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Collaborative Research – *how should it sharpen your own competitive edge?*

Author: Andrew Okely

It is a sobering thought that an industry can be a victim of its own success.

Take the mineral processing industry; starting with copper and gold and leading on to the more durable bronze, these metals saw humanity emerge from the Stone Age.

From the time wonderfully malleable Copper was found naturally occurring on the surface - then exploited by the native Americans near Michigan 7,000 years ago – it has been beaten and heated to form weapons and ornaments that have revolutionised societies.

Early metalsmiths of Sumer, Babylon and Egypt were among the most highly prized members of their society. They were so valuable that invading armies made a special effort to carry them off into captivity.

The onward march of technology soon produced pits in which fires were lit, then quickly quenched, so as to create sudden changes of temperature to crack the rock containing metals. The first stopes were large underground rooms supported by pillars of unmined rock. They often collapsed on the slaves and prisoners who worked them.

Fast forward to the 21st Century. Now our technologies have improved so vastly that we can produce all the minerals the world can use – and then some.

Our biggest suppliers periodically close down their giant investments in mining and mineral processing to drive up prices. Prices rise as economies emerge from recessions and grow (which is probably what is about to happen) then shrink as excess supply lowers demand or economic slowdown dries it up.

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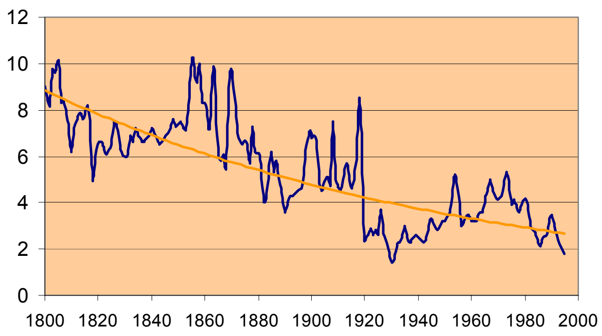
Through each boom-bust cycle, however, a trend is emerging of a steady decline in prices (refer to graph below). Throughout these cycles, industry strives to improve its efficiency and structure, mainly through technological improvements.



Real copper prices: $ per kilo

Pursuit of efficiency through technology has driven a rise in the popularity of collaborative research projects in the mining and metals industry over the last 10-20 years.

These types of projects now reach across a broad range of industries from Alumina to Zinc and focus on most of the key technological processes in mineral processing. Projects encompass matters from blasting for rock breakage control through to crushing/grinding, physical separation, flotation and dewatering. Geographically, many research projects combine the resources of multinational companies as well as operate through institutions based in a number of countries. The benefits sought from such collaborative research projects are now being observed throughout the industry.

This concept of bringing together the financial, technological and intellectual resources of many individuals and companies to seek substantial improvement in the economics of the mining industry is undoubtedly a noble and effective one.

Key Questions - Stakeholders

The key question this article hopes to pose is who actually benefits from all of this work? If we review the key stakeholders and the potential outcomes, we may find that each is affected differently.

Mining Companies

Mining companies seek an improvement in the economics of the mining and mineral processing aspects of their business. This can be achieved through either greater recovery or reduction in capital and/or operating costs. Without doubt such improvements will be found more effectively in a collaborative environment, however, how long the benefits will last when all of the major mining houses have access to the same research outcomes is a large question.

It is very possible that all producers will see a reduction in the cost of production. Reductions in the cost of producing commodities such as Copper will make more ore bodies economic to mine. This creates a larger pool of potential supply whilst long-term demand for commodities continues to grow at a slow, relatively steady rate. This mismatch in the ability to supply versus ability to create demand has been a major factor in the decline in real value of commodities over the past 100 years. Thus the real winners are likely to be the consumers of commodities not the producers.

Technology Providers

In a similar way, the potential benefits of improved understanding of the fundamentals of a process could easily be translated in improvements in the design of equipment to provide the enhanced performance that the mining companies seek. However, if all providers of a particular technology have access to the outcome then a commercial advantage is not achieved. We then turn technology provision into a commodity-based business, which trades on very low margins and provides little or no continuity of knowledge and service, luxuries such commodity-based business cannot afford.

The outcome is likely to be fewer technology providers in the business as low margins can only be combated by increased turnover if businesses are to continue to be profitable.

Future contribution to research and development would also suffer with internal developments being prohibitively expensive in this new low margin era. Under this scenario, the mining industry's dependence on collaborative research could well grow.

Research Providers / Managers

The providers and managers of the research facility gain through the development of a service which is unmatched by any other. As the scope and scale of the projects grow so does the value obtained from directly managing them. In addition, the research providers can also take "new" discoveries, which are the result of combined intellectual effort and produce new commercial products and services for the marketplace. These services would be available to all mining companies whether they contribute to the knowledge or not, albeit at different pricing structures, which can never reflect the true difference in value obtained from many developments.

University Students

There is little doubt that those undertaking Masters and PhD work within the collaborative research program gain from the high degree of hands on experience received. Many of these students will be the future of the mining industry.

These students will take their new knowledge and spread it worldwide which ultimately improves the efficiency of the mining industry as a whole but does not represent a competitive advantage for those funding the research program.

So what does it all mean?

A pattern emerges suggesting that, as a result of this rapid dissemination of information, any significant improvement uncovered by large-scale, broad-based, collaborative research will be incorporated into the general practice of the industry.

History tells us that the economic gains will then be passed to the wider community through lower commodity prices.

Despite this outcome, collaborative research will continue as its ability to contribute to the knowledge base in the mineral industry has been clearly demonstrated. However, the process of collaboration alone will not generate competitive advantage for individual stakeholders. Participants need to identify how they will obtain their competitive edge from this source of common knowledge.

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Flash Flotation of Copper and Gold

- *a review of current practice*

Author: Peter Bourke

Flash Flotation involves the instantaneous recovery of valuable minerals from the cyclone underflow stream in a milling circuit. The technology was originally developed to reduce mineral loss caused by the over-grinding of minerals with a significantly higher specific gravity (SG) than the host rock. The high SG of these minerals causes them to report to the cyclone underflow in preference to the cyclone overflow even when they have achieved the target grind size, resulting in over-grinding and sub-optimal recovery results. Since the initial installation of SkimAir® machines, the potential benefits of this technology have expanded beyond recovery improvements to include circuit flexibility, reducing the impact of feed grade changes on the main flotation circuit, reducing the use of collector and improved concentrate dewatering.

This article will examine the circuit configurations developed to date.

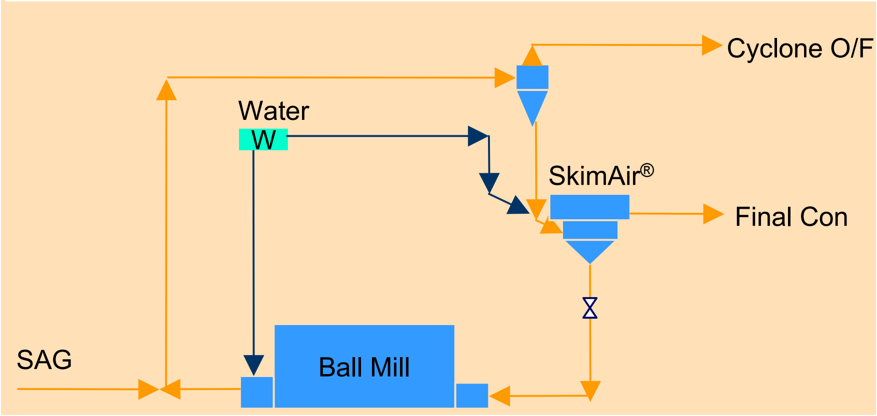
Circuit Options

Four distinctly different Flash Flotation circuit options have been employed in copper/gold operations. Each of these is designed to target a particular mineral separation issue. All four of these circuits can be operated with or without the dual outlet option.

Flotation Cell Producing Final Grade Concentrate

This circuit is the original concept and has been effectively superseded by more flexible designs.

The circuit is outlined below:

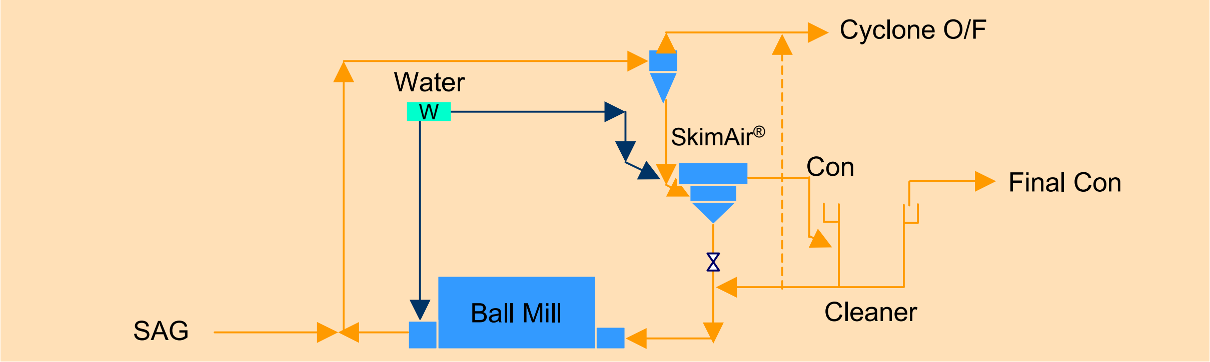


Circuit 1. Flash Flotation Producing Final Concentrate

The definitive disadvantage of this circuit is the lack of flexibility. The objective of Flash Flotation is to remove as much of the liberated mineral from the cyclone underflow yet in this circuit the SkimAir® must be operated to achieve a final grade concentrate, not to achieve the maximum recovery. This creates a situation where significant losses resulting from over-grinding may occur despite the presence of the SkimAir®.

Flash Rougher with Dedicated Cleaner

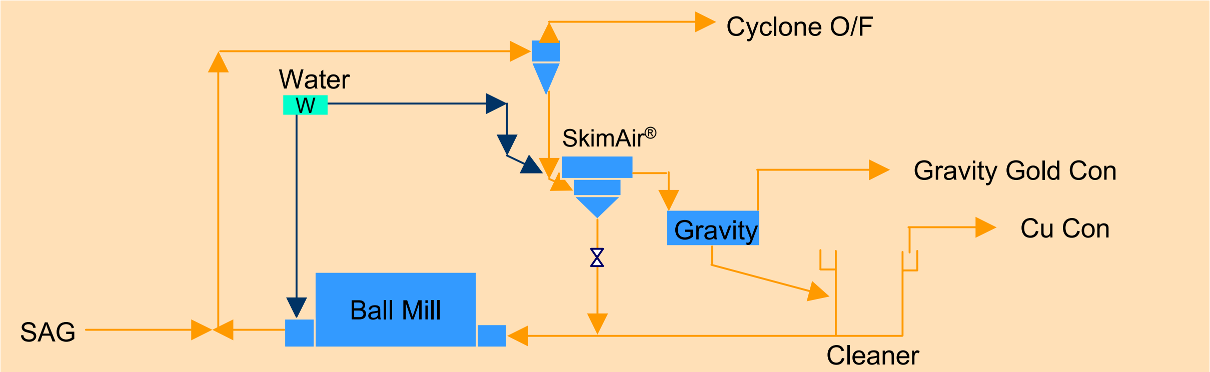
This circuit provides the great benefit of unhinging the recovery performance of the Flash Flotation cell from the concentrate grade. This allows the Flash Flotation cell to be operated for maximum recovery whilst still achieving final grade concentrate via the cleaner cell.



Circuit 2. Flash Flotation / Cleaner Producing Final Concentrate

Flash Rougher/Gravity on Conc / Cleaner on Gravity Tail

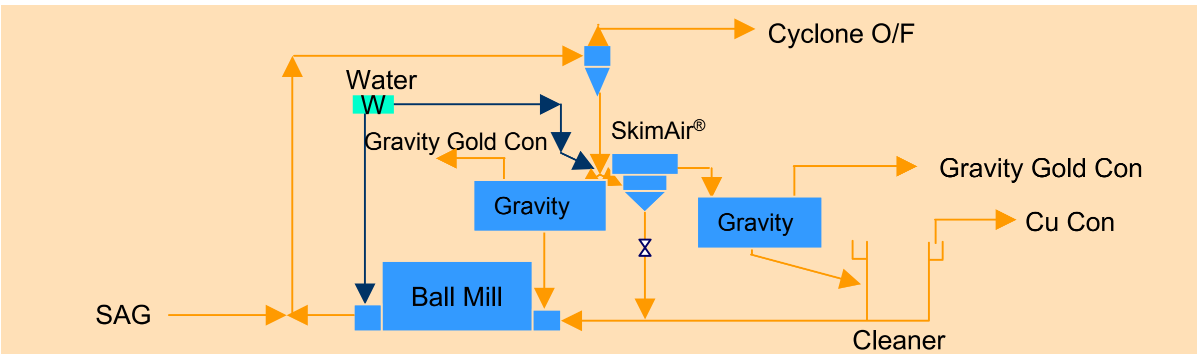
This circuit provides a unique combination that produces a final grade copper concentrate and a free gold concentrate from the Flash Flotation circuit. The key benefit of this circuit is the recovery of fine free gold, which can be processed to produce gold bullion and thus achieve greater value from the ore body. This circuit also prevents steel scats from entering the gravity gold circuit resulting in improved recovery of gold through the prevention of iron oxide coating. Preventing scats from entering the gravity circuit feed removes the need for trash magnets, providing a capital and operating cost saving.



Circuit 3. Flash Flotation / Gravity Producing Final Cu Concentrate and Gold Concentrate

Flash Rougher / Gravity on Conc / Cleaner with Parallel Gravity Circuit

The use of Flash Flotation in parallel with gravity gold recovery achieves the same ultimate benefit as that of circuit 3 above. Selection between the two comes down to the particle size range and liberation of the free gold. In this circuit a significant proportion of the gold is sufficiently coarse in nature to be recovered by direct gravity treatment and the Flash Flotation circuit is used to recover the fine free gold to a final grade copper concentrate. In this way the recovery of gold from the grinding circuit is maximized.

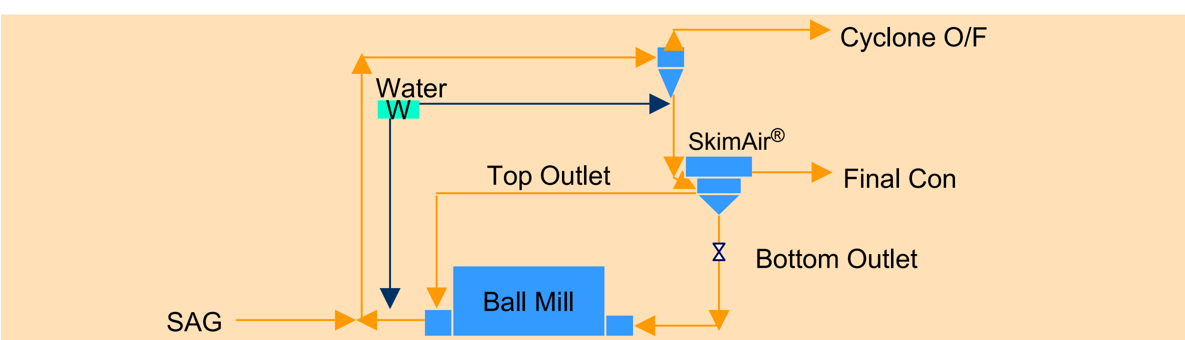


Circuit 4. Flash Flotation / Gravity Producing Final Cu Concentrate and Gold Concentrate

Dual Outlet

An additional option on any SkimAir® is the Dual Outlet. Employing the Dual Outlet option has two key benefits. Firstly, it allows the feed and discharge density of the SkimAir® to be different. This permits the addition of diluted water to the feed for optimal flotation conditions without excessive dilution of the Ball Mill feed, which reduces the efficiency of grinding.

The second benefit of the Dual Outlet is an increase in throughput capacity of the Ball Mill. The top outlet stream, which bypasses the Ball Mill, can carry 5-10% of the mass. This stream is generally made up of particles that should have reported to the cyclone o/f and does not require additional grinding. Thus, the Dual Outlet effectively improves the sharpness of the cut in the cyclones. The circuit below illustrates the general concept on the basic SkimAir® installation depicted earlier in circuit 1.



Circuit 5. Dual Outlet Producing Final Concentrate

Conclusion

These four circuits and the Dual Outlet option are by no means a limit to the ways in which the technology could be employed and circuit designers are encouraged to explore other possibilities to further increase recoveries.

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outokumpu

Audit the Hidden Costs of Inefficient Thickeners

Author: Jason King

Thickener optimisation isn't something mineral processors focus on every day. Once thickeners are up and running, they tend to fade into the background unless they become a bottleneck in the plant. Who's got the time to look at optimal operation anyway, given the pressures of maintaining plant throughput placed on plant metallurgists and operators today?

But there are real benefits to be gained from taking a critical look at whether mineral processors are getting the best out of their thickeners.

Quite apart from environmental benefits - such as smaller tailings dams and extended dam life - an optimised thickener may well return cleaner overflow to the circuit with less wear and tear on internal components. A reduction in flocculant consumption, increasing underflow densities, improved filter performance and regaining operator confidence in automatic control, could be value-adding outcomes of a thickener optimisation program. As an example of the possibilities, the table below illustrates the potential operating cost savings that even a small but sustained improvement in flocculant consumption can provide.

In the Australasian region alone, the minerals industry has installed more than 1000 thickeners since 1988, with the large majority still in service. Of the more than 700 that we believe to be still plugging along, many have been doing the same job for years without a review of performance.

Probably a good proportion of those are still used on their original duty. Conservatively, 10-20 per cent of these could have performance boosted following a process audit, amounting to somewhere between 70 and 140 under-performing thickeners all secretly placing unnecessary pressure on costs, the environment, or both.

Another conservative estimate is that 10-20 per cent would be operating on a new duty (ie different to that for which the original unit was designed to handle), or struggling to handle increased tonnage while being expected to deliver the same performance. These would also include the dozens of thickeners that have been moved from one site to another or acquired through the secondhand marketplace.

Thickener Feed (Mtpa)	Reduction in Flocculant Consumption (g/t)	Total Reduction in Flocculant Consumption (kg pa)	Reduction in Operating Cost (pa)
1.0	5	5,000	$22,500
2.0	5	10,000	$45,000
5.0	5	25,000	$112,500
10.0	5	50,000	$225,000

Both inefficient and 'new-use' thickeners can benefit from a thorough and potentially highly productive audit of performance.

Sometimes engineering staff on-site can conduct this, with guidance from a technology provider. At other times, the job is outsourced to allow in-house staff the get on with the day-to-day job of production. However, in most cases, such audits and optimisation are postponed until such time when resources are available, which always seems a long way in the future.

Optimising a Thickener

Below is a step by step process which can be used to identify the hidden potential of a thickener. A thorough audit should include:

1 An initial process audit consisting of a 2-3 day site visit, where process engineer visits site, overviews thickener operation, reviews trends, and obtains details of:

> Current duty (feeds, particle size, pH)
> Underflow density
> Overflow clarity
> Mixing in feedwell
> Floc formation and consumption
> Rake torque
> Bed level
> Bed mass

2 Compare original design specifications against current operational requirements. Reference made to original test reports and as-built drawings where available.

3 Determine new process design parameters from laboratory testing.

4 Determine correct design specifications for new duty. This may include changes to:

> Feedpipe diameter
> Feedwell diameter
> Feedwell plate gap
> Baffles
> Dilution
> Rake speed
> Method of detecting bed level
> Improvements to control system
> Changes in operating logic

5 Recommend changes to thickener and ancillary equipment required to achieve identified improvements.

6 Present firm cost proposal, incorporating economic justification for project.

7 Deliver project including re-commissioning and training as necessary.

Assessing the performance of a thickener, and where necessary optimising that performance, is an activity that offers quick and potentially lucrative returns to many operations. The methodology of such an audit is simple to understand and the benefits are easy to value making the investment decision straight forward.

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