



SELECTING A LONGWALL PANEL

AN OBJECTIVE APPROACH

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Introduction

The trend for longwall operations has been to increase panel widths, lengths and where possible, cutting height. Increasing panel widths is highly compelling and wider longwall panels have been justified on the basis of increased resource recovery, higher productivity, reduced development needs and lower operating costs. In contrast to the potential upside, the additional capital cost of equipment and increased operational risk are generally recognised and must be carefully considered for the specific resource before making the final selection. The primary technical constraining factors for panel width include geotechnical conditions (roof competence and structure) and the management of goaf gas. Other factors may include capital availability, resource dimensions, existing equipment dimensions and capability, seam dip and the protection of surface features.

A recent options study assigned a panel width of 250m for all panels. Although new Australian longwalls typically fall in the range of 300m to 400m, a more conservative figure was selected on the basis that, at the time there was limited geotechnical assessment to underpin longwall design. When subsequent technical analysis established that much wider

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panels could in fact be designed, an evaluation process was commenced to establish the optimal width for the resource.

Assessment approach

The use of geological, development, operational and financial risk factors can be used to weight discounted cash flows based on probabilities. In consideration of an underground longwall operation and in particular the selection of panel widths, it was felt that a modification of these factors would be appropriate. The key factors assessed as both NPV drivers and project risk factors under this assessment were:

- Resource recovery;
- Development requirement;
- Longwall productivity; and
- Capital cost.

A range of prospective panel widths for the project was identified, and the assumptions (economic model inputs) associated with the drivers estimated for each panel width. A

Resource Recovery

Increased resource recovery is often cited as a prime benefit of increasing longwall panel width. The logic being that each gateroad sterilises a portion of the resource in pillars, roof and floor, and by reducing the number of gateroads, through increasing panel width, the amount of sterilised coal can also be reduced. Recovery can only be maximised if the panel layout completely covers the resource width and as such, panel widths were considered on a step basis rather than a continuum.

For instance, assuming a 3 km wide resource with ten panels, each longwall panel would be approximately 255m wide whilst nine panels would require an increase of 33m (to 288m). This is however, a case of diminishing returns as the panel width increments increase with each gateroad eliminated from the plan. At the point when seven panels are replaced by six, an increase of 70.5m is required.

For the sake of simplicity, this example was based on the assumption that the panels are aligned at right angles to both the mains and the inbye planning boundary. This is infrequently the case, as the alignment of panels in consideration of

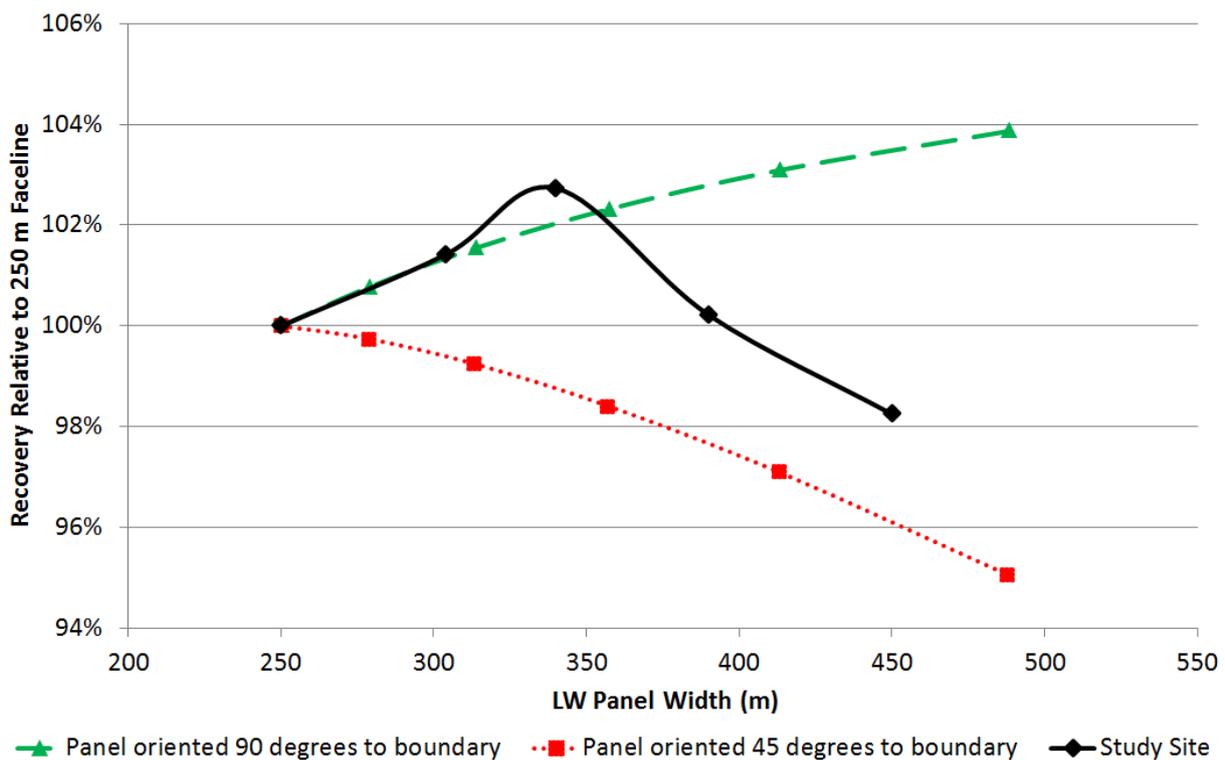


Figure 1: Resource recovery relative to orientation to boundary

high-level economic model was prepared and an NPV and IRR calculated for each width. The change in risk for each of the drivers relative to a base-case of 250m was estimated for the expected, conservative and aggressive risk profiles. Discount factors were estimated based on the panel width risk for each risk profile to produce risk-adjusted NPVs from which design recommendations could be made.

geotechnical requirements (stress, faulting or cleat) is normally prioritised ahead of aligning for recovery. When panels are oriented at an angle to the boundary, a wedge of sterilised coal is formed. As panel widths are increased, the size of this wedge increases on a square relationship to the width increase. This can potentially negate any benefits from the recovery of gateroad resource.

The best-fit widths used for this assessment were 250m (base case), 304m, 340m, 390m and 450m. Figure 1 shows the relative change in recovery from a 250m face up to a 500m face for ideal layouts (90o to the boundary), worst case layouts (45o to the boundary) and for the specific project. For the 90o case there is an incremental but diminishing increase in recovery for each face widening but for the 45o case, there is an accelerating decrease in recovery. A panel width increase from 250m to 400m would therefore be expected to result in a recovery change of between +3% and -3% for most resources depending on the layout relative to boundaries and other constraints.

Development Requirement

Systematic improvements in longwall equipment and processes have provided significant benefits to production rates over the years. Unfortunately despite industry investment, similar improvements have yet to be realised for the associated development operations.

Solutions to the development performance gap fall into three broad categories: increase performance, increase resourcing or reduce the amount of development required. Although the elimination of one or more gateroads from a mine plan has limited benefit from a resource recovery perspective, the benefits associated with reducing development are highly attractive.

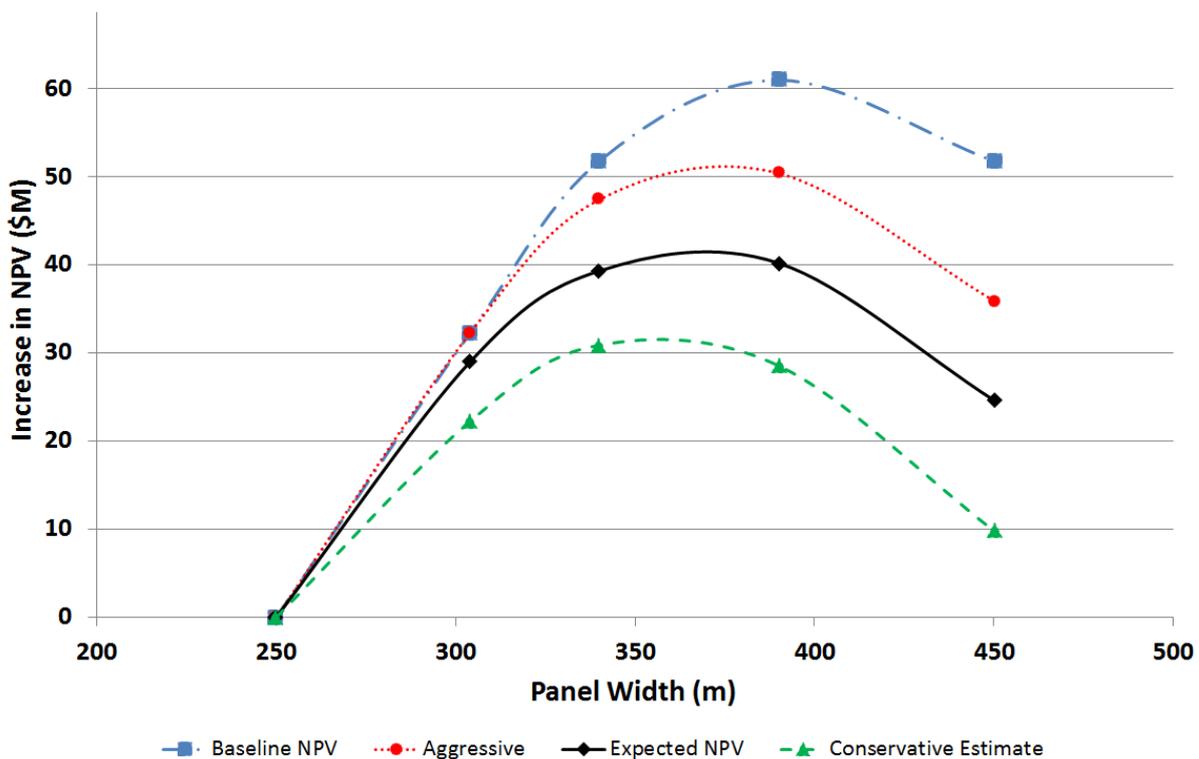


Figure 2: Risk adjusted outcomes

This is smaller than the level of accuracy for most geological models and mining operational techniques, and is not seen as a compelling reason to increase panel width. A increase in width can be associated with an increase in risk to the resource. Any disruption to the panel due to operational or geological/geotechnical issues will result in a greater loss of resource than narrower panels. Geological features such as large faults or dykes crossing a panel at an angle may result in longwall relocation or truncation which will sterilise both a greater length and width of the panel.

The elimination of a gateroad minimal relationship between development requirement and panel width and as such this represents a real opportunity for mines to maintain longwall float without increasing development resources. Needless to say, development risk and the risk of longwall delay as a result of development underperformance, has been assumed to reduce with increased panel width.

Discount Factors				
Panel Width (M)	Baseline	Aggressive	Expected	Conservative
250	8.9%	8.9%	8.9%	8.9%
304	8.9%	8.9%	9.0%	9.2%
340	8.9%	9.0%	9.2%	9.3%
390	8.9%	9.1%	9.3%	9.6%
450	8.9%	9.2%	9.5%	9.8%

Table 1: Risk Factors by Panel Width

Longwall Productivity

For a 250m face virtually all of the production is achieved in about 50% of the cycle time during the main cut portions of the shear. By widening the face, the low output activity at both the maingate and tailgate ends remains constant and the high productivity portions of the cycle are extended. Productivity is therefore expected to increase in proportion to the face width.

Productivity modelling (using RPM's UG TALPACTM software) shows a 15% increase in output rate from 1,406 t/hr on a 250m face to 1,615 t/hr on a 390m face which equates to a potential output increase of 610,000 tpa. This is a highly favourable outcome that would make a significant impact on NPV if applied over the life of an operation.

From an operational perspective, wide longwalls can be more challenging to operate efficiently, especially in poor geotechnical conditions. The ability of teams to control the face has improved through the use of face automation, but even with latest technology, an experienced operational and management team is required to provide the greatest chance of maintaining a fully controlled face. Operational risk is typically the greatest threat to be considered when selecting wider longwall faces.

Capital Cost

The initial capital cost of a project is a key driver of NPV and another factor that is sensitive to panel width. Within the longwall system the cost of the Beam Stage Loader, shearer, monorail, pump station and electrics are largely fixed irrespective of panel width. The cost of the Armoured Face Conveyor and powered roof supports are however, proportional to panel width. Information gathered as part of this study was collated to estimate the cost to purchase longwall sets relative to the panel width ranges under consideration. All large-scale mining operations are exposed to capital risk; the risk of project failure resulting in the loss of the initial investment or an inadequate return on that investment. In general terms, the greater the investment, the greater the risk, although projects must be adequately funded to deliver the targeted outcomes. Ill-considered cuts to the capital increase project risk rather than reduce it. Assuming that the project is adequately funded then each incremental increase in panel width must be assumed to increase capital risk.

Resource Risk

In dealing with the assessment of risk, risk tables are widely used throughout the Australian mining industry and enable risk

to be estimated on the basis of probability and consequence. Industry experience has shown that in recent years major mining organisations in Australia typically use figures between 8% and 15% for opportunity cost of capital, although higher rates have been used. For this exercise a low-risk resource has been assigned a rate of 8%, an average or typical resource 10% and a high-risk resource 16%. The inherent resource risk characteristics were estimated using the measures of structure & intrusions, roof competence, depth of cover, gas, and spontaneous combustion.

A similar approach was applied to the four key width-related risk factors discussed in this paper (resource risk, development risk, operational risk, and capital risk).

The inherent resource risk profile was combined with the panel width factors to estimate an overall risk rating which was then converted to a discount factor. These factors describe the expected risk for the operation at each of the panel widths. Given the subjectivity of this stage of the assessment, revised figures were estimated to provide a more aggressive and a more conservative set of factors in order to conduct sensitivity of the outcome over a range of risk profiles. Table 1 shows the discount factors applied to the baseline model and the aggressive,

expected and conservative cases.

Financial Assessment

As seen from previous discussion, there are multiple factors that define the attractiveness of a particular panel width but ultimately it is value that forms the basis of width selection. Production schedules were developed using the estimated productivities for each width over the resource size. Capital and operating costs, product pricing and other economic factors were prepared and the NPV and IRR were estimated for each width using the baseline resource discount factor of 8.9%.

The discount factors estimated for the various longwall panel widths were applied to the model in order to estimate the expected NPV for each of the panel widths as well as the conservative and aggressive cases. The expected case shows that the 340m and 390m cases are most attractive and that there is little difference between the two. The conservative profile marginally favours the 340m case whilst the aggressive profile marginally favours the 390m case. Under no case are the 250m and 450m cases preferred.