My connection with Whittle Optimisation

By Doug Stewart, February 2019

I claim to have first introduced the software to North America whilst with Teck Corporation. I also introduced it to consulting groups and to a couple of mining companies in Australia. It was part of my very credible bag of tricks that kept me busy. I forget how many copies I purchased as I moved from job to job but it was sufficient to earn a handwritten note from Jeff. At that time, I was reading up on Graphology and so ran Jeff's handwriting style through the analysis process. His tiny letters and neat, concise lettering suggested he was a person very focused on detail and on getting things right. I knew that. Graphology worked!

In conducting Due Diligence on projects in which the Rothschild Golden Arrow Fund might invest, the key to understanding the real nature of a project was to judge the competence of the managers and so rely on or refute their views. If an open pit design had been "Whittled" they passed the first test. The name had become a verb.

Then they had to pass the second test – how well do they Whittle? The Parameters File was a great insight into the fundamentals of a project. Practitioners who attended carefully to this passed the second test. It formed a reliable basis to ask questions of the person doing the optimisation – did he or she really understand the matters that were being considered or not? A well-founded Parameters File showed that the depth of detail the engineer or geologist was applying was comforting and that person was expert in understanding risk, the nature of the orebody and likely success in its most profitable exploitation. The project became investment grade. Jeff's group had brought new boundaries to diligence in mining.

As a consultant with Snowden Associates, I had several occasions to use the software on different mines, managing to acquire interfaces with Gemcom software and the Whittle output file and so to plot up pit plans and sections with ease. In 1991, I authored a paper on Aspects of Optimisation using Four-D. In March 1995 I co-authored a paper with Alistair Tiver which presented our attempt to link Whittle Optimisation with Ken Lane's optimum cut-off grade theory as espoused in RTZ Consulting's Optimal Grades for Resource Exploitation software (OGRE). At about the same time, the Whittle group released Opti-Cut and kept moving ahead in the optimisation game with new developments almost annually.
Any consulting group or major mining group wanting to embrace mine design and planning in its most pure form had to use the tools developed by the Whittle group.

Pit design – Sixties style

Most of us who started work in the sixties and were tasked with designing open pits knew well how to draw sections through orebodies, stack those sections on each other and draw in a pit slope outline with the help of a light table. Multiple cross sections and long sections were needed so draftsmen and women were pretty busy.

We were astute enough to calculate incremental strip ratios and roughly figure out a 'profitable' limit for each section. It was required to draw increasingly deeper pits and then calculate the break-even point of ore revenue and costs of mining and processing for each incremental slice. Then came the matter of smoothing between the sections and deciding whether a little more waste was to be mined or a little ore lost on each section so as to make the pit wall practically smooth in plan. The draftsperson was tasked to generate flitches or plans showing each section limit on each bench plan, draw in an outline for each mining bench and then smooth out the lines on plan. The plans of course had to refer to the bench above and below and obey the limits put on pit slopes. It was often a case of going back to the sections and plotting newly adjusted slopes.

There followed some rudimentary maths; out came a planimeter to measure areas, figures were tabulated and added with the help of a Facit adding machine – eventually of the electric type. Reserves were either on a Sectional or Bench Plan basis, depending on which polygons were informed by the drill-holes. And so a pit design was created. This design then had to be modified to allow for ramp access and an "Ore Reserve" was calculated within that design. Seldom was the sectional design re-run to allow for changed pit slopes.

Pit Design – Seventies Style

Along came Mini Computers and hot on their heels were Personal Computers. The HP9845C had a twelve-inch CRT colour screen and came with 13K RAM standard. It became a popular mine-site computer programmable in HP Basic language. The geo-statisticians and other math-savvy engineers and geologists developed three-dimensional block models to represent the ore bodies.

To figure out how big a pit should be, one could write a program in 'Rocky Mountain Basic' language on an HP desktop. This program would upload the orebody model and work on it to

determine the pit limits. Popular was the Floating Cone method. An inverted cone with a frustum representing minimum mining widths would be developed and placed over each ore block. In each cone, the revenue from ore and the cost of mining waste and ore and processing the ore would be calculated. If the cone was profitable then it would be 'mined out' and the adjacent block was then interrogated until all blocks were completed on a bench. Then the process would be repeated for the bench below and the next bench until no more cones were profitable.

The complexities of allowing for ramps were handled by completing a run, hand-designing a ramp and adjusting the slope in the appropriate quadrant where it was required in the pit wall and re-running the whole process from the start.

The method had its weaknesses – cones necessarily overlapped and so combining nearby or an adjacent block value in the mining decision was not possible. The resulting pits were referred to as 'Ultimate Pits'.

The word 'Optimisation' was not contemplated. The catchcry was, "Get it approximately right, not precisely wrong."

Pit design – Eighties Style

Lerchs and Grossmann had published their optimisation algorithms as early as 1965 but it took until the mid-80's to develop a readily available computer that could apply the algorithms to an orebody block model. Jeff Whittle released his Whittle Three-D and so began what is probably the greatest value-add to the mining industry ever contributed by a single person.

Throughout the mining industry, hundreds of millions of dollars are at stake in getting open pits optimised for maximum return. The advent of Whittle Three-D not only provided a tool for improving mine value, it triggered a new discipline and diligence in the process. Engineers and geologists recognised more clearly the dollar value of assumptions they were making for all aspects of mining from pit slopes to recoveries and cost of mining and processing, as well as pushback sizes, mining rates and metal pricing.

The whole process of optimisation was bit clunky at first. In case of hardware failure. there had to be a restart interval to allow data to be stored periodically before continuing with the work. This took some time off the calculation process. Some runs could go well into the night. A printout of the shell for each run was possible. Hardware included unreliable tape drives for data storage and impact dot matrix printers. These printers worked hard zipping back and forth along their inked ribbons to print several key sections onto continuous feeding paper sheets. It is rumoured that there was a midnight optimisation run at the mine site of a major mining company when the z-fold printer paper jammed. As the print head whipped obediently back and forth to provide a hardcopy of the pit limits, there was enough friction heat to light the paper. The computer room came close to burning down.

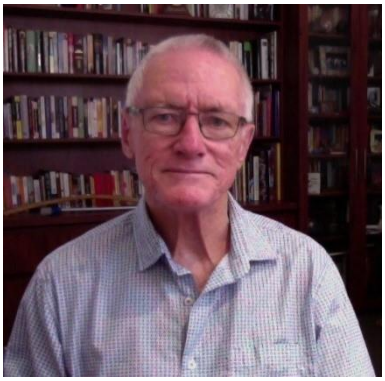
Pit design – Nineties and beyond

The matter of creating an open pit shape around an orebody has become only a part of deciding what can be mined. Now the pit can be optimised for changing costs and prices, stress tested to fit capital requirements, mined in the best possible sequence at pushbacks that are themselves careful considerations of mining rates and geometries, and fitted into the overall strategy of the mining company whilst considering several pits simultaneously. And more.

It's like evolving from eating thawed fast food into fine dining – complete with dietary advice from a wise nutritionist. Silver service from Whittle Programming comes with free fine wine (profit).

Nice work, Jeff and the Whittle team.

To read Doug's bio please scroll to the next page…



Doug Stewart, Mining Advisor BSc, FAusIMM, FAIG (Retired)

Doug is a mining industry expert with over 45 years' experience in technical assessment, investment, development and operation of many mining businesses.

Over this time, he has operated at senior levels in key sectors of the mining industry including:

- Senior Planning Officer for an underground block caving operation;
- Chief Engineer at Cassiar mine (Brinco Ltd) and at Afton mine (Teck Corporation) in Canada;
- Senior Mining and Geological Consultant for Snowden Associates, focused on mine planning and optimisation;
- Group Mining Advisor to Macraes Gold Mining Company Ltd;
- Senior investment executive and Associate Director of NM Rothschild and Sons;
- Founding Managing Director of ASX listed Territory Iron Ltd. From IPO to mine production;
- Various senior advisory roles to ASX-listed mining exploration, development and operating companies;
- Non-Executive Board roles with Alara Resources, Vital Metals, Conquest Mining, Grange Resources and Bullion Minerals.

Currently Doug has a Project Management role with Red Hill Iron Limited (ASX:RHI) and is on a Technical Advisory Panel for Inca Minerals (ASX:ICG).

Doug is intimately involved with the Men's Shed organisation. Projects have been undertaken for individuals including disabled people as well as for charitable organisations, including the Salvation Army and Alzheimer's Australia and for hospitals and schools.