

CHAPTER 5 RESULTS AND FINDINGS

5.1 Results related to the study objectives

5.1.1 Mine scenario analysis

The HLP model was successfully applied to analyse various mining scenarios within Anglo Platinum. The effect of layout changes on various outputs was correctly quantified and correlated with manual calculations and mine simulation programs, like Cadsmine. Stope width changes immediately impact on the grade and the revenue. Waste and reef quantities vary with any alteration to the mining layout, blast efficiency, etc., and logistical requirements can be assessed immediately. Some mines changed their mining systems and production plans after investigating the outcome of the HLP model's results.

5.1.2 Monthly production planning

The HLP model in its current state can only support monthly or longer period planning. Daily planning can be done by dividing the monthly plan by the number of shifts available, but systems like Day-call are in use to cater for daily production variances. Day-call simply uses the monthly plan divided by the number of shifts, which is then compared with daily achievements as recorded by the production personnel.

The HLP model calculates the ideal monthly progress requirements and it allows actual monthly measurement inputs to be made. It then compares the ideal situation with the actual achievements and flags problem areas for management's attention in a special summary table. The HLP model also shows the ore reserve situation numerically and graphically on a monthly basis, and shows a comparison between the ideal and the actual ore reserve values.

5.1.3 Long-term production planning

The HLP model has a built-in 7-year production planning facility as illustrated in Table 3.16. The user is given the option to build flexibility into this plan by

defining the amount of idle or spare panels per half level. This plan contains every possible output required and is divided into two sections, namely the annual progressive section and the average monthly production section. Some mines adopted these outputs as their 5-year production plan for 2003 to 2007. The sum of all these plans equates to the total shaft's production plan. Furthermore, this process is automated – once the user has arrived at the required "fit" between the current position and the ideal position, it is activated by an action button. Accurate shaft 5-year plans have been compiled in less than a week after starting the process whilst conventional systems took as long as three months.

5.1.4 Mine production optimisation

Most mines produce at lower than optimum production levels. Some areas investigated indicated production levels at less than 50% of the optimum. The HLP model doesn't only indicate where problems are experienced, but it also gives management direction towards bottle-neck identification and solutions. Most half levels need in the region of R3 million in year 2000 money terms³⁴ (Appendix 4) to upgrade the current infrastructure towards achieving these targets. Others need additional development meters, for example some sections only have single ore passes where a minimum of three is required for handling optimum production rates. Sub-optimum stope face lengths or stoping widths are in place thus causing underutilisation of current labour and equipment. In some cases the ventilation quantity available is the reason for poor production due to the fact that double the required amount of half levels is being mined simultaneously.

5.1.5 Understanding ongoing capital replacement

The importance of ongoing capital replacement was covered and certain mines in Anglo Platinum were defined as "at risk" after assessments were completed. This means that the current production levels exceed the replacement rate of main infrastructure. The HLP model calculates the optimum shaft capacities based on current replacement rates, but a simplified version was subsequently developed to be used on a macro scale. Some findings indicated level replacement rates exceeding 40 months where the extraction rate required 25-month level

replacements. This means that some levels will be depleted up to 20 months before they can be replaced. (Appendices 7, 8 and 15)

5.1.6 Layout selection

This is normally one of the most sensitive issues since every stakeholder has unique ideas³⁵ (Appendix 5). The HLP model allows the user to define the specific layout and thereafter the relevant scheduling. The model then takes over and calculates key parameters that can be used to assist with the selection process. Important however, is that the user must know exactly what is expected in terms of managing the mining system as well as output and timing requirements. Some layouts build up to very high steady-state output values but take rather long to get there – these layouts may not be useful where a quick build-up is expected. The working cost may however be lower. In large common block layouts, typically found amongst breast layouts with long backs, the upfront development is highly efficient with replacement ratios of more than 50 square meters per meter development (18 square meters per meter developed in down-dip systems). This is offset by the period required to reach steady-state production rates – typically 45 months as opposed to 30 in the case of down-dip layouts. The flexibility also plays a major role and, in the case of breast mining, less than 50% of the available face length is mined at any point in time when using a one-day cycle. In the case of down-dip mining, every face has to be mined as soon as it becomes available and in the event of face losses that may occur from time to time, no contingency panels are available. The HLP model however indicates that it is more advantageous for a company like Anglo Platinum to make use of a breast mining system.

5.1.7 Layout optimisation

Once the preferred layout has been selected, additional enhancements can be modelled. In many cases common block widths are not optimised and the HLP model allows the user to make effortless changes. It is important to ensure that the scheduling is still correct after any dimension changes. When block dimensions are increased, immediate output increases and development efficiencies can be observed. Decreasing stoping widths and/or increasing panel lengths will show the effect on dilution and thus revenue per total ton broken. In

most cases the capability of the people, equipment and the infrastructure must be known before attempting any optimisation exercise, for example the maximum pull distance of a winch or the minimum stope width people can work in.

5.1.8 Production impact on revenue

The HLP model uses a fixed value per 4e gram and any changes to the reef production rate will be expressed in a rand-based revenue value. The HLP model does not calculate the cost of production and profitability calculations can thus not be performed. Existing working cost databases are available and may be used for draft profitability calculations, but a detailed costing exercise must be conducted before any final decisions can be made.

5.1.9 Determining equipment requirements³⁶ (Appendix 4)

The calculation of equipment requirements is limited to winches, locomotives and hoppers (rock transport conveyances). These are considered the main equipment items for any conventional mine and various other calculations can be performed once their quantities are known. The HLP model accurately calculates the winch requirements based on pre-reclamation data as per user definition – management has to ensure a service-exchange pool to optimise the quality of new winch installations (every winch has to be overhauled after the reclamation phase, prior to re-use). The tramming equipment quantities vary with distance and tramming speeds. A proper work-study has to be conducted before this calculation can be made.

Power and compressed air needs cannot be calculated without the basic information as supplied by the HLP model.

5.1.10 Simplified management approach³⁷ (Appendix 6)

The approach followed throughout this study may be used as a management approach. Dividing the mine into manageable independent units and then optimising these will lead to optimised shaft systems and ultimately an optimised Anglo Platinum. The HLP model contains a simplified monthly management sheet where the actual and the optimum performance levels are

compared on a continuous basis. Management's attention is directed at problem areas by means of a colour-coded variance analysis summary and unique problems can be addressed on a monthly basis. Development requirements are end-specific and not based on a single ratio.

5.1.11 New mine design

Every new mining project in Anglo Platinum has to be assessed with the HLP model. The capital and ore reserve requirements can be defined³⁸ (Appendix 9) and accurate build-ups of revenue and production can be calculated.

Shaft capacities can be aligned with the requirements of the combined half levels and the optimum-level replacement rates.

5.1.12 Summary of results

A summary of these results is:

- The HLP model was successfully applied to analyse various mining scenarios within Anglo Platinum.
- Monthly planning is the smallest planning unit supported by the HLP model.
- The HLP model was successfully used to do long-term production planning and periods of up to seven years can be summarised.
- The HLP model was successfully used to guide management towards optimising the current production levels.
- The half-level concept was applied to indicate the importance of ongoing capital replacement development as part of optimising the mine.
- A layout comparison was successfully done and selections can now be made based on the area's specific requirements.
- The HLP model has proved its capability to assist in optimising layouts by allowing the user to see the output effect after making relevant alterations.
- The HLP model expresses any change by the user in a monthly revenue format thus sensitizing the stakeholders to the financial implications of their decisions.
- The HLP model has a component that accurately calculates the needs around major ore handling equipment requirements directly aligned with the production levels.

- Managing a mine on the half-level concept with or without the HLP model is broadly discussed.
- The HLP model is selected by a group of senior managers within Anglo Platinum to form the basis for approving any new mining project.

5.2 Expected impact of results ²

The HLP model indicated that Anglo Platinum can increase its current production per half level from around 2 000 to more than 3 000 square meters per month. This does not necessarily imply that the output may be increased by 50% or $(3000-2000)/2000$. Current operating half levels may rather be reduced to allow better resource utilisation. Mines can now be divided into more manageable units to ultimately optimise overall efficiencies. Layouts may be assessed on a scientific and financial basis instead of personal preference basis. Development of both working cost and capital types will be managed on a just-in-time basis.

Capital allowances can be made according to the true infrastructure requirements and cash flow profiles may be optimised by making use of the HLP revenues as well as available working cost databases. Managing capital projects can be managed accurately by making use of the ideal versus actual performance comparison sheet contained within the HLP model.

5.3 Conclusion

A simplified mine planning system meeting all the requirements of the set objectives has been designed, developed, tested and is currently being implemented throughout Anglo Platinum. It has acceptable correlation levels with more complex mine planning systems (within 10%). The HLP system has been accepted as a norm for mine planning and mining project evaluation by senior mine management throughout Anglo Platinum within less than a year since the initial introduction. It is user friendly and it focuses management's attention towards optimising Anglo Platinum from the smallest independent production unit, namely the half level. Attention is directed towards individual development ends instead of total mine planned development rates thus eliminating more difficult development ends from being neglected. The focus is

also directed towards revenue awareness and layouts can be optimised on a technical, as well as a financial basis without expert assistance.

Capital as well as ore reserve optimisation forms an integral part of mine planning and the importance of replacement capital is highlighted. The main equipment calculation is done accurately and services requirements can be calculated from the HLP model's results. A total mine's long-term plan requires one person and it may be completed accurately in less than one week.

A so-called "tonnage factory" is currently being designed by making use of the HLP model and at this point it seems capable of delivering a sustainable 17 000 square meters per half level per month, which is more than 800% above the current 2 000 square meter average achieved by Anglo Platinum³⁹ (Appendices 10 and 11).

5.4 Recommendations for future work

Based on the results of this thesis, the following improvements and developments can be identified and their development is recommended:

1. The design of a labour-planning module linked to the HLP model. This has commenced and Rustenburg Section will be the pilot site from January 2003. This entails a complete zero-based exercise of all activities and labour disciplines⁴⁰ (Appendix 3).
2. The design of a stores-planning module linked to the HLP model. Links between the SAPR3 system are being investigated and a previously used stores model will have to be refined for this purpose from May 2003.
3. The development of a HLP profitability model after the labour and the stores modules are completed. This system is planned to manage profits and profitability from half level up to shaft level only.

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