F is the scale factor representing the velocity change from the assumed velocity. The values K_1, K_2, and K_3 are the constant errors in measurement, which are a function of the individual ground stations, and E is the Shoran distance minus the geodetic distance.

The results of the above solution are:

$$\begin{aligned} F &= 1{\cdot}0000606 \pm 0{\cdot}0000065 \\ \text{or } c &= 299{,}794{\cdot}2 \pm 1{\cdot}9 \text{ km./sec.} \\ K_1 &= -0{\cdot}00193 \pm 0{\cdot}00065 \\ K_2 &= -0{\cdot}00369 \pm 0{\cdot}00074 \\ K_3 &= -0{\cdot}00200 \pm 0{\cdot}00053 \end{aligned}$$

The Shoran distance was S.

$$\begin{aligned} \text{Thus} \quad & K_1 + K_2 = -0{\cdot}0056 \\ & K_1 + K_3 = -0{\cdot}0039 \\ \text{and} \quad & K_2 + K_3 = -0{\cdot}0057 \end{aligned}$$

The probable errors in these values of K are sufficiently low to indicate that the analytical method of determination is satisfactory.

These results are summarized in the accompanying graph, which shows the adjusted velocity curve together with the individual observations. The derived velocity of 299,794·2 ± 1·9 km./sec. is higher than the one previously reported by me. However, the removal of the troublesome signal intensity error together with other improvements in the equipment and the techniques lend more confidence to the above figure.

In my previously reported value[2] of c, a value of the index of refraction for dry air at 760 mm. pressure and 0° C. of 1·0002835 was used. In the present work I have adopted a value of 1·0002876. That figure is based on the means of a number of measurements made by various observers in the optical band. Warner[4] adopted a statistical value of 1·0002895 ± 0·0000550, basing that figure on the dielectric constant determinations of seventeen workers between 1872 and 1946. Birnbaum, Kryder and Lyons[5] published a value of 1·0002853 for air and 1·0002877 for air as determined from its component gases. Essen[6] recently published a value of 1·0002882. In the same paper Essen states that a new optical equation of Barrel gives a value of 1·0002878. It seems certain that the figure I have adopted is accurate to about 1 part in 10^6.

Essen[7] summarizes recent determinations of the velocity of light. In Table 2 I have added my value to his list.

Table 2

Author	Method	Velocity *in vacuo*	Weight
Birge	Optical	299,776 ± 4 km./sec.	1
Essen and Gordon-Smith	Cavity resonator	299,792 ± 9	1
Bergstrand	Optical	299,793·1 ± 0·26	2
Aslakson	Radar	299,792 ± 2·4	2
Essen	Cavity resonator	299,792·8 ± 3	2
Bol	Cavity resonator	299,789·3 ± 0·4	2
Aslakson	Radar (Shoran)	299,794·2 ± 1·9	

It is particularly noteworthy that these observers used widely varying frequencies, ranging from the optical wave-lengths of Bergstrand, through the 220–300 Mc./sec. of the Shoran band to the 30 Mc./sec. of Essen's experiments.

Aslakson's 1949 value would be reduced by about 2 to 3 parts in 10^6 if the new value of the index of refraction and the corresponding interpolation equation were used. Certainly the close agreement and relatively low probable errors are significant.

At the present time a new series of Shoran measurements is in progress. The value of the velocity assumed in projects now under way is 299,793·1 km./sec. So far, comparisons of measured distances and Shoran distances indicate that this value is correct within 1 part in 150,000.

A more complete report of the measurements described here will be published elsewhere.

[1] Aslakson and Rice, *Trans. Amer. Geophys. Union*, **27**, 459 (1946).
[2] Aslakson, *Trans. Amer. Geophys. Union*, **30**, 475 (1949).
[3] Aslakson, *Nature*, **64**, 711 (1949).
[4] Warner, Radiophysics Laboratory, Commonwealth of Australia, RPR 93 (Aug. 1949).
[5] Birnbaum, Kryder and Lyons, *J. App. Phys.*, **22**, 95 (1951).
[6] Essen, *Nature*, **167**, 512 (1951).
[7] Essen, *Nature*, **167**, 258 (1951).

SCIENTIFIC MANAGEMENT

IN a stimulating article, the warden of Urchfont Manor Residential College for Adult Education suggests that there is a real danger of accepting a number of false propositions in the name of so-called 'scientific management' (*J. Inst. Personnel Management*, **33**, No. 315; May–June 1951). In an analysis of what is implied by the term 'scientific management', Mr. Hunter suggests, first, that there are parts of management in which certain sciences are of use. Good statistical analysis of costs, accurate measurement, controlled experiment on alternative methods of layout or process will clearly be useful and are rightly called 'scientific'. Motion study also might be included, since the human body is in one sense a machine which will function best with certain directions of movement and load. When time study and rate fixing are included among the sciences, a little more doubt creeps in; owing to individual variation in rates of learning and final speeds attained, a subjective element is introduced. Aptitude testing suffers from similar limitations, for the world is full of adaptations successfully made by people with apparently crippling disability.

Secondly, although organization is often included in 'scientific management'—industry is fond of organizational charts and maxims regarding 'the span of control'—it is doubtful whether organization is in any real sense a scientific subject. There is, indeed, a considerable amount of experience regarding organization of, say, a company with many local branches or a flow production plant, but it is scarcely suitable to describe knowledge of this experience as scientific: it is mainly empirical.

It is when the term 'scientific management' is applied to the management of human beings, however, that real muddle begins. The object of management in this field is to get a large number of human beings working together in mutual co-operation and giving maximum output. If there is a science of this activity, it implies that there should be an ordered body of knowledge relating to it and capable of being applied by any competent student. The claim appears to have been made that there are laws of group behaviour which can be ascertained and used in the management of groups. If this were true, it would clearly be of immense importance to industry, since a systematic application of these laws for defined purposes should result in producing co-operative effort. Examining the nature of this claim more

closely, Hunter considers the simple and semi-technical factors such as fatigue, boredom, lighting, rest pauses and hours of work. From this it might appear that a simple or at least a direct correlation between variations of these conditions and output might be established. But at once the Hawthorne experiment springs to mind, apparently proving that the effect of such variations, if any, can be completely masked by the simple fact that the working group was stimulated to higher effort by the evidence of management interest in their work.

The first difficulty in producing a science of management is that the material to be handled insists on taking a hand in the experiment. Moreover, there is little evidence that this reaction will itself be regular, or predictable. The shop steward may be flattered or co-operative, or he may decide that the whole experiment is designed to save man-power and will endanger his job.

Hunter then goes on to consider the nature of the knowledge which the psychological scientists in industry bring back to the manager who employs them.

The psychologists discover that healthy rivalry can increase production, and advise the introduction of merit rating and merit awards. Perhaps this succeeds; but perhaps it does not, and instead produces jealousy and suspicions of favouritism, in which case another scientific investigation will produce a new diagnosis—that there is too much competition and jealousy due to merit rating. They discover that fear plays an enormously important part in determining behaviour; that a suppressed fear may have results not apparently connected with its cause; for example, a man in fear of unemployment may suddenly be rude to the foreman. They discover that men have a sense of dignity and will react unfavourably if this is affronted, that praise and blame work better than indifference, and that natural leaders appear in small groups and may lead in good or bad directions. Experience of individual psychology should warn us that the method of detailed analysis of unique cases cannot possibly produce a system of scientific rules applicable to industrial groups. Each group is, to begin with, a collection of unique individuals; each group will be coloured by its own unique history, that of the factory or its social environment; each will be affected differently at different times by current social and political attitudes absorbed from the general atmosphere of society. Possibly a year's work by an experienced team of investigators might unravel a great deal of the psychology of a group in the machine shop, and describe it in a book of considerable length. Industrial management, however, cannot possibly work at this rate.

The manager's job in industry, as that of the military commander, is to get co-operation from a group as a result of hundreds of different personal motives and influences of history and tradition which analysis might discover among any single group. Moreover, he must succeed not only with the machine shop but also with the typists and with the whole factory, composed of many utterly different groupings. Analysis cannot give him these answers. The history and experience of human leadership will, however, tell him what qualities he must show to obtain the same good result from widely different groups.

Hunter believes that the search for 'scientific management' is a search for the lazy man's way of doing the job, for a book of rules which any manager can use. If there is such a book it is one which tells of the personal qualities which the manager must show; of the self-discipline, the imagination, and the love which he has somehow to create, very painfully, in himself in order to lead others.

In conclusion, Hunter insists that he does not want to abandon observation of industrial situations or to cease experiment on organization. The excellent work which has been done on methods of selecting foremen or of drafting joint production council constitutions, the analysis of absenteeism or the organizational chart—all these have been of high value, since they provide a better channel through which leadership can flow. But he also insists that they will never provide a science of management, because there is no such thing. T. H. HAWKINS

FOREST POLICY IN AFRICA

UNDER the question of policy and legislature in the annual report of the Forest Department of Uganda for the year ending December 31, 1949*, the following appears: "African Local Governments are being encouraged to play an increasingly more active part in forestry work, especially in areas which have been declared to possess adequate forest estates or which are within appreciable distance of attaining that objective. As time goes on District Forest Officers will act less and less in an executive capacity in so far as local reserves, Crown Land, and the supervision of local Government Staff are concerned, and more and more in a true advisory capacity."

Such a statement is all right on paper, but its practical implications must be considered. Forestry is rather different from other branches of administration in that policies must be thought out for centuries ahead; merely changing, for political reasons, an administration from British to African in no way alters the true relation of the forest to the countryside or to the local economy. The only way to preserve forests and to improve and restore those which have been badly exploited is to place them under the *direct* administration of a staff trained in forest methods from the highest ranks to the lowest; and they must know their job and be granted annually adequate funds to carry it out. For forest work entails adequate and constant supervision from the time of obtaining the new young crop of trees until the day they come to maturity—50, 100, 150, 200 or even more years later—as is being practised in France under modern conditions. Rotations may and will be shorter in the tropics. But more rapid growth entails closer supervision and in many cases a larger staff.

From the beginning of this century some of the Colonial administrations have given in the annual forest reports statements of their forest policies; but it has been little more than words. The matter now becomes more serious. If the Africans are to enjoy in future more executive authority in charge of forests, it becomes essential that the proposed position of the trained forester, and what his authority within the forest consists of, should be closely and clearly defined. Otherwise the deterioration of the African forest estate is certain. E. P. STEBBING

* Uganda Protectorate. Annual Report of the Forest Department for the Year ended 31st December, 1949. Pp. iv+54+10 plates. (Entebbe: Government Printer, 1950.) 3s.