of the improvement of existing methods and materials. Something can also be done, he said, to educate the consumer in the use of new materials, and more attention to the relations between consumer and producer is required. This is the reason for the importance of the liaison officers of the research associations, and although Sir Arthur did not himself refer to this aspect of their work, it is related to the operational research which he cited as an outstanding example of bridging the gap between scientific discovery and its practical application. Sir Claud Gibb dealt with the heavy capital cost of development, and the importance of intimate contact between the designer and research worker; but even for the engineering industry, his suggestion that if every research worker had a little more commercial instinct there would be less of a gap between science and industry seems a little naïve and confuses the functions of management and investigation.

While Prof. H. E. Hackett was critical of the training in engineering schools, that aspect was not further pursued in the discussion; but Dr. A. T. Bowden strongly supported Sir Andrew McCance's remarks on the importance of scientific and technical knowledge at the managerial level; the main problem, he said, is not so much one of new materials as of making better use of existing materials. This was a main theme of Sir Henry Tizard's remarks in concluding the discussion. Sir Henry said that there was very little in Sir Arthur Fleming's address with which he would disagree; he expressed the view that we are unlikely to be far behind when it comes to industrial application in the study of nuclear phenomena: if we were, it would be due not to shortage of experienced scientific men, as Sir Arthur suggested, but rather to the shortage of engineers with the right kind of education.

Sir Henry then returned to the theme of his presidential address to the Association last year. Unless we can hasten the application of science to industry in Britain, we shall cease to count among the great nations of the world. We can only escape disaster if we make things better and cheaper, and if we are bold and adventurous in industry. There must be changes, and on a big scale, if we are to recover our balance and maintain our standard of living. Nevertheless, the need for extending facilities for fundamental research, he said, needs no emphasis; in quality and quantity, fundamental research in Great Britain is unsurpassed in any other country, and it is true to say that fundamental knowledge is being acquired faster than it can possibly be applied in industry.

To secure the more effective utilization of existing knowledge is partly a matter of education—of scientific and technical education in all branches and of education for management. That, however, is a slow process, nor did Sir Henry suggest that the industrial research associations as yet provide the right answer and are able to meet the needs of the hundreds of small industrial units unable to support extensive research laboratories individually and often managed by those who are not likely to understand scientific reports. Even large industrial units are sometimes reluctant to embark on adventurous projects, possibly because they are not prepared to risk the capital expenditure on development. Sir Henry suggested that the possible deterrent effect of fiscal laws on development is a subject worthy of dispassionate discussion between sections of the Association. He is convinced that we must find a way of spending far more on development, large-scale application and re-equipment than we have done in the past. It is almost useless to extend the facilities for scientific and industrial research unless we are prepared to take promising results a stage further. It may be that the ability and willingness to finance new and unproved developments and processes, rather than the volume of research, really determine the rate of application of science to industry, and Sir Henry sees in the study of the capital equipment of British industry and of its rate of obsolescence a useful field for combined effort by engineers and economists.

TECHNOLOGY AND THE HUMANITIES

FOLLOWING the presidential address to Section L (Education) of the British Association, delivered on September 2 by Sir Fred Clarke, a discussion took place on "Technology and the Humanities in Further Education". This was introduced by two short papers on the subject, one by Prof. A. F. Burstall, of King's College, Newcastle, who spoke from the academic point of view, and a second by Mr. K. R. Evans and Mr. B. J. Crowther, of Metropolitan-Vickers Electrical Co., Ltd., Manchester, who spoke as industrialists. The authors of both papers were emphatic that the further education of the technologist should include the humanities as well as advanced technology; both were equally insistent that the character and personality of the teacher are all-important to success.

The first paper was devoted to considering what is being done, and could be done, for undergraduates destined for a career in industry. Prof. Burstall described how some humanities have been introduced into the final year of one of the engineering degree courses at Newcastle; the new course includes some special lectures for engineers on economics, accountancy, industrial health and industrial psychology given by the professors of those subjects, as well as lectures on factory management and a course of technical report writing. The results indicate that this kind of work tests some other quality of mind which is not tested by examining in technical and scientific subjects, since there is no correlation between the marks in these special subjects and those in the others.

Prof. Burstall concluded that since the standard in mathematical subjects of an engineering degree course is continually rising, and there is a growing insistence upon the possession of a university degree for so many posts in industry and Government, there is a danger that ultimately all engineering work will be dominated by mathematical minds. He thought this would not be a good thing. "There may be men of character and of value to the engineering profession who cannot stomach the mathematical discipline—they may be fascinated by engineering work and determined to succeed at it, some having the creative type of mind that is often undisciplined, others administrative ability amounting almost to genius. Are these men to be deprived of a university education?" He thought that some alternative courses should be offered for those who cannot achieve the standard in mathematical discipline now required at the universities. "The question is what other discipline can be substituted for the mathematical one without lowering the standard ?" His own preferences are for logic, economics and psychology, or for a training in creative work—design or construction. Possibly all these could be combined with some engineering studies; but almost inevitably the length of time required to achieve a reasonable standard would be longer than is needed for a training in the mathematical technique.

He explained the practice of the University of Durham in admitting a small number of students to the engineering courses each year who had the Higher National Certificate in Mechanical Engineering as their qualification for admission. Some of these students had been very successful, but the greatest difficulty they presented was how to select the best of those who apply for the small number of places available.

Those who advocated making management a closed profession like the medical profession wish to see university degrees in management made a compulsory requirement for anyone holding a managerial position. The universities have not responded enthusiastically to the suggestion that they should provide courses in management, and there is little or no provision for those who intended to make management studies their postgraduate work.

The best solution Prof. Burstall could offer for bringing together technology and the humanities in further education was a combination of four main studies over four years: (1) philosophy (logic and ethics); (2) economics (including the principles of accounting); (3) the principles of physical science (mostly applied science, including machine drawing and some laboratory work—taught with the minimum of mathematics); and (4) biological science, with emphasis on public health, safety and industrial psychology. Such a training ought to make the successful candidate worthy of a bachelor's degree.

Mr. K. R. Evans and Mr. B. J. Crowther were concerned not only with university graduates in engineering but also with other apprentices, including trade apprentices, to whom further education is given during their works apprenticeship. They asserted that practical experience in the humanities is gained by apprentices in the course of their human relationships in the works, especially in running the apprentice associations. These are administered by elected apprentices who receive only guidance from the staff of the works education department. They administer the social, recreational and athletic activities of the association and produce their own magazine. Senior apprentices also take part in assessing applicants for apprenticeship when they visit the works for interview.

Messrs. Evans and Crowther also described the teaching of social and economic history as valuable to apprentices, and said it is best approached through the history of engineering, particularly that of the local industrial area. The selection of subjects for further education of the manual or unskilled worker is a difficult problem. "Those industries in which the manual operations are repetitive and whose management grades are less likely to be derived from those who started their working life as manual workers, will find more difficulty in instigating formal or informal studies in cultural and non-technical subjects, not necessarily because the workers lack intelligence or even basic education, but because there exists no ready-made study interest on which to build."

They recommended sending young workers for a short period for a residential course, such as that given at Rugby School. The selection should be made not from those who would be a credit to the company, but from the type of young person who is in need of just such an experience.

During the ensuing discussion, it was suggested that justice had not been done to the technical colleges, which had scarcely been mentioned, though in many places they are becoming local colleges of education rivalling the universities in the variety of subjects taught. One principal of such a college thought they did much to bring the humanities and technology together in further education, and appealed for a wider development of residential facilities, so that the technical colleges could extend this side of their work. There was general agreement that the conventional type of engineering course does not develop the qualities most needed in administrative work, and one speaker referred to the present difficulty of finding suitably qualified men to occupy posts in the higher levels of administration, particularly in the nationalized undertakings.

There was a marked difference of opinion about interesting students of technology in art, music and literature. Some had been unsuccessful in their attempts to do this, and had given it up; another referred to outstanding success in this endeavour achieved by the Scandinavian colleges. One speaker asserted that pure science is just as effective as logic in teaching a student how to think. This was challenged by a later speaker, who referred to the report on "Transfer of Training" published by Section L of the British Association in 1930.

Several speakers mentioned that students of languages and of the arts would be all the better for some knowledge of technological matters.

CONVERSION OF MANNITOL AND SORBITOL INTO DULCITOL

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In a recent publication[1], the preparation of 1 : 6-dithiomannitol is described. In subsequent attempts to obtain this dithiol by other routes, two of us (L. N. O. and P. B.) have treated 1 : 6-ditosyl 2 : 5-diacetyl 3 : 4-*iso*propylidene mannitol[2] with potassium thioacetate in boiling acetone, a reaction which has been shown[3] to result in the replacement of tosyloxy- by acetylthio-groups. Removal of the acetyl and acetone residues from the product gave crude 1 : 6-dithiomannitol, m.p., 120–135°, the hexa-acetyl derivative of which had m.p. 109–111° $[\alpha]_D^{18°}$ + 85·0° (all rotations in chloroform). This was clearly not identical with the previously described hexa-acetyl 1 : 6-dithiomannitol of m.p. 188°, $[\alpha]_D^{18°}$ ± 0°.

The latter material had been prepared by the action of potassium thioacetate on the so-called tetra-acetyl 1 : 6-dibromo 1 : 6-dideoxymannitol of Vogel[4], and since it was unlikely that any abnormal reaction could have occurred at that stage, it was decided to investigate the structure of Vogel's