sharpened the interest in research of those who control the public purse, and as a result every facility was provided for promoting an investigation which in peace-time would probably have received scanty support. It is known that the Germans as well as ourselves were seeking the solution ; but, fortunately for the world, they were not able to achieve practical results.

Nevertheless, the very successfulness of the investigation induces a feeling akin to dismay that science should contribute such an engine of destruction to the world. This feeling must be put aside, though the possibilities must never be forgotten. We must remember that this new source of energy now being tapped, "long mercifully withheld from man", as Mr. Churchill wrote, can and must in the years of peace be harnessed to the needs of industry, to supplement the forms of power now in use. Research into the regulated release of atomic energy, if this has not already been achieved, will be carried on from a new basis and with redoubled energy. No doubt much painstaking work will be necessary before the new source of energy can be utilized in economic competition with fuel and wind- and water-power, but the present position clearly holds possibilities of the utmost significance.

There is another facet of the world situation which this scientific and technical development has brought to the forefront, namely, the immense responsibility now placed in the hands of those with exact knowledge of the steps necessary to release atomic energy. It has been stated that adequate measures have been taken to secure patents on all vital processes, and all rights in such patents have been assigned to the Governments concerned. At present, this must mean that the United Nations, and especially Great Britain, the United States and Canada, hold in their hands a weapon with which they can dominate the world—a responsibility the discharge of which will require the highest degree of statesmanship. They also hold a potential source of power capable of contributing immensely to the welfare and material progress of mankind—a further and even greater responsibility. How will they use it ? Governments are notoriously impersonal, and they come and go. It therefore devolves upon the individual, be he man of science or layman, to understand the potentialities of atomic energy, even if he comprehends little of the method of its release ; and to ensure that his elected representatives, from whom his Government is chosen, are also aware of their responsibilities in the matter. It is not a matter of exact knowledge so much as an appreciation of right and wrong in dealing with our neighbours, who are now every nation of the world ; indeed, the alternatives would seem to be an international brotherhood of nations or chaos. There can be no question of halting investigations until mankind is fitter to receive them ; if material research has outstripped the progress of knowledge of man, then the tempo of investigation of man as a social being must be increased until both can progress, side by side, carrying man onwards to the higher ideals of life for which the best of each generation are always striving.

MAN-POWER AND TRAINING IN THE SCIENTIFIC INSTRUMENT INDUSTRY

IN an article in *Nature* towards the end of 1943*, attention was directed to the dependence on a live and efficient scientific instrument industry in Britain of the hopes that the technical and research resources and facilities of industry would be raised to a level which would allow of full application being made of scientific knowledge and of advancement in that knowledge. Further, it was pointed out that in no branch of industry is the need of technical knowledge and facilities greater than in the scientific instrument industry. At the time these observations were made, the manufacturers of scientific instruments and equipment were completely occupied in fulfilling the demands of the Government in respect of war requirements and, indeed, this state of affairs still persists. It is, however, reasonable to suppose that the post-war period now lies in the near, rather than in the distant, future, and it is opportune to review the position of the manufacturers of scientific instruments and of laboratory equipment in relation to their ability to meet their vital commitments to the nation during the period of the re-creation of national prosperity.

Two factors which are vital to the efficient manufacture of scientific instruments and equipment are craftsmanship and technical knowledge in its widest sense and, while neither was in a very healthy condition before the War, both have certainly been adversely affected by the War. The desperate demands on man-power of the Fighting Services during the past six years have inevitably resulted in the scientific instrument industry, in common with all other industries, being engaged in a losing battle with the Ministry of Labour and National Service for the retention of its craftsmen and technicians. Moreover, for six years the industry has been engaged in the mass-production of instruments for Service use, and it will be appreciated that, excellent as the British war-time instruments have been, there is a vast difference between the delicacy of instruments designed for accurate measurement under reasonable conditions and that of instruments required to be as accurate as possible under the very robust conditions which must exist in the tank, aeroplane and other engines of war. In consequence, the craftsmen, generally those of mature age and experience, who have remained in the industry, have not been required to exercise their craft to the full, and will, to some extent, have to regain their skill. As regards technicians, the demands of the research and development departments of the Services have been such that it has been impossible for the industry to avoid losing much of its technical personnel, and have prevented any recruitment being made by the industry to make good its technical deficiencies. Further, the large extent to which development has taken place within Service departments has reacted unfavourably on

* *Nature*, **152**, 704 (1943).

the maintenance of efficient development in the industry itself. The industry therefore faces its post-war commitments under the shadow of a very serious deficiency both in craftsmen and technicians; and, in view of the vital function of the scientific instrument industry in the national life, the position calls for serious thought and remedial action.

It has already been remarked that craftsmanship and technology within the scientific instrument industry—and indeed in all industries—have not been what they should or might have been; and it is an encouraging sign that there is a general recognition of this fact within the industry itself, and that serious consideration is being given to the means of ensuring a marked improvement in the future. It is evident, however, that any policy which may be adopted to this end must be a long-term one, for neither craftsmen nor technicians in sufficient numbers can be produced by any means other than by education and training over a long period. It is well that such a policy should be pursued, but it must be realized that three immediate tasks, which cannot depend on any long-term policy, confront the industry: the home demands for instruments and equipment in the industrial, educational and other civil spheres must be met, and it should be noted that the industry is already some two years behind in the fulfilment of orders; the industry must take its full share in the rehabilitation of the technical facilities of liberated Europe; the industry's export trade has to be recovered and extended, and it is relevant to observe that foreign governments have long realized that the scientific instrument is, from every point of view, the ideal article for export. If these tasks are to be carried out with some measure of adequacy, a short-term policy must be evolved which will ameliorate the conditions at present existing in the industry. The continuing war in the East must necessarily restrict the possibility of certain procedures being adopted, but it is well to state the actions which might be taken to instil confidence in the industry as it faces these tasks, and to increase its competence to carry them out. Three of these actions may be briefly stated. There are craftsmen in the Armed Forces whose service may continue for some considerable time: their release would confer great benefit on the industry. There are young craftsmen who have achieved a considerable degree of skill but who will normally be called up for service in the near future: their retention in the industry is most desirable. There are older and more mature craftsmen in the industry who have been long starved of the opportunity to exercise their peculiar skill in full measure: encouragement to the industry to recommence, even on a limited scale, the manufacture of its civil and export products would not only provide a preparation for production for the future, but also would furnish an excellent refresher course for these craftsmen. No such encouragement has yet been received.

What has been said of craftsmen applies, to some extent, to technicians, but the formulation of a short-term policy to meet the technical needs of the industry presents considerable difficulty. Scientific instruments and equipment are produced in Britain by relatively small firms which are distributed over the whole of the country, and, in consequence, it is almost impossible that adequate technical facilities should exist in every individual firm. Here then surely is a case in which, certainly for some years, a considerable proportion of the technical, and especially the research, facilities of the industry must be found in its research association. The British Scientific Instrument Research Association has evolved a scheme of expansion which, if quickly achieved, should go a long way towards covering the whole field of problems associated with the manufacture of scientific instruments. It would seem that in whole-hearted co-operation with its research association lies the best hope of the industry to resolve its technical difficulties, at least until any long-term policy to deal with the technological aspects of instrument production has had time to affect the situation.

Any immediate action which may be taken to meet the pressing need of the moment should in no way prejudice the pursuance of policies by the industry to overcome deficiencies in craftsmanship and technology. In a book recently published*, Mr. F. Twyman has described the rise and fall of the apprenticeship system and has put forward a passionate plea for its revival. It is only too frequently true that apprentices to-day receive no systematic instruction in their crafts but have of necessity to pick up their knowledge as best they may. The training of apprentices cannot be fully efficient while their work is considered to be an integral part of production, and it would be of inestimable worth to the industry if a scientific instrument apprentices school were established from which a steady stream of trained craftsmen could flow into the industry and thus provide a solid core of craftsmanship. The wide distribution of the industry renders any local system of training very difficult, but it is conceivable that united action by the entire industry might evoke the co-operation of the Ministry of Education and result in the establishment of a true school of apprenticeship for scientific instrument makers, which might effectively resolve the question of craftsmanship and would constitute a national asset. The provision of technicians in the industry will be vitally affected by the nature of academic and technical education in the future. In this connexion the recommendations of Lord Eustace Percy's Committee will be awaited with interest. Again, the hope may be expressed that in the post-war period a far more adequate liaison will exist between the academic scientific worker and the industrialist than has been the case in the past. The research association movement has now achieved considerable dimensions and a large measure of stability, and forms a very useful halfway house between science and industry. The research association would seem to provide a very convenient channel through which scientific men who desire to enter industry might well pass in their transition from academic to industrial life.

Long-term policies, however, cannot affect the

* "Apprenticeship for a Skilled Trade." By F. Twyman. (London: Charles Griffin and Co., Ltd., 1944.) 5*s*. net.

immediate future. There is every reason to anticipate that victory over Japan will not be long delayed, and that, in the near future, industry in Great Britain will be called upon to make perhaps its greatest effort in order to secure the future well-being of the country. There is no more important tool in industry than the scientific instrument, and it is to be hoped that no unnecessary restriction imposed at the present moment will cause the manufacturer of scientific instruments to falter when the demand is made on him for the tools vital to the technical rehabilitation of our national life.

VOLCANIC FORMS AND STRUCTURES

Volcanoes as Landscape Forms

By Prof. C. A. Cotton. Pp. xv+416. (Christchurch and London: Whitcombe and Tombs, Ltd., 1944.) 32*s*. 6*d*.

IT is no accident that the varied landscapes of New Zealand should have stimulated Prof. Cotton to enrich the literature of geomorphology with a series of books of outstanding interest and importance. In no other country of comparable size can a greater variety of geological agents and processes be seen in active operation, and since land-forms result from the interaction of the internal and external processes, it follows that New Zealand is a geomorphologist's paradise.

In his latest work Prof. Cotton gives us for the first time a detailed and systematic account of volcanic land-forms and their subsequent modifications. Along this line of approach, discussion of theories of vulcanism and petrogenesis is not to be expected. Nevertheless, the author devotes six introductory chapters (Part 1) to the mechanism of volcanic activity, and when he comes to volcanic landscapes (Part 2) he continues to adopt a treatment which, throughout the ten chapters dealing with the primary forms of construction and destruction, is quite rightly genetic as well as descriptive. The last two chapters, which deserve expansion and might well have formed a third part, are concerned with the erosion and dissection of volcanic plateaus and mountains. Volcanic contributions to atmosphere and ocean are briefly discussed in an appendix.

The author emphasizes the fundamental distinction between (*a*) dominantly lava volcanoes, mainly basaltic, and characterized by relatively quiet effusion; and (*b*) dominantly pyroclastic volcanoes, generally emitting more silicic materials and characterized by explosive eruptions, which not infrequently reach catastrophic intensity. An attempt is made to correlate this striking contrast in behaviour with the chemical compositions of the lavas concerned. Attention is directed to the importance of iron oxides in promoting mobility and high temperature (by reaction of Fe_2O_3 with juvenile hydrogen), and it is surmised that the high viscosity and lower temperature at which the more silicic lavas commonly arrive at the surface may be partly due to their lower content of iron. The development of this idea in relation to other elements is less happy. Thus, after suggesting that the peculiarities of the Vesuvius eruptions may be related to the highly potassic character of the lavas, the author goes on to say (p. 63): "The lava of Etna also is a potash-rich basalt, and the activity of Etna is not very unlike that of Vesuvius". Actually, the lavas of Vesuvius are leucite-tephrite with 7·5 per cent of K_2O, while those of Etna are andesitic basalts with only 1·6 per cent. Moreover, on p. 47, it is wrongly assumed that the dome-building volcanoes of central Africa are basaltic. Far from being basaltic, the lavas of Nyamlagira and Ninagongo are felspathoidal types with 3·5 and 5·5 per cent of K_2O respectively. These examples add point to the author's own warning (p. 63), based on the eruptions of Tarawera, "against too confident prediction of the eruptive properties of magmas from chemical composition".

Other warnings may not be out of place in relation to Part 1. Admittedly the problems of mechanism remain intractable, but no useful purpose is served by the uncritical reiteration of immature or untenable hypotheses. Jaggar's conception of the mechanism responsible for the Hawaiian cycle of activity might be of value if it were intelligibly expressed, but on pp. 33–34 the author, like earlier writers (including Jaggar himself), merely succeeds in befogging the reader. Again, in dealing with the sources of magma on p. 46, it is unfortunate that Hobbs's naïve and unacceptable assumption that local relief of pressure leads to the fusion of sediments should be cited, especially as attention is directed later on to the necessity for changes of composition by introduction of emanations from the depths.

Part 2 is concerned with less controversial topics and is an invaluable storehouse of information, admirably classified and discussed, and so thoroughly up to date that the new Mexican volcano, Paricutin, and the 1944 eruption of Vesuvius both receive appropriate mention. The chapters deal in turn with basaltic domes and cones; lava plateaux and plains; lava fields and their minor relief forms, including lava surfaces, fire fountains and their effects, bombs and spatter cones; coulees (the thick tongue-like convex flows of viscid non-basaltic lavas), tholoids (spreading cumulo-domes exuded in and over craters) and plug domes of piston-like protrusion; *nuée ardentes*, ash showers and ignimbrite sheets (a chapter that deserves special commendation); ash-built and stratified cones, with a good account of lahars of various kinds; maars and meteor craters; submarine eruptions and pillow lavas; craters, calderas, volcano-tectonic depressions (for example, that of Lake Toba) and volcanic lakes; the dissection of basalt and ignimbrite plateaux; and finally the erosion of volcanic mountains. In this last chapter welcome features are the accounts of erosion calderas and the planeze stage of dissection, a *planeze* being a dwindling sector of the initial constructional surface, surviving for a time between deeply eroded consequent valleys. The section on volcanic skeletons is, however, disappointingly brief. The collection and correlation of successive members of denudation series is a long-overdue task which Prof. Cotton is well equipped to undertake successfully. In particular it should be possible to trace ring structures from the surface manifestations developed on volcanoes such as Kilauea, Mauna Kea and Niuafo'ou, down to the ring-dykes and cone-sheets revealed at the roots of old volcanic centres, as in Mull. As it is, ring structures receive scant attention; and in Fig. 7 what are obviously cone-sheets are wrongly described as ring-dykes.