

four-point cycle.

Higher productivity, within any given system of mining, can be attained if attention is paid to these matters.

REFERENCES

1. HERZBERG, F., MAUSNER, B., and SNYDERMAN, B. B., *The motivation to work*. John Wiley, 1959.
2. BRAYFIELD, A. H., and CROCKETT, W. H. Employee attitudes and employee performance. *Psychological Bulletin*, vol. 52, no. 5. 1955. pp. 396-424.
3. VROOM, V. H. *Work and motivation*, John Wiley, 1964.
4. TRIANDIS, H. C. A critique and experimental design for the study of the relationship between productivity and job satisfaction. *Psychological Bulletin*, vol. 56, no. 4. 1959. pp. 309-312.
5. LAWLER, E. E., and PORTER, L. W. The effect of performance on job satisfaction. *Industrial Relations*, vol. 7. 1967. pp. 20-28.
6. LAWLER, E. E., and PORTER, L. W. Antecedent attitudes of effective managerial performance. *Organizational Behaviour and Human Performance*, vol. 2. 1967. pp. 122-142.
7. PORTER, L. W., and LAWLER, E. E. *Managerial attitudes and performance*. Richard Irwin, 1968.
8. RAMSER, C. D. Performance, satisfaction, effort. *Personnel Administration and Public Personnel Review*, vol. 1, no. 1. 1972. pp. 4-8.
9. GREENE, C. N. The satisfaction-performance controversy. *Business Horizons*, vol. 15, no. 5. 1972. pp. 31-41.
10. CHERINGTON, D. J., REITZ, H. J., and SCOTT, W. E. Effects of contingent and non-contingent reward on the relationship between satisfaction and task performance. *J. Applied Psychology*, vol. 55, no. 6. 1971. pp. 531-536.
11. SCHWAB, D. P., and CUMMINGS, L. L. Theories of performance and satisfaction: a review. *Industrial Relations*, vol. 9, 1970. pp. 408-430.
12. HOUSE, R. H., and WIGDOR, L. W. Herzberg's dual-factor theory of job satisfaction and motivation: a review of the evidence and a criticism. *Personnel Psychology*, vol. 20, no. 4. 1967. pp. 369-389.
13. GRANT, G. V. The development and validation of a Classification Test Battery constructed to replace the General Adaptability Battery. Johannesburg, National Institute for Personnel Research, *Report C/Pers 181*, 1970.
14. FELGATE, W. S. The acclimatization process as a source of dissatisfaction among boss boys and other mine-workers in the gold mining industry. Johannesburg, Chamber of Mines, unpublished research report.
15. LAWRENCE, A. C. Motivational factors among production shift bosses: Part II. Johannesburg, Chamber of Mines, unpublished research report, 1969.
16. WORTLEY, R. H., and STROHBACH, H. J. B. R. A case study of locomotive accidents in a gold mine. Johannesburg, Chamber of Mines, unpublished research report.
17. LAWRENCE, A. C., and NILSSON, B. B. An investigation into dissatisfaction among learner officials (mining). Johannesburg, Chamber of Mines, unpublished research report.
18. LAWRENCE, A. C. Individual differences in work motivation. *Human Relations*, vol. 25, no. 4, 1972. pp. 327-335.
19. NILSSON, B. B., and LAWRENCE, A. C. Attractiveness of mining engineering as a career analyzed in terms of six major dimensions. Johannesburg, Chamber of Mines, unpublished research report, 1973.
20. LAWRENCE, A. C. The movement of men in the mining industry. Johannesburg, Chamber of Mines, unpublished research report, 1972.
21. WYNDHAM, C. H., and COOKE, H. M. The influence of the quality of supervision on the production of men engaged on moderately hard physical work. Johannesburg, Chamber of Mines, unpublished research report, 1963.
22. MAUER, K. F., and LAWRENCE, A. C. Human factors in stope productivity—a field experiment. *Journal of S.A. Institute of Mining & Metallurgy*, vol. 74, no. 3. 1973. pp. 116-123.

Contribution to the above paper

by H. G. M. Rose* (Fellow)

INTRODUCTION

Dr Lawrence is to be congratulated on his most interesting and instructive paper, particularly on his suggestion for a model to increase mining productivity through improved management performance. In view of an experiment initiated in one Union Corporation mine (Mine A) and later extended to a second mine (Mine B), it might be of interest to review the many human factors involved and the initial productivity results achieved. This experiment was based on the concepts and organizational changes laid down in a paper presented to the Association of Mine Managers of South Africa and entitled 'A Stopping Productivity Programme Instituted at Winkelhaak Mines Limited'.

Cyclic mining is not a new concept. Any successful mining operation must of necessity follow a logical sequence of events. Certain human

factors were, however, taken into consideration in the design of the cyclic mining operation in an effort to achieve greater productivity.

BACKGROUND TO THE EXPERIMENT

Towards the latter part of 1969, investigations were started on Winkelhaak with the object of establishing the reasons for poor performances in stoping contracts. Underground investigations by senior personnel revealed the following.

- (a) The stope work was being directed by the contractor, who, although highly skilled in the technicalities of stoping, had only a limited knowledge of how to organize the workers under his control.
- (b) In general, the shift-boss was no more experienced than the contractor in organizational matters and, as a result, did not interfere with the contractor's inefficient organization.

- (c) A slightly chaotic state of affairs existed in the stopes. An examination of stope sheets showed that some faces were being blasted only three times per month, resulting in an eight-day working cycle of operations. Investigations underground indicated that the cleaning operation was not in phase with the drilling operation. Machines continued to drill in a less and less efficient manner.

It appeared that senior management were at fault in that they had failed to clearly define and lay down what work was to be done and how it was to be done. It was decided to design a stoping operation in which a known amount of effective work would be performed daily. This work would have to be conducted in an orderly fashion by a trained labour force whose strength would be dictated by accepted work performance norms and the planned production objective.

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THE EXPERIMENT

In the experiment, the responsibilities were first defined, and, before the scheme was implemented, the various categories of workers were given a training in accordance with their responsibilities.

Definition of responsibilities

- (1) *Management (Mine Overseers and above)*
 - (a) The training of shift bosses and contractors in planning, cyclic mining, and control techniques.
 - (b) The checking of shift-boss monthly production plans and production objectives.
 - (c) The checking of cyclic mining operations underground.
 - (d) The supply of material in accordance with the production objective.
 - (e) The supply of labour in accordance with the production objective.
 - (f) The recognition and elimination of workers, who, in spite of continual training, remained inadequate.
 - (g) The establishment of a working environment in which every department on the mine would participate in the attainment of production objectives.
- (2) *Shift-bosses*
 - (a) The planning at the beginning of each month of the stopping operation on a day-to-day basis.
 - (b) The replanning of this operation in the event of unexpected factors such as fault intersections, the appearance of unpay ground, or any major disruption to normal production.
 - (c) The setting of production objectives based on the shift-boss's own planning.
 - (d) The controlling of the stopping operation by personal supervision and designed control techniques.
 - (e) The establishment of a working environment in which the full co-operation of the contractor is obtained in the planning of the stop-

ing operation and the execution of the cyclic mining principles.

- (f) The attainment of the production objective based on the shift-boss's own planning.
- (g) The control of a budget based on the material requirements necessary for the attainment of the production objective.
- (h) The control of labour requirements based on the shift-boss's own production objective.

Training and Implementation

Training was started at mine overseer level. The underground managers, all of whom had been involved in the design of the scheme, were given the responsibility of training the mine overseers, who, in turn, were required to train the shift-bosses and contractors. To start with, very few people were fully confident that increased production would result. It was therefore necessary to produce individual successes. Attention was given to selected contractors in each section, and every effort was made to ensure that the details of the scheme were carried out. The participation of the contractor was encouraged in all aspects of the work, and he shared in the responsibility of setting and achieving the production target laid down for the stope. Production rose, and each individual success built up confidence in the new way of working.

RESULTS

Productivity improvements and turnover and absentee figures over the years 1969 to 1973 are shown in Figs. I to X. It will be seen that European productivity has improved at a greater rate than Bantu productivity. It must be pointed out that the nature of the experiment was such that all efforts were directed at improving European productivity, and gains in Bantu productivity were in reality a side effect of better European supervision.

OBSERVATIONS ON SOME HUMAN FACTORS INVOLVED

An examination of the increased productivity results obtained, and the improved turnover and absentee

figures, must give some measure of the success of the experiment. In the light of this success, there have been marked changes in personal attitudes.

Shift-Bosses

Achievement

Before the introduction of the scheme, the shift-boss had very little sense of personal achievement. Production depended almost entirely on the competence of the contractors working for him. The shift-boss had no say in the setting of production objectives, which, in general, were unrealistic and often unattainable. With the introduction of a new way of working, shift-bosses found that they were personally directing the contractors' work and were achieving objectives that they themselves had set. The resulting sense of achievement has brought greater confidence, and the shift-boss now feels capable and ready to accept further responsibility.

Recognition

The shift-boss is conscious of a change in attitude on the part of higher management. He is now accepted as the man in charge and, as such, enjoys a higher status.

The Job Itself

The job has been enlarged. The shift-boss now lays down what is to be done and is responsible for ensuring that it is done. He has a full management function in the work operation.

Salary

Salaries have increased over the years in conformity with Chamber of Mines' policies. In addition, a small bonus based on safety performance can be earned.

Advancement

The legal requirements for the Mine Manager's and Mine Overseer's certificates prevent a normal job advancement process based on competence from taking place. There is evidence, however, that more shift-bosses and mine overseers are attempting to obtain the higher certificates. Among shift-bosses who are holders of the mine overseer's certificate, there is now an awareness that promotion depends on competence, and not only on years of service.

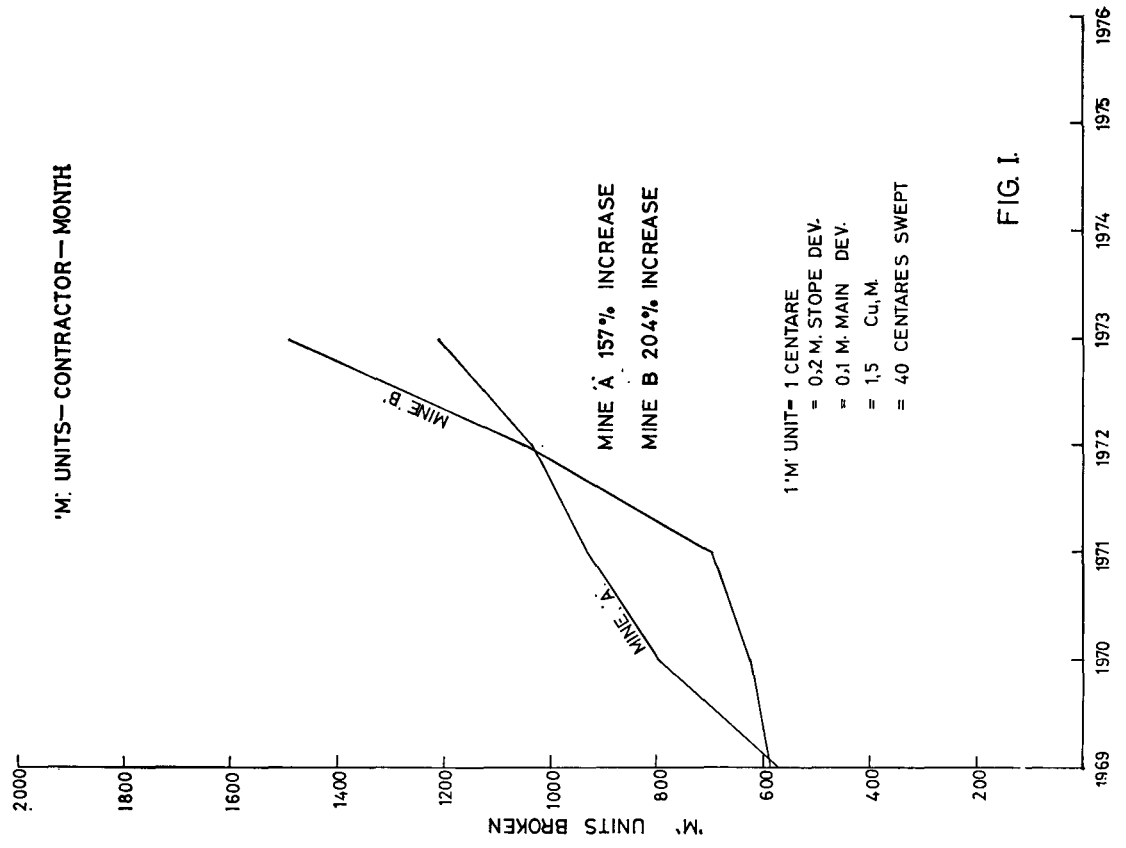


FIG. I.

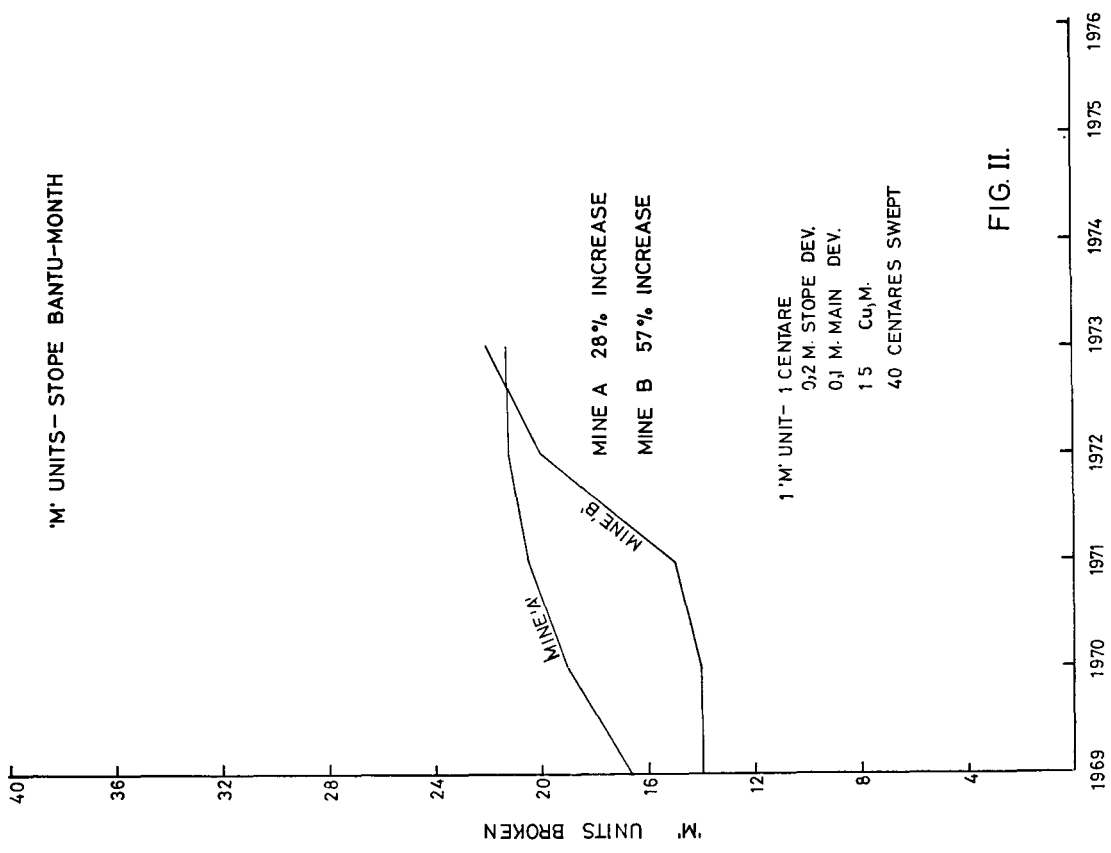


FIG. II.

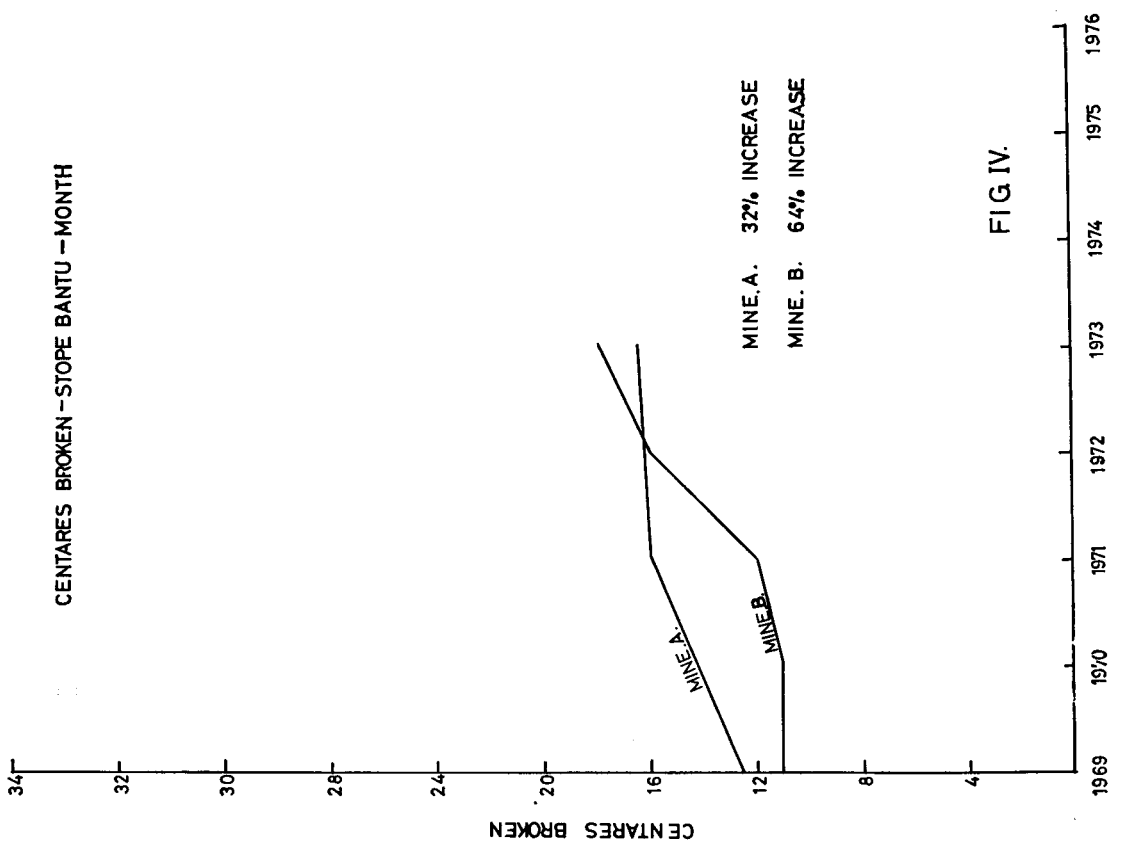


FIG. IV.

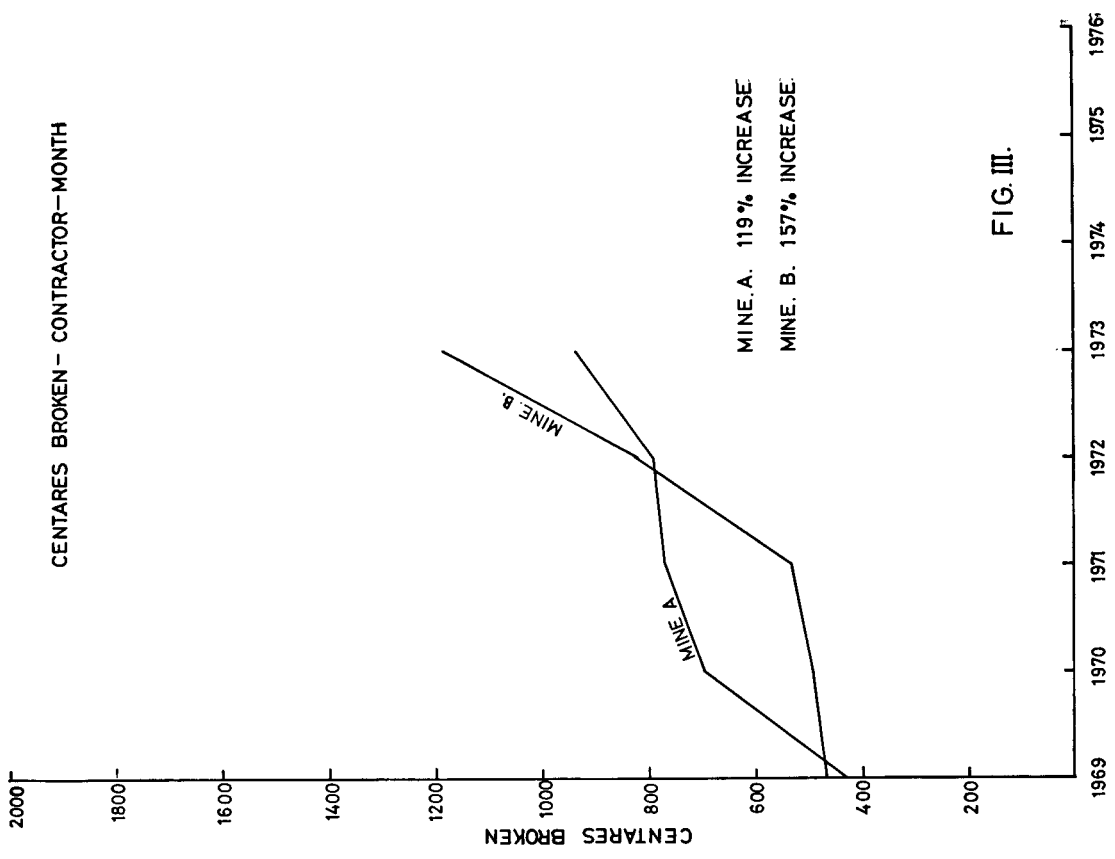


FIG. III.

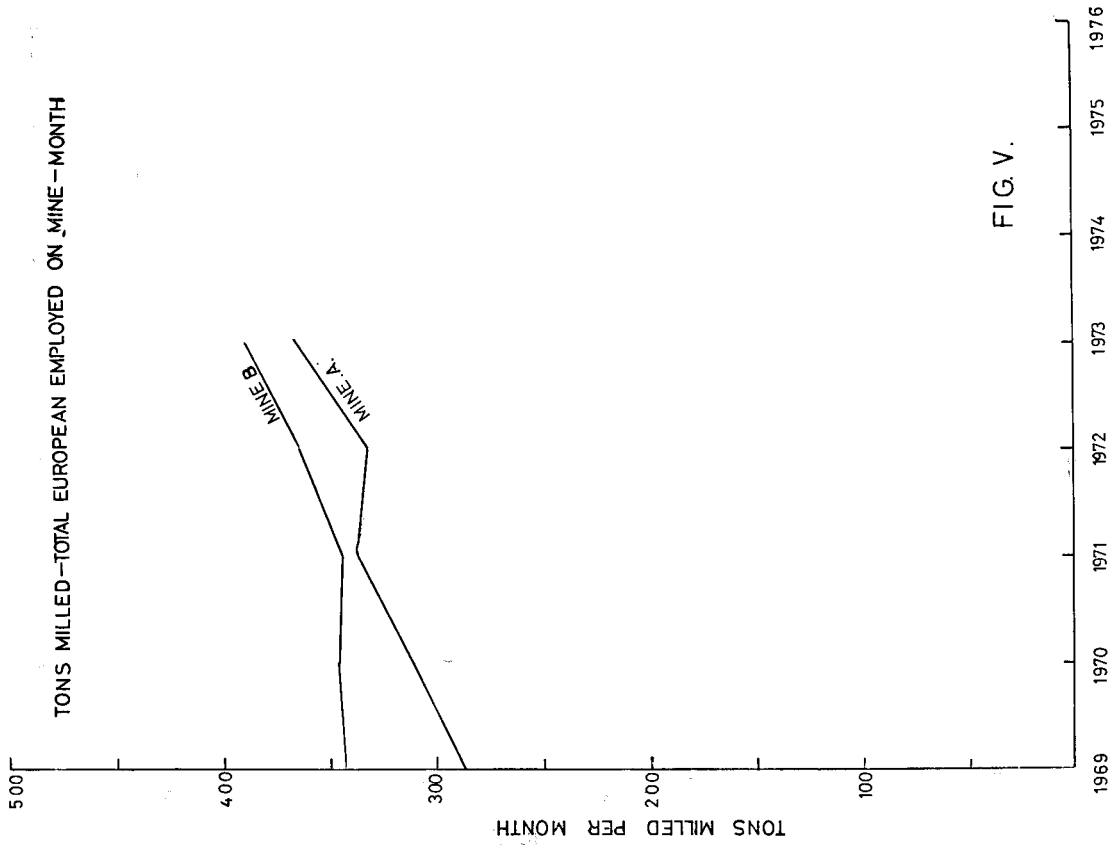


FIG. V.

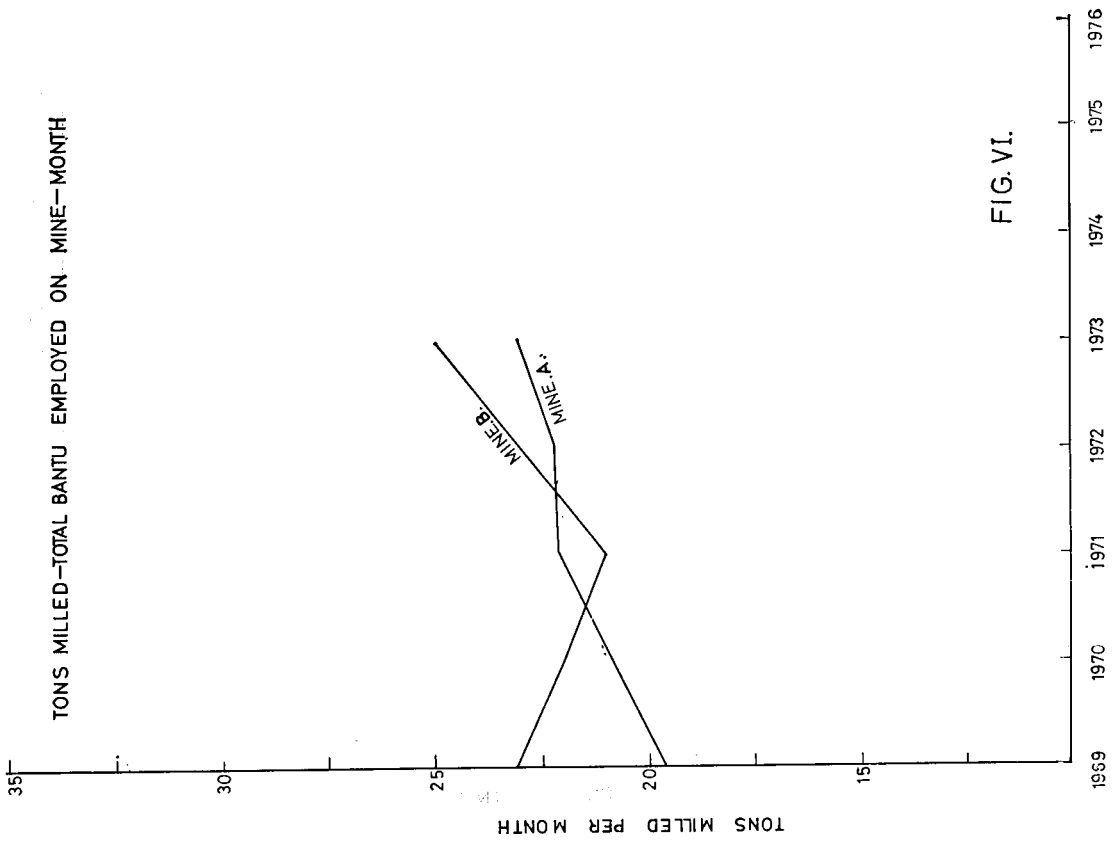


FIG. VI.

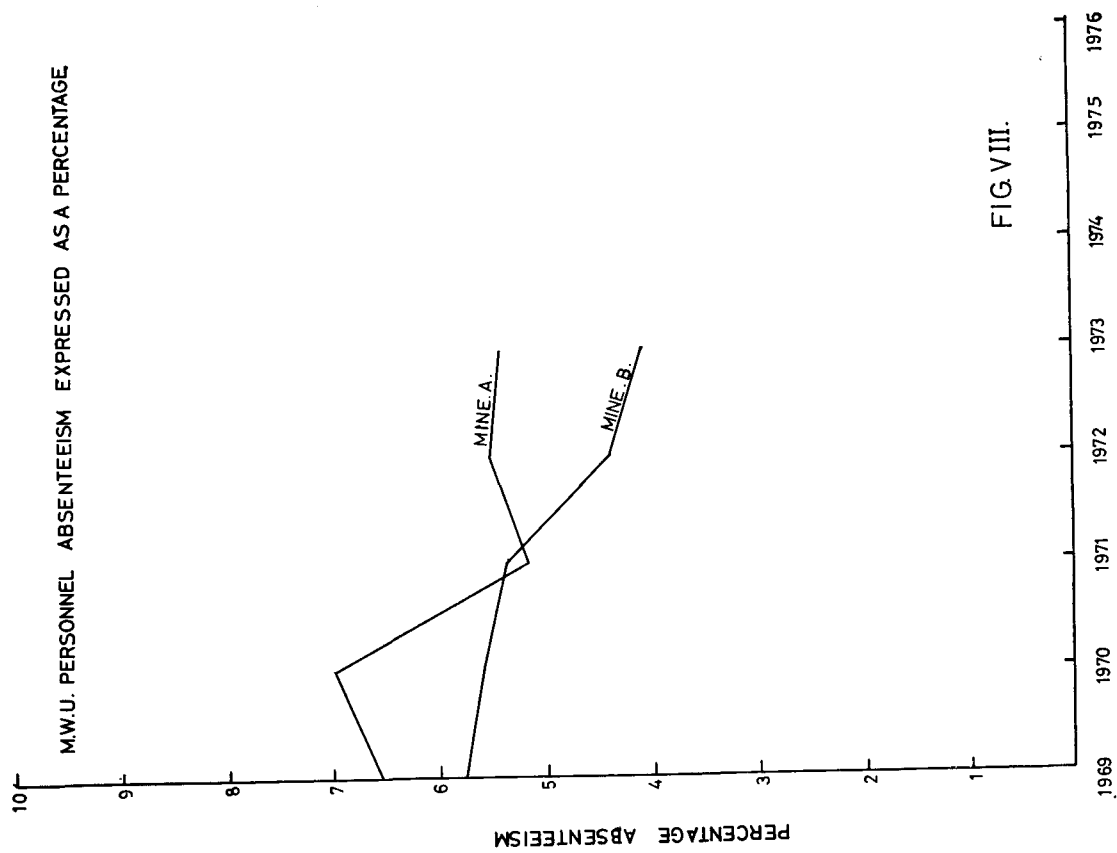


FIG.VIII.

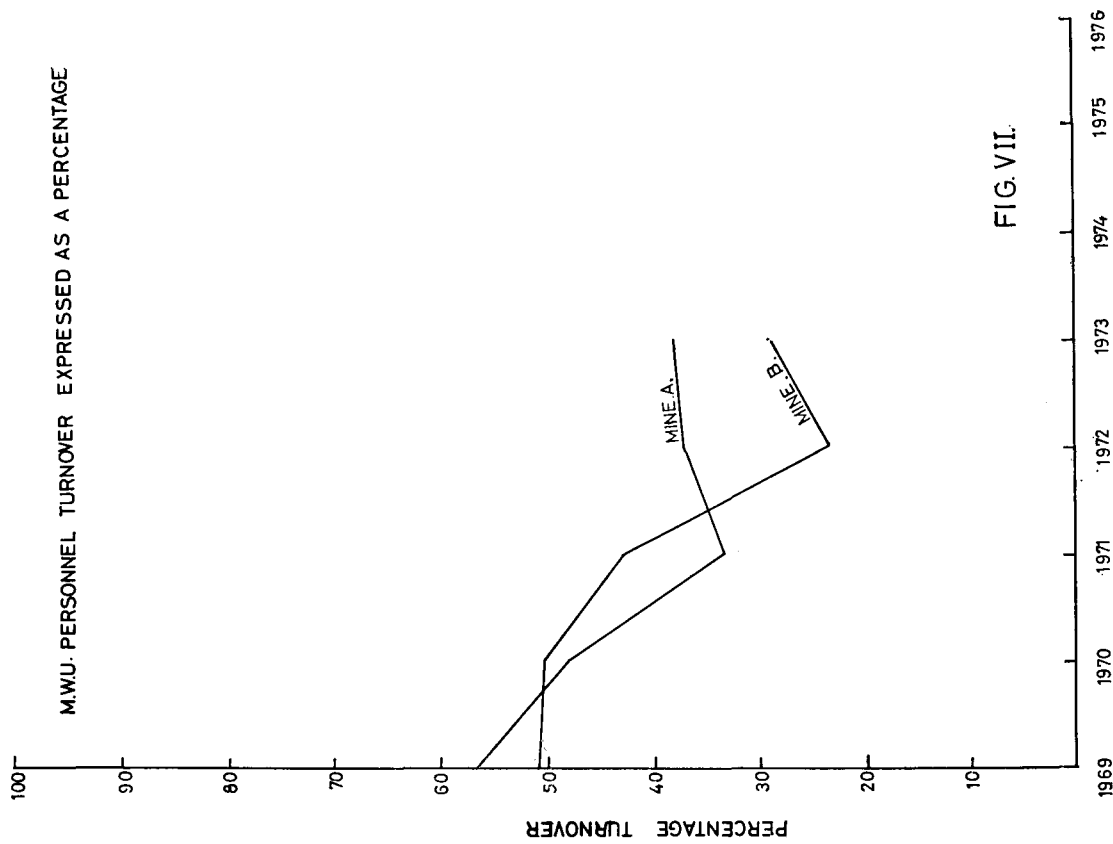


FIG.VII.

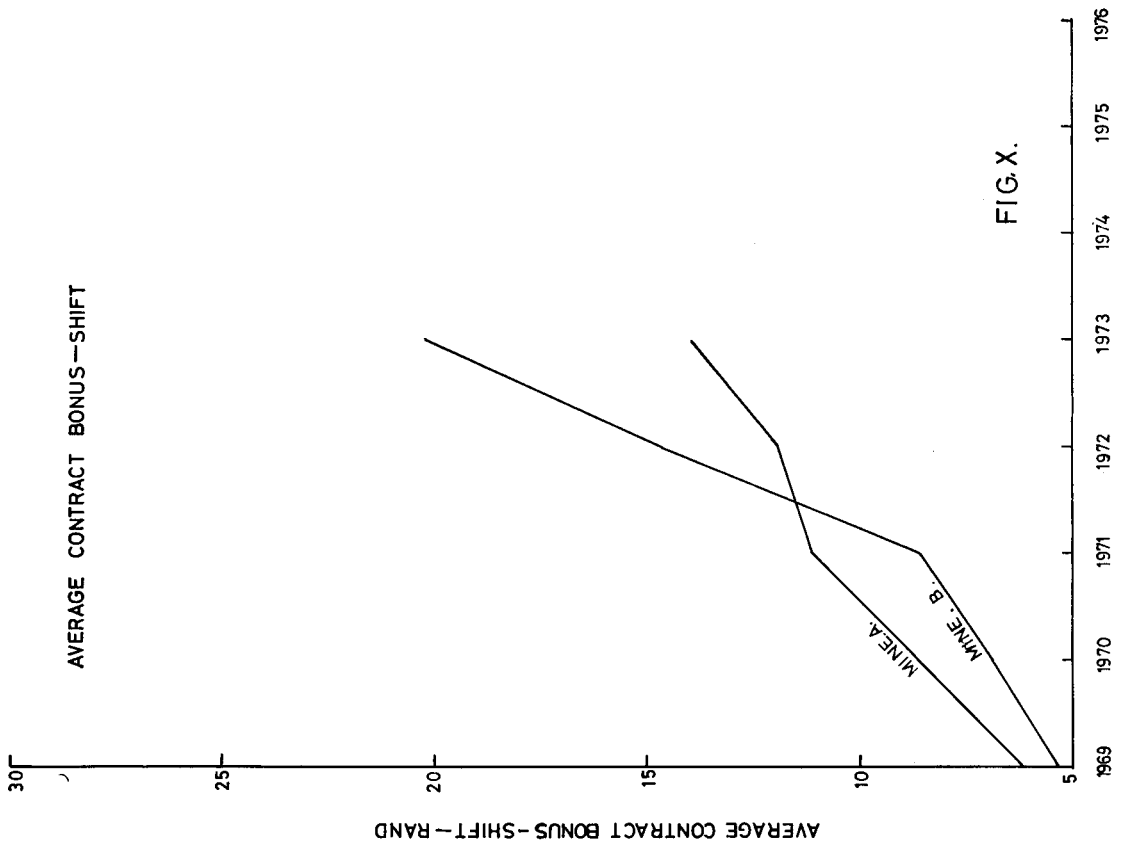


FIG. X.

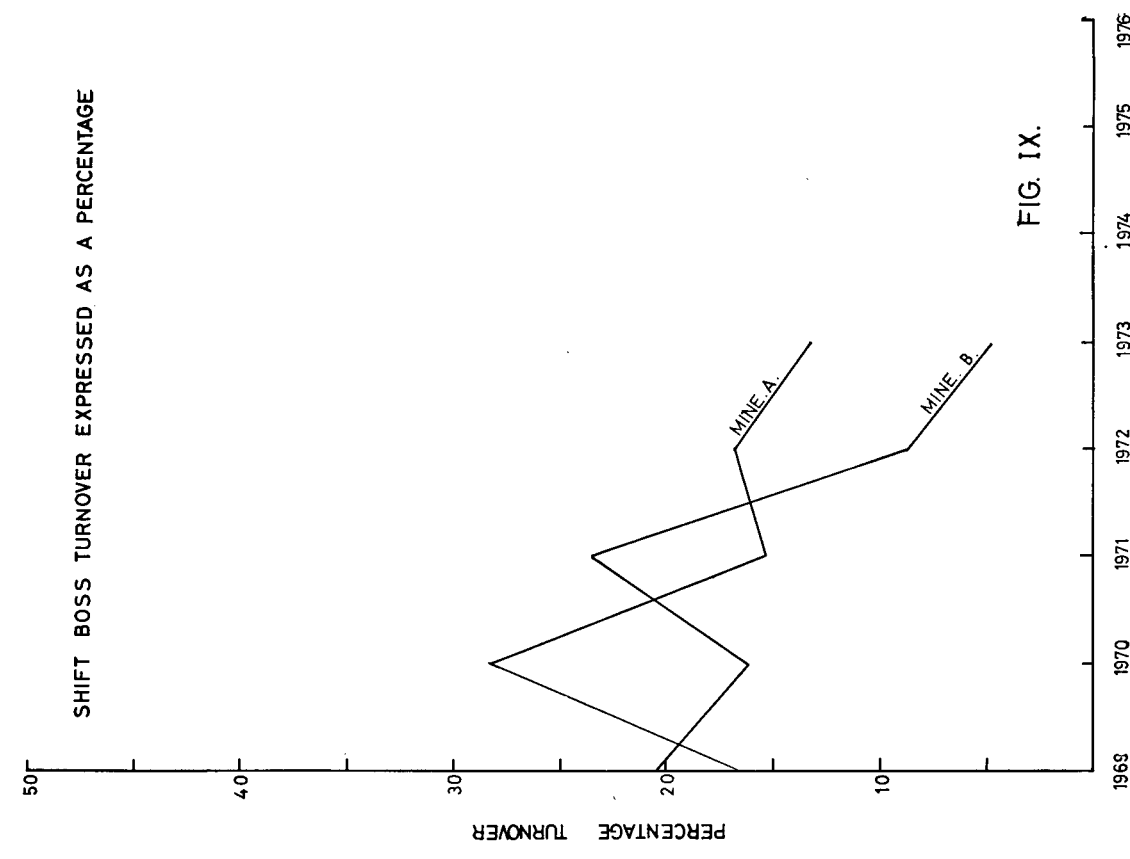


FIG. IX.

Contractors

Achievement

In particular, the younger, less experienced stoper has gained a greater sense of achievement. As a result of better training and direction, he now achieves high production results within a shorter period of time.

Recognition and responsibility

Under the present system of working, the contractor is consulted in the drawing up of the working plan. He feels that he is now part of the management team. Production graphs prominently displayed in the shaft office show relative contract performances. This has resulted in the development of friendly competition.

The Job Itself

The contractor now has a better comprehension of what his job entails. His participation in the setting of objectives, and the more orderly nature of the work, have resulted in greater job satisfaction.

Wages

The contractor has indeed been fortunate in that his bonus earnings have improved in proportion to his increased production.

Advancement

To the older contractor the lure of further advancement holds no great attraction. In general, he is more concerned with earning as much money as possible to achieve his planned ultimate objective—the purchase of a farm, or the establishment of a small business. It is noticeable, however, that the younger man, becoming competent in a shorter period, is realizing that he can further his advancement on the mines by entering the official ranks

GENERAL COMMENTS

Competence

Dr Lawrence appears to be correct in considering competence as the first requirement in any successful working operation. In considering the experiment, there is no doubt

that both the workers and the managements are more competent in relation to a specific plan of action. Competence can be judged only in relation to the requirements of the job. Correct selection and training must therefore be based on these same requirements.

Opportunity

The senior officials of both Mine A and Mine B fully accept the responsibility for ensuring that an adequately trained worker is allowed to exercise his skill within the framework of the management organization. It is very necessary for management to ensure that its policies and operational procedures create a work situation in which the trained worker can produce effective results.

Recognition and expectations

There is every reason to believe that rewards in the form of recognition, increased pay, and general job satisfaction are playing their part in the establishment of an atmosphere in which the workers are reaching a stage of self motivation. These rewards have stirred up latent ambitions, which, in the past, have lain dormant in a climate of boredom and lack of interest. The personal challenge associated with the awakening of ambition results from the realization that well-directed efforts can lead to success. Confidence is born, and self motivation starts to play a part in the drive towards greater productivity.

Job Satisfaction

The object of the experiment was to achieve higher labour productivity. No specific efforts were made to consider job satisfaction in the re-organization of the job. As productivity rose, it became evident, however, that shift-bosses were experiencing far greater job satisfaction. Dr Lawrence has stated that there is little likelihood that higher productivity will follow from meas-

ures that improve only job satisfaction. Our experience tends to support Dr Lawrence's contention, and it appears that job satisfaction can, in fact, result from higher productivity efforts.

CONCLUSION

It appears that productivity improvements brought about by the better use of people can be effected only within the limits of the job design. The introduction of improved methods and mechanization will certainly enlarge the scope for further improved productivity. It is contended, however, that the successful implementation of new ideas is dependent on the ability of management to create an environment in which these changes in organization will be accepted and fully developed. The experiment conducted on Mine A and Mine B related mainly to shift-bosses and contract miners. Senior management were deeply involved and gained invaluable experience. More attention will have to be paid to the increasing of Bantu labour productivity, and specific objectives must be set in the restructuring of Bantu jobs and the design of adequate training.

In a mine as a whole, the scope for the improvement of work performances is considerable. Management productivity objectives should be directed at all departments on a mine. A closer examination of the organizational functions of the engineering, secretarial, and reduction-plant personnel would no doubt prove most interesting.

I have no doubt that Dr Lawrence's paper will stimulate thinking on a subject that is of great interest to mine managements, and I am sure that his work in this respect will contribute substantially to the improvement of the overall labour productivity within the gold-mining industry.