

The value of incentive payments in the mining industry

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SYNOPSIS

This paper reviews the history of incentive payments in the mining industry, and gives some indication of the magnitude of improvement that has been achieved by this means in the past.

The objective is to promote a more general belief in the efficacy of these methods, and thus to encourage their wider and more effective application by mining engineers in general, and by the rising generation in particular.

It is concluded, from a consideration of current productivity levels in the gold-mining industry (still South Africa's leading revenue earner), that further substantial improvement can be achieved by a better understanding of the time-tested principles of incentive payments.

SAMEVATTING

Hierdie verhandeling gee 'n oorsig oor die geskiedenis van aansporingsbetalings in die mynboubedryf en gee 'n aanduiding van die omvang van die verbetering wat daar in die verlede daardeur bewerkstellig is.

Die oogmerk is om 'n meer algemene geloof in die doeltreffendheid van hierdie metodes aan te moedig en daardeur die wyer en meer doelmatige toepassing daarvan deur mynbou-ingenieurs in die algemeen, en die opkomende geslag in die besonder, te bevorder.

Na oorweging van die huidige produktiwiteitspeile in die goudmynbedryf (steeds Suid-Afrika se belangrikste bron van inkomste), word die gevolgtrekking gemaak dat nog 'n aansienlike verbetering deur 'n beter begrip van die beproefde beginsels van aansporingsbetalings bewerkstellig kan word.

INTRODUCTION

Gold mining is, and is likely to remain for many years to come, one of the major sources of revenue for the Republic of South Africa and of dividends for the shareholders. The industry is also exceptionally well documented, and for these reasons the examination of productivity trends in this paper is confined to gold mining. It is believed, however, that the main conclusions reached as regards the effect of incentive payments on productivity are applicable to all types of mining.

The late Professor R. A. L. Black¹ and, subsequently, H. H. McGregor², drew attention to the low rate of productivity improvement in the gold-mining industry, in spite of greatly increased mechanization, as compared with other types of mining and other industries in the Republic. Research in a number of fields, and especially in the fields of better equipment and of the human sciences, has now been accelerated and, doubtless, these influences will make themselves increasingly felt in the not too distant future.

It is considered that, in conjunction with these activities, the mining industry cannot afford to overlook more direct methods of improving productivity, particularly

those that are immediately applicable by the mine managements themselves.

GOLD-MINING PRODUCTIVITY TRENDS

Figs. 1, 2, and 3 show very different productivity trends, expressed as tons handled per employee per year (as a five-year moving average) for different groups of workers in the gold-mining in-

dustry. These differences are a pointer to the areas where future improvements will be achieved most readily. The records (kindly provided by the Chamber of Mines of South Africa) commence in 1937, the first year for which the figure of 'tons handled' is available.

Surface European Labour (Fig. 1 and Table I)

Productivity of this group has improved by 96 per cent since 1937-1941, although no progress at all

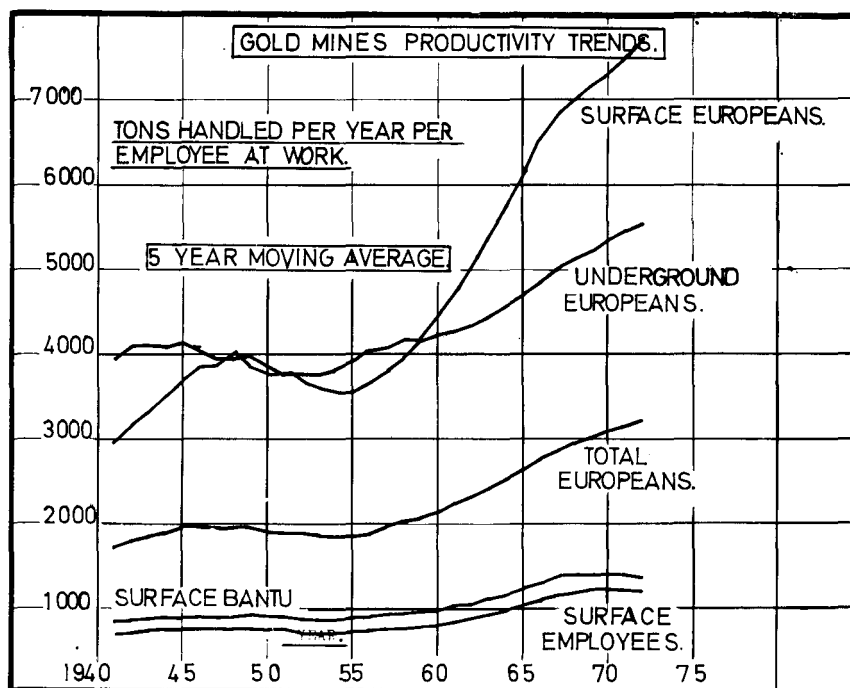


Fig. 1—Productivity trends for European employees

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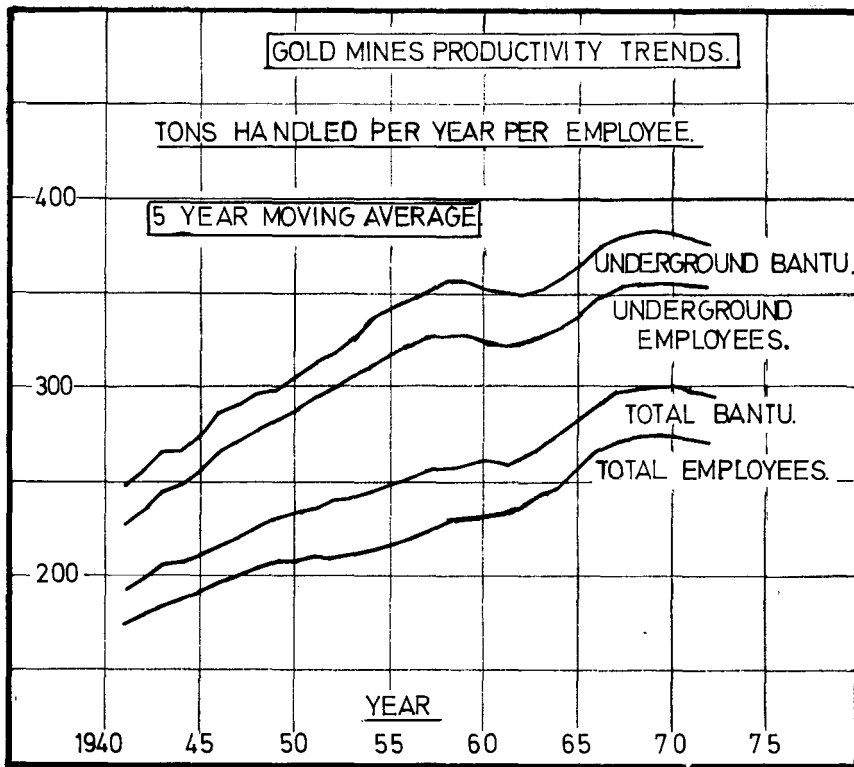


Fig. 2—Productivity trends for Bantu employees

was made in the first twenty years (1937-1957).

A promising advance then commenced, which is still in progress. This advance is due, primarily, to an improvement of 124 per cent in the tonnage handled per surface artisan (Fig. 3 and Table II), who make up about one-third of the surface European labour. Some of this improvement may be due to a planned reduction in the types of work undertaken in surface workshops, but the very marked effect, well documented on numerous individual mines, of incentive bonuses to this group, which was first initiated in an East Rand welding shop in 1952, appears to be the main cause.

From 1952, incentive payments were introduced on a large scale, both for workshop personnel (mainly group bonuses) and for surface plant-maintenance men (individual bonuses).

Productivity figures for European employees in surface plants and for clerical workers (Table II) show improvements of 68 per cent (since

TABLE I
FIVE-YEAR MOVING-AVERAGE PRODUCTIVITY
EXPRESSED AS YEARLY TONS HANDLED PER EMPLOYEE IN SERVICE

Year	Surface European	U/G European	Surface Bantu	U/G Bantu	Total European	Total Bantu	Surface employee	U/G employee	Total employee
1941	3950	2980	826	249	1700	191	685	229	172
42	4100	3150	855	255	1785	197	708	236	177
43	4130	3310	869	264	1835	203	719	244	182
44	4110	3490	876	266	1885	204	722	248	184
45	4100	3720	885	275	1950	210	738	256	189
46	4025	3820	885	284	1965	215	728	265	194
47	3920	3840	878	291	1940	219	717	271	197
48	3920	3900	893	297	1950	224	728	277	201
49	3950	3960	913	307	1960	230	740	285	205
50	3860	3830	901	312	1925	232	732	288	206
51	3740	3790	883	318	1880	234	717	294	208
52	3690	3770	877	326	1865	238	707	300	210
53	3620	3760	870	333	1840	241	700	306	213
54	3560	3740	864	339	1825	244	695	311	215
55	3560	3820	875	347	1840	248	702	318	219
56	3640	3900	889	351	1885	252	716	322	222
57	3790	4020	922	355	1950	257	742	327	227
58	3960	4080	944	356	2010	258	763	327	229
59	4180	4175	973	354	2090	259	788	326	230
60	4420	4230	993	351	2160	260	810	323	231
61	4690	4270	1045	347	2240	259	839	321	232
62	5020	4340	1065	347	2330	263	880	323	236
63	5380	4440	1125	351	2430	268	930	325	241
64	5740	4560	1185	357	2540	274	983	331	247
65	6170	4700	1260	364	2670	282	1045	338	255
66	6530	4860	1325	372	2790	291	1105	346	264
67	6790	5000	1370	378	2880	297	1140	352	269
68	7000	5130	1395	381	2960	299	1165	354	271
69	7180	5230	1405	383	3030	300	1180	356	273
70	7330	5350	1405	381	3090	299	1180	356	273
71	7520	5475	1400	378	3170	298	1180	354	272
72	7725	5560	1395	373	3230	295	1170	350	270
	+96%	+87%	+69%	+50%	+90%	+55%	+71%	+53%	+57%

1949-53) and 30 per cent (since 1937-41) respectively. Computerization and improved surface equipment and layouts are seen as the major influences accounting for these advances.

Underground European Labour (Fig. 1 and Table I)

An 87 per cent improvement in the productivity of this group has been recorded since 1937-41. The main cause of this improvement is apparent in Fig. 3 and Table II.

The productivity of underground Union men, who make up rather more than half of the total underground European employees, has advanced steadily over the period for a total 141 per cent improvement.

Little increase is apparent in terms of other underground European employees.

The improvement in productivity of underground Union men is directly connected with incentive payments. Stoppers and developers have

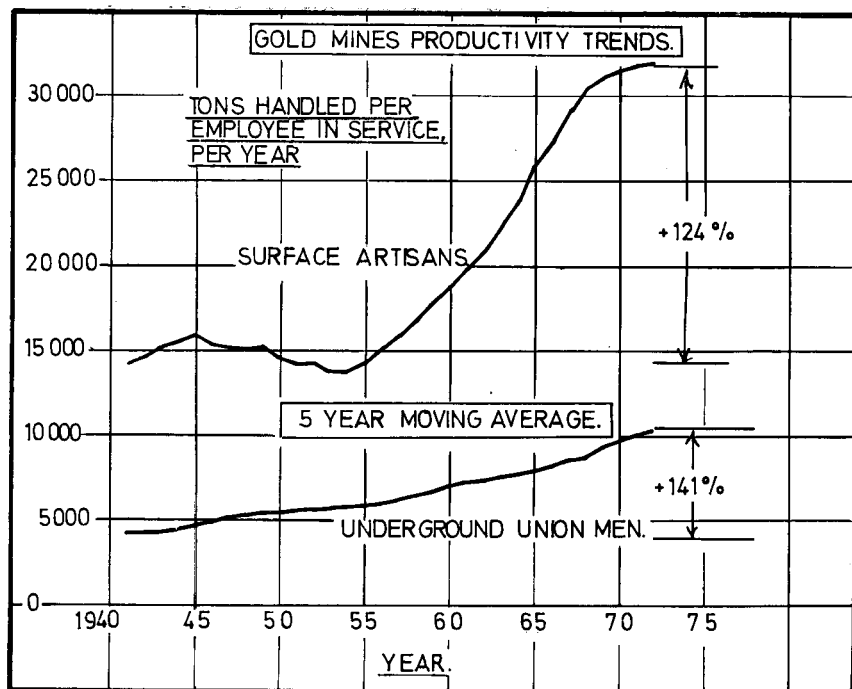


Fig. 3—Productivity trends for surface artisans and underground Union men

TABLE II
FIVE-YEAR MOVING-AVERAGE PRODUCTIVITY OF SPECIAL GROUPS EXPRESSED AS YEARLY 100'S OF TONS HANDLED OR MILLED PER EMPLOYEE IN SERVICE

Year	Clerical		Artisans		Plants*	
	European	Bantu	Surface	Underground	European	Bantu
1941	263	Not available	143	391	Not available	Not available
42	263	"	149	403	"	"
43	255	"	152	413	"	"
44	245	"	155	430	"	"
45	242	"	159	453	"	"
46	235	"	155	443	"	"
47	225	"	151	429	"	"
48	221	"	151	421	"	"
49	221	"	152	421	"	"
50	214	"	145	403	"	"
51	204	"	144	396	"	"
52	201	"	142	391	"	"
53	198	249	140	381	228	33,0
54	193	240	139	369	218	33,1
55	193	236	144	364	199	32,8
56	194	234	152	360	185	32,3
57	198	234	160	360	175	32,7
58	210	232	170	363	170	33,3
59	213	231	180	364	169	34,5
60	222	225	188	362	174	36,2
61	232	220	200	360	185	37,3
62	245	Not available	210	358	200	Not available
63	258	"	224	355	219	"
64	270	"	240	355	242	"
65	283	"	260	361	270	"
66	299	"	276	368	294	"
67	309	"	292	375	316	"
68	323	"	305	375	335	"
69	325	"	311	375	352	"
70	339	"	315	371	361	44,7
71	341	267	318	363	373	44,4
72	342	261	319	358	384	43,8
	+30%	+5%	+124%	-8%	+68%	+33%

*Tons milled.

readily accepted the extra responsibility of supervising more and more labour with more and more equipment, because their contract earnings have been increasing dramatically. Since 1947, when Chamber figures were first available, total earnings of this group have more than quadrupled.

The payment of individual bonuses to underground artisans, which commenced about 1954 and is now common practice in most Groups, was a factor in arresting the sharply deteriorating productivity trend of these men that had been evident since 1945. This deterioration was due, no doubt, to the very great and continuing increase in underground mechanization outlined by both Professor Black and Mr McGreggor in their papers. Total earnings of underground artisans have also increased more than four-fold since 1947.

Surface Bantu Labour (Fig. 1 and Table I)

Tons handled per surface Bantu employee have increased by 69 per cent since 1937-41.

The effect of computerization, etc. on clerical workers (5 per cent improvement since 1949-53, when records were first available) and on plant workers (33 per cent improvement since 1949-53), shown in Table II, does not account for this advance, and other favourable influences clearly have been at work.

The campaign for improved surface layouts in the newer goldfields, launched about 1950, is seen as a major factor in this general improvement in the utilization of surface Bantu labour. The subject is well documented in a series of papers to the Mine Managers' Association from 1950 onwards.

Underground Bantu Labour (Fig. 2 and Table I)

Tons handled per underground Bantu employee have improved by 50 per cent since 1937-41, which is considerably less than for the three groups previously discussed, in spite of the great increase in underground mechanization referred to above.

For the first twenty years, a much more satisfactory trend was evident, but this has not been maintained. At the present time, the productivity of this group appears again to be on

the down-grade.

A Chartist, making a simple projection of the 1937-57 trend, might be tempted to conclude that the gold-mining industry, if it had been able to maintain this earlier trend, would now be employing some 45 000 fewer Bantu underground for the present production.

An important factor in the failure to maintain a more desirable rate of progress is considered to be a deterioration in the extent and effectiveness of incentive bonuses to these workers, particularly to those engaged in the main stoping and development operations.

What has caused this suspected deterioration? To answer this important question, a brief review of the past history of these payments is made in the following section.

HISTORY OF INCENTIVE PAYMENTS

Direct Incentives

The mining industry has always been at the forefront in terms of direct individual payments by results to underground workers, such as contract payments to European stopers and developers, and drilling bonuses to Bantu machine operators. Such payments are made the more necessary on account of the dispersed nature of underground operations and of the difficulty of close supervision.

This direct type of payment, based on simple measures of production such as centares* broken or metres advanced for Europeans, or holes drilled or tons trammed for Bantu, are generally accepted by mining men as quite essential for high productivity.

It is not so generally recognized that even a fairly complicated incentive scheme, such as the gang bonus scheme described below, is, or can be made to be, equally effective, and therefore should not be neglected in the current drive for increased productivity.

Gang Bonuses

Work studies of Bantu operators were first undertaken in the early 1930s, when gold production was expanding rapidly in the face of a Bantu labour shortage and it was most desirable to maintain a low cost structure in view of the fixed

* 1 centare = 1m²

gold price. These studies were initiated on the then new East Rand gold mines.

There were three main results of this innovation: firstly, labour control to keep each group of workers, or gang, at the correct strength determined by the output required; secondly, a concerted effort to bring working conditions closer to the standards required by Management; and, thirdly, the introduction of incentive payments to a large proportion of Bantu workers, particularly underground workers. In the main, these are the stoping and development gangs engaged in direct production, and the gang bonus scheme was first developed to meet this requirement.

The results of these efforts, which were made on an increasingly broad front from 1934 onwards, are clearly discernible in Fig. 2, as previously indicated in this paper. Perhaps even more impressive are the actual results achieved on individual mines, often in a comparatively short space of time. Typical cases are shown in Figs. 4, 5, and 6, each of these mines belonging to a different mining Group, and each with a very different level of performance. Improvements of 65, 48, and 55 per cent in 6, 5, and 5 years respectively are shown.

This is very old history, but equally striking improvements have been recorded by mines in the Evander area in recent years by the application of a similar type of gang-bonus scheme.

It is suspected that further advances can be achieved by this means without change in basic method or equipment. The keys are believed to be, firstly, extensive job combination with, of course, the necessary re-training; and, secondly, a very substantial increase in the actual amount of incentive payments to be adopted more generally throughout the industry. The maintenance of standard working conditions, which is an essential requirement for bonus payment, will become of even greater importance.

A few mines have not attempted the introduction of gang bonuses, whilst others have introduced and subsequently discontinued them. In still other cases, no doubt, payments

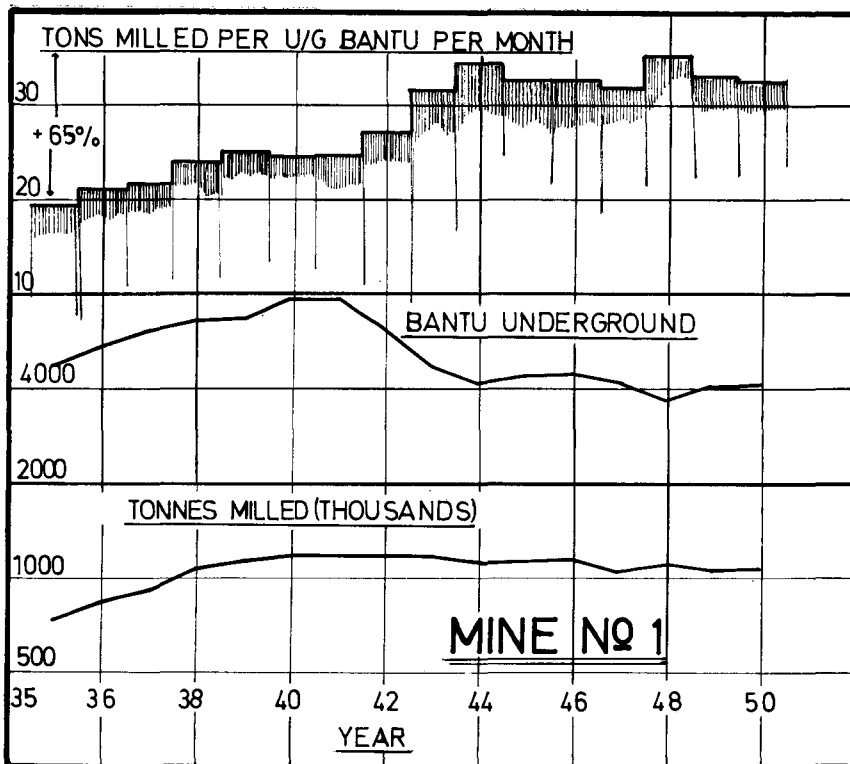


Fig. 4—Output of underground Bantu employees—Mine No. 1

will have become virtual 'hand-outs' through lack of the essential management control and follow-up.

All in all, then, this appears to be a promising field, in which considerable benefits to all can be won, awaiting the closer attention of the young and enthusiastic mining engineer.

BASIC REQUIREMENTS FOR EFFECTIVE INCENTIVES

It seems desirable at this stage to recapitulate the well-known, but not always practised, basic requirements for any successful incentive scheme, particularly those designed for a group of Bantu workers.

- (1) The scheme must be based on unassailable performance figures.
- (2) The details of the scheme, which must always take local conditions into account, must be readily understood and must be considered reasonable and fair by the participants. The method of initial introduction of the scheme and the continuous publicity provided thereafter are thus of considerable importance.
- (3) Careful administration is es-

sential. This requires the constant attention and interest of Management, preferably exerted through a special section of technical services. Payment of bonuses can be made monthly, but it is highly desirable that the performances of Bantu gangs should be calculated and published weekly.

- (4) The scheme must be carefully controlled, especially in terms of changing conditions underground. In some circumstances, rectification of sub-standard conditions by special Management action is called for. In others, standards must be changed to suit changed conditions. It must be emphasized that improved Bantu performances following the introduction of incentive payments result more from improved working conditions achieved in this manner than from an increased tempo of work. Any alterations to standards without full knowledge of the facts, or without full explanation to the scheme participants, will quickly undermine the in-

centive value of the scheme.

- (5) The original theory that incentive payment must be in direct proportion to work done to give the optimum incentive effect has amply proved itself in practice over the last fifty years in all types of industry throughout the world. The mining industry is no exception. This means that what is known as a 100 per cent performance should be rewarded by a bonus payment equal to one third of current basic pay. In the determination of the present level of basic pay for any Bantu work group for the purpose, at least part of the value of these workers' 'board and lodging' should be taken into account.

ESSENTIAL PROCEDURE IN APPLICATION

It is not intended in this paper to describe the techniques of work study and job evaluation. Both are well known and have been practised extensively in the mining industry for many years. The need for these techniques as essential preliminaries to the establishment of any kind of incentive scheme, however, must be emphasized.

Method study is a necessary preliminary to the determination of the best working routine with minimum delays and to the exploration of the possibility of advantageous job combinations. Work measurement is then required in the determination of time standards for the various tasks being examined.

Job evaluation will indicate the correct level of basic pay for the different jobs. Incidentally, careful job description is obviously an essential preliminary to job evaluation.

This differential in basic pay is not only a motivating influence encouraging the individual to fit himself for a better job, but it also shows the difference in incentive payments for the different classes of worker for the same performance.

SOME TYPES OF INCENTIVE PAYMENTS USED IN MINING

Given the necessary training, the right tools and equipment, and

reasonable working conditions, the average underground worker, including the Bantu worker, will maintain a satisfactory rate of working when receiving an incentive payment he can understand.

There are many types of payment falling into this category. The three types briefly described below are among the most commonly used in the mining industry.

Direct Individual Bonuses

Payments to individuals based directly on a straightforward measure of their own 'output', such as holes drilled by machine operators, require no further explanation. This is a most powerful incentive but, unfortunately, its application is limited.

The field for individual incentive payments can be widened considerably to include workers whose output cannot be measured in such simple terms, by the use of standard times, usually determined by work study. In this manner, a great variety of jobs completed by the individual are translated into 'credit' minutes, which determine his performance over a period of time.

This form of incentive payment has been introduced with some success for surface and underground

maintenance men, as indicated earlier.

Gang Bonuses

This type of incentive payment has been used with good effect for stoping and development gangs, which usually make up over 70 per cent of underground Bantu workers.

The current production target for each gang—centares to be broken or metres to be advanced—which is set by various methods, is translated into daily requirements in terms of tons to be handled, packs to be built, etc. These 'calls' provide the basis for determining the labour requirements for each operation, resulting in a total labour complement for the gang, based on the work standards in use on the mine. For example, the production call might be 100 tons per day with 35 Bantu or 2,86 tons per total shift worked. The actual tons handled per shift worked by the gang over the week in comparison with this figure gives the weekly performance of the gang. This performance determines the weekly incentive bonus earnings per shift worked for each member of the gang.

Continuous propaganda through the media of Bantu supervisors and Bantu personnel officers to publicize

the current requirements for various levels of payment is a basic necessity. Low bonus earnings must be investigated without delay and remedial steps taken as required.

Perhaps the greatest advantage of this form of incentive payment is the team-spirit it can engender, encouraging a sharing of the work among all members of the gang.

Fixed Additional Bonus

A fixed additional bonus payment, perhaps 20 cents per shift, is made in this type of incentive, provided the worker maintains a clearly defined level of performance. For example, if a spanner boy in a development drilling crew is successfully serving two machine operators, he might receive a fixed daily award of this kind.

Similar payments have been instituted to facilitate Bantu job combinations in the Reduction Works and in a variety of other surface occupations.

THE PROMISE OF JOB COMBINATION

The principle of employing specialists who carry out only one type of work, such as drilling, timbering, etc., is still common practice in our mining industry.

The present trend in overseas mining, where labour costs are of prime importance, is for one operator to undertake several basically different jobs in sequence, so that delays and unbalances cannot occur.

The advantages of job combination, particularly in stoping and development, were realized in the mining industry as far back as 1934. Bantu stope workers were trained to work at several jobs, such as stonewalling, pipe-fitting, and track-laying. Development drillers have qualified as loader drivers as well in multi-blast development work, and many other job combinations have been successfully attempted. Generally, however, only limited permanent progress has been made, owing, perhaps, to the short average Bantu contract period and to the fairly strict limits that have applied to pay scales until recent times.

The pay position is now changing rapidly, and the time appears to be

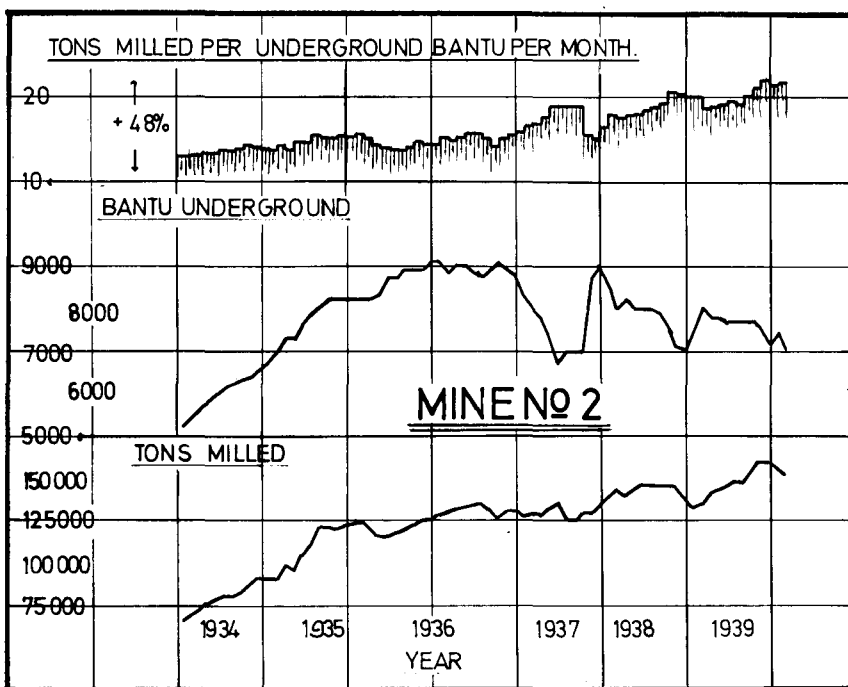


Fig. 5—Output of underground Bantu employees—Mine No. 2

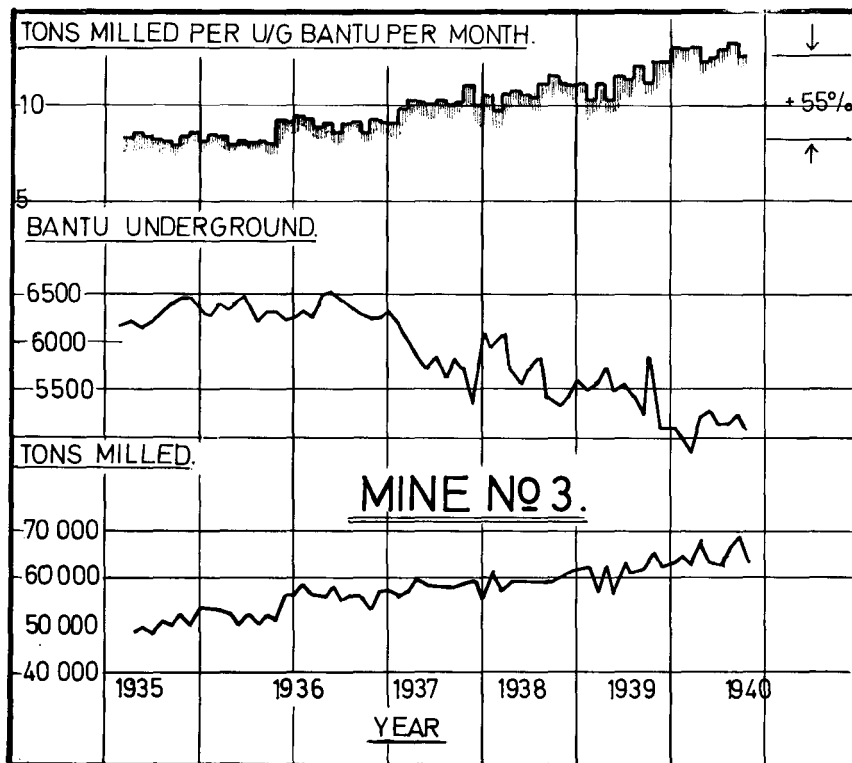


Fig. 6—Output of underground Bantu employees—Mine No. 3

ripe for a final breakaway from these traditional practices.

As an example of the great potential of job combination in stoping, a recent feasibility study in the Klerksdorp area concerned the allocation of a short stope panel, with its own drilling and cleaning facilities, to each group of five Bantu workers. The group, working on delay-free routines, could readily drill, clean, support, and sweep the panel daily, giving an output of 25 tons per shift, a performance greatly superior to current stoping results.

This type of technical advance calls both for more extensive training and for considerably increased earnings, not neglecting the very important incentive part of the pay packet.

CONCLUSION

The present productivity campaign in the mining industry, on which all the mining groups are engaged, comes at a time when Bantu earnings are increasing at an unprecedented rate and overall pro-

ductivity in gold mining is decreasing.

There are encouraging signs, however, that every avenue for advance is being vigorously explored. It is the purpose of this paper to suggest that not the least fruitful of these will be the improvement in the quality, the amount, and the extent of incentive payments to Bantu miners.

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Contribution to above paper by A. A. Hazell*

It is particularly relevant at the present time to present a paper on the value of incentive payments. There is little doubt that we are in

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an era of rapidly escalating wages, and is therefore important that management should strive to attain increasing productivity. The author advances many arguments to show that incentive payments can result in greater productivity. Furthermore, of course, they provide a protection to management in so far as payment is made only if productivity is improved, and the scheme can be designed to ensure that management gets its share of the improvement.

Bonus and incentive schemes are effective only within the framework of good management, and the important requirements are the following:

- (a) well-trained personnel,
- (b) correct production planning,
- (c) correctly set complements,
- (d) unassailable performance measurements,
- (e) unassailable performance standards,
- (f) a simple relationship between production and reward so that a good estimate of reward can be made by the worker even on a daily basis,
- (g) a management team committed to improving productivity,
- (h) a substantial reward directly proportional to production, and
- (i) the possibility of personal promotion.

Whether individual or team incentives are used depends on the organization. If the individual can get results that depend primarily on his own contribution, (e.g., a stoper, developer, or gang leader, who must co-ordinate, organize, and direct the efforts of his gang), then the payment should be to the individual and the scheme should be designed as such. However, as far as the stope or development Bantu gang is concerned, a team bonus is desirable since the results obtained are entirely dependent on the completion of work by other gang members. If the gang is to optimize output, it must look to the plan designed by the miner and shift boss. The optimum can be obtained only by working to a plan, and the individual must pitch his output to achieve the plan, i.e., average or standard performances are required, not outstanding performances. From this it