Optical Technology.*

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IN recent years the sciences have certainly reached a high state of development in India. The original contributions, reckoned either by their quality or quantity, constitute a record of which we could be proud. But when one considers the extent of knowledge of a practical character that prevails in the country which is necessary for the manufacture of apparatus with which these researches are carried out, one will make rather dismal discoveries. Not only is there a complete lack of instrumental skill but there is also a sort of contempt for the acquisition of that knowledge and skill. There is also a tendency to regard such knowledge and skill as purely mechanical and unscientific. I do consider this tendency highly detrimental to our material progress; the science of Physics comprises also applied and industrial aspects capable of extensive commercial application and it is high time that we concentrate and direct our scientific knowledge to this much-neglected direction and produce results

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of the greatest economic importance to the country.

I am particularly anxious that I should not be misunderstood. Theoretical researches will and should be going on under those specially inclined for it, but whatever we try to do by spending the country's feeble resources it should be useful and calculated to benefit the large suffering population.

We already see before us the sorry spectacle of a modern mechanical civilization coming into violent contact with a simple agricultural population. It has just educated them to increase their wants for manufactured articles before teaching them to manufacture them themselves. We find a similar deplorable state of affairs prevailing in the field of science as well. To take a simple example let us consider the familiar Raman effect. It is true it has given us international reputation. But it has not served to feed us. It has promoted the manufacture of a large number of costly spectrographs and their accessories in other countries. But in our own country it has only helped us to increase our imports of these very costly apparatus. Although I have the greatest admiration for the academic triumphs of our countrymen, I cannot but help feeling that some at least of these men would have done much better if they had directed their knowledge of physical science to the making of these costly spectrographs and their accessories. Work of this character does belong rightly to men of these academic attainments as well for in the design, construction, testing and adjustment of these instruments one finds ample scope for every variety of scientific knowledge. The very cost of these apparatus makes it worthwhile for an M.A. or M.Sc., getting in India barely Rs. 50 a month to engage himself in producing apparatus costing more than Rs. 2,000 a piece.

In work of this kind I find that the ratio of the cost of the finished product to the cost of the raw material range anywhere from ten to fifteen. The capital outlay required is comparatively small and hence particularly suited to small-scale production by individual efforts. Thus it is a line most directly suited to employ modern scientifically educated Indians. But as things are at present in India with our education in the universities running purely on academic lines divorced so much from practical realities with little insistence on knowledge of detail and practical skill, it is almost impossible to use the educated material available to-day for any such purpose. It affords in a way an explanation for there being so little of scientific instrument making in India to-day notwithstanding the enormous scope for it in this country.

Subjects like high class optical work on which is based the construction of spectrographs remain practically unknown even in the highest academic circles in India. To combat this deplorable position, we, at the Madras Presidency College Physics Department, have been devoting some attention to Optical as well as other aspects of Instrument Technology for the last ten years. We have been able to develop successful processes and methods for the production of high class optical surfaces—both large and small, plane and curved. There might be a feeling whether these products of ours finished by research students as by-products of their optical researches are exactly equal in quality to those imported from abroad. We are quite alive to our imperfections; at the same time the results achieved are very encouraging and our optical products employed under comparable conditions often give pretty much the same performance undistinguishable even by experienced workers.

There seems to be a universal belief even amongst scientists that work of this kind is based upon a large number of trade secrets. This appears to be largely untrue. At the same time it must be remembered that every successful work cannot but be having its own special processes developed by years of experience in the field. These cannot, by their nature, be public property. Beyond this I do not think there is anything of the nature of specially guarded secrets in the optical industry.

The raw material, optical glass, in any quality (dispersion) is easily purchaseable from well-known makers like Messrs. Chance of Birmingham. It is different from ordinary glass in that it is very homogeneous in composition and perfectly annealed to free it from double refraction arising from strains. It can be obtained from the makers in any size and shape. The next material is carborundum powder sold in a variety of grades of fineness. By working the glass against cast iron tools using a paste of carborundum powder and water as abrasive the glass surface can be made plane or curved as desired and given the requisite degree of fineness. This fine ground surface is then rubbed on a surface of pitch using a paste of rouge and water as the polishing medium, which results in the surface developing rapidly a good polish.

So far the work may be said to be mechanical and the piece of the article has barely doubled the price of the raw material used. Next comes the difficult and careful operation of figuring which alone gives the finished piece the optical perfection and is responsible for its proportionately high price. During this operation frequent optical tests, involving considerable scientific understanding of the factors involved, are required to control the work; and if one fails to make the correct interpretations of the appearances and adopt the proper remedial measures, articles of the required finish and accuracy are never attained. Foucault's tests for concaves, Newton's rings tests for planes and complimentary surfaces in contact are fields where our graduate physicists can find ample scope for the physics they have studied.

Very many optical pieces that are required in such large numbers in laboratories for conducting the routine teaching operations do not require any very high class finish and figuring and they can easily be made in India to-day. Work of a higher class, like Interferometers, have also been attempted at Madras by special processes with considerable success. We have now on hand a 24-inch diameter glass disc to be made into a paraboloidal mirror of focal length 12 feet for a reflecting telescope which, when finished, will be the largest telescope in India.

A point of doubt which it may be advisable to clear, is about the relative merits of hand-working and power-working. The amount of power required for optical work is in any case very very small and quite a considerable lot of work can be done by hand alone. But the preparation of such surfaces like the 24-inch disc is certainly hard work for the hand. In such cases, very simple inexpensive machines requiring not more than one horse power can easily be improvised.

The mechanical operations involved in the mounting of these finished optical parts into complete instruments, calls for no great equipment or outlay other than that of a modest workshop and good scientific guidance.

Thus, considered in every way optical or instrument technology seems to be a line in which the attention of the scientifically educated but unemployed in India should get interested, and it is hoped that in providing the necessary training the Indian Institute of Science will play its part.