CHAPTER 1 GLOBAL OVERVIEW

Preface

Several mine design and production planning software packages were released during the past thirty years and systems, like Datamine and Cadsmine are widely used. These are however specialist fields and are not totally user friendly to the untrained. They are also not simple for optimisation and scenario planning in the sense needed by managers for quick decision making[3]. However, if these systems are properly used, very powerful and accurate information can be generated and it is not the intention of this document to suggest that current planning systems should be replaced.

Half-level planning (HLP) should rather be run in parallel with the formal planning system focusing on the longer term issues. One system can also verify the accuracy of the other to achieve higher levels of confidence. The half-level planning system as discussed in this document requires basic Microsoft Excel knowledge as well as some understanding of mining layouts and the relationships between the various underground activities – development, ledging, equipping, stoping, sweeping, vamping, reclamation, logistics and services.

1.1 Introduction

Two commonly used terms in the mining world are green fields and brown fields operations. Green fields refer to new or virgin areas and brown fields to existing operations. In an expanding business world, most of the attention and focus is enjoyed by the green fields operations due to the large amounts of initial capital required.

The true potential of brown fields is often overlooked because of annual comparisons to historical business plans that may not be optimised in the first instance. The contents of this document will focus on determining the optimum

quality and quantity (OQ[2]) from existing or brown fields operations by utilising mine design concepts.
It mainly addresses technical design aspects but financial and human resource issues can't be isolated from the optimisation process and may thus be referred to from time to time.

Narrow reef conventional underground platinum mine design parameters will be used throughout the document, but the processes could be applied to other business scenarios. Narrow reef in this document refers to the ore body not exceeding 3 m in width.

The underground mining methods have not really changed since inception but the introduction of rock drills, winches, locomotives and conveyor belts, etc. have caused noticeable labour efficiency improvements. The fear exists that the different mining layouts have reached efficiency limits with serious safety implications if labour numbers are reduced any further. Several projects have been initiated to address both safety and efficiency concerns[4].

There is a constant productivity improvement drive that results in less people producing at higher levels from the same environments as in the past. It reduces the exposure risk, but shortcuts are often taken thus resulting in unsafe work. Additional pressure is added by metal price variations, inflation, exchange rate fluctuations, labour relations and the vast amounts of capital involved. Capital for a typical 200 000 tons of ore per month operation (mining and concentrating) amounts to R 1,500,000,000 or R1,5 billion in year 2000 financial terms[5].

1.2 Background

South Africa is rich in mineral resources and contains the largest known platinum reserves in the world situated in the Bushveld Igneous Complex. Anglo Platinum is the world's largest platinum producer with most of its reserves in the form of an underground narrow tabular ore body dipping (inclination relative to horizontal) from 9 to 22 degrees with an average mining width of less than 1 m. There are two main mineral zones, namely the Merensky Reef and the UG2

(Upper Group 2) Reef horizons. However, there is another variation in the Potgietersrust area called Plat Reef, but this is currently being mined by open-pit mining methods and will not form part of this study.

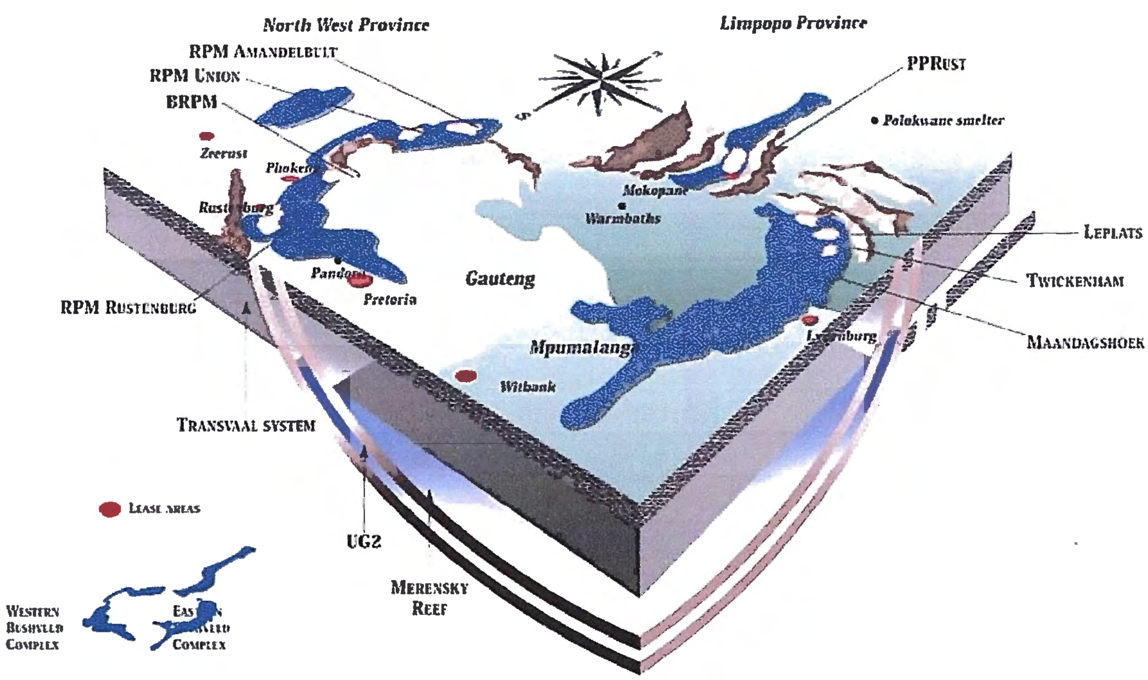

Figure 1.1: Bushveld Igneous Complex: Map of the Anglo Platinum mines and lease areas[6]

For the purpose of this exercise the emphasis will be on the interrelationship between the main activities and some aspects surrounding it, i.e. the services, equipment and infrastructure inputs supporting the main activities to arrive at the optimum output levels.

These main mining activities can be broken down into:

Development: Creating tunnels to access, service and extract the ore body.

Ledging: The widening of tunnels (normally in the reef plane) to install equipment necessary for reef extraction (stoping).

Equipping: The preparation of a ledged-out area to allow the extraction of the remaining reef area through a process called stoping.

Stoping: The main reef production activity from an equipped stope.

Sweeping and vamping: Removal of all remaining broken ore left behind after the stoping activity. This may commence during the stoping phase and continues after stoping has been completed.

Reclamation: In this activity all the useful material is reclaimed for use in other areas, which includes pipes, winches, electric cables, etc.

1.3 Need for research in this field

Conventional mining optimisation revolves around sustaining the optimum blasting efficiency for the life of the mine. This implies getting the most possible blasts at the best possible advance per blast from the appropriate ends (blast attack fronts). In addressing these improvements, the following questions exist:

- Which development ends should be blasted and what advance rate is required to sustain and maintain an optimum production rate?
- Is the mining layout optimised?
- Is the equipment adequate and can the services support all the mining activities in the production area?
- Is the capital replacement rate synchronized with the ore extraction rate?
- Is there a simple planning system in place that can assist the operations to supply answers to all of the above questions?

1.4 Need for this research by Anglo Platinum

The outcome of an exercise[7] (Appendix 2) conducted during January to May 2001 indicated that the group operations were operating at a blast efficiency of around 60% – this was measured on existing panels (term used for stoping blast attack fronts). Blast efficiency refers to the blast frequency (actual blasts/possible blasts) multiplied by the advance efficiency (actual advance per blast/maximum possible advance per blast). Further investigations into the outputs of half levels indicated that most extraction rates are in the region of 2000 square meters per month[8]. A half level refers to the smallest independent self-sustainable production unit encompassing all the main mining activities (also one side of a level). This is in the region of 65% of a calculated sustainable 3 000 square meters per month per half level. In both instances a 35% to 40% output improvement or an efficiency improvement possibility of 35% to 40% could be observed. The output improvement is however limited by the infrastructure capacity, but if 35% improvements could be achieved, it would mean an additional 664 000 platinum ounces per year from Anglo Platinum's underground operations, or 2 562 000 platinum ounces in total – an additional R5,36 billion revenue per year[9].

1.5 Problem statement

- What is the true sustainable potential of the existing operations within Anglo Platinum?
- What are the various requirements to achieve the optimum quality and quantity production levels from existing and future mines?

1.6 Objectives

The objectives are:

- To determine the production GAP in the existing Anglo Platinum operations
- To create a system or methodology that can assist mine management with the following:
  - Mine scenario analysis
  - Monthly production planning
  - Long-term production planning
  - Mine production optimisation
  - Understanding ongoing capital replacement
  - Layout selection
  - Layout optimisation
  - Production impact on revenue
  - Determining equipment requirements

- Simplified management approach
- New mine design.

1.7 Contributions of this study

A "Half-Level Planning" system (known as the HLP system) was developed with the following results:

- The optimum sustainable production levels of all the underground operations within Anglo Platinum were determined.
- Some equipment and infrastructure requirements to leap from the current to optimum output levels were determined.
- Capital replacement rates and requirements were defined and aligned with optimum shaft capacities.
- The scheduling of activities to arrive at optimum levels was also determined.
- Priority areas (development end bottle necks and lags) were identified to optimise ore reserve and sustainability management.
- Several new mining layouts were evaluated in terms of maximum expected output levels, build-up period to optimum production and the equipment requirements to support these production levels.
- Some existing operations and layouts were optimised.
- Total shaft 5-year plans were produced in five days where it normally takes up to three months.
- Mine management adopted the half-level concept as a means to manage mines simpler and more effectively.

This HLP planning system has been evaluated against existing software packages and correlations were within 10%[10] (Appendix 1). The system was demonstrated to the entire mine management team of Anglo Platinum and a decision to use it for the next 5-year planning session was made within three months after the demonstration[11]. The model has the flexibility to build mine-specific requirements into it and is constantly developed further with mine involvement. It also has the potential for further development into an operating cost/profitability planning model that will make it a total business profitability-planning tool.

1.8 Brief overview of dissertation

Chapter 1 contains general as well as Anglo Platinum specific mining information. Anglo Platinum is an expanding mining company and is the world leader in platinum production. The majority of the platinum produced is from labour-intensive conventional underground sources. Some risks the mining industry is exposed to are discussed. Average efficiency numbers of the current operations are compared with the true potential that can be achieved. The main conventional mining activities are identified and explained. The problem statement, objectives and the needs of this study are defined. The contributions made are summarized and the HLP model, which was developed to arrive at these contributions, is introduced.

Chapter 2 is focused on explaining important mining terms and concepts that need to be understood. Current mine production-planning systems as well as their associated shortcomings are mentioned.

Chapter 3 covers two important terms, namely ongoing capital and the half level. The importance of the half-level ore reserve and ore reserve management is discussed. The HLP model's basic operating procedure is summarised. A detailed step-by-step half-level assessment exercise with relative input and output example tables is then completed and explained.

Chapter 4 is a discussion around some other applications of the HLP model. Revenue calculations, half-level management and incentive scheme suggestions are made. The role of the HLP system in the calculation of equipment requirements is proved and examples where ore-handling equipment is calculated are included. An important but different approach to calculating shaft capacities is discussed. A real layout selection and optimisation exercise is included and explained.

Chapter 5 is the final chapter and contains the results and findings of this study. Reference is made to all objectives mentioned after which the conclusion follows. Possible future work with specific mention of the development of a financial HLP model is discussed.