of national strength. It is for

this reason that we require men to be trained, not merely to make scientific discoveries, but to make useful commercial applications of them, which are wealth-producing or wealth-conserving in a national sense. This requires a peculiar combination of scientific ability and commercial insight, and it is just here that Germany has the advantage.

Mr. Lloyd George said on one occasion that he feared Germany's war-bread spirit, by which he meant the willing subjection of a whole Empire to discipline. We might say, with even more truth, that what is to be feared is Germany's militant chemistry and engineering, or that combination of commercialised science which is relentlessly applied to undermine and take away sources of power of other nations. This, however, is what we have to meet. We have to train chemists, engineers, electricians, and physicists who are not only learned in the knowledge of their science and originative in discovering new facts and principles, but have also a keen commercial sense which directs them to the solution of the practically useful problems. We have, therefore, to create a very much closer union between industry and science. To some scientific men this seems derogatory to the dignity of science. On the other hand, men concerned with the business side of manufacture are apt to undervalue the aid which science can give them. Meanwhile our scientific industries suffer from this dissociation.

In the first place we should aim at bringing about a much more intimate relation between the universities and technical colleges and the factories and workshops, so that the college teaching may result in producing a type of man more useful in the factory. For this reason I am an advocate of the so-called sandwich system, by which the student spends a year alternately in the shop or factory and in the college, the first and third year being at the college and the second and fourth in the shop or factory. This turns out a better type of man than two years at the college and two years in the shop taken consecutively. It should apply not only to engineers in all branches, but to chemists as well.

Then, again, conferences should be held from time to time between teachers and practical engineers and chemists for the exchange of ideas on the subject of the schemes of work and study to be followed by the student-apprentice, so as to turn out all-round men and not unpractical theorists or unscientific practists. We have to improve in many ways our college teaching, so as to expend to better advantage the available time and place more stress on ability to use information than to store it. Engineering and chemical students should be brought much earlier than at present into contact with questions of cost and estimates, so that they may know not only how and why a certain machine works, but what it costs to make it, or to run it. They will then be far better able to take advantage of the workshop training and obtain earlier that "workshop sense" or instinct which looks at everything from the point of view of cost and profit, as well as operation or efficiency.

We have before us a tremendous task to restore the waste of this great war. To do this we have to utilise all waste products and to abolish waste and inefficiency in all departments of life, domestic, commercial, political, and industrial, and we have to get rid of them in scientific work as well. We can only do this by bringing to bear the scientific method upon all these regions of activity and even upon scientific research itself. As a small contribution to this work the above suggestions are tentatively put forward, and with the greatest diffidence I submit them now to your careful consideration.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—A friend of the late Dr. Donaldson, master of Magdalen College, has endowed a bye-fellowship of the annual value of 100*l.*, to be called the Donaldson Bye-Fellowship, in memory of the late master; the fellowship is intended for the encouragement of research, and is tenable for one year. The Financial Board reports that Sir Eustace Gurney has offered to present to the University a farming estate of about 257 acres with a view to the encouragement of the study of forestry in the University; the net income in rent of the estate is about 100*l.* per annum. The General Board of Studies reports that the council of the Royal Geographical Society has decided to make grants of 300*l.* per annum for five years to the schools of geography in Oxford and Cambridge. Mr. H. H. Brindley, of St. John's College, has been appointed demonstrator of biology to medical students, and Mr. C. Warburton, of Christ's College, demonstrator in medical entomology; both appointments are for a period of five years.

LONDON.—The following new doctorates in science are recorded in the *London University Gazette* for February 9:—*Physics*: E. J. Evans (Imperial College—Royal College of Science), for a thesis consisting of three papers on spectroscopy published in (i) NATURE, September 4, 1913; (ii) *Phil. Mag.*, February, 1915; (iii) *Phil. Mag.*, January 1916. *Organic Chemistry*: Biman Bihari Dey (Imperial College—Royal College of Science), for a thesis entitled "A Study in the Coumarin Condensation" (Trans. Chem. Soc., 1915). *Applied Statistics*: Leon Isserlis (University College), for a thesis consisting of the following papers:—(i) "On the Multiple Correlation Ratio," parts i. and ii. (*Biometrika*, November, 1914, and November, 1915); (ii) "On the Conditions under which the 'Probable Errors' of Frequency Distributions have a Real Significance" (Proc. Roy. Soc., A., 92, 1915).

A NOTE in the *Times* of February 10 states that Mr. C. E. Probyn, who died on December 1 last, left estate of the gross value of 14,563*l.*, the residue of which, amounting to about 10,000*l.*, is bequeathed to the University of Bristol.

WE gather from the *Münchener medizinische Wochenschrift* that of the 18,110 students inscribed during the present semester in seven of the German universities, 13,629 are absent in the army, *i.e.* slightly above 75 per cent.

DR. E. H. GRIFFITHS, principal of the University College of South Wales and Monmouthshire, who had arranged to resign at the end of the present session, has consented, at the request of the council, to continue in office until the end of the session 1917–18.

WE learn from the *Pioneer Mail* that the staff has now been selected for the Lady Hardinge Medical College and Hospital at Delhi, which Lord Hardinge opens to-day:—Principal and professor of medicine, Dr. K. A. Platt; professor of anatomy and gynæcology, Miss Hitton; professor of pathology, Miss Field; professor of anatomy, Miss Murphy; professor of chemistry, Miss A. M. Bane; professor of biology and physiology, Miss M. R. Holmer. It is expected that tuition will begin next September, and the Government of India will contribute a lakh of rupees (6700*l.*) yearly to the annual maintenance charges.

THE issue of the *Pall Mall Gazette* for February 8 contained an interesting account of an interview with Sir Philip Magnus, in which he expressed his views