east that we must look for the origin of cultures, late in time though still prehistoric, in Nigeria. The town of Ife was thought to be the centre of the world. Here, according to Yoruba tradition, the High God came down a chain from heaven with a five-toed chicken and a bowl of sand, which the chicken scattered over the ocean to form land. Fifty years ago Frobenius made a number of investigations at Ife, and desultory discoveries have been made since in the sacred groves. Old Oyo was once the capital of Yorubaland, a site of vast size which until recently had scarcely been touched by the archæologist. Both these places have now been studied by Frank Willett, who was released by the University of Manchester to work as an archæologist in the Nigerian Department of Antiquities.

Willett would be the last person to suggest that he had more than scratched the vast site of Old Oyo. Not only is the site very difficult of access, but it has also been completely overgrown. However, a rock-shelter site was excavated and below the Yoruba-levels occurred one with Pygmy tools and no pottery. Such industries are not unknown in Africa since Magosi times, but the exact age of the finds at Old Oyo are, of course, unknown. Several 'gong' sites were also discovered. Here, exfoliated chunks of rock occur which give out a musical tone when struck. Not infrequently, paintings can be found in the rock-shelters where the 'gongs' are present.

At Ife, Willett has been more concerned with bringing together the knowledge already obtained by various previous investigators. As a result, what is known to date of the early history of Ife, and, to an increased extent, of Old Oyo, is now set out in convenient form. Students of the later prehistory of Yorubaland in Nigeria will do well to get hold of Willett's two articles, namely, "Investigations at Old Oyo, 1956–57, and Interim Report" in the *Journal of the Historical Society of Nigeria* (**2**, No. 1; 1960), and, "Ife and its Archaeology" in the *Journal of African History* (**1**, No. 2, 231; 1960).

M. C. BURKITT

INTERNATIONAL JOURNAL OF PRODUCTION RESEARCH

A NEW international journal, devoted entirely to problems of production in industry, has been launched by the Institution of Production Engineers. The first issue reaches a high standard and contains a number of articles which should prove of value to all industrial engineers*.

Of particular significance is a note submitted by C. Gregory of the Department of Statistics, University of Melbourne, indicating a method of estimating the precision of time-study observations. In conventional time-study practice the work content of a job, or element of a job, is expressed in terms of the time that the job should take at a prescribed rate of working. The time-study engineer bases this time value on observations of performance of the actual job, and is handicapped by the fact that he cannot normally require the job to be carried out at the prescribed rate of working, even if he could define it precisely. He has to take observations at the prescribed rate of working that he happens to see.

The method adopted is to time the job on several occasions, each time independently assessing the rate of working. Of the several ratings scales in use, probably the most common is that which assigns a rating of 60 to a rate of working which, in terms of the effort involved, is equivalent to walking at 3 m.p.h. The time taken to do a job at a rating of 60 is known as the 'normal time', and this is generally accepted as a measure of work content. Since, *inter alia*, production planning and incentive payments are based on this measure, the need for an accurate estimate of work content is apparent.

The method used is to convert each observed time to 'normal time' by multiplying by the ratio of the estimated rate of working to the normal rate. Thus, if the observed time is T and the estimated rating is R, the estimate of the normal time is $RT/60$. In theory, the reciprocal of the rating is directly proportional to the time taken. There are several sources of error in the observed rates of R and T, by far the most important of which is the error in rating.

* *The International Journal of Production Research*, Vol. 1, No. 1 (November 1961). Pp. x + 1–65. Published quarterly. Subscriptions: Members of the Institution of Production Engineers, 84*s*. per annum; Non-members, 105*s*. per annum. (London: Institution of Production Engineers, 1961.)

The subjective nature of the procedure makes errors inevitable, but certain steps can be taken to ensure uniformity not only between several time-study engineers, but also for an individual over a period of time.

A series of observations may be taken of a job where the definition is clear, the raw material is uniform, and timing may be obtained accurately. The job of walking a measured distance is an example, which has the advantage of a generally accepted normal time. The job is repeated a number of times varying the rating over the practical range of about 40–100. An individual time-study engineer records his ratings, and if y, the reciprocal of the rating, is plotted against the time T, the relationship should be a straight line through the origin. The slope of the line should be $(60\ W)$, where W is the accepted normal time of the job. Comparison of the regression line $y = a + bT$ with the theoretical line $y = (60\ W) - 1T$ will indicate the degree of agreement between the theoretical rating scale and the engineer's conception of it.

The first hypothesis to be tested is that the value of y corresponding to $T = W$ is 60^{-1}, that is, the engineer has the correct concept of normal rating. Confidence limits for the regression value of y corresponding to $T = W$ are calculated, and, if these include the value $y = 60^{-1}$, it can be assumed that the correct concept of normal rating is being used. Having established this, it is then reasonable to ask whether or not the line which is apparently being used is of the correct slope. A common fault, and one which a time-study engineer would recognize, is 'flatness', that is, a tendency to underestimate high rates of working and overestimate low rates, resulting in a smaller gradient than the theoretical line. This hypothesis $B = (60\ W)^{-1}$ can be tested. If the tests $\alpha = 0$ and $\beta = (60W)^{-1}$ had been used, it would have been possible to reject both hypotheses while still having the correct concept of normal rating. This would, in fact, occur frequently.

The above tests have measured 'concept of normal' and 'flatness'. A third measure of interest which can be derived from the regression analysis is that of 'consistency' and Gregory suggests a new equation to measure this.

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