THE FOREST RATHER THAN THE TREES

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I will attempt to use this opportunity of a keynote address to put pit optimization into the broader context of mineral resource development. I have chosen, "The forest rather than the trees" to describe my theme. However, by way of introduction, I should explain something of my involvement with the subject of this conference.

In the period from 1980 - 1988, I worked for what was then, Newmont Australia, but is now Newcrest Mining, as General Manager Projects. Jeff Whittle had been a consultant to Newmont for part of this time, working on software development, and it was during this period that Jeff commenced work on his 3D pit optimization program, using the Lerchs-grossman technique as the basis. The first application of the Whittle 3D software was on the design of a pit for a Newmont gold project, which happened to be in my area of responsibility. I can, therefore, claim to have been there at the birth, as an interested observer, rather than the midwife. It is of some relevance to the topic in hand to explain that in parallel with Jeff's 3D run, I was going through a laborious manual design of the same pit. Not as elegant a procedure, but a useful crosscheck against a program that was still to be proved. I came from a long line of Luddites and a healthy dose of scepticism has proved useful over the years. Needless to say, the Whittle 3D program became a well established success and quickly led to 4D, with refinements and additional concepts following.

It is interesting to note that at the time of its development, 3D was a quantum leap forward, some call it technological leapfrogging. Those of you who were involved in open pit design in the mid 1980s will recall that the application of 2D Lerchs-grossman and floating cone techniques were at an early stage of use in the Australian mining industry. Most companies were still using manual methods to derive a pit outline.

It's worth digressing for a moment to consider what this involved. Undoubtedly there will be many here who, in a technical sense, have grown up with 3D and 4D optimization and have only limited knowledge of what preceded it. Memories soon fade - who can remember life before the photocopier and facsimile machine, leave alone MacDonald hamburgers and cappuccinos.

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The starting point in manual pit design was to decide on the minimum working width at the base of the pit, given a presumed scale of operation and the equipment to be used. A pit outline was then determined for each drill cross section by equating the marginal strip ratio with a break even strip ratio for the diluted sectional grade, to fix the maximum pit depth. The pre determined pit slope was then drawn in, to coincide with each cross sectional pit bottom. At the end of the process, one was left with a series of disjointed sectional pit outlines. Black art then took over from simple mathematics, and a subjective smoothing process took place giving a bit here and taking a bit there. An arduous process, with the end result invariably a long way from a financial optimum. A change in any of the assumed input data required the entire process to be repeated.

The combination of Lerchs-grossman with block modelling was a major step forward, but it took Whittle 3D Lerchs-grossman to really make a difference. Then with the advent of 4D, the industry had not only a powerful tool, but a flexible one.

However, it is very much in the nature of things, that increased power can lead to misuse as well as efficiency. Given the speed and capacity of current computers, coupled with sophisticated software, there is a tendency to generate ever increasing amounts of data. Wide ranging sensitivities are available at the touch of a keyboard and a multitude of variations on a particular theme are printed out. Added to this is the risk that once generated as computer print out, data gains increased credibility, as if by magic. We all understand that garbage in equals garbage out, but how many of us apply the necessary checks and balances, to sensibly test the final product?

Computational risks extend from the various steps in resource estimation through to in pit reserve calculation, and the more distant the mining engineer is from the raw data, the greater become the risks. During my time at Newmont, it was a requirement that before heading down the path of block modelling, geostatistics, block inventories and pit optimization, the engineer involved carried out a rough and ready manually derived estimate. This was generally no more sophisticated than a simple end area method, using polygonal grade estimates, for resource estimation and a manual in pit reserve estimate using the method described earlier.

This procedure brought the engineer close to the raw data, gave him a feel for ore body geometry, grade continuity and grade distribution. This level of understanding is built up over time by the exploration geologist responsible for resource definition drilling, but invariably this level of insight is lost once the mining engineer takes over the data for pit optimization and ore reserve estimation. The point of the process was to develop a good feel for the end result before sophistication takes over and what I refer to as, "Data disorientation" occurs. In school mathematics we are taught estimation procedures, so that we can immediately recognise if the calculated answer looks right or not. The foregoing, follows this principle, and reduces the risk of major computational error.

Another aspect of pit optimization that deserves comment is the orebody modelling that provides the optimization step with its primary data source. The relative ease of data manipulation encourages an interactive process such that if the output fails to meet expectations, there is a temptation to change the inputs. One of the more profound inputs is the resource grade/tonnage combination and changing cut-off grade assumptions or reducing edge dilution effects is often the fallback chosen. There are more examples of open pit mining grades falling short of model grades than the reverse and this can often be traced back to unrealistic orebody modelling.

Once we start to work with drill hole data and the resource model begins to take shape, a natural cut off grade invariably emerges from the data. This is the grade where ore body continuity and predicability provide the modeller with comfort. Lifting the cut off grade causes discontinuity and narrowing of ore zones. The predicability of ore contacts becomes more tenuous and pit grade control becomes more of a challenge. Grade control and mining costs also escalate, but this is invariably overlooked in the quest for a more acceptable economic output.

I am sure that in this gathering, I am preaching to the converted, but it is surprising how often geologists and engineers under the pressure of an improved economic result fall into the trap of trying to convert a naturally occurring low grade resource into an artificially modelled high grade reserve. The Whittle pit optimization process is of course an innocent bystander, it can provide a range of pit Net Present Values for a range of inputs, but there is no achievability quotient that senior management can use in their deliberations. Sensitivities are usually run in copious quantities, but they help to mask the underlying deficiencies rather than reveal them.

The point to this apparently rambling discourse is that there is often confusion in the decision making process because of the quality of data presented. The important underlying assumptions are invariably lost in the reams of computer print out. Data is certainly information but it shouldn't be confused with knowledge - the two are not necessarily the same.

In concluding, Whittle pit optimization has provided engineers with a powerful tool in promoting resource utilisation and the economic outcome. It can also encourage the generation of copious and for senior management, at least, confusing amounts of data. The engineer carries the responsibility of ensuring that the decision makers are provided with a clear understanding of the underlying assumptions used, and where the risks are greatest. Don't bury them with data just because its easy to generate. In other words, help them see the forest despite the trees, and save them from data disorientation.

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