PINCOCK perspectives

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An Integrated Procedural Approach to Underground Mine Planning that Increases Value

CALENDAR

■ ***Mineral Exploration Roundup 2009***
January 26 – 29, 2009
Westin Bayshore Resort & Marina
Vancouver, B.C., Canada
Email: shendry@amebc.ca

■ ***Mining Indaba 2009***
February 9 – 12, 2009
Cape Town International Convention Centre
Cape Town, South Africa
Email: mcady@iiconf.com

■ ***2009 SME Annual Meeting & Exhibit***
February 22 – 25, 2009
Colorado Convention Center
Denver, Colorado
Email: meetings@smenet.org
Visit PAH/Runge at Booths 523 & 525

■ ***PDAC 2009 International Trade Show & Investor's Exchange***
March 1 – 4, 2009
Metro Toronto Convention Centre
Toronto, Ontario, Canada
Email: info@pdac.ca
Visit PAH/Runge at Booth 708

■ ***Asia Mining Congress 2009***
March 23 – 27, 2009
Raffles City Convention Centre
Singapore, Singapore
Email: winnie.koh@terrapinn.com

■ ***AR Minera 2009***
April 28 – 30, 2009
Costa Salguero Center
Buenos Aires, Argentina
Email: info@viewpoint.com.ar

■ ***2009 CIM Conference and Exhibition***
May 10 – 13, 2009
Metro Toronto Convention Centre
Toronto, Ontario, Canada
Email: cmurphy@cim.org
Visit PAH/Runge at Booth 1320

Introduction

The value that is derived by good mine planning is often underestimated as many mines steer their attention and recognition to the more immediate and more easily recognized successes made by the day to day operational "bush fire" fighting. Similar to machine maintenance, the efforts made to quickly rectify short term, breakdowns are well recognized, whereas the value derived from the work in planning, and scheduling and undertaking preventative maintenance is not so obvious or readily quantified. Too often the focus of the business shifts to building and supporting an efficient operations team at the expense of developing a highly experienced team of mine planning practitioners that are well trained with procedures and purpose built tools to develop optimum mining strategies.

A resource has an inherent value based on its quality parameters, its physical constraints and its likely mining conditions. How well that value can be unlocked is governed to a large degree by the proficiency of the mine planning practitioners, as they essentially set the foundation of the mine business and the path along which the mine will operate. (We are of course taking marketing and commodity price for granted for the sake of this discussion.)

The importance of having a well documented and procedural mine planning methodology which integrates both a thorough technical and economic understanding of the resource cannot be over emphasized. The aim of the mine planning process is to develop a robust mine design and production capability which can best cater for future uncertainty whilst providing the best opportunity to maximize cash flow into the business. The planning process must be transparent and auditable, clearly summarizing the process steps and assumptions made to arrive at a justifiable and defendable outcome. To provide maximum value to the business, the planning process must be repeatable and scaleable to enable easy replication throughout the different mines and projects within an organization.

The diminishing numbers of highly experienced personnel within our industry, coupled with the growing pressure to clearly demonstrate that appropriate due diligence has been exercised, means that well documented and monitored mine planning processes using purposed built and innovative tools need to be developed to ensure optimum outcomes.

The aim of this paper is to:

1. Discuss a systematic approach to establishing well designed mine planning processes which incorporate purpose built tools;
2. Provide an overview of one of the main fundamental processes for incorporating an economic understanding of a resource early in the mine design process, namely Margin Ranking; and
3. present the summary results of a case study which demonstrates the value gains which can be realized through the implementation of a well integrated technical and business planning methodology.

Developing Effective Planning Processes and Tools

As part of our international mine planning consulting work, Runge has observed the growing need and strong desire expressed by mining corporations for a well designed, systematic and procedural mine planning methodology which is consistent between the mines and projects within their portfolio. Their desire is for a system which can provide for:

1. Monitoring and control of the process;
2. The development of common, purpose built

tools designed in a modular fashion to facilitate the generation and communication of mining strategies and resultant plans;
3. The movement of personnel whilst ensuring the capture and retention of valuable intellectual property; and
4. Simplifying and accelerating the training process.

To meet these needs and to ensure the successful design and implementation of an efficient mine planning system, Runge suggests the following key "ingredients" are required:

1. Recognition that change is required, plus a desire for improvement and a willingness to devote the resources and time to the process.
2. A mine planning domain specialist who can provide the guidance and expertise as well as provide customizable tools or integrate existing tools to suit the process. This specialist will facilitate the process and build the business flow charts and documentation in a usable and easily understood format which the user can interact with via computer software or web browser.

The key initial step in the process is to engage in a strategic conversation. The purpose of the strategic conversation is to obtain "buy in" to the process and achieve a common understanding of the problem, the desired goal and the roadmap of tasks which need to be undertaken to move from the current situation to reach the goal.

A well designed planning system requires the integration of technical and business streams operating across a range of time frames or planning horizons. These discrete planning horizons commence with the strategic view and cycle through the Life of Mine planning phase, Five Year and Annual Business Plans and ultimately down to the operational Weekly and Daily planning processes. In broad terms these various planning time frames can be divided into three discrete planning horizons being the Strategic, Tactical and Short term operational horizons. Recognizing and understanding the purpose and output requirements as well as the input data and the detailed process steps within each planning horizon is essential to ensure maximum value is obtained.

Ideally, mine planning should provide a risk weighted set of alternative outcomes so as to provide the most robust strategy which can quantify and cater for future uncertainty. A well designed mine plan should provide no "surprises" for operations personnel so that they can do what they do best which is mine coal.
So what are the essential components that make up a best practice mine planning system? Runge suggests the following:

- ♦ An appropriately experienced mine planning team with a mix of technical, operational and business analysis skills
- ♦ Recognition and understanding of the different business planning horizons
- ♦ A clear and well documented "mapping" of the planning workflow and individual processes and tasks.
- ♦ Purpose built tools designed to meet the workflow within each planning horizon
- ♦ The engagement of mine planning specialists with the mine planning domain expertise and IT skills.

What becomes quite apparent when looking within most mining corporations is that there is a wide and varied opinion of what mine planning is and what it can deliver. Often, even on the one minesite, individual mining engineers have a different opinion of what the planning process is and the overall process of getting from the borehole data through to a complete cash flow valuation of the business in not consistent or well understood. Rarely are the processes flowcharted and properly documented.
To build a well designed and documented business process map requires starting with a facilitated strategic conversation aimed at identifying:

- ♦ The current situations i.e., "Where are we now"?
- ♦ What would be the preferred position i.e., "Where do we want to be"?
- ♦ Determine the roadmap of steps needed to get from the current position to the preferred outcome. i.e., "How do we get there"?

These conversations should be undertaken with an appropriate cross section of personnel within an organization to initially develop a high level process workflow and then progress down to the detailed steps and tasks within individual processes.

An example of a top level business process flow chart for a typical mine planning process is shown in Figure 1 (page 4). The documentation which should be attached to these charts should clearly state the purpose of each individual process, the input data required plus the source of the input data, the outputs that are to be generated and the recipient of these outputs as well as the storage of the outputs. Each process within the flow chart is broken down into the sub process charts until the appropriate level of detail in obtained.

The completed workflow charts and documentation can be well presented in a HTML text sensitive computer format similar to the familiar windows based help style format making navigation of the processes easy and the presentation of the detailed information simply understood.

Once having designed a well thought through planning methodology it then becomes necessary to design the various tools need to meet the requirements of the workflow process. Runge have developed a range of state-of-the-art technical and financial software tools to facilitate efficient mine planning. These software packages are widely recognized as industry standards in the Australian and South African coal industry and are rapidly gaining recognition in other regions of the world.

Through the adoption of these tools within a framework of well designed planning methodology, mine planners are able to gain a significantly better understanding of their coal resources as well as the sensitivity of their business to the inherent attributes of the resource as well as influences external to the business. With these increased insights, plans can be developed or refined to maximize the value of the business by identifying the areas of the deposit with lower risk, higher productivity, best coal qualities, highest margins etc.

Runge has additionally developed a state of the art technology architecture which enables the monitoring, control and visualization of the complete workflow process and manages the storage and flow of data from all point solution packages. The system known as Mining Dynamics enables the control and visualization of all forms of 3D and 2D spatial data and interfaces this data with reports and charts from Enterprise Resource Planning (ERP) planning systems. This then provides a clear, auditable and transparent decision making process and promotes good corporate governance.

To demonstrate the value to be gained from a well designed strategic planning methodology, this paper provides details of one of the fundamental processes which should be included with in the early stages of the resource analysis and mine design phase. The process known as Margin Ranking seeks to identify the key drivers of productivity, cost and revenue and embodies these within a modelling framework to enable the calculation and subsequent mapping of the relative variation in operating margins both laterally and vertically across a coal deposit.

Underground Coal Margin Ranking

To date, a systematic technique which can provide an initial or ongoing assessment of the comparative marginal costs of mining an underground coal deposit has not been developed as a standardized technique. Techniques such as Cut Off Grade, used to assess economic limits on underground metal mines are not readily applicable to underground coal deposits.

Traditional assessment of underground coal deposits has generally entailed formulating a mine plan which seeks to maximize the total coal that can be removed within the physical and technical constraints of the deposit, paying limited cognisance to economics.

Once a mine design has been established, a production schedule is derived based on various productivity assumptions. Average operating and capital costs are then applied to generate a future cash flow. The economic viability of the deposit is finally judged on whether the projected future cash flow meets some predetermined hurdle criteria.

A fundamental problem with this methodology is that it is based on ***average*** costs. The method does not provide a basis for determining incremental costs and revenues of mining one area of the deposit compared to another, and so cannot easily highlight which areas of the deposit are more economic than others, or which areas may not be economic to mine.

A planning methodology based on ***average*** economics may well provide an overall economic mine plan which may in fact mine areas of uneconomic coal which are hidden by the returns of other economic reserves.

The Process

Similar to the cost ranking methodology used in open cut coal operations, all variable operating costs and the factors which affect their variability must firstly be determined.

In an underground operation there are two basic groups of factors which have impacts on productivity and operating cost: factors which can vary depending on location within the deposit and those which can also vary depending on distance from pit bottom.

Typical factors which vary by location are those related to geology such as roof and floor conditions, gas emission, seam thickness, yield and coal quality etc. Typical factors which vary depending on distance from pit bottom include conveying costs, ventilation costs, labor costs, system availability etc.

The basic steps involved in cost ranking an underground deposit are outlined below:

1. As with open cut cost ranking, firstly divide the deposit into appropriately sized mining blocks, commensurate with the level of geological knowledge. Typically a block size between 50m to 100m square is appropriate.
2. Derive the in situ block data using a suitable geological model.
3. Select suitable mining systems and determine basic default mining parameters which suit the nature of the deposit. From these basic starting parameters an average mining recovery and ratio of development to extraction can be estimated.
4. From the geological mining conditions, determine the likely variation in productivity and then assign the mining costs, process costs, product yields and revenues which vary in relation to the geological and quality parameters.
5. Determine the mining costs which vary with increasing distance from the seam entry point and establish the fixed and variable components for each mining process. As the distance from pit bottom increases mining costs will increase, as will the overall system complexity with increasing length and number of conveyors. All else being equal, this will result in lower system availability and potentially a lower overall mine output. This **must** also be considered in estimating the overall unit mining cost per block. If the seam entry can be located in a number of locations, the ranking process should be repeated based on these alternative pit bottom locations to determine which location provides the most economical entry point.
6. Sum the component mining and processing costs and downstream costs to derive the total incremental costs to produce the incremental saleable coal and revenue.
7. Present the incremental costs, revenue and margin for each mining block in a graphical format.
8. Undertake sensitivity analysis by ranging the various input parameters in accordance with the level of uncertainty. This will assist to build up a picture of how variable the inherent economics of the deposit are based on the future uncertainty.

Once completed the margin ranking output plots become another layer of information guiding the development of the future mine layout. With this information now at hand, mine planning engineers can now look to design the mine to ensure maximum extraction occurs in the high margins areas, panels can be limited where margins fall below acceptable thresholds and access to highest margin areas occur sooner in the mine life. Not only does margin ranking assist to direct the mine design process it also highlights where data gaps exist and so equally assists to focus the requirements of future exploration.

The results of the margin ranking process provide a clear auditable and transparent basis on which mine planning decision can be easily communicated to senior management and ensures that appropriate due diligence has been undertaken to satisfy corporate governance standards.

This month's article was provided by Mike Rowlands, Manager Underground Coal Consulting, Runge Limited
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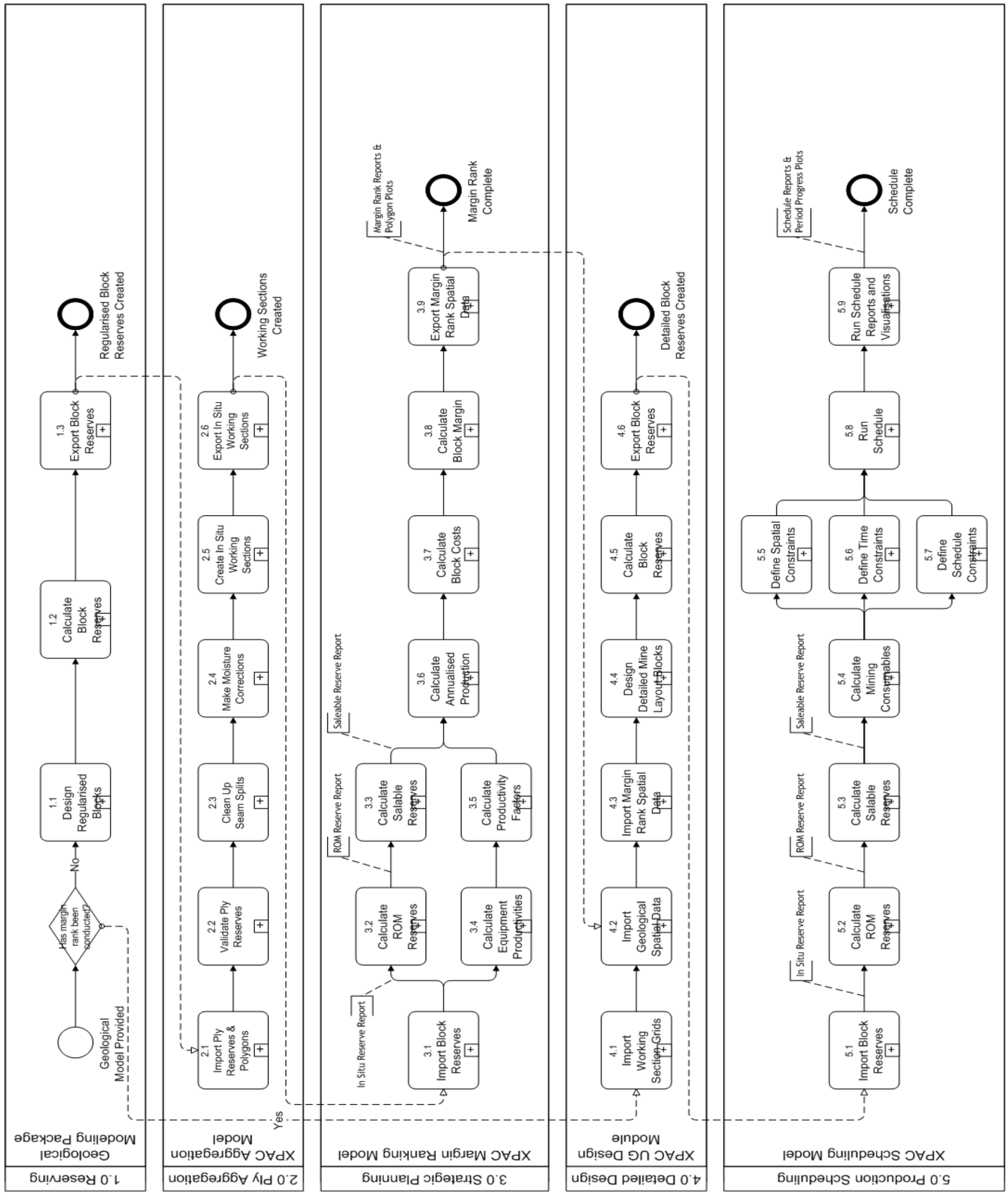
FIGURE 1

Standardized Underground Mine Planning Process – Top Level Process Flow Chart



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