

***'The age of the innovators'***  
**Address to the Melbourne Mining Club**  
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Thanks for the introduction Patrick.

I'd like to begin by acknowledging the Traditional Owners of the Land where we gather today - the Wurundjeri people of the Kulin nation – and pay my respects to their Elders, past and present.

I'd also like to acknowledge the distinguished guests here today. In particular, I would like to acknowledge the Patron of the Melbourne Mining Club, Sir Arvi Parbo, who sent me a note yesterday to say he wouldn't be able to attend.

Sir Arvi is a legend of our industry. I remember the first time I met him, which was when I was GM of WMC's nickel smelter in Kalgoorlie. I recall clearly how nervous we all were waiting to meet the great man himself. It was a great honour to meet Sir Arvi then, as it is an honour to be presenting at the club where he is Patron.

It's a pleasure to be with you today and I'd like to thank the Melbourne Mining Club for the opportunity.

My father was a renowned metallurgist and so naturally, I ended up as a chemical engineer. I started my career as a graduate in research and development.

And though I'm now a CEO of a gold mining company, those who know me, know that deep down I'm still a bit of a propeller-head.

Which is why the topic I wanted to talk to you about today is innovation, and its role in securing our industry's prosperity.

Let's be clear about our context. Our operating conditions are getting tougher.

As we exhaust the more commercially attractive ore bodies, we are going to have to dig deep to convert previously commercially unviable ore bodies into profitable operations.

Innovation will have to be front and centre for all of us.

Australia's contribution to the modern world of mining has been immense. Many of the innovations in the global industry originated here, as I'll show you later.

But the technology and processes of the past won't be enough.

We will need more breakthroughs, and we will need them faster.

So we have to raise our level of ambition – not only as independent enterprises – but collectively as an industry.

And we will have to build an innovator's mindset.

Let me begin with an example of innovation on safety in the frontline.

In September 2015, sadly and tragically, we experienced a fatality at our Cadia operation near Orange in New South Wales.

Our colleague who died had been working to dislodge material from a drawpoint in our Ridgeway underground mine.

For those unfamiliar with caving, material from above gradually works its way down to the extraction drive through drawpoints.

Sometimes the material gets stuck in the drawpoints, and our operators then need to work through a fairly complex decision tree to either:

- Water blast it
- Drill it
- And/or blast it.

Many of the activities are quite intricate due to the tight geometries, and some of this work would require our people to be on foot in the drawpoint area.

Following this tragedy, we set a new standard of 'never having someone on foot near the drawpoint whilst carrying out these activities'.

We didn't actually know how to do this. Nor did anyone that we spoke to. But this was the new standard, so the team had to find a way.

There were some elements you could do remotely quite readily. But others posed a real challenge – like remote explosive charging.

The team set about coming up with different ideas for how it could be done. They spoke to suppliers and other mines. They built some mock-up prototypes and conducted field trials. They did a lot of trial and error, and within six months, they'd cracked the problem. They found a way to conduct all activities without the need for people being on foot near the drawpoint.

So now,

- All our water cannoning activities are done from inside the cab of a machine,
- Drilling is conducted from within a remote, mobile workstation,
- And they found a way to remotely charge the explosives within the tight geometries.

So this has been a great step forward for improving the safety of our people. And interestingly, it's also proving to be more efficient than the previous methods. There are now plans afoot to automate these processes.

The reason I tell this story at the outset of my address today is that it illustrates the essence of 'the innovator's mindset':

Having a transformative vision – knowing your objective, but not the solution for getting there.

Being prepared to experiment and to fail

Collaborating with others - drawing in those who can offer expertise and ideas to find a solution faster.

And fast adoption – putting the solutions into practice quickly.

The example is not about high-tech gadgets saving the day. The technology elements are rather straight forward. It was the mindset that was different. Going back to the fundamentals and asking if there could be a better way to approach a problem.

If anyone wants to know more, get in touch with us, because we'd be happy to share whatever we have.

Innovation is not new in mining. We have a long history of it.

This chart shows the copper price over the 1900s, more or less to today, as well as the industry costs during that time.

The thing I want to draw your attention to in this chart is that, despite the wild ups and downs, the industry as a whole continues to adapt by finding new ways to reduce costs, to maintain positive margins and meet increasing demand.

I've picked copper in this instance, but it is equally applicable to other commodities.

Our ability to adapt has been largely driven by innovation in the form of new technologies or new approaches to finding, mining and processing our resources.

Research on copper mines indicates that 70 per cent of the decrease in the cost base can be accounted for through applied innovation.

Take flotation for example. It's hard to imagine modern mining without it.

Flotation enabled us to concentrate low-grade minerals then process them further, as if they were high-grade minerals.

It opened up the large sulphide mineral provinces like Broken Hill, and many of the big base metal and porphyries deposits worldwide.

Where would we be without it?

Or take bulk explosives, mechanised mining and large mills.

They drove a huge step change in productivity from the 1960s to the 1990s.

In the 1990s, the advances in instrumentation and process control helped lower our cost base considerably.

So it's clear that we have a track record as an industry, but is that going to be enough to meet the challenges coming at us? And can we do it fast enough?

This chart provides a bit of a snapshot of how long it has taken us to go from invention to broad-scale adoption on many pivotal technologies.

In many cases, there is a long lead-time.

When there is a compelling need, we *can* apply new technologies relatively quickly.

But on the mining timescale, the definition of quick is about a decade. Or, let's say about 2.4 CEOs in today's terms.

At 10 years, **flotation** also had a fairly rapid rise from being a proven methodology to being commonly adopted.

And a key reason it was relatively quick was because one of the inventors of this methodology, Delprat, became the general manager of Broken Hill.

On the other side of the coin, there are plenty of other innovations that have been on a much longer path to adoption:

- Digital and advanced process control and
- high-pressure grinding rolls

are now at over 30 years to industry-wide adoption, and still counting.

All in all we have done a reasonable job, but it is difficult to call our industry a systematically fast adopter of new technologies.

If you're wondering why it takes us so long, there are a few obvious reasons:

As I said earlier, we are driven by necessity.

We will act when under pressure. When we have a difficult deposit that cannot be economically developed without it.

And we are typically very risk averse. And innovation involves risks. We like innovations that have been trialled successfully by others. We all want to be fast followers. It's easier to mount a business case when you can point to Exhibit A. I know this because I've been guilty of asking to see Exhibit A myself.

And innovation by definition means disrupting our established ways of doing things. And that will often test our determination to get a result.

So it's not easy. But we're going to have to get used to it. Because whether we like it or not we're going to have to innovate faster as an industry to address the challenges ahead.

And so the message I have for this audience today is that we need to build an innovation mindset that will accelerate the pace of progress in dealing with these challenges.

One of these challenges is the substantial decline in total factor productivity over the past decade or so.

It's costing us relatively more today to move material than it did a decade or so ago. Our productivity may have begun recovering in the past few years, but we have a lot of ground to make up. And even then, we can't fully counter the fact that strip ratios are increasing, and we are mining increasingly complex and deeper ore bodies.

This is being further exacerbated by declining grades. If you take gold for example, in the 1960s and 1970s, the global average gold grade was 12 grams per tonne of ore. Now it's two grams per tonne. As you can see on the slide, grades across a range of commodities have fallen at an average rate of 2.7% each year.

So we are spending more to move the tonnes, and then there is less of the stuff that we want in those tonnes. These factors combine to lower overall global mine productivity. So how are we tackling these issues of declining productivity and declining grade as an industry?

Well, innovation in minerals processing has a big role to play in addressing declining grades, and there's a lot of work going on in two main areas.

Firstly, being more selective about what we choose to process

And secondly, boosting the processing intensity of the material we put through the plant.

In many metalliferous mines, 20 per cent of the rock has 80 per cent of the metal. And standard practice has long been to grind everything.

But it's clear that this must change if we are going to continue to run viable businesses. We need to find a way to more efficiently separate out the metal from the rock.

I regard this as one of the most significant productivity opportunities for the industry.

And if we could crack this problem, it would lower unit costs, reduce energy and water consumption, and secure longer-life operations. And that would be good for everyone.

The good news is that there is already some good work going on within this space, and Newcrest was fortunate to be an early partner of CRC ORE, which is working to improve overall productivity.

In its first collaboration with industry a few years back, CRC ORE worked with our **Telfer** operation in the Pilbara on a large, structured experimentation program to identify at which point in the process we could liberate waste from ore.

The first task in our experiment was to despatch half a dozen students and scientists out into the blazing Pilbara sun to shovel dirt for six months.

That sounds a bit rough doesn't it? Don't worry, we told them to slip, slop, slap and drink plenty of water.

Anyway, this crew collected loads of samples and we were able to run tests on the material that showed us that we had been putting SAG mill scats through the mill that were near tailings grades.

Armed with that knowledge, we could then reject the scats, which boosted our processing rates by 20 per cent and reduced unit costs, with a very small impact on recoveries.

The beauty of this collaboration with CRC ORE is that they have now been able to share the learnings with other program participants who have benefited also.

So it's been an important advance for reducing unnecessary processing.

But the journey isn't complete. The techniques are still in their infancy, and we need to expand and accelerate this co-operative R&D work in order to refine the approaches and technologies as soon as we can. The task is too large for any one company and broad-based industry co-operation is needed.

Another significant challenge and opportunity for the mining industry is our relatively low asset utilisation.

This chart shows our overall equipment effectiveness, based on global data collected over the past 10 years across a range of industries.

You can see that a sizeable gap exists between ourselves and our peers in the oil and gas sector, who are operating at or near world-class OEE levels.

So, relatively speaking, there is huge potential for us to improve our productivity. And while the processes differ, we obviously have a few things to learn from oil and gas in particular.

For me it begs the question of what it would look like if we were able to run all of our assets at comparable OEEs?

It would need a different mindset, including one of continuous manufacturing, rather than the stocks and flows that characterise much of the mining industry.

We've recently done some work at Newcrest, as others have I am sure, that has again highlighted to us that data analytics offers tremendous potential for productivity improvements.

And yet as an industry we use very little of the information available to us to improve our decision making.

In fact, the research shows that it can be less than one per cent. As an industry, we capture less than half of the information we generate, we store even less of it, we have

systems for accessing a smaller portion still, and ultimately, we analyse and use very little of it in our decision making.

Now I'm sure that number is not accurate for every company in this room. And I'd like to think that it's not for Newcrest. But the fact is there's tremendous value on the table for all of us.

As part of our digital transformation, we've entered into a collaboration with a great organisation called Unearthed, which among other things, convenes hackathons for the resources sector.

As you may know, hackathons are intensive competitions for bright programmers, data scientists, and engineers, typically university and Masters students, to produce the best prototype solution to an industry challenge.

In August last year, we set a challenge for one of these Hackathons to see if they could predict surge events at our Cadia SAG mill.

We're pumping material pretty fast through our plant at Cadia and our operators were finding that our SAG mill would experience a surge event at times, that flooded our conveyor, and would result in us needing to reduce our feed rate for a few hours, costing us valuable production time.

The trouble is we didn't know what the factors were that would lead to these events.

So we got these teams to comb through the data to see if they could find the root causes within a large data set with around 100 different parameters.

Within a matter of hours, some of these teams came up with some very valuable insights, and that enabled us to begin making adjustments to the way we ran the mill.

You can see in the chart that the number of surge events – the blue spikes – have dramatically reduced. And that has of course contributed to improved throughput.

So we see tremendous value in better utilising our data and we will be continuing with this open collaboration model to uncover other opportunities for improving our equipment efficiency.

I've discussed the challenges of declining productivity and grades, and the potential for improved OEE performance.

The final challenge that I wanted to discuss today is that of profitably mining deeper deposits. The top 100 to 200m of the Earth's crust has been heavily explored, in most regions, and we will need to go deeper under cover for the next generation of discoveries.

So the challenge is:

How are we going to find them, and do it cost-effectively?

And then how are we going to economically develop these deeper deposits?

That's exactly the challenge we faced with our Cadia East deposit in the 1990s.

Back then, the Cadia East mineralisation was regarded as being too low-grade and too deep to economically mine. It had a '0' next to it on our Reserves ledger.

Today it's over 20 million ounces, the lowest-cost operation in our Group, and one of the lowest-cost gold mines in the world.

How did that happen? The answer is through collaborative innovation.

In the 1990s, we joined an international caving study convened by JKMRRC, with participation from CSIRO, Rio Tinto, Codelco and others.

Together, this group spent a number of years trialling different caving techniques to help the rock fragment and cave more readily. We also trialled different monitoring innovations, so that we could track the rock flow processes.

We shared information with the study group and the result was faster learning by all participants, and ultimately, faster adoption of block caving methodology.

I would like to stress that if it had been left up to any single one of us, we would probably still be refining the methodology today.

By 2005, Newcrest had the confidence that it could safely and reliably develop block caves in deep, strong ground. And this enabled Newcrest to make the \$2 billion plus investment decision that has transformed the company.

So to me, the benefits of innovation, and the benefits of collaboration are clear. And we have a strong interest in super-charging our efforts to accelerate the pace of innovation in our industry.

This is an exciting time in the history of our industry. We have some big challenges ahead, but also some great opportunities. And the next chapter in our story belongs to the innovators.

Those who:

- have the courage to think differently, and experiment
- learn from others
- collaborate effectively
- and who will quickly adapt and adopt.

We have a proud history of innovation within our industry. And we, in Australia, with our rich mineral endowment, leading mining companies, leading equipment and service providers, and broad base of scientific and R&D organisations, have an unrivalled foundation to accelerate the pace of innovation in the mining and resources industry.

Thank you.