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## The Relation of Universities and Research Institutes to Industrial Development

IN the Report of the Chemistry Research Board of the British Government Department of Scientific and Industrial Research for the triennial period ended 31st December 1937, the following statement is made in the Introduction to the Report of the Director of Chemical Research:

> "During the last 3 years some 20 members of the staff in various grades have resigned to take up responsible positions in Industrial organizations dealing with different branches of chemical manufacture."

In contrast with this may be mentioned a reply given by the Director of the Government Test House, Calcutta, when the remark was made to him that no doubt many of their workers found positions in industrial concerns. The Director's reply was: "On the contrary, we have a number of applications from men holding positions in industry to be taken on to the Research staff at the Test House." This contrast would appear to be significant and to reveal conditions wherein the state of industry in India differs markedly from what exists in England. In the first place, it would seem that the young Indian scientific worker prefers the quiet atmosphere of a Research Laboratory—whether scientific or technical—to the more adventurous existence in an industrial concern. The fact that much of the Research work of the Industrial Research Bureau is carried out at the Alipore Test House would no doubt also add the attraction of Government service to even a humble position. Moreover, in many cases a University graduate will find the surroundings of a factory in India uncongenial after the peaceful atmosphere of the University or the Research Institute laboratory. He will often find no doubt that there is not much scope at present for his academic attainments. It does not require great scientific knowledge, *e.g.*, to notice where steam is escaping from faulty flanges, or where an appreciable percentage of the product of the factory finds its way on to the floors from leaky containers, but it is just this faculty of what was termed by a lady speaker at the Silver Jubilee Meeting of the Indian Science Congress "good house-

keeping", which is a preliminary requirement of success in technical industry.

On the other hand, the desire for a quiet life in a scientific atmosphere is very different from the urge which, we are told, led young W. H. Perkin to leave his Assistantship in the laboratory of the great Hoffmann in order to make a supply of his new mauve dye and to become a somewhat unsuccessful commercial traveller among the calico printers of Scotland, and finally to persuade his father to build a works and to evolve suitable processes and plant, in the first place, for the manufacture of aniline, though he (Perkin) had never been inside a chemical works before. A whole series of other difficulties—chemical and mechanical—had to be overcome before the dye industry was established and Perkin was free after 16 years to go back to his beloved scientific laboratory.

In another field of technical enterprise it is related that one of the members of the "Big Five", responsible for the installation of the "Grid" in England, in the early days of his career was so determined to become a mechanical engineer that he signed on in the engine room of a cargo steamer and braved the horrors of sea-sickness—he was a bad sailor—in order to acquire the real competency which is only to be gained by actual contact with day-to-day difficulties.

It is possible that the reason why engineers often hold more responsible positions in technical industry than do chemists is because in a majority of cases, hard workshop practice, necessitating early morning hours and the wearing of overalls, is part of the customary training of an engineer. Sir P. C. Ray has more than once spoken very frankly about the special disabilities of Indian University graduates. Dr. H. E. Watson, in a recent letter to the present writer, mentions an under-graduate course designed to act as a connecting link between the Faculties of Science and Engineering in the University of London.

On the other hand, it is doubtful whether more than a limited number of industrialists in India really appreciate the possible advantages of the application of scientific knowledge to the operations of their factory.

There need not, however, be undue discouragement. The early records of the Indian Institute of Science show that the first members of the staff were very much concerned at the lack of practical laboratory competence on the part of many of the first students. They possessed a fair amount of book knowledge, but appeared quite incapable of handling even simple experiments in the laboratory. Since those days the outturn of reasonably well qualified graduates in chemistry and physics is more than sufficient to supply available vacancies. Nevertheless, the number of those who are really in a position to take responsible posts in industry, as apart from simple positions as analysts or subordinate supervisors is still small. Complaints are still heard of the lack of what may be termed "bench craft" on the part of the average University graduate. The lack of "machine sense" and of the capacity of making intelligible drawings is also remarked by responsible people.

It would seem likely that Indian scientific education has been somewhat circumscribed and one-sided. In the early days of what was then known as "technical education" in England, the need for which was awakened in the seventies by the phenomenal progress of Germany, the appeal was made to a rather wider public than has necessarily been the case in India. Great men like T. H. Huxley and Sir Henry Roscoe lectured to audiences of industrial workers and intelligent middle class amateurs, awakening an interest in the outstanding discoveries of the science of that time, and powerfully influencing the type of education to be introduced into the elementary and secondary schools then coming into existence. It was Huxley who emphasised the educative influence of drawing. The following is taken from a volume of his "Aphorisms and Reflections":—

> "I do not wish to exaggerate but I declare to you that in my judgment the child who has been taught to make an accurate elevation, plan and section of a pint pot has had an admirable training in accuracy of eye and hand."

Unfortunately in India, although no one doubts the practical manual dexterity of the Indian workman and the intelligent fitter or mistry, these men are often illiterate while the educated graduate has not acquired the practical competence of the workman. The habit of taking verbatim notes of lectures goes far to kill the real faculty of assimilation. By contrast an incident related as having happened in the early days of the Manchester Technical School, later to grow into the Manchester College of Technology, may illustrate the point. A working man took his place in an evening class and prepared to listen to the lecture. He was reminded that he had not got a note book. "What would I want a note book for?", he said. "To write down what the lecturer says", he was told. "What should I do that for?" he asked. "In case you might forget". "Wot's me blinkin' 'ed for?" was his final and sufficiently crushing response. If the education in the primary and secondary schools and in the intermediate colleges is made less academic and the aspect of craftsmanship stressed at every stage it will not be so difficult for the University and the Research Institute to take up the problem at a later stage.

At this point the difference may be emphasised between the type of work which can be usefully carried on at a University as distinct from a Research Institute. The University is concerned with general education rather than specialist investigation, at any rate of an industrial type. Nevertheless the work done at the University can be of great importance in preparing the student for his future career in industry. The subjects of "bench craft" and drawing have already been referred to. In the later stages research work of an industrial bearing, which yet can be taken up in the University without serious alterations in the syllabus and equipment, has been indicated in an admirable paper published by Dr. T. S. Wheeler in the *Journal of the University of Bombay*, Vol. I, Part II, September 1932. Dr. Wheeler shows how the various types of chemical development research may be classified broadly as follows:—

1. Production of a new product.
2. Production of an existing product by a new process.
3. The improvement of an existing process.
4. The transference of a known reaction from the laboratory to the technical scale.

He goes on to show the fundamental characteristics of new processes, *viz.*, the ready availability of raw material and the control of external conditions particularly pressure, temperature and electrical external conditions. The problem of the transference of a known reaction from the laboratory to the technical scale is intermediate between the task of the University and of the Research Institute or the actual factory. Even here experiences which have been related by several of those who have delivered the Streatfield Memorial Lecture under the auspices of the Institute of Chemistry have testified to the success of the homely methods employed by Streatfield at the Finsbury Technical College to awaken "technical sense" amongst his students. Thus we are told that one of the exercises given to them was the distillation of 2 or 3 gallons of coal tar separating the various fractions and preparing specimens of as many substances as could be isolated. The distillation was carried out with a small scale iron retort in a room downstairs. Almost invariably a too rapid heating during the initial stages resulted in an uncontrollable frothing when the water began to boil. Streatfield did not forget to point out the moral which the necessary cleaning up made unforgettable.

In the University may, and should be instilled, those qualities of *character* which

are essential for success in any technical enterprise of moment. It is sometimes forgotten by the academically-minded that success in the honest development of a great productive business calls for qualities equal to or even more admirable than those developed by scientific research. This is rightly recognised in Government Honours Lists and even, of late years, by such a body as the Royal Society. It has been pointed out by responsible authority that the practical working out of a new process, while it may not result in many publications in scientific literature, yet calls for an equal or even greater truly scientific ability. Moreover, such work inevitably entails the development of the team-spirit, the need for which among scientific workers has been eloquently referred to in the Presidential Address of Dr. J. C. Ghosh before the Lahore meeting of the Indian Science Congress.

The importance of the cultivation of the *inventive* faculty has been stressed by the present writer in another connection.* How far opportunities for the cultivation of this faculty are multiplied will depend very largely on the experience and personality of the teacher. A danger which besets the graduate whose training is confined to the University is a tendency to a purely laboratory outlook. It has been fairly argued that in India owing to the fewness of manufacturing centres and the great distances between them it is very difficult for many University students to visit actual factories. With the modern development of the cinema it should be possible without too great expense to exhibit to even elementary classes, films illustrating fundamental technical processes more vividly than the old-fashioned diagram or model.

The Research Institute differs from the University in the fact that it is concerned as a rule with the study of a single industry or at most of one or two. It is, therefore, possible for much greater expenditure to be incurred in equipping the specialist department with the plant necessary to carry out technical work on a scale, at any rate approaching that of the actual factory. India has been fortunate in the multiplication of such Institutes of recent years, Iron and Steel can be studied at Jamshedpur, Fuel at Dhanbad, Sugar and Oil at Cawnpore, Electrical Technology at Bangalore and Lac at Ranchi. These centres are mentioned as being concerned with technological rather than techno-agricultural research such as the several institutions sponsored by the Imperial Agricultural Research Council.

Government has been criticized for not having shown the same generosity towards Technological Research as in the case of agricultural investigations. It would seem, however, that the work already done and still being pursued by the Industrial Research Bureau, working under the guidance of the Imperial Industrial Research Council, has not been sufficiently recognized. In the first place and at the outset of its work an admirable bibliography of industrial publications was compiled and is available at the Government Press. In addition, no fewer than 13 valuable Bulletins dealing with such subjects as the Indian Glass Industry, Manufacture of Photographic plates in India, the Development of Heavy Chemical Industries in India as well as several important aspects of the Oil and Soap Industry have been published. The Bureau, it may be remembered, has only been actively at work during less than 4 years. The laboratories of the Industrial Research Bureau are being continually extended and work of great importance is in progress concerned particularly with standardisation of manufactured articles, the testing of liquid fuels in engines, the study of the weather-resisting properties of paint products and the manuacture of dry cells. Important work has been undertaken in connection with the glass industry, involving the design and operation of a special furnace.

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* Address to the Institution of Chemists (India) entitled: "Research and Invention" on 26th August 1938. *Proceedings of the Institution of Chemists (India)*, Dec. 1938, **10**, Pt. IV.

There is no doubt, however, that the work of the Bureau could be greatly developed if sufficient funds were provided to enable it to extend its area of usefulness in *liaison* with the Universities and the Research Institutes. In a recent lecture on Research in the Iron and Steel Industry, published by the Institute of Chemistry, Dr. W. H. Hatfield, F.R.S., gives a table showing the number of official organizations co-operating with the Research Council and Research Committees. There are nearly thirty of these organisations including four Universities and several University Colleges and a number of Professional Institutions and Research Associations.

It is doubtful whether it is fully recognized, either by those in financial authority or by would-be *entrepreneurs*, that the development of a new industry or even of a new process entails usually the expenditure of very large sums of money. Even those who were closely associated with Ludwig Mond in the early days of the Brunner-Mond Works at Winnington, Northwich, were sometimes almost appalled at the way in which he would scrap an expensive plant and build another if he saw that certain lines of investigation were not worth pursuing. The amount of money necessary to be expended before the simple laboratory apparatus, in which nickel-carbonyl was first prepared, could be developed into the plant of the Mond Nickel Company, must have been enormous. That is why even in the laboratory exercises of a University course, attention should be paid to the question of yield of product and the prevention of wastage at every stage. There is no doubt also that those who are to take their place in technical industry should, at some stage of their early career, have a fairly rigorous training in business methods and fundamental economics.

However near the technical laboratories of the University or the Technological Research Institute may approach to real factory conditions, they can never be a substitute for real experience in the actual world of industry. It is possible, however, although not always easy of accomplishment, to create as we have seen in the case of the Iron and Steel Industry just quoted a close connection between the University or the Research Institute, and the industrial concern. This is easier if the industry is more or less of a public character or if the technical problems to be investigated are concerned with activities natural to a Government or Municipality. Thus in Manchester, the Electricity Department and the Rivers or Sewage Purification Department of the Corporation maintained close touch with the University laboratories to their great mutual advantage. The beginnings of such co-operation are already evident in India as has been mentioned in a former article in *Current Science*.† Where possible, the teaching staff in a Research Institute or in the Technological Department of a University should be recruited from those who have combined both academic training and practical and responsible experience in the industrial world.

On the foregoing lines existing institutions in India may play their valuable part in helping forward the industrialisation which, it is generally agreed, is necessary if the future growth of the new Indian nation is not to be one-sided or limited.

It must, however, always be remembered that the urge to industrial development in the West derived its original impulse mainly from individual men of genius and vision. India also owes much to such men as Jamsetji Tata, Sir P. C. Ray and their associates. Soon it may be hoped that the facilities provided by the generosity of Laksmi Narayan and other wealthy benefactors will also bear fruit. The fulfilment of the great ideas present in the minds of such pioneers will require the loyal and keen enthusiasm of younger India and the support of widely diffused and intelligent public opinion.

GILBERT J. FOWLER.

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† "Water Pollution Research," *Curr. Sci.*, January 1939, pp. 3–5.