ENERGY EXPENDITURE OF MINING TASKS AND THE NEED FOR THE SELECTION OF LABOURERS

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Contribution to discussion

M. J. Martinson (Associate Member)*: Application of the simple selection test mentioned in the penultimate paragraph of the paper (reference to a more detailed description of the test would not have been inappropriate) should assist South African mining engineers to make more efficient and possibly more humane use of available labour. The authors mention that the test 'is in use in the gold mining industry', and it would be interesting to know the extent of this usage in terms either of number of mines or as a percentage of the total number of labourers employed on 'heavy' tasks.

The paper would have been of greater interest had the authors attempted to relate their findings to the statistics of labour usage in gold mines, members of the Chamber, and to the 'heavy' tasks in particular. On this the authors confine themselves in their Introduction to the somewhat ambiguous statement that 'A relatively high proportion of the 360,000 Bantu mine labourers are employed underground on manual tasks'. To appreciate the practical significance of the authors' work one needs a detailed breakdown of the underground labour force by occupations, together with estimates of quantities such as:

(*a*) total stope and development tonnages moved manually per shift:
by shovelling
by shovel/tram
by tramming

together with distances and any other relevant data;

(*b*) theoretical energy expenditures required to accomplish (*a*);

(*c*) actual energy expenditures required to a accomplish (*a*);

(*d*) energy theoretically available to accomplish (*a*) based on 50 per cent of the total maximum oxygen intakes of the labour force allocated to these tasks.

Analyses of this sort on an industry basis might demarcate the more promising areas for detailed investigation. Stress is often laid on the need for increased mechanisation to increase stope productivity, but it may be questioned if enough is known about the characteristics, performance and potential of our underground labour force to warrant blind acceptance of stope mechanization as the industry's panacea. Provided that health and safety are not compromised, the ultimate yardstick for assessing any form of stoping is profitability; obviously the industry must investigate very thoroughly any form of mechanization which might reasonably be expected to increase profitability, but it should also be remembered that a radical overhaul of existing systems—which have after all evolved by trial and error over the past 75

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years—might produce the same or better results. A year or two ago Newman, at a meeting of the Mine Ventilation Society, described an experiment conducted a few years earlier in a Witwatersrand mine in which 12 'top-class Africans' happily performed the work normally done by 35 men in a face-scraping stope simply by offering the 12 men three times the normal rate for the job. A measure as crude as this might not be successful on an industry basis if only because a significant number of men employed on 'heavy' tasks are probably already working at a rate in excess of the recommended 50 per cent of maximum oxygen intake, but nevertheless Newman's story vividly recalls the famous Hawthorne experiments, and it does suggest that productivity—and profitability—might be increased primarily through better selection and utilization of manpower. This would require an intensification of research in the physiological and psychological aspects of the human sciences.

Without knowing the total numbers of men employed in the industry on the several tasks investigated by the authors it is difficult to comment on the size of the authors' samples, but in relation to the numbers of men and the number of physical and physiological variables likely to be encountered the samples seem small. As regards the 'heavy' tasks it would be interesting to know more about the physical working conditions (e.g. stoping width, dip, grade of track, condition of track and other factors which may have affected the measured energy expenditures), and the basis on which the four mines were considered to be representative of the industry in this respect. To what extent could the variations in energy expenditure reported by the authors have been due to inter- and intra-mine differences?

One imagines that it is no easy matter either for the subject or the observer to measure oxygen consumptions of, say, men shovelling in a narrow stope or pushing hoppers along a congested stope inter-track, and it would be interesting to know if any 'control' observations were made before or after the main tests to assess whether the test procedure materially affected the work rate.

Authors' reply to discussion

We are grateful to Mr Martinson for raising certain broader issues in his comments upon our paper. We would like to take up one contentious point he raises. It is the economics of innovations in mining equipment and methods for the removal of gold bearing rock from the orebodies compared with the economics of innovations in the utilization of manpower. At present about five times more money is spent on research into new mining methods than upon research into the better utilization of manpower. It would be unrealistic not to put the cost of the next stage, the development of the new mining equipment for selective mining, at many times higher than the costs of research.

It is the aim of those engaged in research into innovations in mining machinery and methods of mining to increase the productivity of mining by an order of magnitude. This they may well do, especially if the new methods are applied to a new mine at the planning stage and before the shaft is sunk. Extensive application of selective mining to a well established mine is probably less likely. An estimate from an experienced consulting engineer is that only 20 per cent of working places in most developed mines would lend themselves to mining by these new methods.

Moreover, we should not expect selective mining to have a major impact on productivity in the gold mining industry for at least five years. During this time gold will continue to be mined as it is today—by the manual labour of the largely

unskilled work force of about 250,000 underground Bantu labourers. A large sum of money is going to be spent on labour in the next five years. The indications are that if this labour were better utilized in terms of selection, training, motivation (in which the emphasis is focussed on the quality of European leadership, good human relations in the stope teams and improved communications, both upwards and downwards), and if the work were better organized (such as setting of realistic production standards based upon the physiological capacities of selected men), and if better use were made of the horsepower put into mine ventilation (by direct cooling of the microclimate of the workmen instead of cooling everything around the men as well) then productivity might be increased, not by the 50 per cent which is sometimes quoted, but by one or two hundred per cent. These returns will not be as spectacular as those expected from improved mining methods, but the research costs are much lower. Moreover, experience has shown that the practical implementation of research results on the better utilization of manpower in the gold mining industry is relatively inexpensive. The returns are quick and the increase of productivity could be achieved without material increase in labour costs. A good example of this is climatic room acclimatization. The research and development on this project cost approximately R150,000, spread over a three year-period from 1965 to 1968. It is estimated that when this procedure is in full operation, which it should be by the end of 1969 (on 93 per cent of the 268,000 Bantu acclimatized each year), then there will be a gain of four fully, productive shifts in most of the 268,000 men being acclimatized each year and a reduction to one-third in the number of European and Bantu supervisors needed. The advantages to the gold mining industry of this innovation will probably be of the order of R1-2 million per annum.

Even if selective mining is introduced on a large scale, research on the utilization of manpower will have to continue. At the moment the gold mining industry has an almost unlimited source of inexpensive manpower available, at a relatively low level of industrial sophistication. This type of labour is not suited to highly mechanized mining, where some degree of skill will be required of the operators. Further research might reveal, however, that within this labour pool there are sufficient men who are capable of being trained to operate efficiently the new, more sophisticated, mining machinery. The reduction in costs of maintenance, and in keeping to a minimum damage of expensive equipment, would, probably, repay research into methods of selection and training of men for these skilled tasks.

There is however, another problem which must be kept in mind. Skilled manpower, probably at the artisan level, will be needed for the maintenance of the highly specialized equipment. Anyone who has visited Mt Isa mine in Australia will have been struck by the extensive maintenance operations and the large staff of artisans which is needed in order to keep the equipment running in that highly mechanized mine. Skilled artisans are in very short supply in South Africa and the only way through this bottleneck appears to be to select and train Bantu for these tasks. If it is important to make the best use of the labour potential when it is abundant and unskilled, how much more important will it be to make the best possible use of the limited proportion of labour that is suitable to be trained for these more highly skilled tasks?

There is current belief in certain sectors of the gold mining industry that with the advent of selective mining, the need for research into the utilization of manpower disappears. This is a misconception which we hope the above discussion will go some way to dispel.